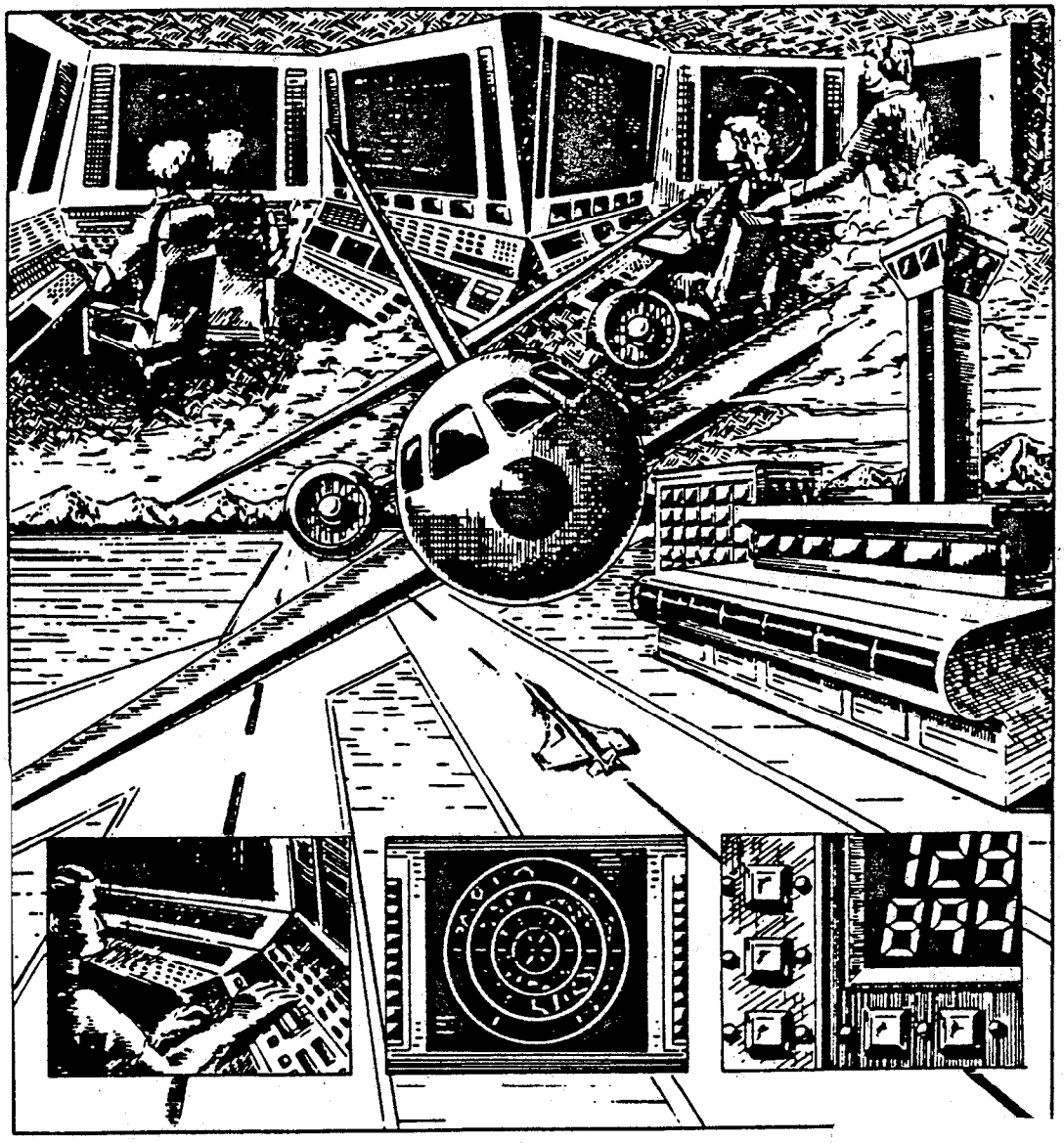
AERA 2

OPERATIONS CONCEPT



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AERA 2 OPERATIONS CONCEPT

31 January 1986

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AERA 2 OPERATIONS CONCEPT

31 January 1986

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16. Abstract

This document describes the operational interaction between the ACF air traffic controller and the AERA 2 system. The controller's job is categorized into activities, sub-activities, and tasks. Individual tasks are characterized in terms of information requirements, required cognitive/sensory abilities, human performance factors, and recommended tools to support controller performance.

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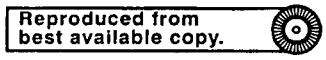
ABSTRACT

This document describes the operational interaction between the ACF air traffic controller and the AERA 2 system. The controller's job is categorized into activities, sub-activities, and tasks. Individual tasks are characterized in terms of information requirements, required cognitive/sensory abilities, human performance factors, and recommended tools to support controller performance.



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LIST OF ACRONYMS

AAS	Advanced Automation System (including AERA 1 and VSCS changes through SCN-004)
AC/AC	Aircraft-to-Aircraft
ACCC	Area Control Computer Complex
ACF	Area Control Facility
AERA	Automated En Route Air Traffic Control
A&M	Aeronautical and Meteorogical
ARSR	Air Route Surveillance Radar
ARTCC	Air Route Traffic Control Center
ARTS	Automated Radar Terminal System
ASR	Airport Surveillance Radar
ATACT	Air Traffic AERA Concepts Team
ATC	Air Traffic Control
ATCT	Airport Traffic Control Tower
BASOPs	Base Operations
CTA	Computer Technology Associates, Inc.
CWP	Central Weather Processor
CWSU	Central Weather Service Unit
FAA	Federal Aviation Administration
FDB	Full Data Block
FDE	Flight Data Entry
FFI	Formalize Flight Intent Macro
FP	Flight Plan
FSD	Future Situation Display
FSS	Flight Service Station
HCI	Human-Computer Interface
IAS	Indicated Airspeed
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rules
INSAC	Interstate Airway Communications

LIST OF ACRONYMS (cont.)

MSAW	Minimum Safe Altitude Warning
NAS	National Airspace System
NATAC	National Air Traffic Automation Coordinating Committee
NAVAID	Navigational Aid
NWS	National Weather Service
PAR	Preferred Arrival Route
PCA	Positive Control Area
PDR	Preferred Departure Route
PIREP	Pilot Report
RDP	Radar Data Processing
RNAV	Area Navigation
SIGMET	Significant Meteorological Information
SLS	System Level Specification
SS	Sector Suite
SSRVT	Sector Suite Requirements Validation Team
TAS	True Air Speed
TCCC	Tower Control Computer Complex
TMS	Traffic Management System
UPR	User Preferred Route
VFR	Visual Flight Rules
VOR	Very High Frequency Omni-directional Range
VSCS	Voice Switching and Control System

AERA 2 OPERATIONS CONCEPT
EXECUTIVE SUMMARY

The Air Traffic Control (ATC) system in the United States is a complex combination of hardware, software, personnel, and procedures. The role of the controller and the controller's interaction with the automated components of the system is critical since ATC is a real-time, life-critical operation. This detailed analysis and documentation of changes to the controller's interaction with the ATC system is an essential ingredient in the early phase of the AERA 2 life cycle to ensure the safe, efficient, and expeditious flow of air traffic.

This Operations Concept is a definition of the controller role in the ATC system. The scope of an Operations Concept ranges from a high level discussion to a detailed definition of individual tasks. The AERA 2 Operations Concept captures the details of all tasks that the controller will perform (in response to normal and predicted ATC events) in the AERA 2 time frame. Detailed task definitions, task information requirements, and task characterizations are included in the AERA 2 Operations Concept for each of the new controller tasks which are introduced by AERA 2.

AERA 2 greatly enhances the AAS capabilities by providing increased benefits to airspace users and by realizing increased controller productivity. To accomplish this, AERA 2 offers sophisticated problem detection and problem resolution tools:

(a) Accurate computer-generated resolutions to predicted problems among flight plans, flight plan and flow restrictions, and flight plan and airspace restrictions;

(b) Automated coordination among sector controllers and between sector controllers and the Traffic Management Coordinator;

(c) Timely notification to the controller that a previously requested pilot preferred route is now available;

(d) Timely notification to the controller that an aircraft has not yet begun a maneuver which is necessary for it to remain in conformance with its flight plan;

(e) Graphic display of predicted traffic patterns; and

(f) Graphic display of predicted workload factors.

The use of AERA 2 will facilitate the control of air traffic by supporting the controller's decision making and strategic planning.

A primary goal of the NAS plan is to accommodate the projected growth in traffic demand. The NAS Plan includes several interrelated programs:

(a) The Advanced Automation System (AAS);

(b) The Automated En Route Air Traffic Control (AERA) enhancements to AAS;

(c) The Voice Switching and Control System (VSCS); and

(d) The Traffic Management System (TMS).

Though AAS builds on the functionality of today's ATC system, the human-computer interaction (HCI) will change because of the modernized Sector Suite and because much of the controller's

interaction with the system will be automated. The AAS introduces new capabilities in the area of automated problem detection. Because of the very close coupling between the AAS and AERA, this document builds the controller requirements for AERA upon the knowledge gained from the analysis and specification of the AAS.

Development of the Operations Concept relied on the expertise and dedication of the Air Traffic AERA Concepts Team (ATACT), a group of ten experienced enroute and terminal controllers. The result of the ATACT deliberation is captured in a set of composition graphs and a definition of task information requirements. The process of collaborating with the ATACT to define controller requirements provided an expert forum for considering issues upon which the useability and acceptability of the HCI will depend. These results provide a traceable rationale for the specification of operational requirements and a basis for identifying issues involving Sector Suite displays and data manipulation, procedures, testing, and training.

The task definition process identified 66 new controller tasks required to use the AERA 2 capabilities. These tasks were analyzed in terms of information required to accomplish each task, the demands each task places on the controller's cognitive and sensory abilities, and the controller skills associated with the performance of each task. These analyses identified specific supplemental tools and capabilities to support the controller's effective use of AERA 2.

Recommended tools to support data extraction and planning include:

(a) Selective presentation of necessary information, based on the situation and tasks at hand;

(b) Graphical representation to integrate complex sets of data;

(c) Look-ahead displays to consolidate large amounts of data into trend information;

(d) Emphasizing important data to call attention to it; and

(e) Defining meaningful symbols, shapes, icons, abbreviations and colors to represent information.

Tools recommended to support data entry include:

(a) System defaults for data entry,

(b) Predefined-function activation,

(c) Prompted data entry, and

(d) Drawing or sketching of geometric objects, for example, sector boundaries.

Analysis of the ATACT product shows that AERA 2 requires the controller to extract data from multiple displays, to integrate the information into a coherent picture, to develop a plan on the basis of integrated information, and to enter new data into the computer. Over 50 percent of the AERA 2 tasks require controller data entry; over 50 percent require the controller to access more than one information item (from either a logical display, memory, another controller, a pilot, or a supervisor); and over 70 percent require assessment of information from more than one logical display.

The ATACT definition of controller tasks and task information requirements will guide the FAA in developing an efficient human-computer interaction for AERA 2.

SECTION 1 - INTRODUCTION

This document is concerned with describing the operations concept for AERA 2. Toward that end, this section provides the basis for understanding the AERA 2 capabilities and the importance of an operations concept. Thus, the early introductory sections present the basic concepts of AERA and explain how AERA fits into the National Airspace System (NAS) Plan. Later introductory sections define the terms "human-computer interaction" (HCI) and "operations concept", which are also briefly defined in the Glossary of Terms (Appendix B). Emphasis is placed on the benefits of developing an operations concept for HCI in the AERA 2 environment. Additional topics covered in the introduction are the purpose and scope of the operations concept and assumptions on which it is based. Finally, a brief overview of the document's contents completes the introduction.

1.1 BACKGROUND: NATIONAL AIRSPACE SYSTEM (NAS) PLAN

The United States National Airspace System (NAS) currently accommodates over 232,000 civil and military aircraft. During the 1990s, the continuing growth in the number of aircraft operations, the diversity of operations, and the quantity and sophistication of aircraft will place unprecedented demands on the air traffic control system. Its continued safe and efficient operation requires improved services, new facilities for system expansion, and the provision of adequate airport capacity.

In December 1981, the FAA adopted a comprehensive plan to modernize the NAS air traffic control and air navigation capabilities. The primary objectives of the NAS modernization plan are to realize increased safety, capacity, productivity, and economy through higher levels of automation; to apply modern technologies in computer and telecommunications equipment; and to consolidate major facilities. This approach to modernization

will achieve a system that is flexible enough to accomodate future demands and technology, allow for a rational system evolution, and recognize the user's desires for minimal restrictions on the use of airspace. Figure 1-1 presents the schedule for implementation of elements of the NAS plan (Ref. 15).

1.1.1 ADVANCED AUTOMATION SYSTEM (AAS)

The purpose of AAS is to provide an automated system that will provide the capacity to handle the projected traffic load through the year 2000. AAS is expected to increase productivity through the introduction of new Sector Suite workstations which are expected to incorporate an efficient human-computer interface and a high degree of reliability and availability. In a typical Sector Suite, multiple displays will provide a view of the live traffic and weather situation, flight data, aeronautical information (e.g., notices to airmen), and traffic planning information.

Operational requirements for AAS functions have been analyzed in considerable detail (Ref. 4-9, 12, 13). These analyses have resulted in a rigorous definition of controller activities and tasks and a description of information required by the controller and the computer (Ref. 4, 6). Workstation performance characteristics and functional requirements derived from these analyses are reflected in the AAS A-Level Specification (Ref. 14). To date, these analyses have been performed for the AAS sector controller (Ref. 6, 10) and the oceanic and supervisory specialists (Ref. 7). The Sector Suite Requirements Validation Team (SSRVT), a group of experienced controllers and managers, has validated the requirements as meeting the needs of the controller in an operationally satisfactory way.

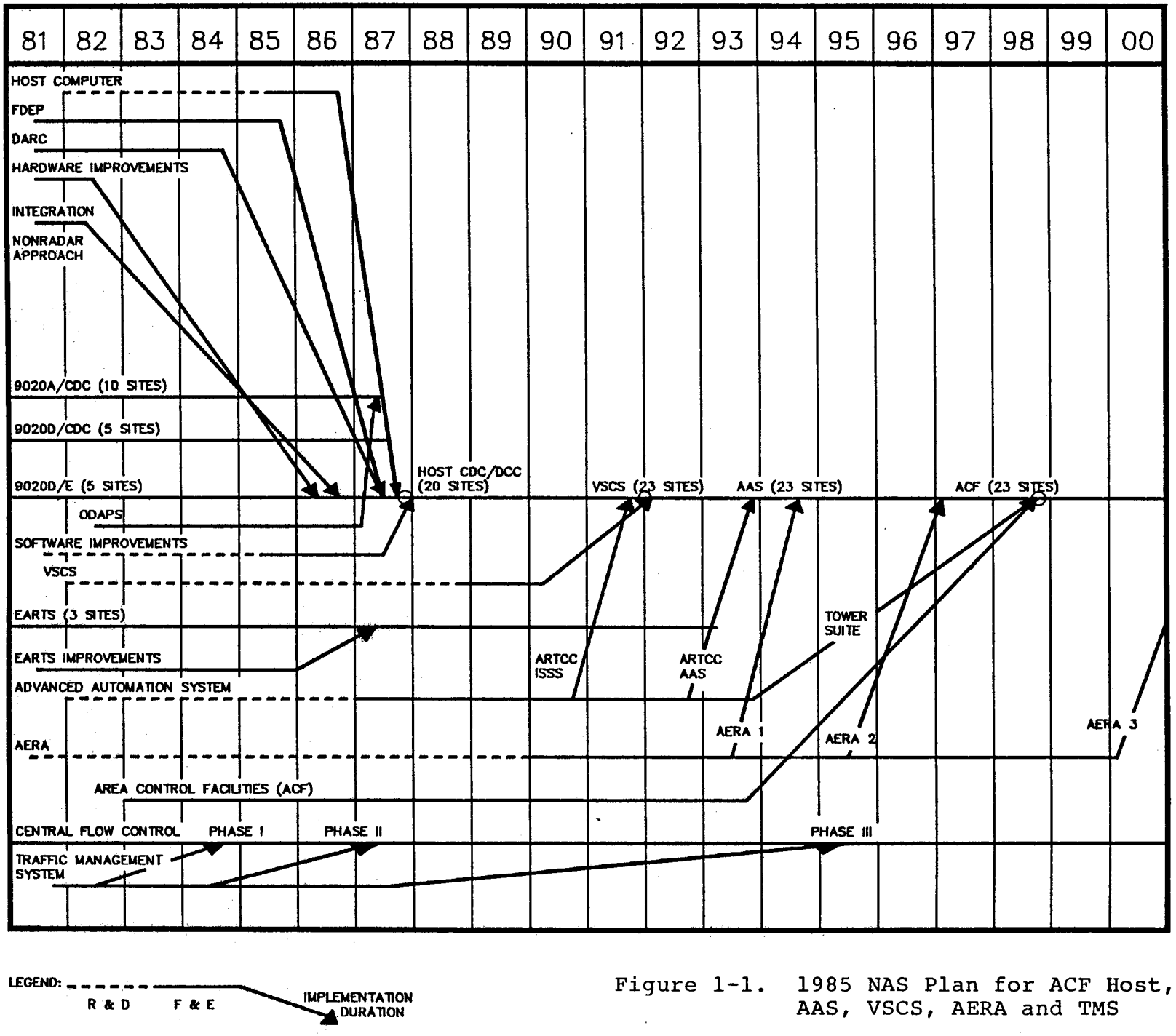


Figure 1-1. 1985 NAS Plan for ACF Host, AAS, VSCS, AERA and TMS

AAS requirements include the capability to introduce subsequent enhancements into the system. Planning and decision aids for the controller will be introduced in the AAS and enhanced with the implementation of AERA 2.

1.1.2 AUTOMATED EN ROUTE AIR TRAFFIC CONTROL (AERA)

AERA is an integrated set of enhancements to the air traffic control system. AERA will provide automated aids to meet the following objectives (Ref. 15):

- permit most aircraft on Instrument Flight Rules (IFR) flight plans to fly fuel-efficient profiles, and support airspace user's requests for direct routing;
- increase safety of the system by reducing potential for ATC operational errors;
- increase system capacity by integrating en route metering with local and national flow control; and
- increase controller productivity by increasing the number of aircraft and volume of airspace that a control team can manage safely.

The first phase of AERA implementation will be part of the AAS package and will introduce the following automated capabilities (Ref. 1):

- detection and notification to the controller of possible conflicts among flight plans and between flight plans and special use airspace;

- detection and notification to the controller of possible flight plan violation of flow and metering restrictions;

- detection and notification to the controller of problems in candidate (trial) flight plans which the controller is considering implementing;

- detection and notification to the controller of aircraft which are out of conformance with their flight plans, and assistance in identifying maneuvers to re-establish conformance;

- tools to assist the controller in constructing candidate (trial) flight plans;

- messages to remind the controller of actions to be taken (e.g., "start of descent"); and

- estimation of selected current and future sector workload factors to aid the controller in planning and prioritizing tasks.

This sub-set of AAS capabilities is sometimes known as AERA 1. Further references to AAS in this document assume the inclusion of these capabilities.

AERA 2, the first enhancement to the AAS, is aimed primarily at increasing controller productivity. AERA 2 will introduce the following new capabilities (Ref. 2):

- computer-generated resolution of problems (e.g., suggested maneuvers to resolve a predicted conflict between aircraft, a predicted conflict between an aircraft and restricted airspace, predicted noncompliance of an aircraft with a flow restriction,

or nonconformance between an aircraft's trajectory and its current position);

- automated coordination (nonvoice communication) in certain specified instances between sector controllers or between a sector controller and a Traffic Management Coordinator; and

- static or dynamic display of projected traffic in a format similar to that of the Situation display.

Additionally, AERA 2 will extend some of the AAS automated capabilities in the following ways (Ref. 2):

- upon removal of a flow restriction or airspace restriction, the controller will be notified of aircraft previously re-routed to accommodate the restriction;

- controller-entered trial plans can be assessed periodically for their current feasibility; and

- a reminder will inform the controller when an aircraft is predicted to go out of conformance because a planned maneuver has not begun; and

- additional workload measures will be displayed graphically to the controller.

Plans for subsequent phases of AERA include the direct ground-to-air transmission of computer-generated clearances, weather messages, and flight information (Ref. 15).

The enhanced capabilities provided by AERA 2 will change the way controllers manage air traffic. Some tasks performed mentally by the AAS controller will now be performed by the

computer. Some tasks performed in the AAS will no longer be necessary because of the increased automation. However, the controller will perform a set of new tasks associated with the AERA 2 capabilities. The definition and analysis of these tasks constitute the core of this operations concept.

1.2 BACKGROUND: DEVELOPING AN OPERATIONS CONCEPT FOR HUMAN-COMPUTER INTERACTION

Air traffic control is a complex process performed by a human-machine system in which the controller's role is crucial to overall system success. Communication between the controller and the automated system is known as human-computer interaction (HCI). The interaction or dialogue between the controller and computer is supported by the physical interface, which is made up of displays, controls, and other necessary equipment. Because controllers can only indirectly receive information about, and execute control of aircraft via sophisticated display, control, and communication equipment, they are heavily dependent upon the appropriate design of this equipment and the supporting software.

Because the air traffic control system is so complex, and because the controller's role is so critical, the definition and analysis of human-computer interaction is essential as the ATC system evolves toward higher levels of automation. Working from a thorough knowledge of the proposed capabilities, developers of operations concepts work with user groups to define tasks that end users of the automated system will need to perform in order to use the new capabilities efficiently. Once they are defined, tasks are analyzed to determine what information the user will need, task demands on the user's abilities, and task-related performance factors such as required speed and accuracy. This operations concept defines the human role in the system to the task level.

The process of developing an operations concept leads to a better understanding of the human implications of proposed capabilities. For example, the process of task definition and analysis provides an early forum for identification of issues relating to the useability and acceptability of proposed features. Thus, an operations concept can be thought of as a paper simulation or prototype, which permits early evaluation of the human aspects of technological advancements. The operations concept for AERA 2 represents the best current estimate of what the proposed capabilities will mean in human terms. It also describes the controller's job in terms which are intended to promote a smooth transition from the earlier system.

The task definitions and analyses in this document, the AERA 2 Operations Concept, and the AAS Operations Concept (Ref. 6) provide a basis for further study and development efforts. They provide a traceable rationale for the specification of operational requirements. They provide a basis for identifying issues involving procedures, testing, and training. Finally, they provide information necessary to the development and design of an efficient human-computer dialogue.

1.3 PURPOSE

This document presents an operations concept of ACF air traffic control as it is expected to occur in the AERA 2 environment. The purpose of the operations concept is to define and document projected interaction by controllers with the ATC system in the AERA 2 time frame. The operations concept describes controller tasks and activities, defines the information required to perform each task, further characterizes the tasks, and recommends automated tools and capabilities to support controller performance. The involvement of FAA field controllers in the development of the operations concept helps to promote operational feasibility and acceptability. The information contained in the operations concept will be used by the development contractor to

understand the human-computer interaction requirements in the AERA 2 System Level Specification and to guide the design of the HCI.

1.4 SCOPE

This document focuses on the controller's role in the ATC system in the AERA 2 time frame. Supervisory personnel, traffic management specialists, meteorologists, tower controllers, and external FAA systems are considered only in terms of the information they pass to or receive from the controller. Emphasis is placed on areas of interaction between the controller and the computer. Algorithmic specifications are not addressed.

1.5 ASSUMPTIONS

In defining how the controller will interact with the ATC system in the AERA 2 time frame, several assumptions were made. Some assumptions were based on CTA's operations concept development methodology; others proceeded from the major guiding documents (Ref. 1, 2, 6, 14). These assumptions, their sources, and their impacts on the AERA 2 Operations Concept are defined as follows:

- Assumption 1: The principal previous work on which this operations concept is based is documented in the AERA 2 Operational Description (Ref. 1); the Draft Automated EnRoute ATC (AERA)2 System Level Specification (Ref. 2) as modified by the ATACT up to the January 1986 meeting; the Operations Concept for the Advanced Automation System Man-Machine Interface (Ref. 6); and the Advanced Automation System: System Level Specification, Design Competition Phase (Ref. 14).

  Source: The operations concept for AERA 2 should proceed from validated documentation on operational requirements for AAS and AERA 2.

Impact: These source documents represent the best available guidance on automated capabilities that do not yet exist. They have been reviewed and validated as conceptually acceptable by ATC user groups (Refs. 1 and 2 by the Air Traffic AERA Concepts Team (ATACT); Refs. 6 and 14 by the SSRVT). Thus, the AERA 2 Operations Concept is based on the validated concepts for AAS and AERA 2. Operational testing is yet to be performed.

- Assumption 2: Consolidation of today's en route and terminal air traffic control centers into Area Control Facilities (ACFs) will proceed as planned. In the ACF environment, controllers may not be designated as "en route" or "terminal", and they are likely to experience significant changes in their roles within the total system.

  Source: Consolidation plans are documented in Ref. 15 and described in detail in Ref. 6. Research indicates that increasing levels of automation have significant effects on the roles of operational personnel (Ref. 18, 21, 22, 24, 25).

  Impact: A major purpose of this operations concept is to project and represent the controller's role in the AERA 2 environment. Procedural allocation of a subset of tasks to each member of a Sector Suite team could change the requirements for communication between crew members, resulting in changes to the controller tasks. Procedural allocation of duties of crew members based on aircraft class, or a flight level could have a similar impact.

- Assumption 3: This analysis is based upon system responses to routine AAS events, such as filed flight plans and pilot requests for flight plan changes. In the AAS and AERA 2 time frames, the controller will also

consider predicted events, such as predicted aircraft-to-aircraft conflicts and predicted aircraft-to-airspace conflicts. The analysis includes responses to such predicted events. Additional analyses are required to consider events related to special situations, emergencies, equipment failures, and backup modes.

Source: The basic set of ATC events was defined in previous work (Ref. 4). These events provide a baseline for application of the operations concept methodology and are augmented by the set of predicted events that will be detected and described to the controller in the AAS and AERA 2 environments. The scope of the present analysis includes tasks the controller is expected to perform routinely; it does not include responses to special situations, emergencies, equipment failures, or backup modes.

- Assumption 4: The AAS, Central Weather Processor (CWP), Traffic Management System (TMS), and Voice Switching and Control System (VSCS) will be operational by the time AERA 2 is deployed. Although formal definitions for CWP, TMS, and VSCS functions are currently being developed, this document assumes the existence of these functions and examines the requirements for information flow between AERA 2 and those systems.

  Source: According to the NAS Plan (Ref. 15), these functions will be operational when AERA 2 is implemented.

  Impact: The operations concept includes information that the controller is expected to receive from and/or send to other systems. The analysis of information flows is documented in Table 3-1, Task Information Requirements. This analysis assumes that the controller is receiving the best available information.

- Assumption 5: Standard air traffic control procedures which reflect the use of AERA 2 will be implemented on a nationwide basis.

  Source: The need for standardized, national procedures for AERA 2 has been emphasized many times by the ATACT.

  Impact: The operations concept does not include any additional local controller tasks or visual displays for a non-standard implementation of AERA 2.

- Assumption 6: AERA capabilities for individual aircraft will extend across sector boundaries. Long-range problem detection for pre-adapted airspaces will extend across ACFs (Ref. 2). Participating aircraft will be positively controlled IFR aircraft operating in en route airspace; these civilian or military aircraft will be equipped with Mode C and will be provided with surveillance coverage by ATC radars (Ref. 1, 2). The specific geographic bounds and altitude limits for AERA have yet to be determined.

  Source: This concept of boundaries for AERA 2 functions comes directly from References 1 and 2, which reflect ATACT consensus.

  Impact: Redefinition of controller tasks might be required if the boundaries of the AERA functions were to change significantly from those assumed. Tools and capabilities recommended in this document would need to be augmented with summarization aids if, for example, all aircraft in an airspace were receiving AERA services. A significant change in AERA's boundaries might also affect the controller's information requirements.

- Assumption 7: Legal responsibility for in-flight safety remains with the controller and the pilot (Ref. 1). In AERA 2 the computer will generate resolutions to predicted problems, but it will not implement any resolutions. The evaluation and selection of a resolution remains with the controller, who may choose to reject computer-generated resolutions to a given problem.

  Source: This concept has been stressed by the ATACT as documented in Reference 1.

  Impact: As defined in this operations concept, controller tasks would change significantly if the computer were evaluating resolutions and issuing clearances.

- Assumption 8: AERA 2 will be unable to detect and/or solve some problems.

  Source: This point is documented in References 1 and 2.

  Impact: Controller tasks in this analysis are defined to handle the need for detection/solution of problems outside the scope of AERA 2.

- Assumption 9: AERA 2 can accommodate but does not require Mode S/data link. Uplink and downlink communications capabilities to properly equipped aircraft are expected to facilitate controller-to-pilot information interchange, but these capabilities are not required for AERA 2 functionality.

  Source: This concept is documented in Reference 1.

  Impact: The operations concept does not include specific controller tasks for the use of data link. Such tasks

could be identified easily from the information that indicates whether or not there is controller-to-pilot or pilot-to-controller communication for an AERA 2 task.

This set of assumptions defines the conceptual domain within which AERA 2 controller tasks are identified and analyzed in the following sections.

1.6 DOCUMENT OVERVIEW

Section 1 defines the purpose and scope of this document and assumptions underlying its development. In addition, Section 1 provides a discussion of the role of the AAS and AERA 2 in the evolution of air traffic control. This section emphasizes the importance of task definition and analysis as a basis for HCI development and design.

Section 2 presents the general approach used to define controller tasks and explains the graphing technique used to depict sets of tasks. The top-down structure of the graphing technique allows increasing levels of detail to be represented and analyzed. Section 2 includes the final set of graphs which incorporate AERA 2 controller tasks within the context of AAS tasks.

Section 3 presents the results of the task characterization analysis of the AERA 2 controller tasks. Each task is characterized by information requirements, cognitive/sensory abilities, and performance factors. Recommendations for tools and capabilities to support controller productivity are derived from the task characterization analysis.

Section 4 summarizes the task characterization analyses and presents information necessary for developing an effective human-computer dialogue.

A set of appendices includes definitions of terms. Appendix A contains a glossary of verbs used in Sections 2, 3, and 4 to describe controller tasks. Appendix B is a glossary of terms used in this document. Appendix C is a Data Dictionary defining the specific items of information required as input to or output from AERA 2 controller tasks. These items are referenced in the graphs in Section 2 and the tables in Sections 3 and 4. Appendix D includes definitions of terms used in the task characterization analyses.

SECTION 2 - CONTROLLER ACTIVITIES IN THE AERA 2 TIME FRAME

The systematic definition and representation of controller activities, sub-activities, and tasks provides a means of evaluating the operational effects of the AERA 2 capabilities. This methodology incorporates the continuous involvement of an experienced user group and the rigor of a structured graphing technique; it is a crucial first step in successful human-computer dialogue design. The SSRVT was instrumental in the definition of the AAS Operations Concept (Ref. 6). The ATACT user team assumed a similar role for the AERA 2 Operations Concept. These teams used similar structured graphing techniques to depict groupings of related controller tasks. This section contains the set of composition graphs describing AERA 2 controller activities.

2.1 DEFINITION OF CONTROLLER ACTIVITIES

The automated capabilities provided by AERA 2 will tend to focus the controller's job efforts on planning for future traffic. To represent these efforts in the context of the AAS, the ATACT has defined five top-level controller activities (Figure 2-1). The most comprehensive activity, "Manage Air Traffic", is the activity where the majority of AERA capabilities apply. Other duties required of the controller form the basis of the remaining activities.

Activities can be decomposed into sub-activities, each of which represents a specific portion of an activity. Table 2-1 identifies the sub-activities associated with each AERA 2 activity. It also lists the major AERA 2 capabilities and indicates which sub-activities reflect the use of those capabilities.

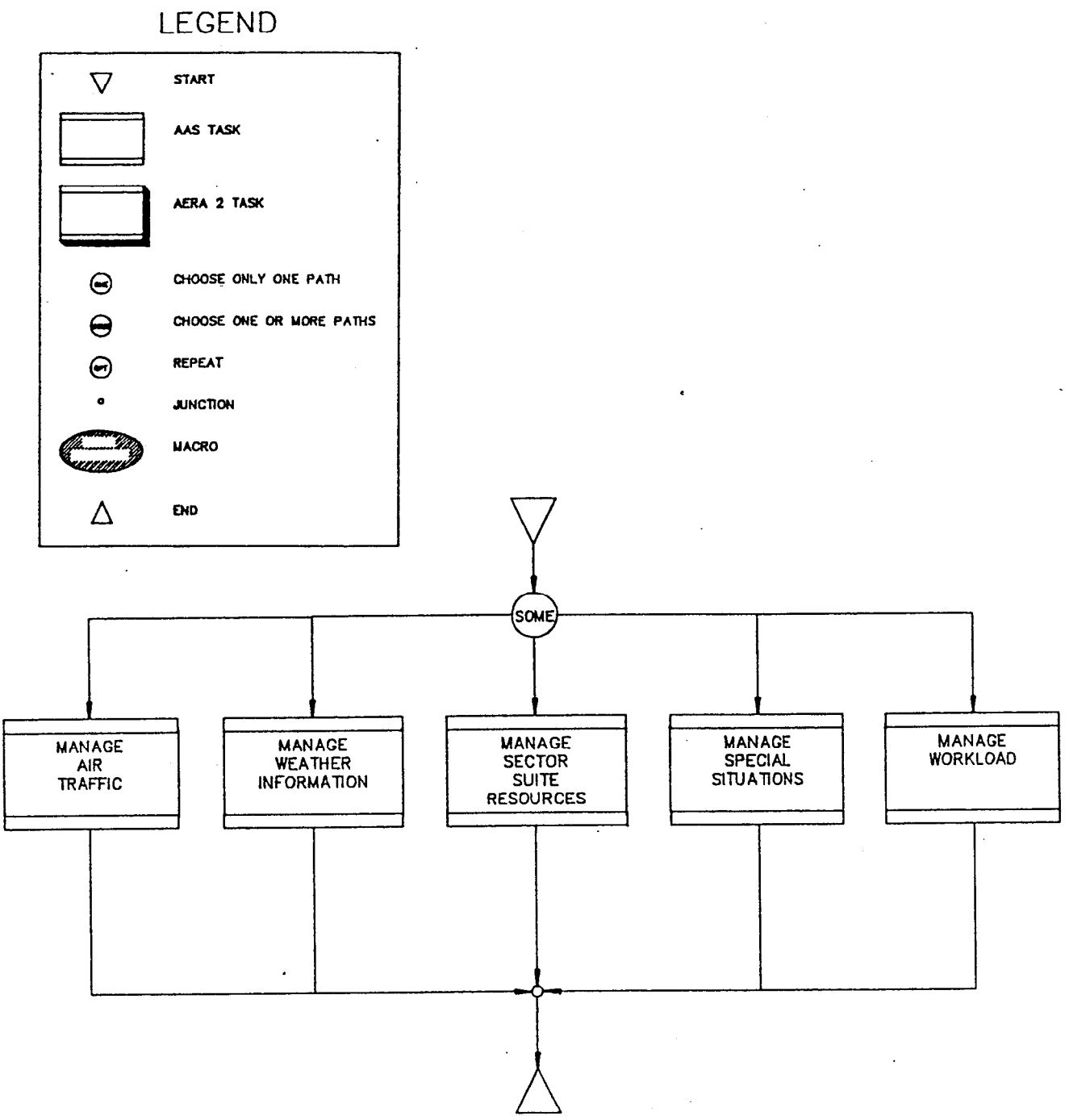
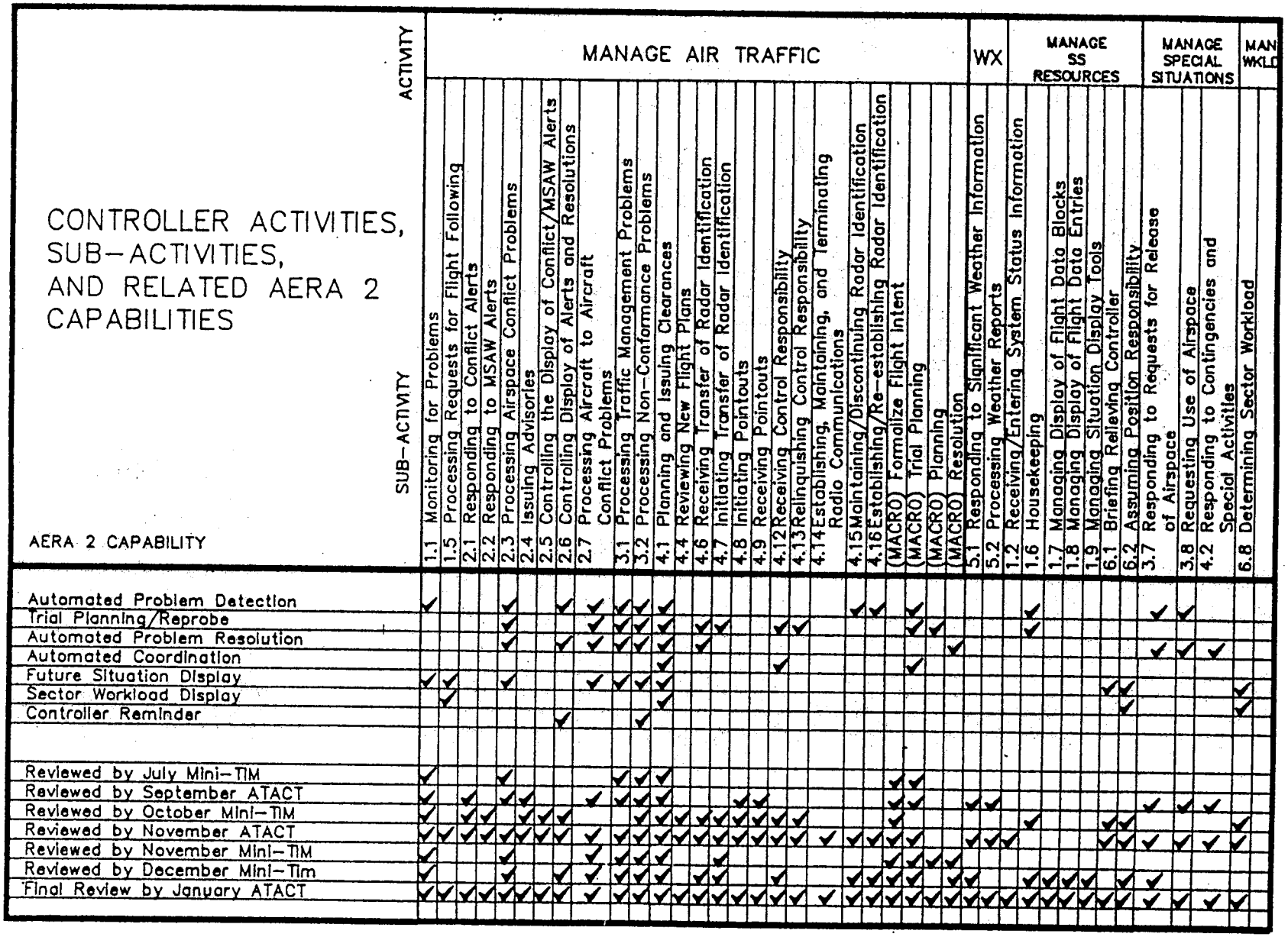


Figure 2-1. Controlling Air Traffic

Table 2-1. Controller Activities, Sub-Activities, and Related AERA 2 Capabilities



January 23, 1986

Sub-activities can be decomposed into sets of logically-related tasks. A task is an ordered, goal-directed, time-bounded sequence of human actions. It is important to note that these sub-activities include both AAS and AERA 2 controller tasks, as appropriate. AERA 2 tasks will always be performed in an environment which includes many AAS tasks, however the use of AERA's advanced aids is expected to reduce the frequency with which certain AAS tasks are performed. AAS tasks which are appropriate in the AERA 2 environment are numbered according to the AAS numbering scheme (Ref. 10). This numbering scheme permits traceability between the AAS composition graphs (Ref. 10) and the AERA 2 Operations Concept. All AERA 2 tasks are numbered according to the following scheme: A1.X.X.50, A1.X.X.51, and so on.

Tasks defined specifically for AERA 2 follow the task-naming guidelines established by the AAS work. The action verb of each task statement has been selected from a defined list of verbs. Table 2-2 lists the verbs which occur most frequently in the task statements of AERA 2 tasks. Appendix A contains a glossary of the complete set of verbs used to define controller tasks. Use of the AAS numbering scheme and task-naming guidelines promotes consistency and compatibility between the AAS and AERA 2 operations concepts.

Table 2-2. Verbs Most Frequently Used to Define AERA 2 Controller Tasks

VERB	DESCRIPTION	EXAMPLE
Evaluate	Examine and judge the merits of an action or alternative	Evaluate Rationale for Maneuver Type/ Ranking
Receive	Acquire transmitted information by seeing or listening, without necessarily taking action to express approval	Receive Resolution(s) to Predicted Problems
Request	Ask another for information, for approval on, or for receipt of, an item; or direct the system to provide a function	Request Reprobe Results
Select	Single out an item on a display or panel in preference to others, or indicate to the system one of several available options or items	Select plan to be forwarded

2.2 COMPOSITION GRAPH STRUCTURE

Sub-activities can be described graphically using composition graphs. An example of a composition graph appears in Figure 2-2. Composition graphs use geometric symbols and directed lines to represent tasks, decision points, and branching conditions. Rectangles represent controller tasks. Shaded rectangles represent tasks which support AERA 2 functionality. The placement of a task indicates its temporal precedence. Precedence is determined by the availability and state of information at a given time. Conditions that initiate the performance of the tasks within a graph are listed as "Stimuli" at the top of each sub-activity graph. Directed lines denote paths through the graph. Arrows indicate the direction in which paths may be traversed. Paths devoid of rectangles indicate that no action need be performed.

Circles delimit groups of tasks. Tasks within a group are preceded by a large circle labeled "SOME" or "ONE" and are followed by a small unlabeled circle. Labeled circles indicate decision points or branching points in the graphs.

Decision points signify instances where paths diverge, and the controller decides which path(s) to follow. Text explaining the criteria for selecting a specific path is indicated at the point of path selection. The determination of which path is to be followed may be based on the type of information received, the content of the information received, or the specifics of the ATC situation.

Tasks may also be grouped with the smaller, unlabeled circle at the top and the larger circle labeled "RPT" at the bottom. This convention represents the instance when the controller can decide to repeat the group of tasks.

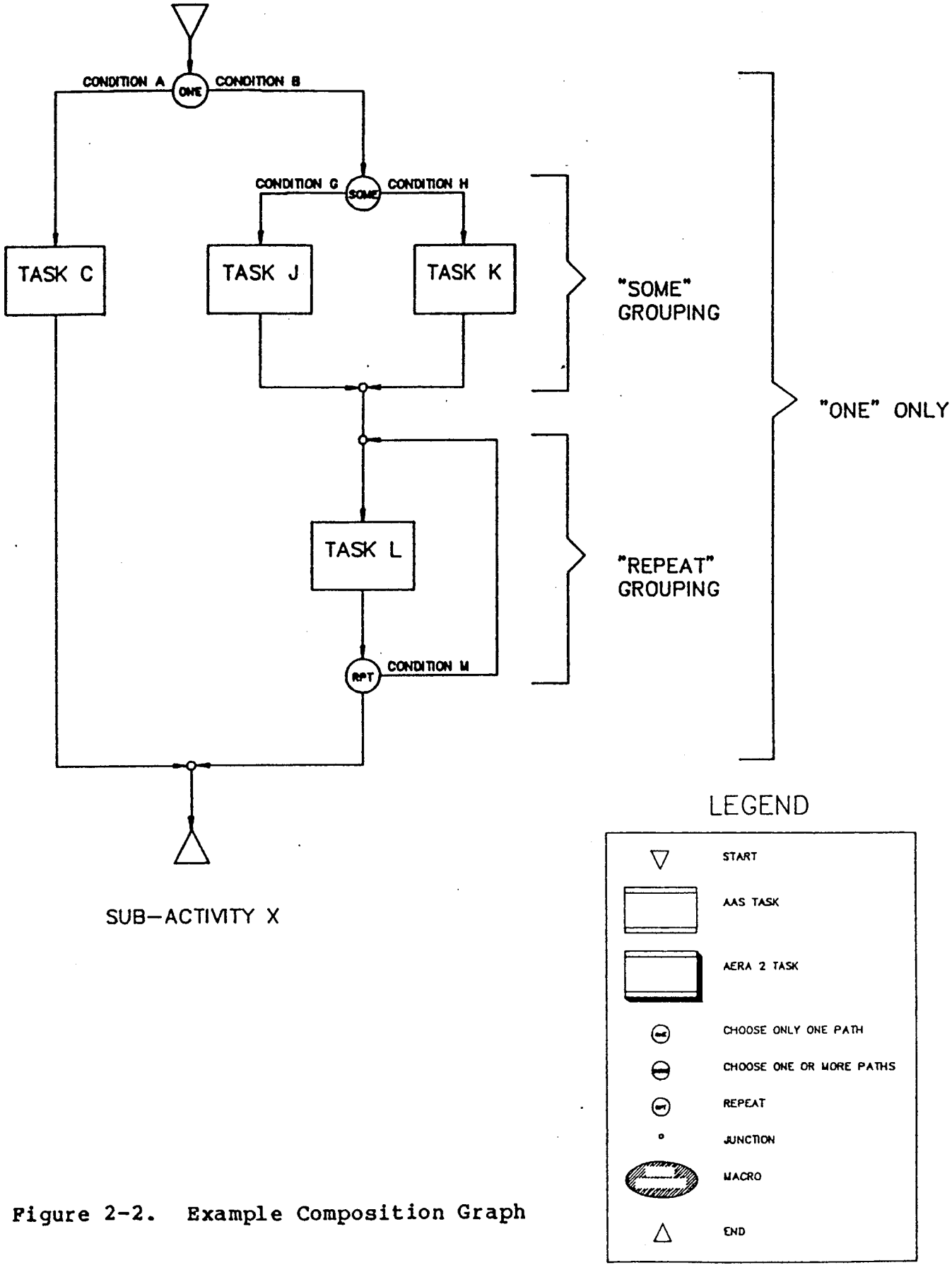


Figure 2-2. Example Composition Graph

The following summarizes the three types of task groupings:

- If the top circle is labeled "SOME," one or more of the paths between the large and the small circles may be traversed before continuing to the next set of tasks.

- If the top circle is labeled "ONE," only one path to the lower circle may be chosen.

- If the top circle is smaller and unlabeled and the lower circle is larger and labeled "RPT," the group of tasks will be repeated until a specific condition is satisfied.

The following paragraphs "walk through" Figure 2-2. The first decision in Sub-activity X is whether Condition A or Condition B is true. These conditions are mutually exclusive and only one path can be selected. If Condition A is true then Task C is performed. Sub-activity X is then complete for the case where Condition A is true.

If Condition B is true, then the next decision checks Condition G and Condition H. If Condition G is true, Task J is performed and, at the same time, if condition H is true, Task K is also performed. Note that one, some, or all of the tasks in a "some" grouping may be performed. Task L is performed and repeated until Condition M is no longer true. Sub-activity X is then complete for the case where Condition B is true.

Another symbol used in the composition graphs is the cross-hatched oval. This symbol is used to represent an invariant set of related tasks, some or all of which are performed within multiple sub-activities. For example, the tasks that the controller performs in Trial Planning occur in a variety of situations. These tasks are depicted once in their entirety and then represented by the cross-hatched oval within appropriate sub-activities. The set of identical tasks is known as a macro,

and the cross-hatched oval represents a macro. The macro symbol does not mean that the controller always performs that exact sequence of tasks across different sub-activities. The exact path through the macro depends on fulfillment of the branching conditions. The value of the macro is that it saves repetition of significantly large portions of graphs by providing an economical means of representation. A legend to aid in decoding the various graphing symbols is provided in Figure 2-2.

Some tasks require that the controller communicate with another person in order to accomplish the task. These communication tasks are identified in the composition graphs by the additional information provided in the bars above and below the task box. The upper bar designates the person with whom the communication occurs while the lower bar indicates the media used to accomplish the communication.

The following codes may appear in the upper bar to designate the originator or the recipient of coordination messages:

AM - Area Manager
AR - Aeronautical Radio, Inc. (ARINC)
AS - Area Supervisor
BA - Military Base Operations
CF - Central Flow Control Facility
CT - Controller (Domestic or Oceanic)
FS - Flight Service Station
OC - Other Coordination
PI - Pilot
MC - Military Mission Coordinator
MT - Meteorologist
SE - System Engineer
TM - Traffic Management Coordinator
TW - Air Traffic Control Tower

In the lower bar, an "S/S" indicates that the controller may communicate via automation using the Sector Suite console. When "VSCS" appears in the bottom bar, the controller can communicate verbally, using the Voice Switching and Control System.

2.3 CONTROLLER ACTIVITIES

This section presents graphic and textual descriptions of the AERA 2 controller activities. The sub-activities for each of the five activities are listed in Table 2-3. Each sub-activity is represented by a composition graph (Figures 2-3 through 2-41) and related textual description. The composition graphs show sequences of tasks in the order in which they would typically be performed in an operational situation.

The textual description that accompanies each composition graph provides a comprehensive discussion of the tasks accomplished in that sub-activity and identifies related sub-activities. A related sub-activity may have a temporal or sequential relationship with the subject sub-activity (e.g., Sub-activity 1.1 - Monitoring for Problems, typically precedes Sub-activity 2.7 - Processing Aircraft-to-Aircraft Problems). A related sub-activity may also describe the actions which are complementary to a coordination-oriented sub-activity (e.g., Sub-activity 4.9 - Receiving Pointouts, is the complement of Sub-activity 4.8 - Initiating Pointouts).

Definitions of controller actions are consistent between the AAS Operations Concept and the AERA 2 Operations Concept at the task level. As mentioned earlier, the specific numbering for all AAS tasks used in this document has been maintained. The grouping of tasks into sub-activities and of sub-activities into activities varies between this document and the AAS document, due to the changing nature of air traffic control as it evolves over the next ten years. The textual description and composition graph for each sub-activity appear on facing pages.

Table 2-3. Guide to AERA 2 Controller Activities & Macros

	MACROS	PA
	Planning Macro	2-
	Trail Planning Macro	2-
	Resolution Macro	2-
	Formalize Flight Intent Macro	2-
ACTIVITY	SUB-ACTIVITY	PA
Manage Air Traffic	1.1 Monitoring for Problems	2-
	1.5 Processing Requests for Flight Following	2-
	2.1 Responding to Conflict Alerts	2-
	2.2 Responding to MSAW Alerts	2-
	2.3 Processing Airspace Conflict Problems	2-
	2.4 Issuing Advisories	2-
	2.5 Controlling the Display of Conflict/ MSAW Alerts	2-
	2.6 Controlling Display of Alerts and Resolutions	2-
	2.7 Processing Aircraft-to-Aircraft Conflict Problems	2-
	3.1 Processing Traffic Management Problems	2-
	3.2 Processing Non-Conformance Problems	2-
	4.1 Planning and Issuing Clearances	2-
	4.4 Reviewing New Flight Plans	2-
	4.6 Receiving Transfer of Radar Identification	2-
	4.7 Initiating Transfer of Radar Identification	2-
	4.8 Initiating Pointouts	2-
	4.9 Receiving Pointouts	2-
	4.12 Receiving Control Responsibility	2-

Table 2-3. Guide to AERA 2 Controller Activities (cont'd)

ACTIVITY	SUB-ACTIVITY	PAGE
Manage Air Traffic (cont'd)	4.13 Relinquishing Control Responsibility	2-75
	4.14 Establishing, Maintaining and Terminating Radio Communication	2-77
	4.15 Maintaining/Discontinuing Radar Identification	2-79
	4.16 Establishing/Re-establishing Radar Identification	2-81
Manage Weather Information	5.1 Responding to Significant Weather Information	2-83
	5.2 Processing Weather Reports	2-85
Manage Sector Suite Resources	1.2 Receiving/Entering Sytem Status Information	2-25
	1.6 Housekeeping	2-29
	1.7 Managing Display of Flight Data Blocks	2-31
	1.8 Managing Display of Flight Data Entries	2-33
	1.9 Managing Situation Display Tools	2-35
	6.1 Briefing Relieving Controller	2-87
	6.2 Assuming Position Responsibility	2-89
Manage Special Situations	3.7 Responding to Requests for Release of Airspace	2-55
	3.8 Requesting Use of Airspace	2-57
	4.2 Responding to Contingencies and Special Operations	2-61
Manage Sector Workload	6.8 Determining Sector Workload	2-91

Planning Macro

Purpose: This macro allows the controller to organize the flow of traffic to fit a suitable strategy.

Function Within AAS/AERA: The Planning macro occurs in all of the sub-activities where aircraft plans are changing or traffic is entering or leaving sector control. This macro contains the tasks that allow the controller to perform long range strategic planning. Since long range planning involves evaluating aircraft flight plans, the Trial Planning macro is included within the Planning macro.

Walk-Through: The controller first considers all of the available planning options (A1.4.11.23) and chooses the one which is most suitable for the present situation (A1.4.11.24). The controller mentally determines what plan is needed (A1.4.11.21) and may mentally project (A1.1.1.4) and evaluate (A1.4.11.20) the aircraft's path, or the plan may be evaluated by the automation processing within the Trial Planning macro. After suitable plans are identified, the controller implements these plans in the Formalize Flight Intent macro.

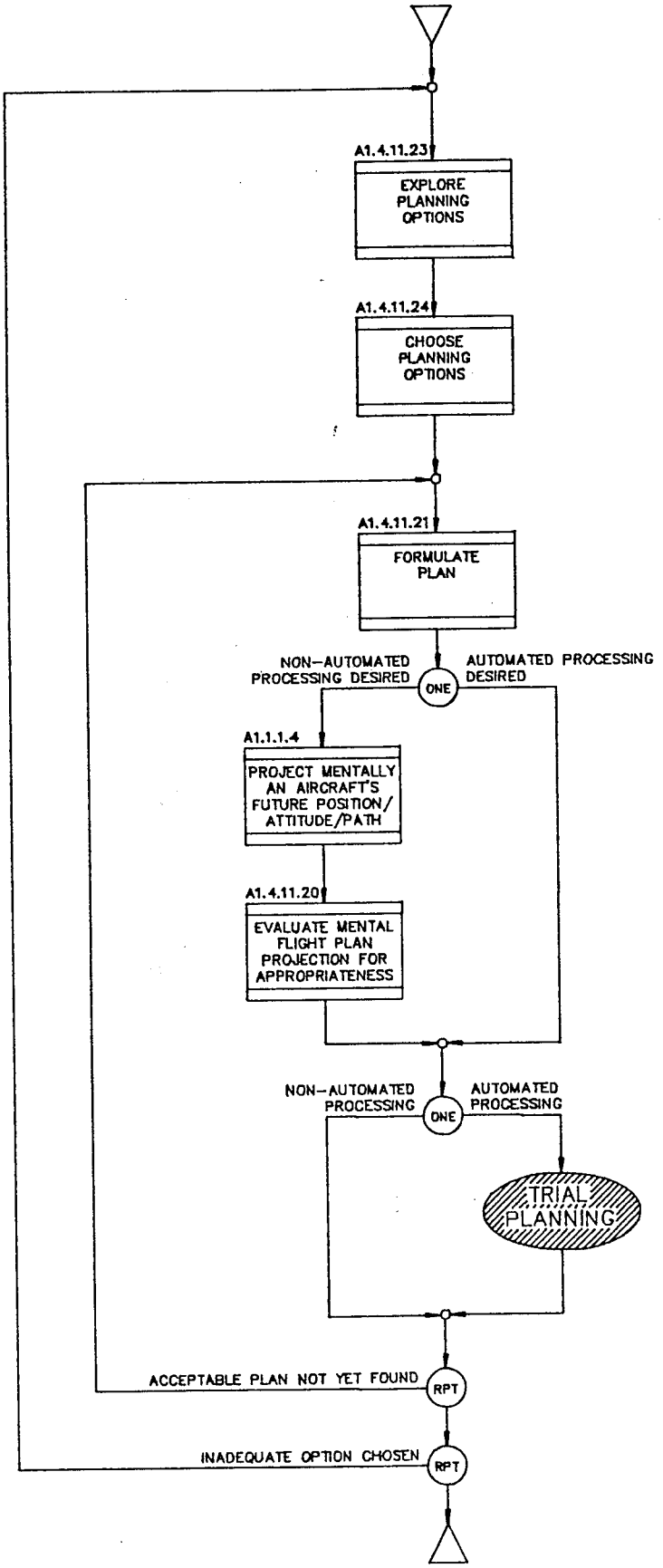


Figure 2-3. Planning Macro

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Trial Planning Macro

Purpose: This macro allows the controller to either select an existing plan or generate a new plan for a specific aircraft.

Function Within AAS/AERA: The Trial Planning macro is included as part of the Planning macro and is therefore found in those sub-activities where the controller needs to change an aircraft's plan. The controller either builds or retrieves and edits a trial plan. Automation processing checks the plan for predicted problems. Finally, the controller selects an appropriate disposition for the plan.

Walk-Through: Initially, the controller selects one of three methods to obtain a plan. If a suitable plan already exists, the controller requests either specific plans (A1.4.11.62) or all plans (A1.4.11.61) for display so they may be reviewed (A1.4.11.64). If a plan is selected, but it is not suitable as is, the controller updates it as desired (A1.4.11.63). The other two methods of Trial Plan creation are for the controller to either manually enter the desired plan (A1.4.11.5) or to have the automation generate a set of trial plans (A1.4.11.22) from which the controller may select the one desired. In both of these cases, the newly generated plan is submitted to automation processing for the detection of problems. If a suitable plan is not found, the controller needs to consider additional plans, the process may be repeated at the beginning of the sub-activity. If the automation processing detected a problem, an alert is received (A1.2.7.50) and evaluated (A1.2.7.51); otherwise, a notice of no conflict is received (A1.4.11.13). Finally, if the plan is not to be implemented immediately, the controller selects an appropriate disposition which may be to make the plan pending (A1.4.11.55), to save the plan for future use (A1.4.11.15), to request automated reprobe (A1.4.11.52), to request automated coordination (A1.4.11.60), or to delete the plan (A1.4.11.54). Additionally, the controller may receive notice that the plan has become invalid (A1.4.11.3).

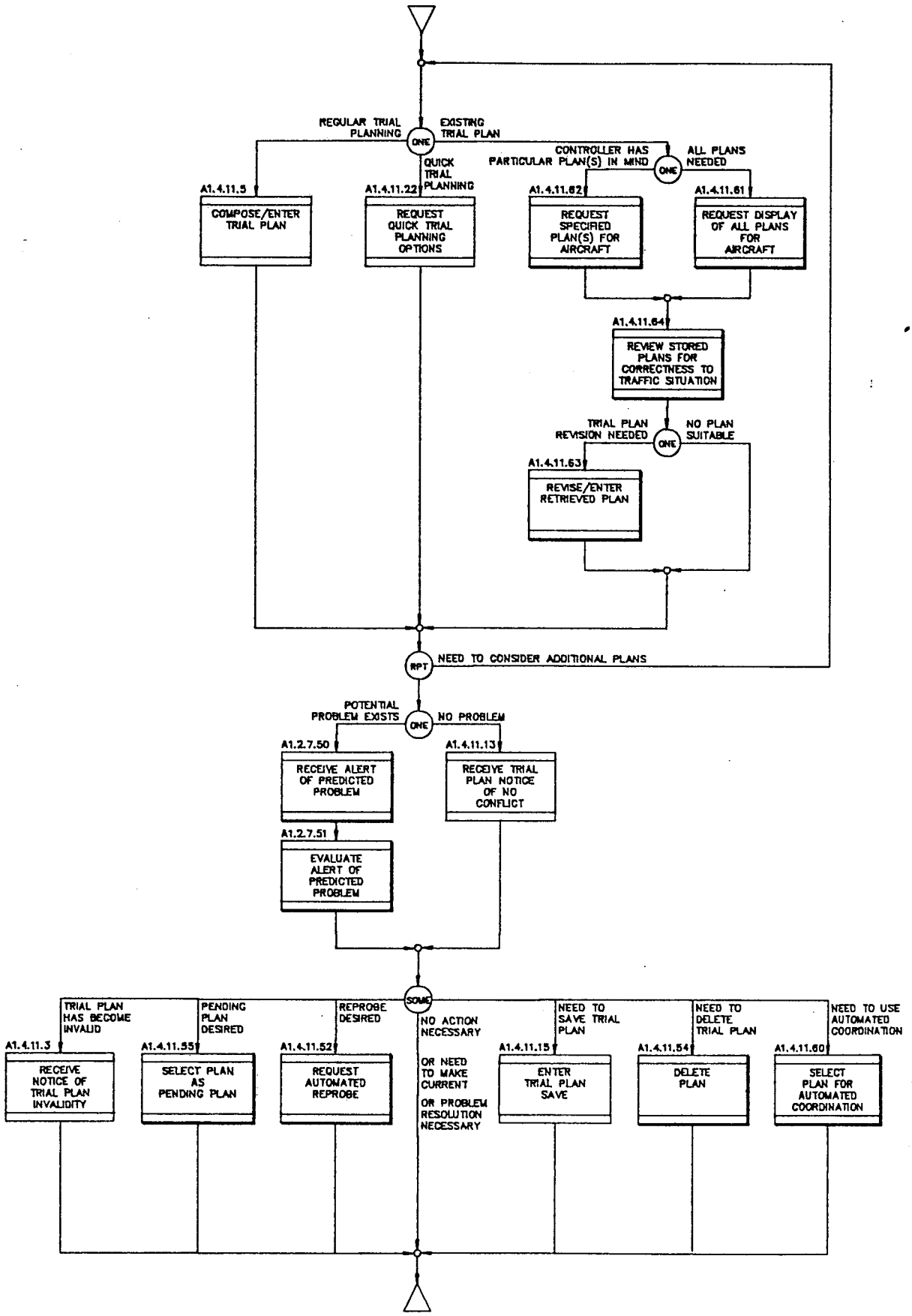

Figure 2-4. Trial Planning Macro 1/17/86

Resolution Macro

Purpose: This macro allows the controller to use the automation for generating plans to resolve predicted problems.

Function Within AAS/AERA: The Resolution Macro is used in all of the sub-activities which involve processing AERA 2 problems. It generally follows those tasks in which the controller determines what the problem is. The most significant task in this macro is the mental evaluation of the resolution. In this task, the controller determines whether the plan will in fact solve the problem, or whether other resolutions are needed. This macro often provides information used in the Planning Macro.

Walk-Through: When a predicted problem exists, the controller will be presented with an automated resolution, unless this feature is inhibited. If a resolution is not presented, the controller can request that one be generated (A1.2.7.62). After receiving the resolution (A1.2.7.53), the controller evaluates it to determine acceptability for the specific situation (A1.2.7.54). If it is not acceptable, the controller may request additional automated resolutions (A1.2.7.62) and may also give the automation specific preferrences or restrictions on how to resolve the problem (A1.4.11.66). After a suitable resolution is obtained, the controller may proceed to the Planning Macro and other tasks to allow integration of the resolution into the overall sector strategy.

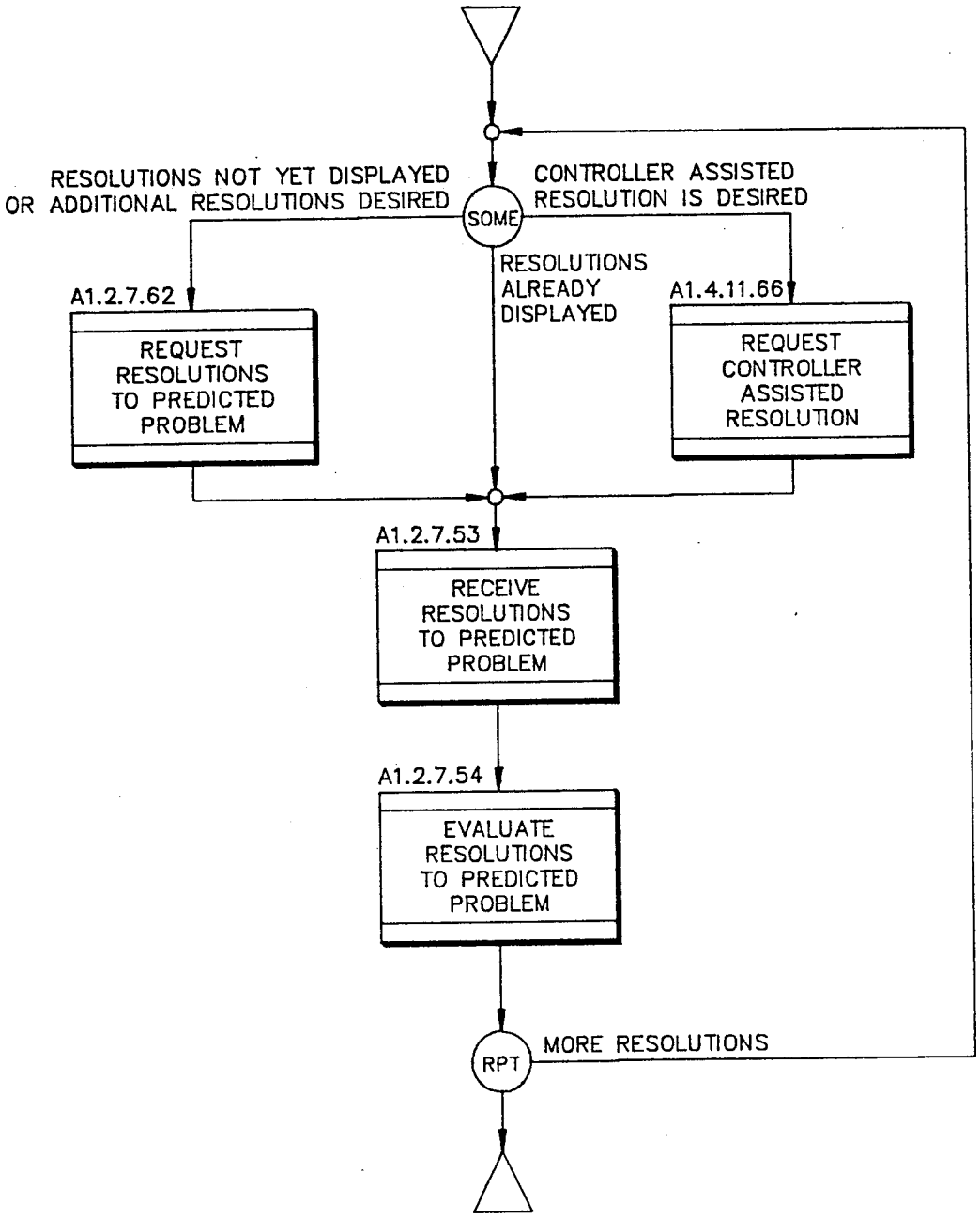

Figure 2-5. Resolution Macro

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Formalize Flight Intent Macro

Purpose: This macro formalizes the intent of a particular flight so that the controller, the automation, and the pilot of the affected aircraft are in agreement.

Function Within AAS/AERA: The Formalize Flight Intent macro is included in each of the sub-activities that deals with generating resolutions to flight plan conflicts. They include Processing Airspace Conflict Problems (2.3), Processing Aircraft-to-Aircraft Conflict Problems (2.7), Processing Traffic Management Problems (3.1), and Processing Non-Conformance Problems (3.2). Once the problem requiring a change in flight intent has been identified and planning has been conducted to determine the best solution, the controller notifies the automation and the affected pilot of the change. The controller will then monitor the aircraft's position to ensure that the change is effected and continue to monitor for problems in sub-activity 1.1.

Walk-Through: Upon entry to this macro, the controller may confer with the pilot (A1.4.10.11) concerning the change to the flight plan. If a plan known to the automation is to be implemented, it is made the current flight plan (A1.4.10.50). If the new flight plan is known only to the controller, the flight plan amendment is composed and entered (A1.4.5.3). The clearance is then issued to the pilot either directly (A1.4.10.5) or through a relayer (A1.4.10.6). Drop throughs are included to allow the situation when no change need be made.

USED:
- 2.1 RESPONDING TO CONFLICT ALERTS
- 2.2 RESPONDING TO MSAW ALERTS
- 2.3 PERFORM AIRSPACE CONFLICT PROCESSING
- 2.7 RESPONDING TO AIRCRAFT TO AIRCRAFT PRIORITY/ADVISORY ALERTS
- 3.1 RESPONDING TO TRAFFIC MANAGEMENT INSTRUCTIONS
- 3.2 PROCESSING NON-CONFORMANCE PROBLEMS
- 4.1 PLANNING AND ISSUING CLEARANCES
- 5.2 PROCESSING WEATHER REPORTS
- 6.6 EXECUTING BACKUP NAVAID PROCEDURES

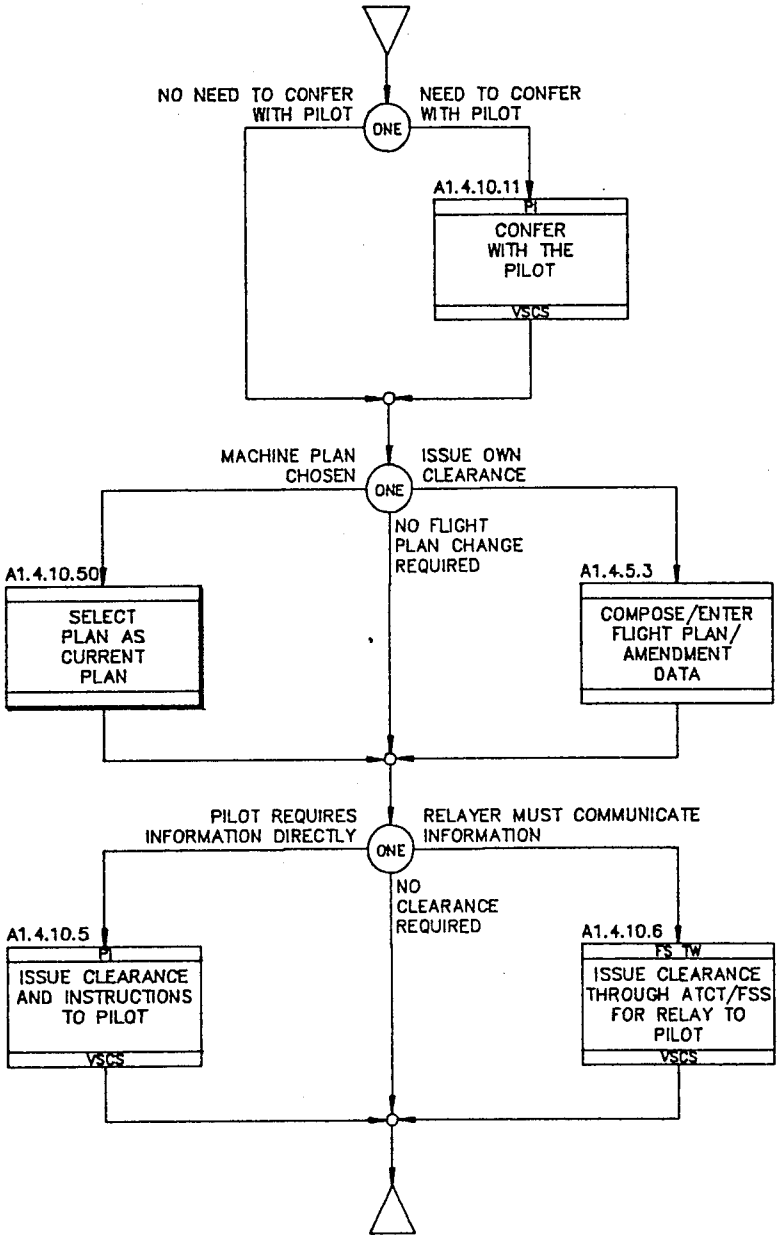

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Figure 2-6. Formalize Flight Intent Macro

Sub-Activity 1.1: Monitoring for Problems

Purpose: This sub-activity identifies potential problems of four types: aircraft-to-aircraft conflicts, aircraft-to-airspace conflicts, aircraft violation(s) of flow restrictions, and non-conformance with the flight plan.

Function Within AAS/AERA: To the extent possible, Monitoring for Problems is a continuous task performed by the controller, even when engaged in planning or problem solving. After determining that a problem does exist, the controller proceeds to resolve the problem by performing the tasks in the appropriate problem-solving sub-activity (e.g., 2.7, Processing Aircraft-to-Aircraft Conflict Problems; 2.3, Processing Airspace Conflict Problems; 3.2, Processing Non-conformance Problems; or 3.1, Processing Traffic Management Instructions).

Walk-Through: This sub-activity is executed continuously but as in all sub-activities, it may be interrupted to perform higher-priority duties. The air traffic situation is monitored by continuous review of the following Sector Suite displays:

- Future Situation display (A1.1.1.53, A1.1.1.54),
- Flight Data display (A1.1.1.17, 1.1.1.20, A1.1.1.58),
- Alert and Resolution display (1.1.57),
- Situation display (A1.1.1.23, A1.1.1.56, A1.3.2.2),
- other Sector Suite displays (A1.1.1.24).

In addition, potential conflict situations are monitored (A1.2.1.7), future positions and separation of aircraft are mentally projected (A1.3.4.7, A1.1.1.4), non-controlled airborne objects are observed (A1.2.4.14), and aircraft compliance with clearances and advisories are verified (A1.4.10.7, A1.2.4.4). The following information is also reviewed:

- metering information (A1.3.1.7), and
- traffic management restrictions (A1.3.1.8).

Then, after review of the situation, the controller determines if a problem really exists (A1.1.1.21) and if so, the priority of the problem is also determined (A1.1.1.22).

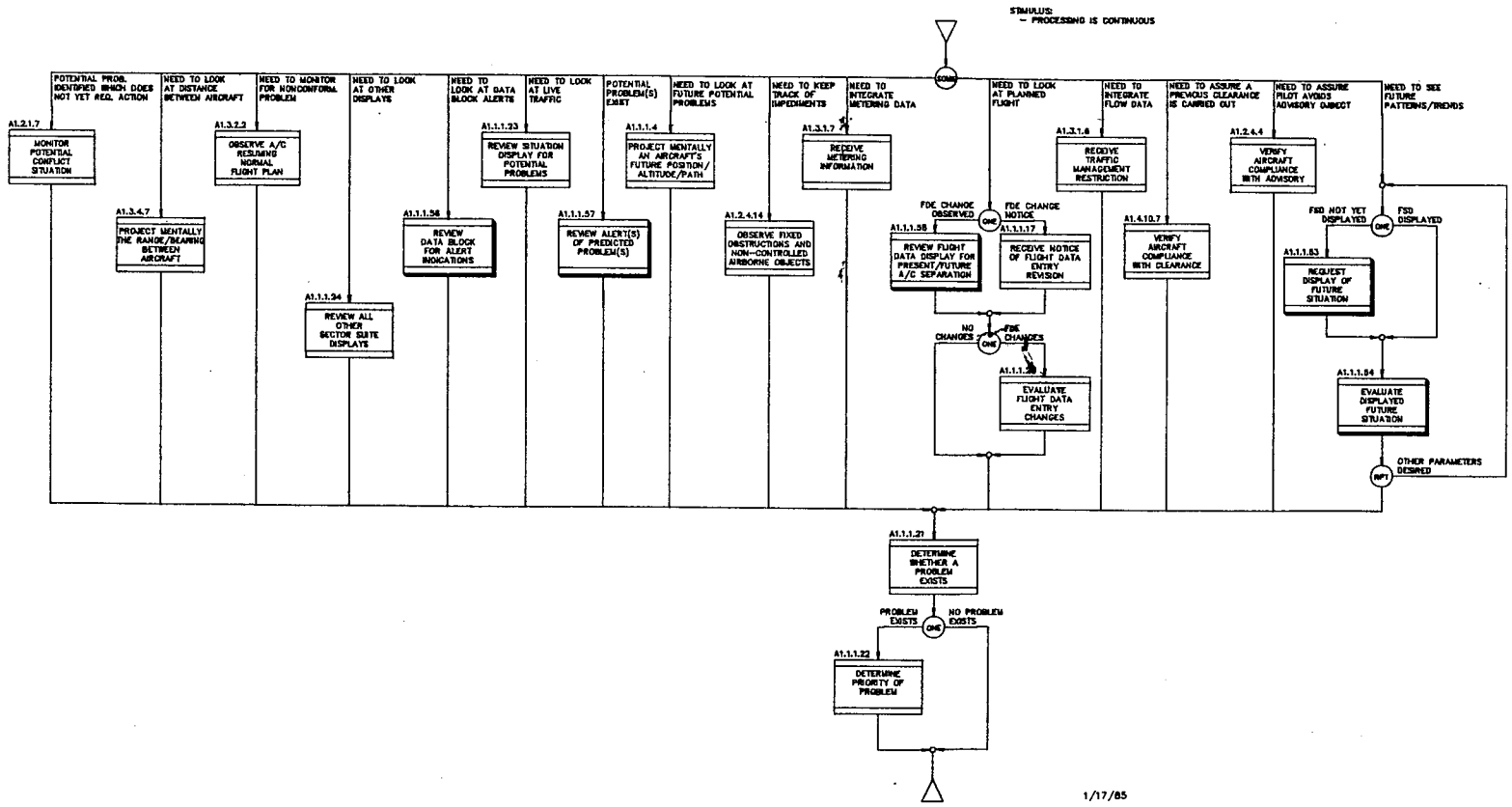

Figure 2-7. Sub-Activity 1.1 - Monitoring for Problems

Sub-Activity 1.2: Receiving/Entering System Status Information

Purpose: This sub-activity processes system status information that is received by the controller.

Function Within AAS/AERA: This sub-activity is executed each time the controller receives a notice dealing with system status. Once the notice is processed, monitoring continues in sub-activity 1.1, taking into account the changed system status. Upon receiving a notice of a change in the system status, the controller may elect to enter a reminder in the system status text area.

Walk-Through: If this sub-activity is activated by an equipment alert, the operational status alert is first detected and acknowledged (A1.1.2.6). The status information types processed include:

- display of new/changed equipment/operational status (A1.1.2.1),
- notice of NAVAID status (A1.6.6.4),
- status of adjacent/backup facility equipment (A1.1.2.3),
- notice of radar sensor status (A1.6.9.3),
- notice of communication status (A1.1.2.5).

In addition, the system status data text chantes may be entered into the system (A1.1.6.13).

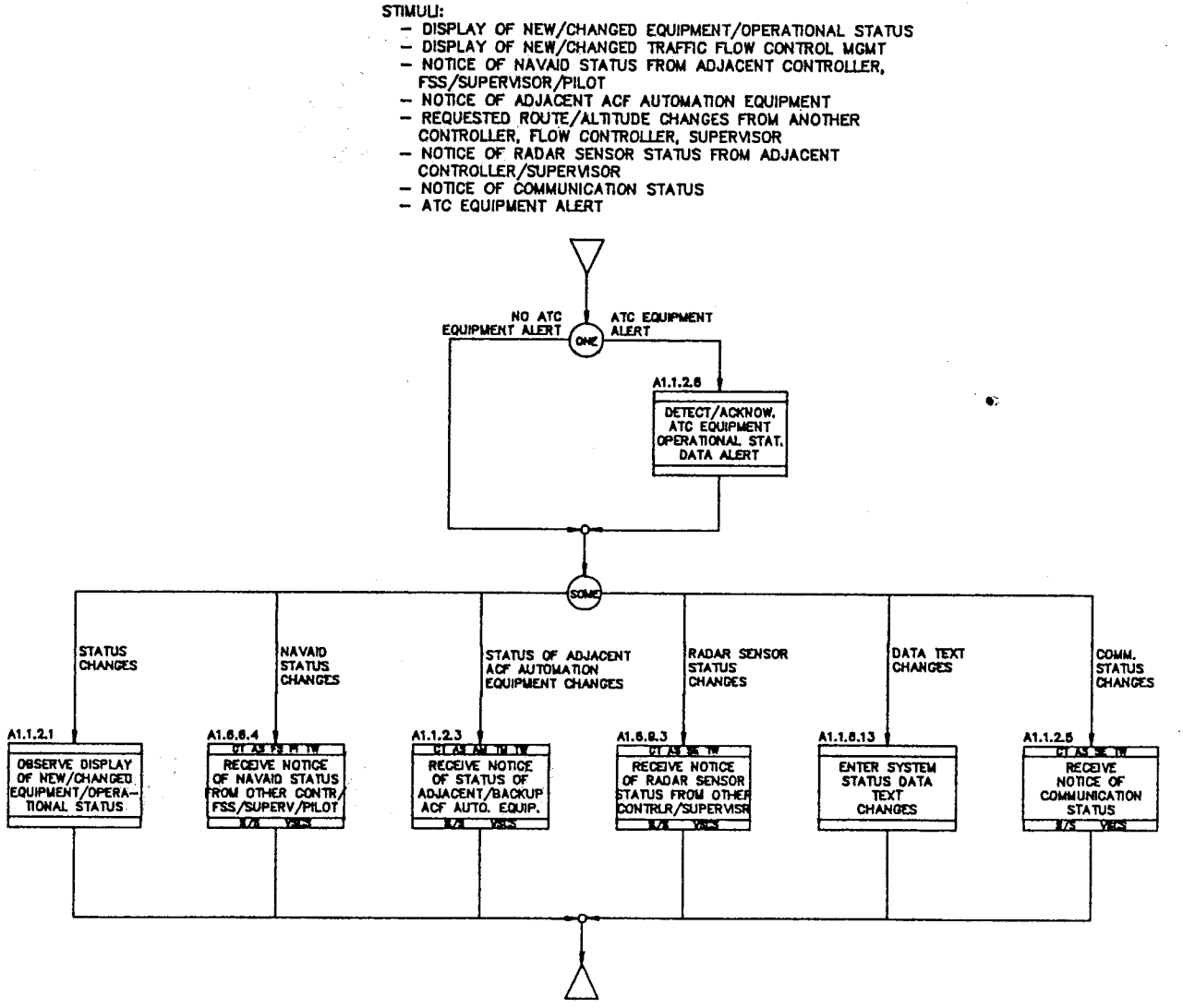

Figure 2-8. Sub-Activity 1.2 - Receiving/Entering System Status Information

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Sub-Activity 1.5: Processing Requests for Flight Following

Purpose: This sub-activity responds to requests for the controller to provide flight following services.

Function Within AAS/AERA: This sub-activity is entered when the controller receives a request for flight following. The request can come from either the pilot of a VFR aircraft or from another controller who is handing the aircraft off. If the request is from the pilot, the controller must enter an abbreviated flight plan into the system. If the flight plan was already entered by the previous controller, it is forwarded normally and no action is required.

Walk-Through: The request for flight following is first received from the pilot or another controller (A1.1.5.2). Then the conditions for providing flight following are analyzed (A1.1.5.1). If supporting information is desired, the controller may look at the sector workload factor (A1.6.8.7) or the future situation (A1.1.1.53, A1.1.1.54). If the decision is made to provide the flight following services, either the automatic handoff (A1.4.6.4) or the verbal handoff (A1.4.6.3) is accepted and a new flight plan may be formulated if one is not available (A1.4.4.3). If the controller decides not to provide flight following, either the request is denied (A1.1.5.3) or the handoff is rejected (A1.4.6.2).

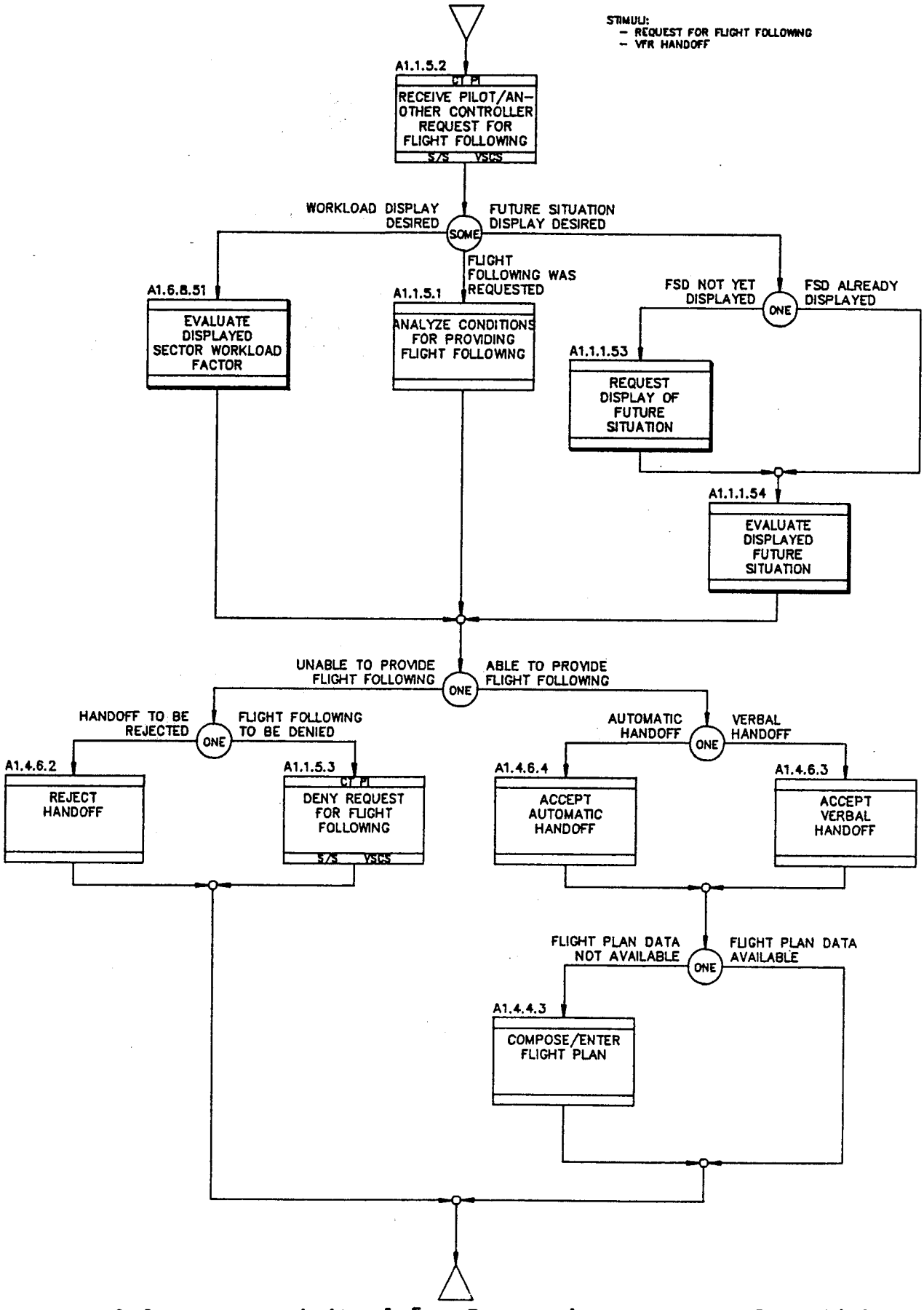

Figure 2-9. Sub-Activity 1.5 - Processing Requests for Flight Following

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Sub-Activity 1.6: Housekeeping

Purpose: This sub-activity allows the controller to tailor miscellaneous AAS/AERA function responses to personal preference. Controller annotation, reprobe status, and restriction notification are included.

Function Within AAS/AERA: This sub-activity is activated when the controller wishes to modify the display of the reprobe function or of aircraft previously affected by a restriction. Additionally, the controller might make personal notes which do not affect the automation. Once processed, monitoring continues in sub-activity 1.1.

Walk-Through: When this sub-activity is activated, normally only one task is executed before completion. The notification of aircraft no longer affected by a flow or airspace restriction can either be suppressed (A1.1.6.54) or restored (A1.1.6.52). If a previously initiated reprobe on a particular aircraft is no longer needed, the reprobe function can be terminated (A1.1.6.50). The notification of a problem-free reprobed trial plan can either be inhibited (A1.1.6.53) or restored (A1.1.6.51). The controller annotation may also be updated or revised (A1.1.6.2).

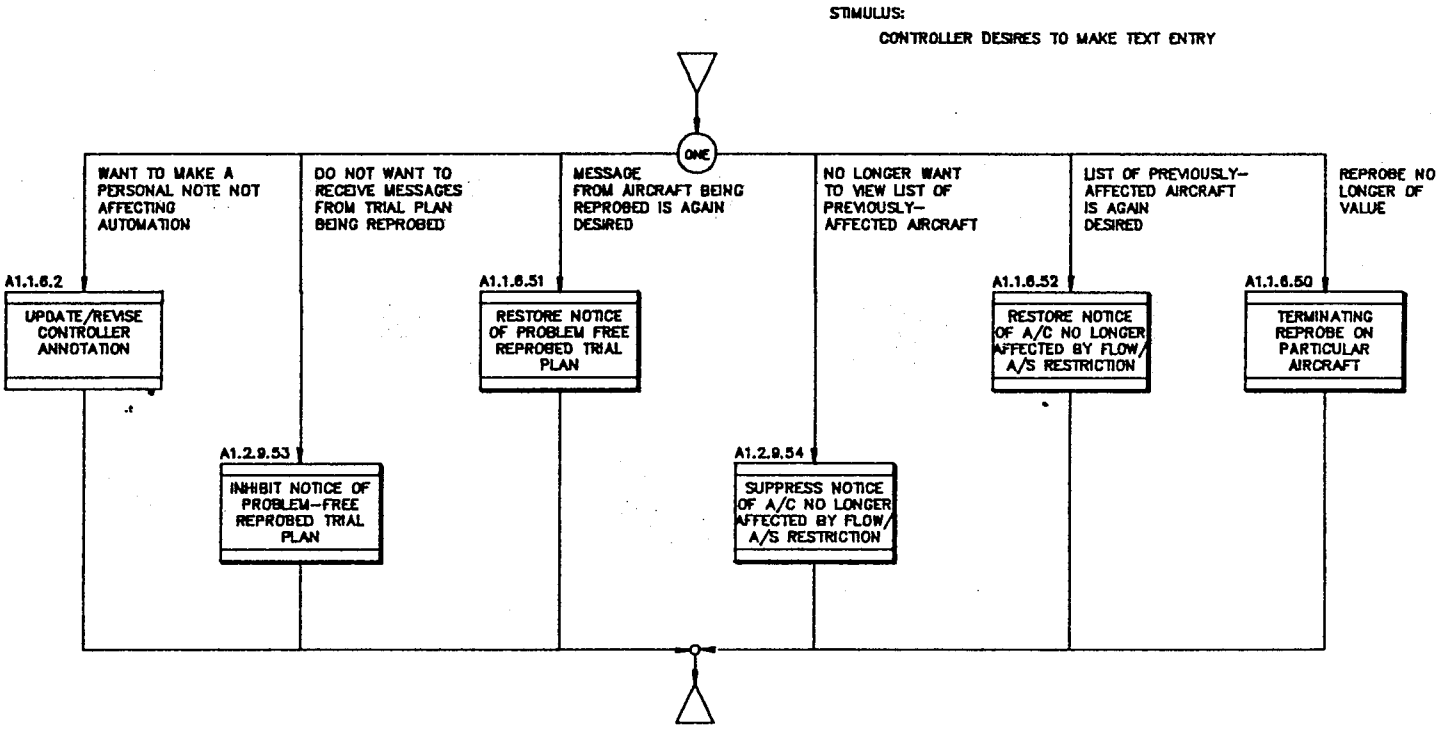

Figure 2-10. Sub-Activity 1.6 - Housekeeping

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Sub-Activity 1.7: Managing Display of Flight Data Blocks

Purpose: This sub-activity allows the controller to manage the various display aspects of the Flight Data Blocks.

Function Within AAS/AERA: This sub-activity is executed whenever the controller wishes to alter the current parameters that govern display characteristics of the Data Block. When the change is complete, monitoring continues in sub-activity 1.1.

Walk-Through: Usually, this sub-activity is activated to make a single Data Block characteristic change. The entire data block may be suppressed (A1.1.6.7) or restored (A1.1.6.8) when needed. The data block of an aircraft in another sector may be forced onto the situation display (A1.1.1.6). The filter for the Limited Data Block may be adjusted (A1.1.7.1) and a Data Block may simply be offset (A1.1.6.1) on the screen. The mode for the Full Data Block positioning may be selected to be automatic or manual (A1.1.7.2) or the format for the Data Block (A1.1.7.3) may be modified. Either the mode or the format may be designated as the default parameters and display for future use (A1.6.2.5).

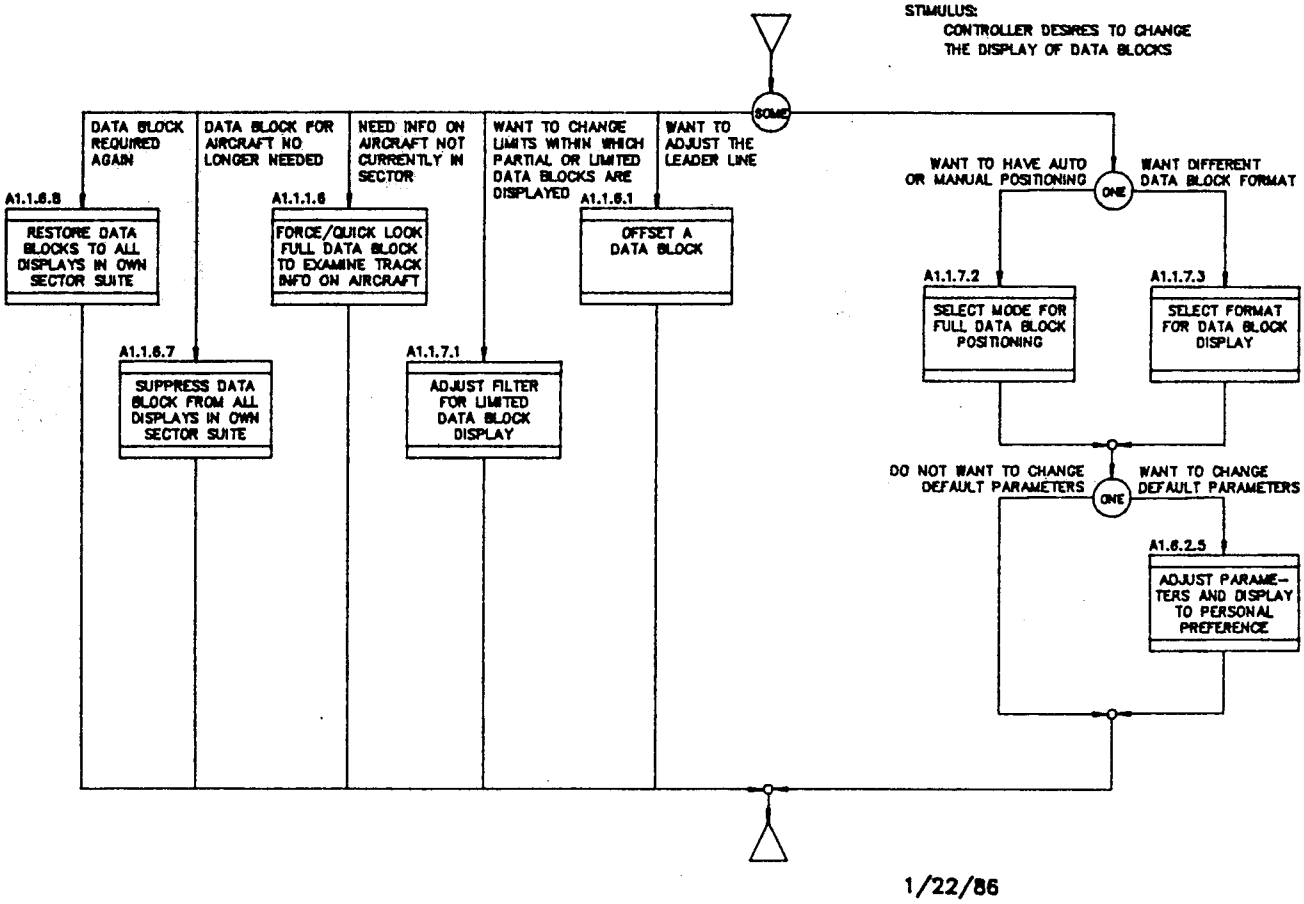

Figure 2-11. Sub-Activity 1.7 - Managing Display of Flight Data Blocks

Sub-Activity 1.8: Managing Display of Flight Data Entries

Purpose: This sub-activity allows the controller to manage the various display aspects of the flight data entries.

Function Within AAS/AERA: This sub-activity is executed whenever the controller wishes to alter the current parameters that govern display characteristics of the flight data entry. When the change is complete, monitoring continues in sub-activity 1.1.

Walk-Through: Usually, this sub-activity is activated to make a single flight data entry characteristic change. The flight data entries and/or Data Blocks may be suppressed or restored from the sector suite (A1.1.6.9, A1.1.6.10, A1.1.6.5, A1.1.6.6). Individual flight data entries may be deleted from the entire ATC system (A1.1.6.3) or from the local ACCC (A1.1.6.4). FDE notations may be entered (A1.1.6.11) or deleted (A1.1.6.12) as desired. The controller may highlight the entire flight plan or specific fields as a reminder (A1.4.5.2) or delete the highlighting (A1.1.6.6). If the manual posting mode is operative, receipt of a new flight plan may need to be acknowledged (A1.4.4.4) and the sequence may need to be adjusted (A1.1.8.2). If automatic sorting is utilized, the priority scheme may be selected (A1.1.1.8) and the controller may choose to designate the sorting scheme to become the default parameter for future use (A1.6.1.5).

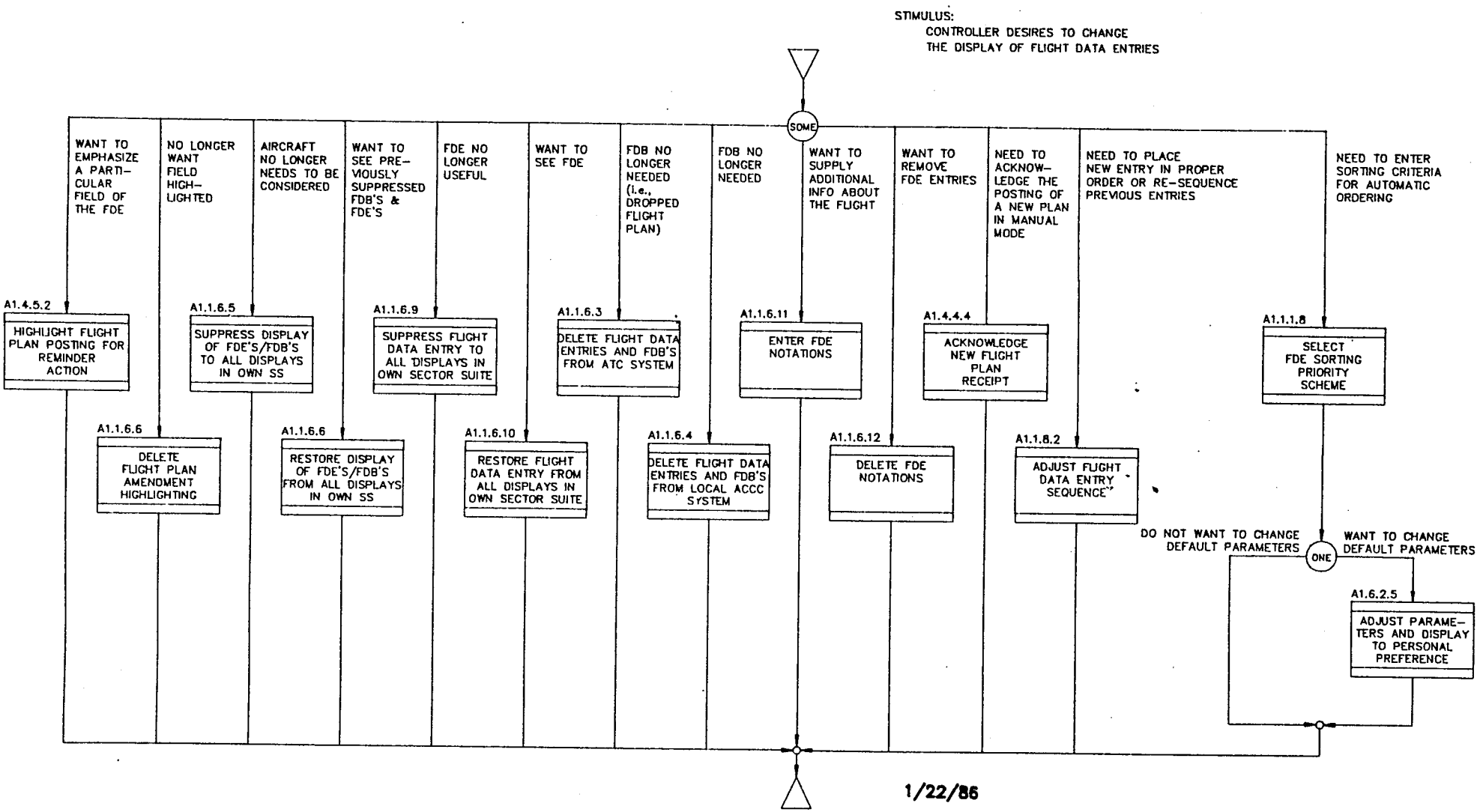

Figure 2-12. Sub-Activity 1.8 - Managing Display of Flight Data Entries

Sub-Activity 1.9: Managing Situation Display Tools

Purpose: This sub-activity allows the controller to manage the various display tools available on the Situation display.

Function Within AAS/AERA: This sub-activity is executed whenever the controller wishes to utilize or suppress one of the display tools on the Situation display.

Walk-Through: Usually, this sub-activity is activated to request or suppress a single tool. The following tools may be requested or suppressed as required:

- continuous range readout (A1.1.9.1, A1.1.1.11),
- fix/time readout for an aircraft (A1.1.9.2, A1.1.9.3),
- vertical velocity readout for an aircraft (A1.1.1.10, A1.1.9.5),
- range/bearing/time for an aircraft (A1.1.1.5, A1.1.9.6),
- aircraft halo (A1.1.9.7, A1.1.9.11),
- range rings (A1.1.9.9, A1.1.9.12),
- longitudinal scale (A1.1.9.10, A1.1.9.13), and
- adapted airspace display (A1.3.7.6, A1.3.7.4).

Also, the controller may formulate and enter geographic tagging (A1.1.9.8).

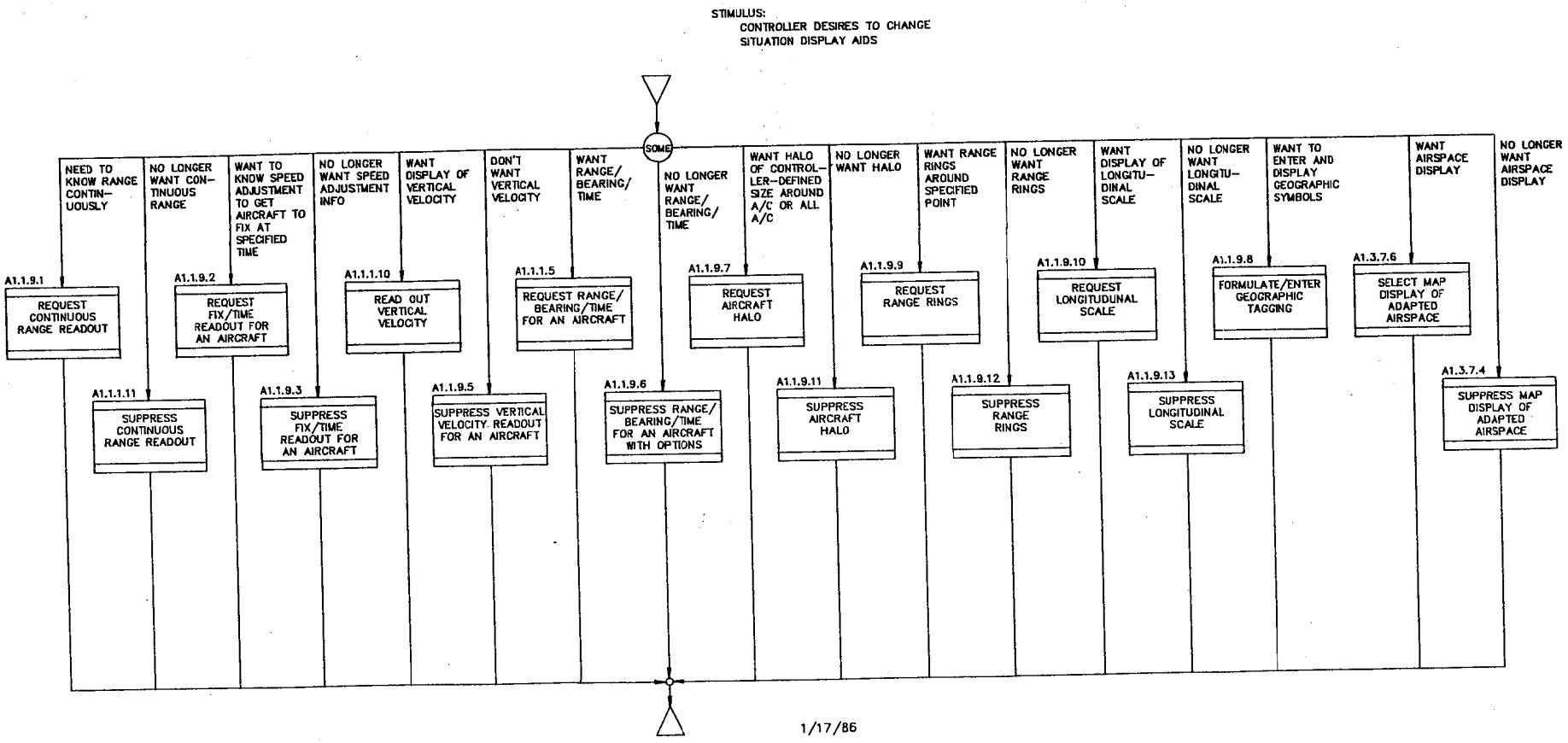

Figure 2-13. Sub-Activity 1.9 - Managin Situation Display Tools

Sub-Activity 2.1: Responding to Conflict Alerts

Purpose: This sub-activity responds to Conflict Alerts.

Function Within AAS/AERA: This sub-activity is executed in response Conflict Alerts. The controller may be alerted to the conflict by either another controller or by a Sector Suite display (the Alert and Resolution, Data Block on the Situation, and the Flight Data displays include the conflict alert indications). After the problem is resolved, the monitoring continues in sub-activity 1.1.

Walk-Through: The conflict alert is first received by the controller either from another controller (A1.2.1.3) or detected on a Sector Suite display (A1.2.1.1). Then the validity of the alert is determined (A1.2.1.2). If the alert is determined to be invalid, no further processing is performed. If the subject aircraft is not under the sector's control, the responsible controller is informed (A1.2.1.4). When the alert is validated, the controller considers the results of the Conflict Resolution Advisory function (A1.2.4.2, A1.2.1.11) and may select one of the machine-generated resolutions (A1.2.1.6) or mentally formulate a new clearance (A1.4.10.4). If safety advisories are necessary, they are provided (A1.2.4.3, A1.2.4.5). The Formalize Flight Intent macro is included to notify the pilot and the automation of the updated flight intent.

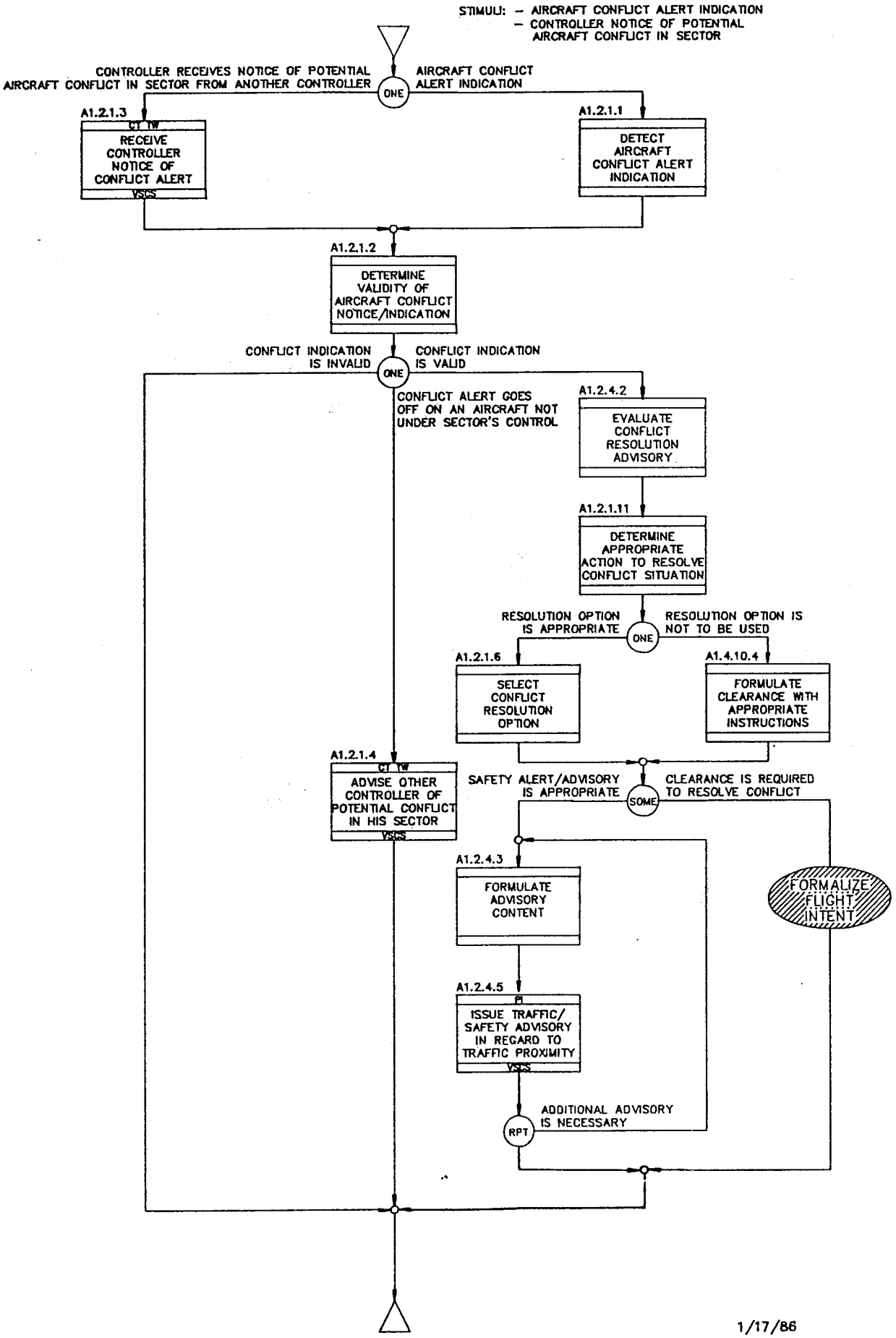

Figure 2-14. Sub-Activity 2.1 - Responding to Conflict Alerts

Sub-Activity 2.2: Responding to MSAW Alerts

Purpose: This sub-activity responds to Minimum Safe Altitude Warning alerts.

Function Within AAS/AERA: This sub-activity is executed in response to the detection of an MSAW alert. The controller may be alerted to the conflict by either another controller or by a Sector Suite display (the Alert and Resolution, Data Block on the Situation, and the Flight Data displays include the MSAW alert indications). After the problem is resolved, the monitoring continues in sub-activity 1.1.

Walk-Through: The MSAW alert is first received by the controller either from another controller (A1.2.2.3) or detected on a Sector Suite display (A1.2.2.1). Then the validity of the alert is determined (A1.2.2.2). If the alert is determined to be invalid, no further processing is performed. If the subject aircraft is not under the sector's control, the responsible controller is informed (A1.2.2.4). When the alert is validated, the controller considers the results of the Conflict Resolution Advisory function (A1.2.4.11, 2.1.22) and may select one of the resolutions (A1.2.1.6) or formulate a new clearance (A1.4.10.4). If safety advisories are necessary, they are provided (A1.2.4.3, A1.2.4.12). The Formalize Flight Intent macro is included to notify the pilot and the automation of the updated flight intent.

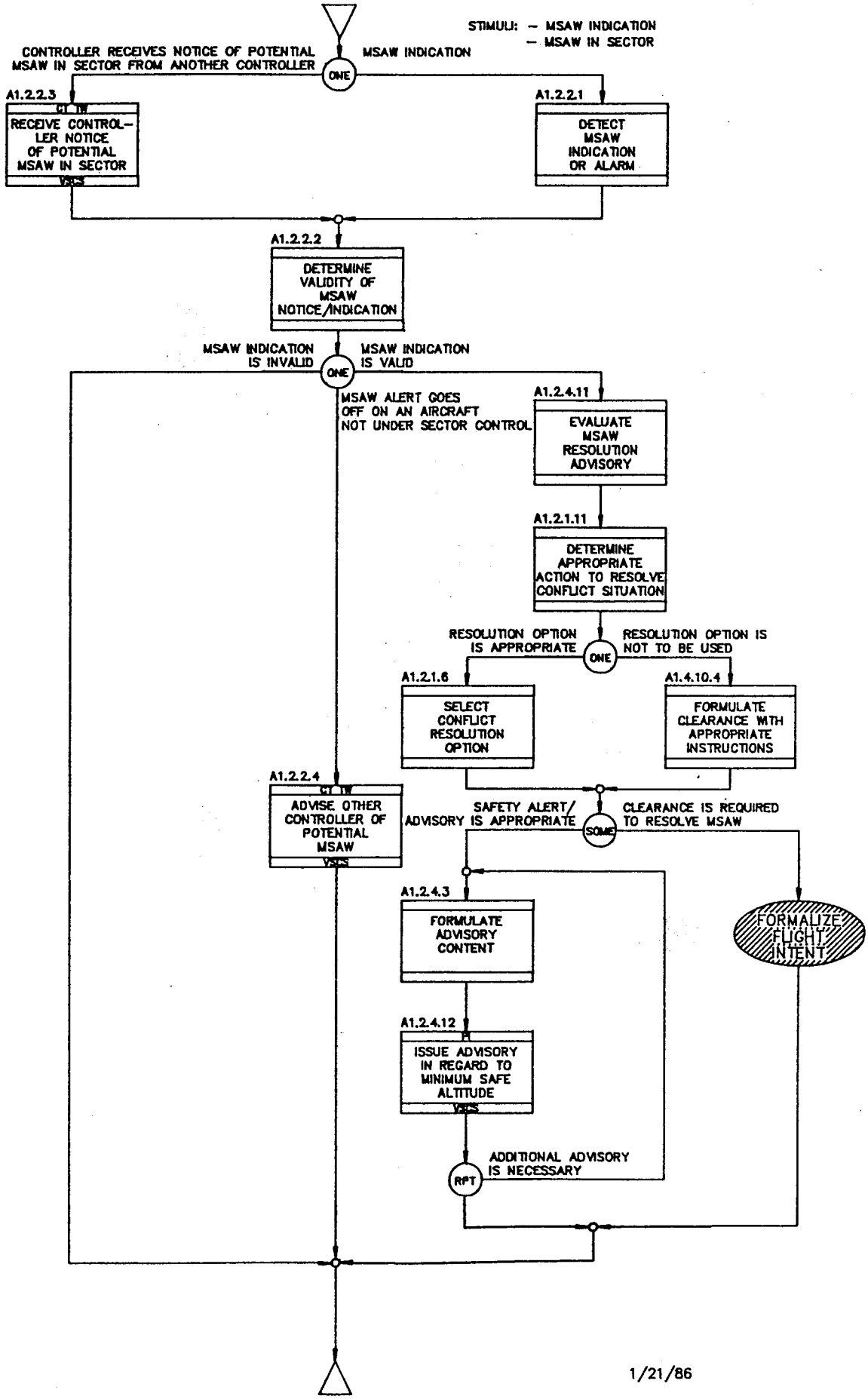

Figure 2-15. Sub-Activity 2.2 - Responding to MSAW Alerts

Sub-Activity 2.3: Processing Airspace Conflict Problems

Purpose: This sub-activity responds to potential aircraft-to-airspace problems.

Function Within AAS/AERA: This sub-activity is executed in response to airspace conflicts either identified by the controller or detected by the automation. The controller may be alerted to the conflict by a Sector Suite display (the Alert and Resolution, Planning, and Data Block on the Situation displays include an indication of an airspace conflict). After the problem is resolved, the monitoring continues in sub-activity 1.1.

Walk-Through: The airspace problem or alert is first perceived by the controller (A1.2.7.50) and evaluated (A1.2.7.51). The Resolution macro is included to consider machine generated resolutions to the problem. The Planning macro is included to allow the controller to plan traffic in the sector. In support of Planning (i.e., simultaneously), the controller may request and/or evaluate the following:

- reprobe status (A1.4.11.58, A1.4.11.59)
- trial plan route display (A1.4.11.19, A1.4.11.16)
- rationale for maneuver type/ranking (A1.2.7.55, A1.2.7.56)
- display of cleared route (A1.4.11.9, A1.4.11.17)
- explanatory information about potential problem (A1.2.7.57, A1.2.7.58)
- airspace conflict display (A1.4.11.17, A1.2.3.8)
- display of future situation (A1.1.1.53, A1.1.1.54)

If the controller is not yet satisfied with the resolution, the Planning and the Resolution Macros are repeated. Otherwise, the Formalize Flight Intent macro is included to notify the pilot and the automation of the new clearance.

It should be noted that the controller has the option of deferring a response to the original notice when workload does not permit action or when the controller prefers to monitor the developing situation.

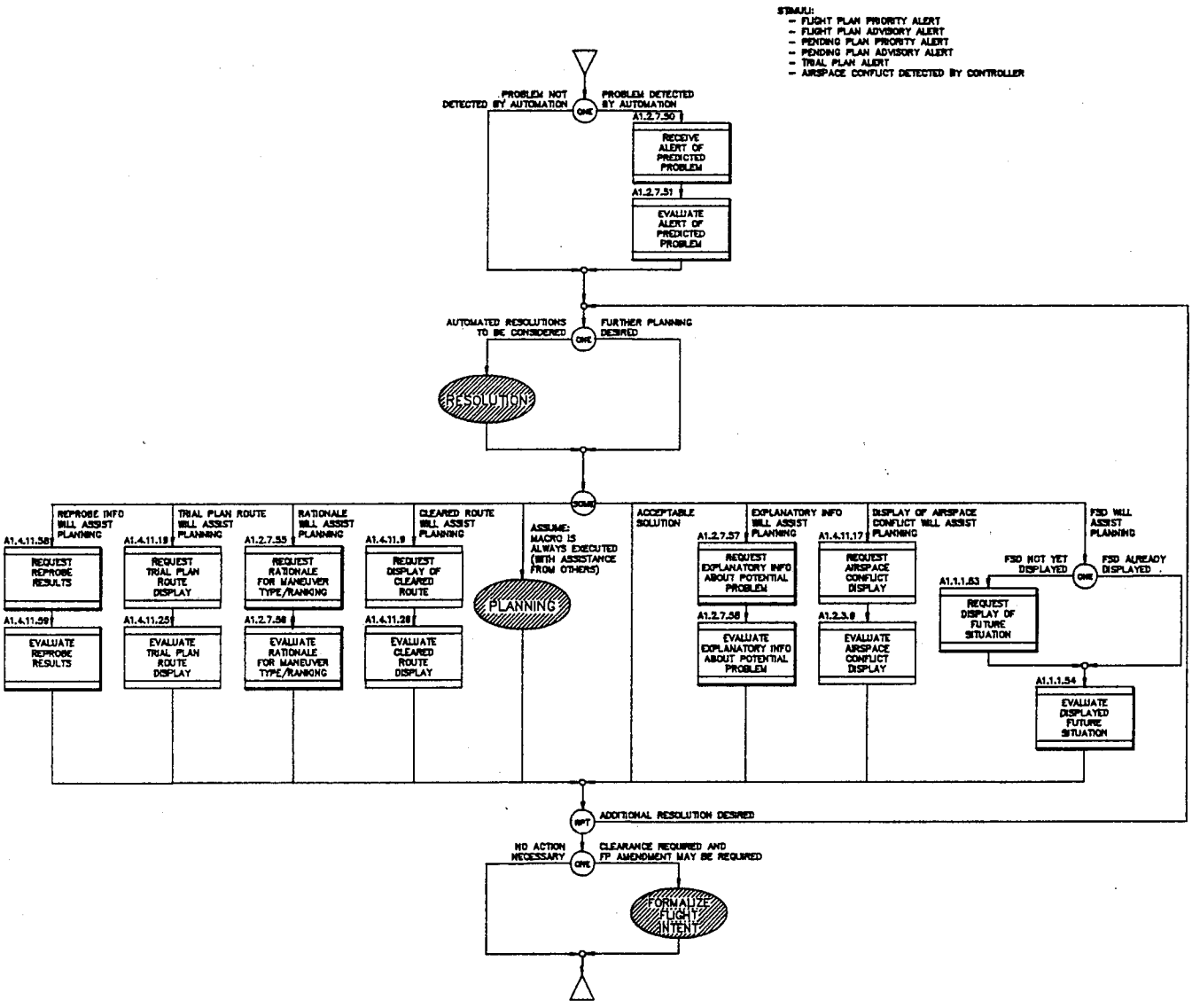

Figure 2-16. Sub-Activity 2.3 - Processing Airspace Conflict Problems

Sub-Activity 2.4: Issuing Advisories

Purpose: This sub-activity responds to situations that require an advisory to be formulated and issued. These include a traffic advisory due to proximity, non-controlled objects, restricted airspace proximity, and safety advisories.

Function Within AAS/AERA: The decision to issue an advisory is determined in other sub-activities. This sub-activity formulates and issues the advisory to the appropriate destination. Following completion of the sub-activity, monitoring continues in sub-activity 1.1 to verify the aircraft's compliance with the advisory.

Walk-Through: Upon entry into this sub-activity, the advisory is formulated according to air traffic control standards (A1.2.4.10). The appropriate advisory is then issued to the aircraft (A1.2.4.5, A1.2.4.7, A1.2.4.9, A1.2.4.11).

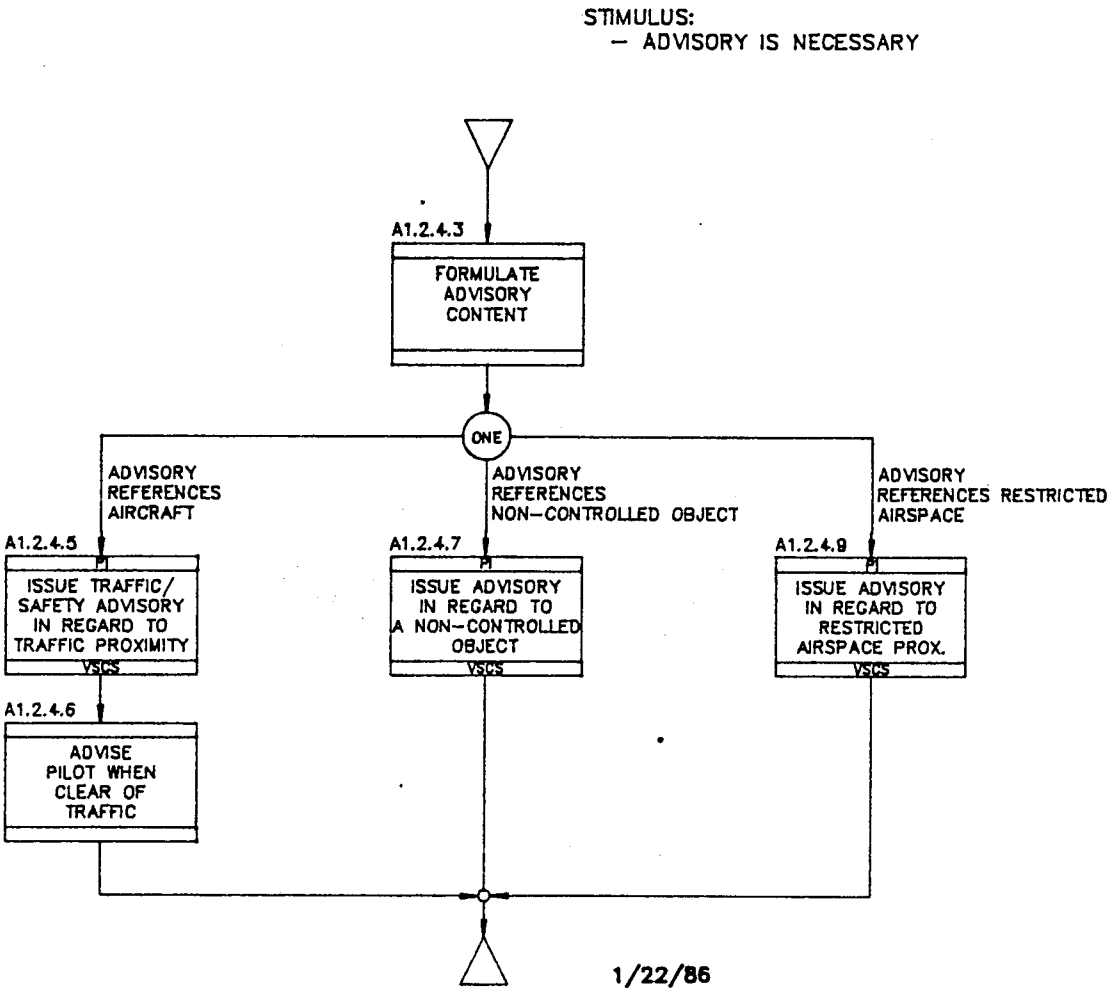

Figure 2-17. Sub-Activity 2.4 - Issuing Advisories

Sub-Activity 2.5: Controlling the Display of Conflict/MSAW Alerts

Purpose: This sub-activity allows for control of the display of conflict alert and MSAW notifications and the associated Resolution Advisories. The sub-activity considers alerts incurred by individual aircraft or aircraft pairs, aircraft flying in group formation, and aircraft flying in a particular designated airspace.

Function Within AAS/AERA: The alerts generated by the Separation Assurance function are detected in the monitoring sub-activity 1.1., and they are processed in sub-activities 2.1 and 2.2. When the need to inhibit or suppress these alerts occurs, this sub-activity is invoked. It provides the inhibit/suppress of all conflict and MSAW alerts and resolution advisories. It should be noted that inhibiting the alerts for individual aircraft or pairs, or for aircraft groups, will automatically inhibit the display of resolution advisories. Alerts and resolutions for aircraft in a particular airspace must be inhibited by the controller individually.

Walk-Through: If the alert and resolution is for a particular aircraft or aircraft pair, the display is suppressed for conflict alert (A1.2.5.2) or MSAW (A1.2.5.6). If the alerts and resolutions apply to a group of aircraft flying in a specified airspace, the displays are inhibited for conflict alert (A1.2.5.4, A1.2.5.11) or MSAW (A1.2.5.5, A1.2.5.12). If the alerts for aircraft flying in a group formation are considered, they are inhibited (A1.2.5.3). Finally, the display of alerts and resolutions are restored (A1.2.5.7) and the status change is observed (A1.2.5.13).

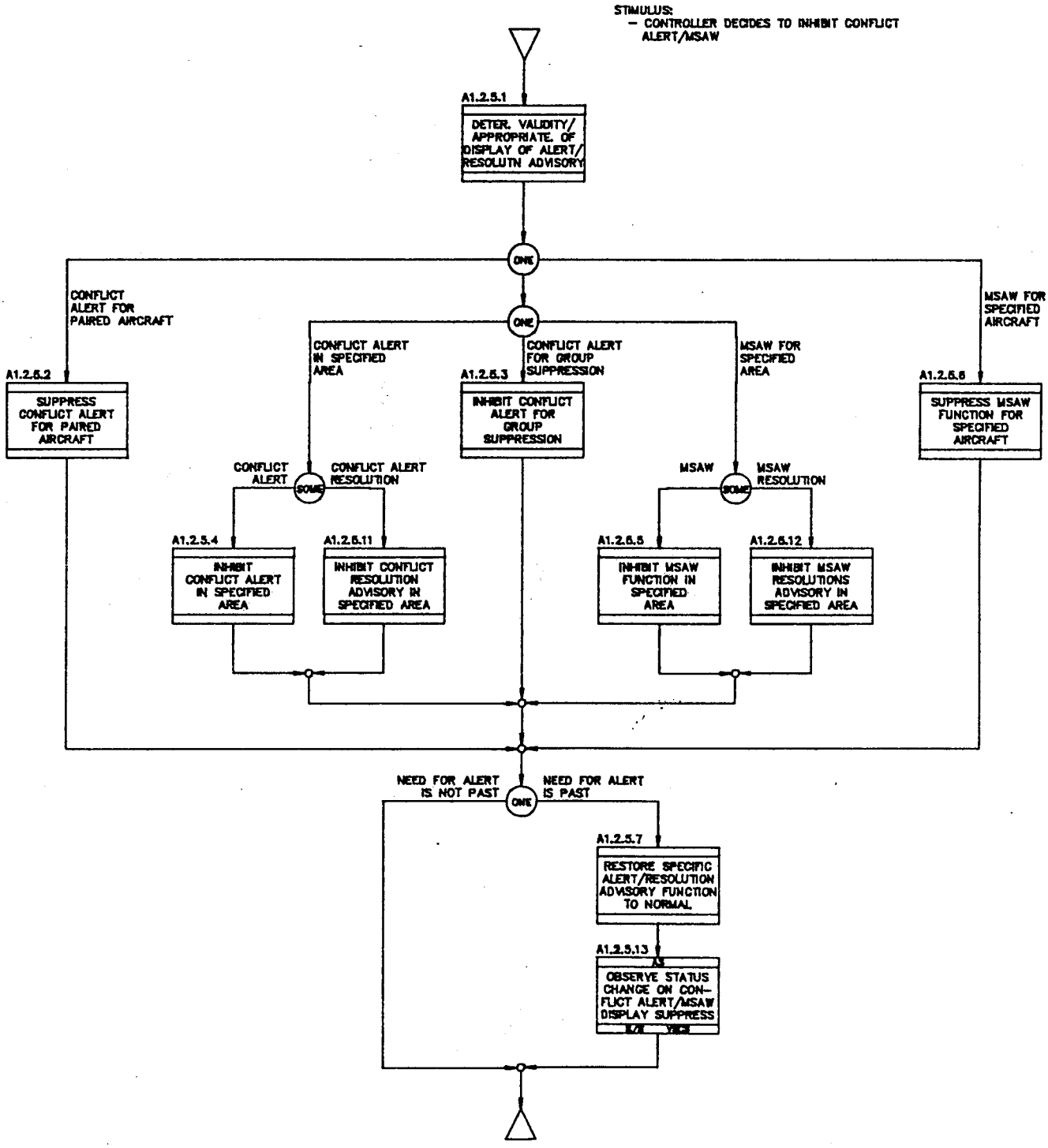

Figure 2-18. Sub-Activity 2.5 - Controlling the Display of Conflict Alerts/MSAW Alerts

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Sub-Activity 2.6: Controlling Display of Alerts and Resolutions

Purpose: This sub-activity handles suppressing and restoring the display of alerts of predicted problems and associated resolutions. The alert types include aircraft-to-aircraft, aircraft-to-airspace, flow restriction violation, non-conformance, and monitor maneuver information. Resolutions may be controlled independently for trial plan alerts and advisory alerts.

Function Within AAS/AERA: The need to suppress an alert or resolution is determined in other sub-activities. This sub-activity simply allows the controller to suppress or restore the particular alert and/or resolution.

Walk-Through: This sub-activity performs one task per iteration. It either suppresses or restores a particular alert and/or resolution each time. It suppresses or restores:

- flight plan conflict displays (A1.2.6.1, A1.2.6.2),
- airspace conflict displays (A1.2.6.3, A1.2.6.4),
- flow restriction violation display (A1.2.6.5, A1.2.6.6),
- monitor maneuver information (A1.2.6.51, A1.2.6.52),
- non-conformance message (A1.2.6.9, A1.2.6.10),
- advisory alert resolutions (A1.2.6.53, A1.2.6.54),
- trial plan resolution (A1.2.6.44, A1.2.6.56), or
- advisory alerts (A1.2.6.57, A1.2.6.58).

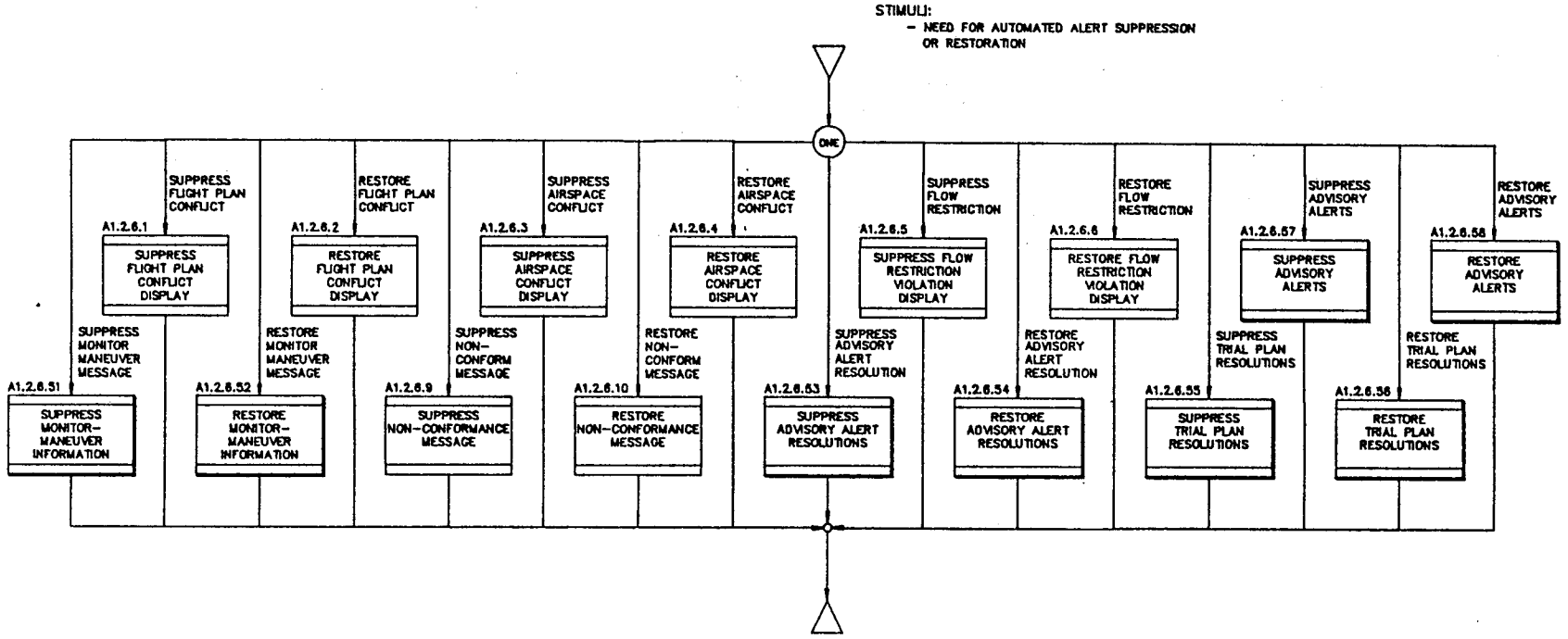

Figure 2-19. Sub-Activity 2.6 - Controlling Display of Alerts and Resolutions

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Sub-Activity 2.7: Processing Aircraft-to-Aircraft Conflict Problems

Purpose: This sub-activity responds to predicted aircraft-to-aircraft problems detected by the controller.

Function Within AAS/AERA: This sub-activity is executed in response to aircraft-to-aircraft conflicts either identified by the controller or detected by the automation. The controller may be alerted to the conflict by a Sector Suite display (the Alert and Resolution, Planning, and Data Block on the Situation displays include an indication of an airspace conflict alert). After the problem is resolved, the monitoring continues in sub-activity 1.1.

Walk-Through: The aircraft-to-aircraft conflict is first received by the controller (A1.2.7.50) and evaluated (A1.2.7.51). The Resolution macro is included to consider machine generated resolutions to the problem. Then, the Planning macro is included to allow the controller to plan traffic in the sector. In support of Planning (i.e., simultaneously), the controller may request and/or evaluate:

- reprobe status (A1.4.11.58, A1.4.11.59)
- trial plan route display (A1.4.11.19, A1.4.11.16)
- rationale for maneuver type/ranking (A1.2.7.55, A1.2.7.56)
- display of cleared route (A1.4.11.9, A1.4.11.17)
- explanatory information about a predicted problem (A1.2.7.57, A1.2.7.58)
- aircraft conflict display (A1.4.11.16, A1.2.7.1)
- display of future situation (A1.1.1.53, A1.1.1.54)

If the controller is not yet satisfied with the resolution, processing of the Planning and Resolution Macros is repeated. Otherwise, the Formalize Flight Intent macro is included to notify the pilot and the automation of the new clearance.

It should be noted that the controller has the option not to respond to the original notice when workload does not permit action or when the controller prefers to monitor the developing situation.

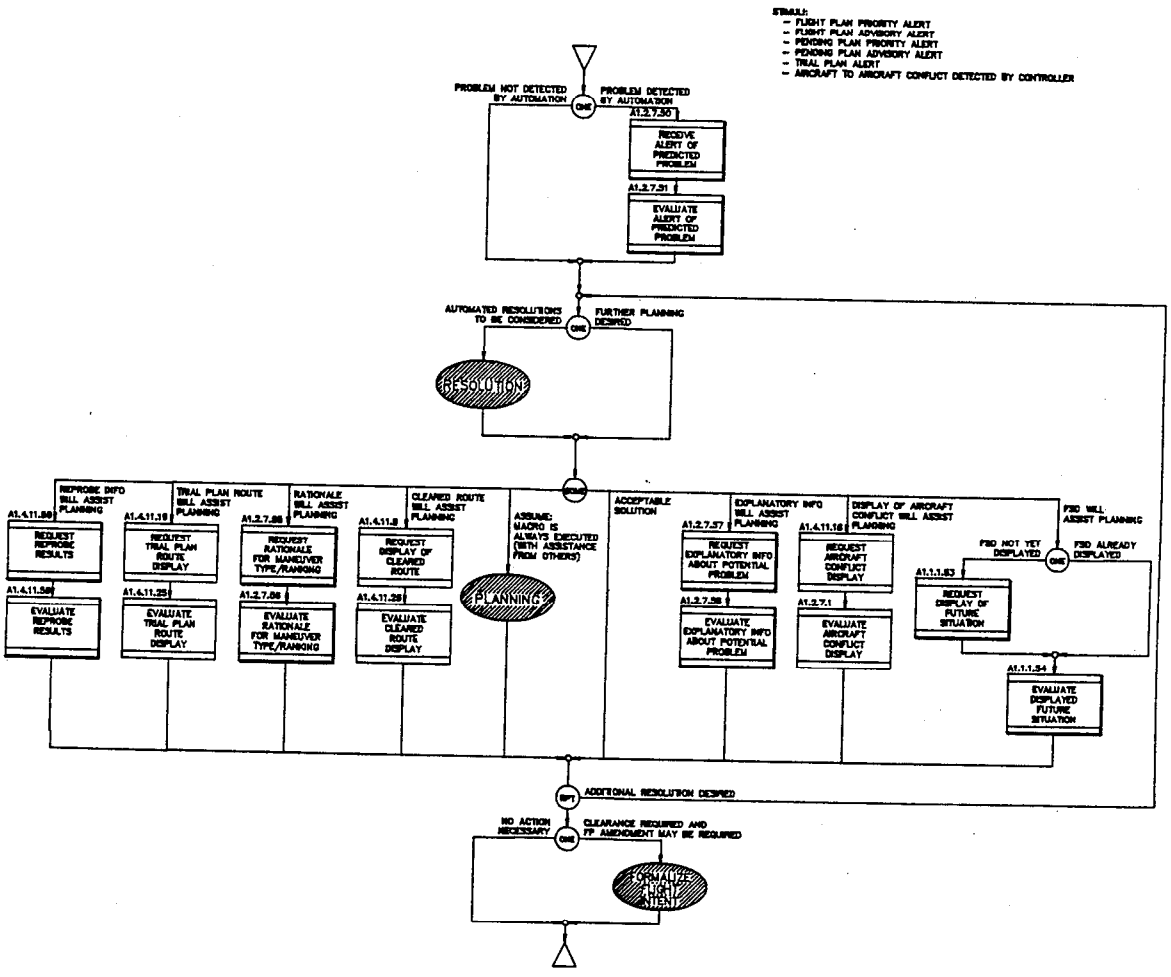

Figure 2-20. Sub-Activity 2.7 - Processing Aircraft-to-Aircraft Conflict Problems

Sub-Activity 3.1: Processing Traffic Management Problems

Purpose: This sub-activity responds to predicted violations of compliance with traffic management instructions (e.g., metering, flow restrictions).

Function Within AAS/AERA: This sub-activity is executed in response to flow compliance problems which are either identified by the controller or detected by the automation. The controller has the option of developing a trial plan solution or using a computer-generated resolution. The processing of changes in traffic management instructions is covered in sub-activity 1.1 Monitoring for Problems. Once the problem is resolved, monitoring continues in sub-activity 1.1.

Walk-Through: The traffic management problem is first received by the controller (A1.2.7.50) and evaluated (A1.2.7.51). The Resolution macro is included to consider machine-generated resolutions to the problem. Then, the Planning macro is included to allow the controller to plan traffic in the sector. In support of Planning (i.e. simultaneously), the controller may request and/or evaluate the following:

- metering advisory list (A1.3.1.14, A1.3.1.15)
- reprobe status (A1.4.11.58, A1.4.11.59)
- trial plan route display (A1.4.11.19, A1.4.11.16)
- rationale for maneuver type/ranking (A1.2.7.55, A1.2.7.56)
- display of cleared route (A1.4.11.9, A1.4.11.17)
- explanatory information about predicted problem (A1.2.7.57, A1.2.7.58)
- exception to flow restriction (A1.3.1.16)
- discontinue of flow restriction (A1.3.1.17)
- traffic management advisories (A1.3.1.12, A1.3.1.13)
- display of future situation (A1.1.1.53, A1.1.1.54)

If the controller is not yet satisfied with the resolution, the Planning and Resolution Macros are repeated. Otherwise, the Formalize Flight Intent macro is included to notify the the pilot and the automation of the new clearance.

It should be noted that the controller has the option to defer responding to the original notice when workload does not permit immediate action or when the controller prefers to monitor the developing situation.

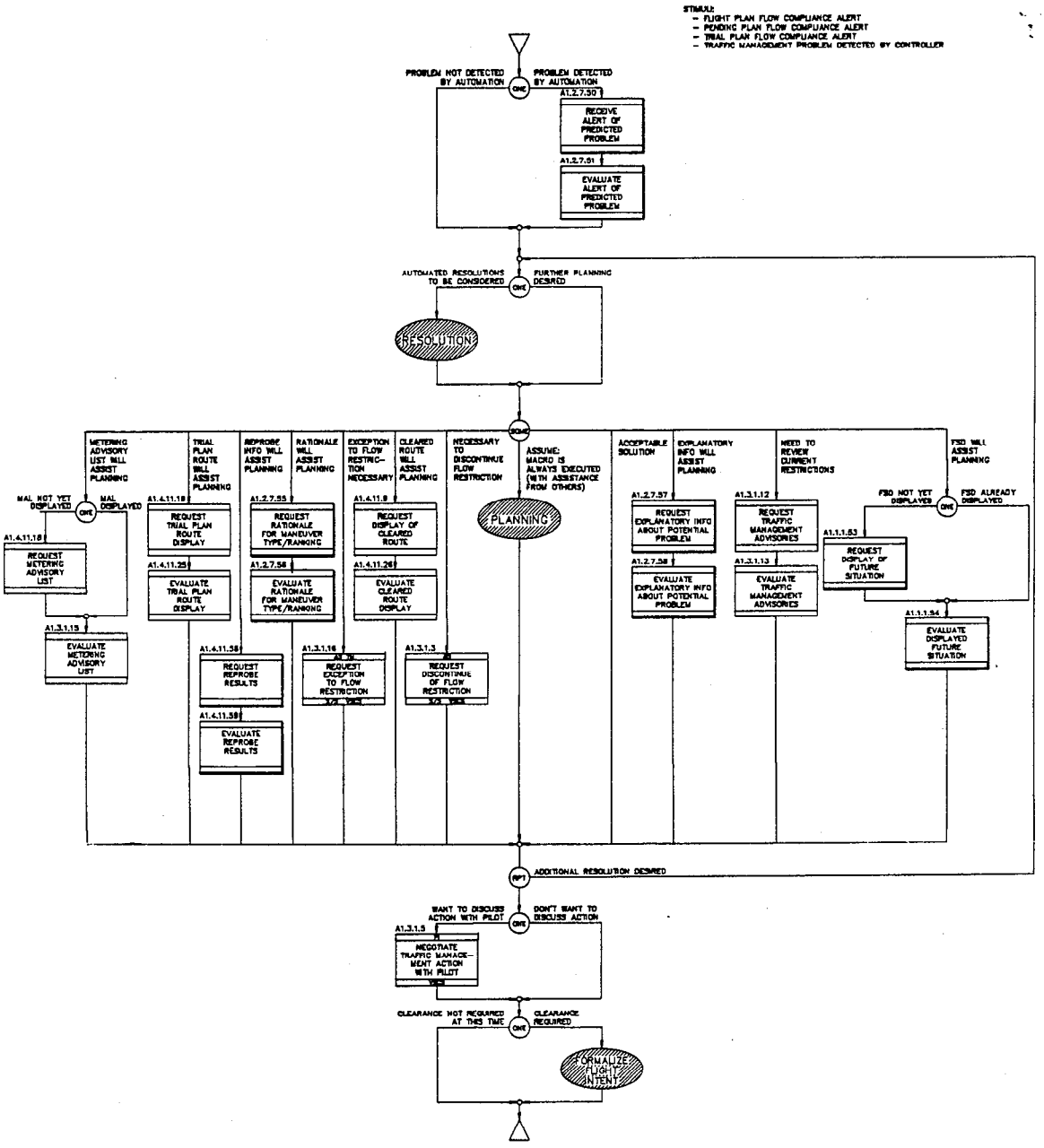

Figure 2-21. Sub-Activity 3.1 - Processing Traffic Management Problems

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Sub-Activity 3.2: Processing Non-Conformance Problems

Purpose: This sub-activity responds to predicted or actual lateral or vertical non-conformance conditions detected by the controller.

Function Within AAS/AERA: This sub-activity is executed in response to a non-conformance condition either identified by the controller or detected by the automation. The controller may be informed of a non-conformance condition by the automation via a Sector Suite display (the Alert and Resolution, Planning, Data Block in the Situation, and the Flight Data displays include the alert indications). Predicted non-conformance conditions occur when an aircraft has passed a nominal maneuver point. This sub-activity restores conformance either by returning the aircraft to its original flight plan, amending its flight plan, or building a new flight plan. Once resolved, monitoring continues in sub-activity 1.1.

Walk-Through: The Non-Conformance message or the Monitor Maneuver message is first received and evaluated by the controller (A1.2.7.50, A1.2.7.51, A1.3.2.50, A1.3.2.51). Optionally, the pilot may be querried regarding the problem (A1.4.10.8). The Resolution macro is included to consider machine generated resolutions to the problem. Then, the Planning macro is included to allow the controller to plan traffic in the sector. In support of Planning (i.e. executed simultaneously), the controller may request and evaluate the following:

- current full Flight Plan readout (A1.3.2.9, A1.3.2.10)
- trial plan route display (A1.4.11.19, A1.4.11.16)
- rationale for maneuver type/ranking (A1.2.7.55, A1.2.7.56)
- display of cleared route (A1.4.11.9, A1.4.11.17)
- explanatory information about potential problem (A1.2.7.57, A1.2.7.58)
- display of conformance bounds (A1.3.2.52, A1,3.2.53)
- display of Future Situation (A1.1.1.53, A1.1.1.54).

If the controller is not yet satisfied with the resolution, the Planning and Resolution Macros are repeated. Otherwise, the Formalize Flight Intent macro is included to notify the pilot and the automation of the new clearance.

It should be noted that the controller has the option to defer responding immediately to the original notice when workload does not permit action or when the controller prefers to monitor the developing situation.

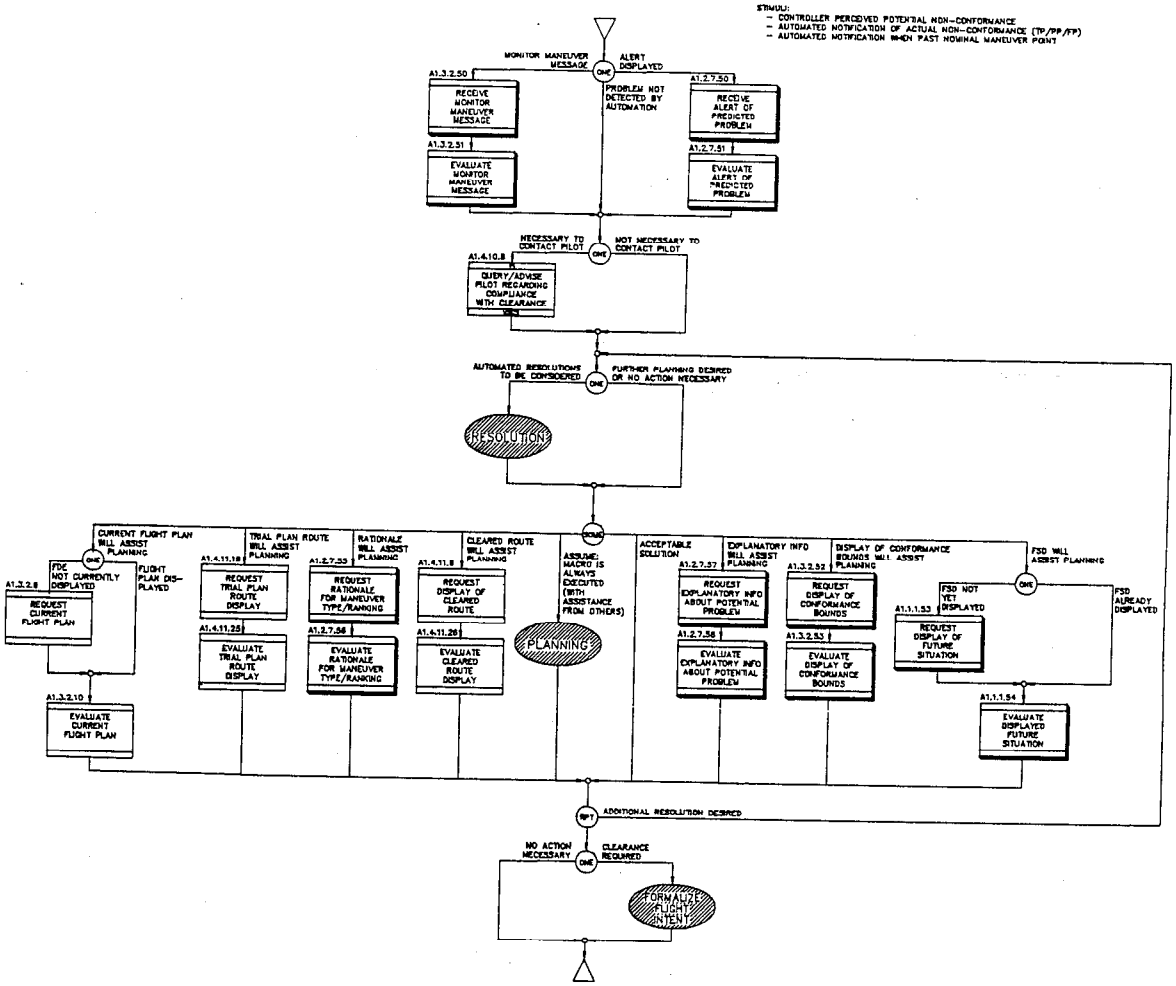

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Figure 2-22. Sub-Activity 3.2 - Processing Non-Conformance Problems

Sub-Activity 3.7: Responding to Requests for Release of Airspace

Purpose: This sub-activity responds to requests for release of airspace due to:

- o change in the status of special use airspace,
- o another sector controller requests temporary use of an airspace,
- o notice of airspace restriction status change, or
- o the controller observes an airspace status change.

Function Within AAS/AERA: This sub-activity processes requests for release of airspace from another controller (sub-activity 3.8) or from the supervisor. It may also be the result of an airspace restriction change. Once the request is processed, monitoring for problems continues (sub-activity 1.1).

Walk-Through: Upon entry, requests for release of airspace are detected from the sources listed above (A1.3.3.7, A1.3.7.1, A1.3.3.6, A1.3.3.5). Then the request may be evaluated to determine if the airspace may be released (A1.3.7.7). Sometimes the airspace release can be constrained by altitude (A1.3.3.4) and also may need to be discussed with another controller or the supervisor (A2.3.7.5). The response is forwarded to the requesting controller as a denial (A1.3.7.3) or an approval (A1.3.7.2). At this point the controller may perform one or more of the following:

- request the supervisor or TMU to enter the ATC airspace into the automation (A.1.5.1.23),
- advise the controller, supervisor, and/or the pilot of the new airspace restriction (A1.3.3.1),
- enter the released airspace information for sector boundary adjustment (A1.3.7.50),
- enter the airspace restriction status change (A1.3.3.2),
- request the supervisor to identify the new airspace restriction as "strategic" to the system (A1.3.3.51).

If the situation requires a tailored set of automated resolutions, the controller may adjust the constraints placed upon the automated resolution capability (A1.4.2.50).

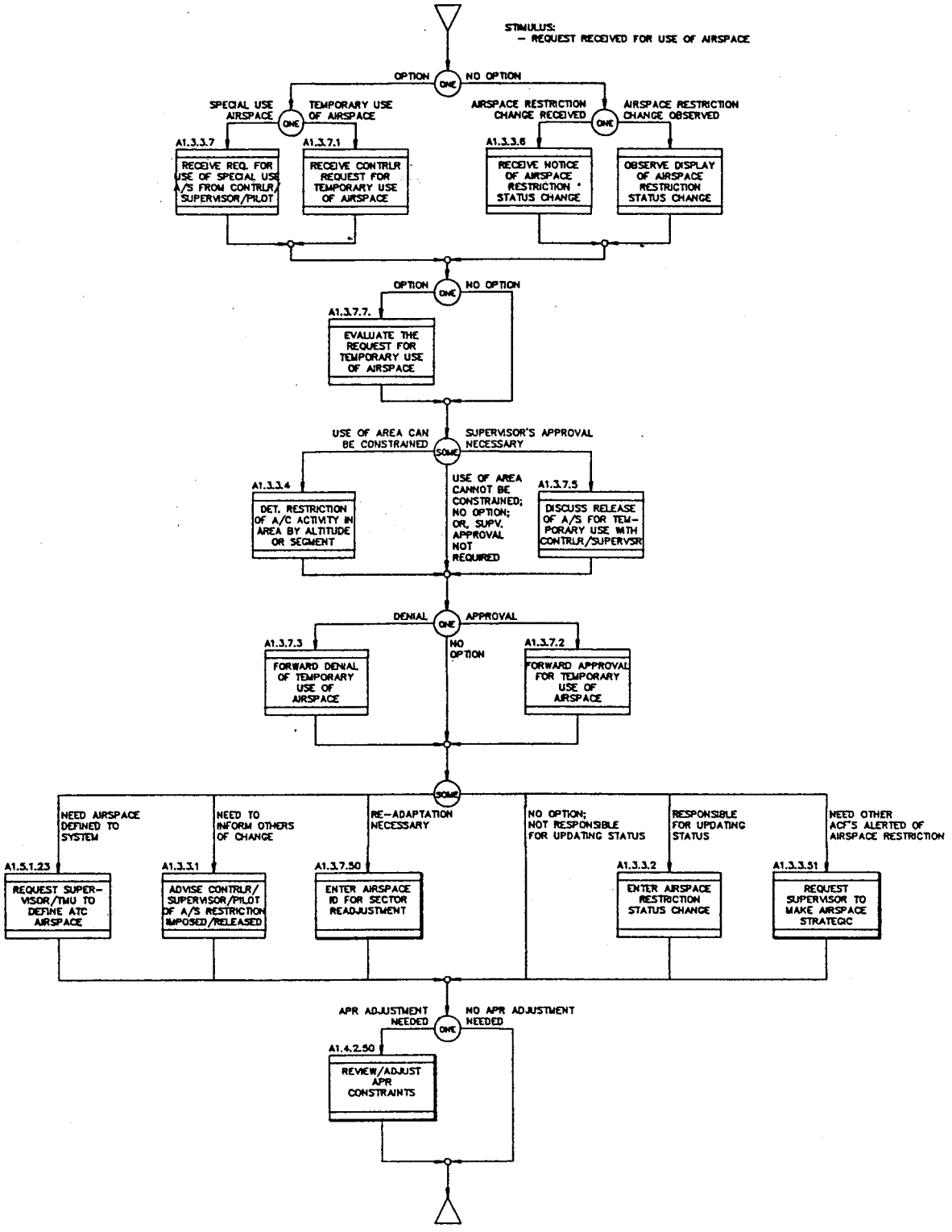

Figure 2-23. Sub-Activity 3.7 - Responding to Requests for Release of Airspace

Sub-Activity 3.8: Requesting Use of Airspace

Purpose: This sub-activity includes the tasks necessary to request the use of airspace that is not currently under the control of the requesting sector.

Function Within AAS/AERA: In this sub-activity the controller requests the use of airspace from another sector. This request is subsequently processed in sub-activity 3.7. Once the request is forwarded and related tasks have been performed, the controller returns to monitoring for problems in sub-activity 1.1.

Walk-Through: Upon entry, the request for use of another sector's airspace is forwarded to the other controller. The request may be for temporary use of airspace (A1.3.8.1) or special use airspace (A1.2.3.3). If flight data is required by the other controller, the FDE is forced to that sector (A1.4.8.3). Depending on the request type, a denial may be received for special use airspace (A1.2.3.4) or for temporary use of the airspace (A1.3.8.3). Similarly, an approval may be received for special use airspace (A1.2.3.5) or for temporary use of the airspace (A1.3.8.2). At this point, the controller may perform one or more of the following:

- advise the controller, supervisor, and/or pilot of the imposed airspace restriction (A1.3.3.1),
- enter the change to the airspace restriction (A1.3.3.2),
- request the supervisor to identify the new airspace restriction as "strategic" to the system (A1.3.3.51).

If the situation requires a tailored set of resolutions, the controller may adjust the constraints placed upon the automated resolution capability (A1.4.2.50).

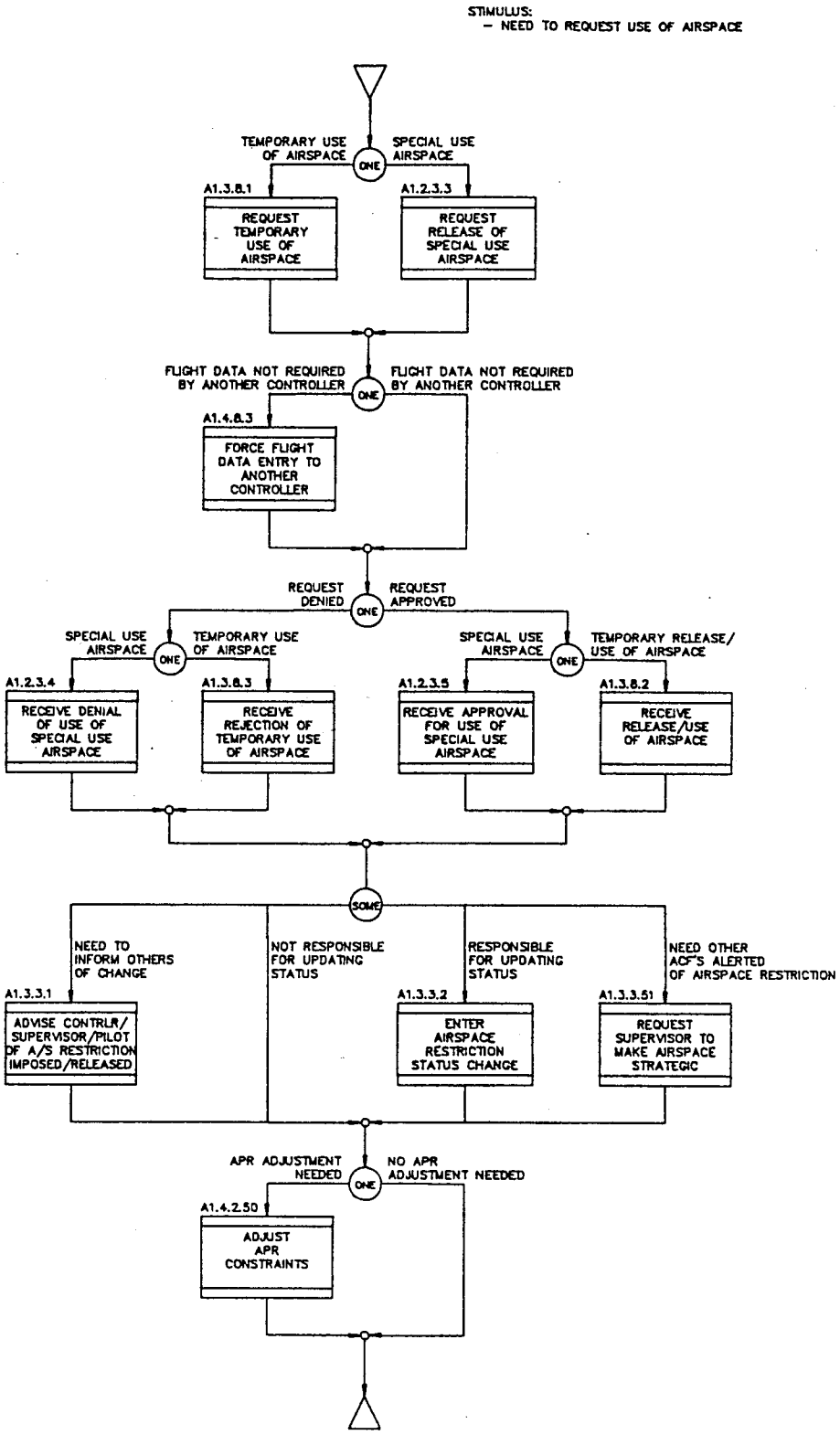

Figure 2-24. Sub-Activity 3.8 - Requesting Use of Airspace

Sub-Activity 4.1: Planning and Issuing Clearances

Purpose: This sub-activity responds to the need to formulate and issue a clearance or directive.

Function Within AAS/AERA: This sub-activity formulates and issues clearances in response to any event that requires a change to a flight.

Walk-Through: This sub-activity gathers information for planning of controller directives or clearances. Information may include:

- resolutions, trial or pending plans (A1.4.1.50&53),
- perceived need for amended clearance (A1.4.1.12),
- clearance request from pilot (A1.4.1.2),
- controller reminder or clearance (A1.4.1.9),
- clearance request (A1.4.1.13)
- controller requested clearance (A1.4.1.3),
- notice of problem-free reprobed trial plan (A1.2.9.50),
- notice of aircraft no longer affected by flow or airspace restriction (A1.2.9.51),
- automated coordination (A1.4.1.55) or response (A1.4.1.56), or
- pilot reportedchanged aircraft specific characteristics (A1.4.1.58).

Then the controller may request and evaluate a predeparture check (A1.4.1.52 and A1.4.10.52) or search for inactive Flight Plan on clearance request (A1.1.3.1). At that point the controller will plan the traffic in the sector (Planning Macro) and will use the following to support the Planning activity:

- trial plan route display (A1.4.11.19, A1.4.11.25),
- mental projection of aircraft position (A1.1.1.4, A1.4.11.20),
- display of cleared route (A1.4.11.9, A1.4.11.26),
- display of future situation (A1.1.1.53, A1.1.1.55, A1.1.1.54),
- full or limited flight plan readout (A1.1.3.2&3),
- display of sector workload factor (A1.6.8.50, A1.6.8.51),

As well as conferring with the pilot (A1.4.4.8) or another controller (A1.4.4.9), the current controller may deny the clearance request (A1.4.10.9, 4.10.3), approve the request (A1.4.10.2), or formulate a new clearance with instructions (A1.4.10.4). The plan is then made current and the clearance issued (Formalize Flight Intent macro). Response to automated coordination is also included to accommodate situations where controllers must obtain approval for a clearance from another controller (A1.4.1.57).

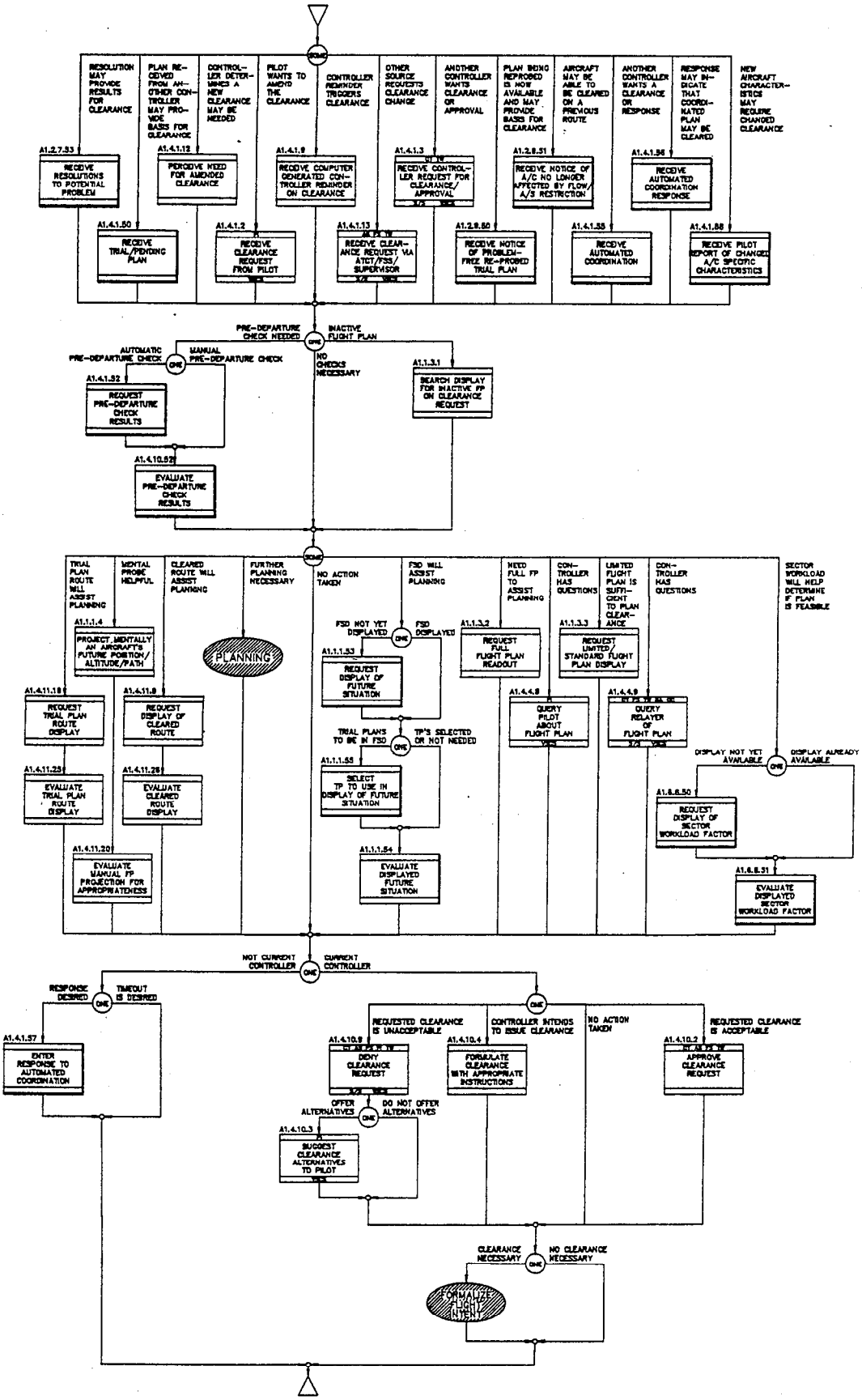

Figure 2-25. Sub-Activity 4.1 - Planning and Issuing Clearances

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Sub-Activity 4.2: Responding to Contingencies and Special Events

Purpose: This sub-activity responds to air traffic control contingencies such as:

- aircraft overdue at an arrival fix,
- loss of radio contact with an aircraft, or
- aircraft emergency.

Function Within AAS/AERA: The contingency is detected and processed within this sub-activity. The controller coordinates possible searches and handles communication with other controllers, supervisor, pilot, and others. Once the problem is resolved, monitoring continues in sub-activity 1.1.

Walk-Through: The particular contingency is detected by:

- receiving information on overdue aircraft (A1.4.2.2),
- receiving information on loss of radio contact (A1.4.2.14),
- receiving TMC/supervisor review of special operations (A1.4.3.2),
- perceiving presence of special operations (A1.4.3.1), or
- detecting emergency status (A1.4.2.4) which would be followed by receiving supervisor notice (A1.4.2.11) or declaring the emergency (A1.4.2.1).

At this point, the contingency is known and the supervisor and/or other controllers may be notified of special operations (A1.4.3.3) or forwarded contingency information (A1.4.2.5). Then, the controller may receive direction from the supervisor to conduct a communication search (A1.4.2.12) or notice that the supervisor will conduct the search (A1.4.2.13). Then, depending on the contingency type, the controller may alert appropriate personnel (A1.4.2.6), or conduct the radio/radar search for the overdue aircraft (A1.4.2.10) or the aircraft without radio contact (A1.4.2.8, A1.4.2.9). Finally, the APR constraints are adjusted if appropriate.

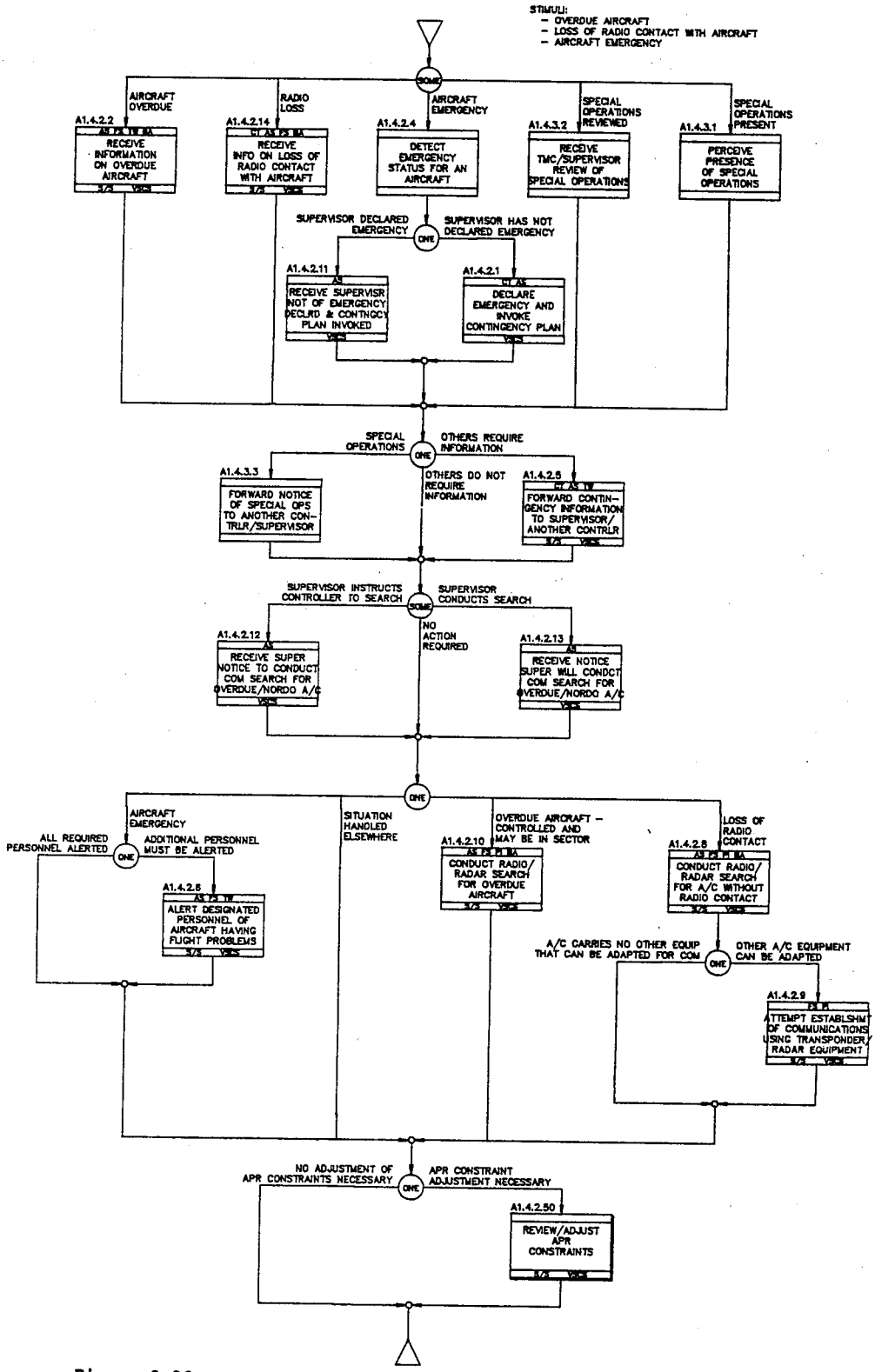

Figure 2-26. Sub-Activity 4.2 - Responding to Contingencies and Special Events

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Sub-Activity 4.4: Reviewing New Flight Plans

Purpose: This sub-activity is concerned with the checking and reviewing of tasks associated with receiving a Flight Plan for the first time. The Flight Plan may be received either automatically, via posting, through verbal communications with a pilot ("pop up") or through another controller. The controller reviews the Flight Plan for completeness/errors and determines the validity of the overall plan.

Function Within AAS/AERA: The new Flight Plan posting or request is received and validated within this sub-activity. Once processed, monitoring continues in sub-activity 1.1.

Walk-Through: A new Flight Plan posting is first observed (A1.4.4.1). Additional information to support review of the plan may be requested including: limited or standard flight plan display (A1.1.3.3) or full Flight Plan readout (A1.1.3.2). The plan is then reviewed for large errors (A1.4.4.5) and acknowledged (A1.4.4.4). Flight plans may also be received directly from the pilot (A1.4.4.6) or verbally forwarded (A1.4.4.7). If verbal transmittal is used, the plan is checked for completeness (A1.4.4.2) and the pilot (A1.4.4.8) or the relayer (A1.4.4.9) may be queried concerning the Flight Plan. Then the Flight Plan may be forwarded (A1.4.4.10) or entered into the automation (A1.4.4.3). Regardless of the source, a VFR Flight Plan may need to be entered into the computer to be included in flight plan processing (A1.4.4.11).

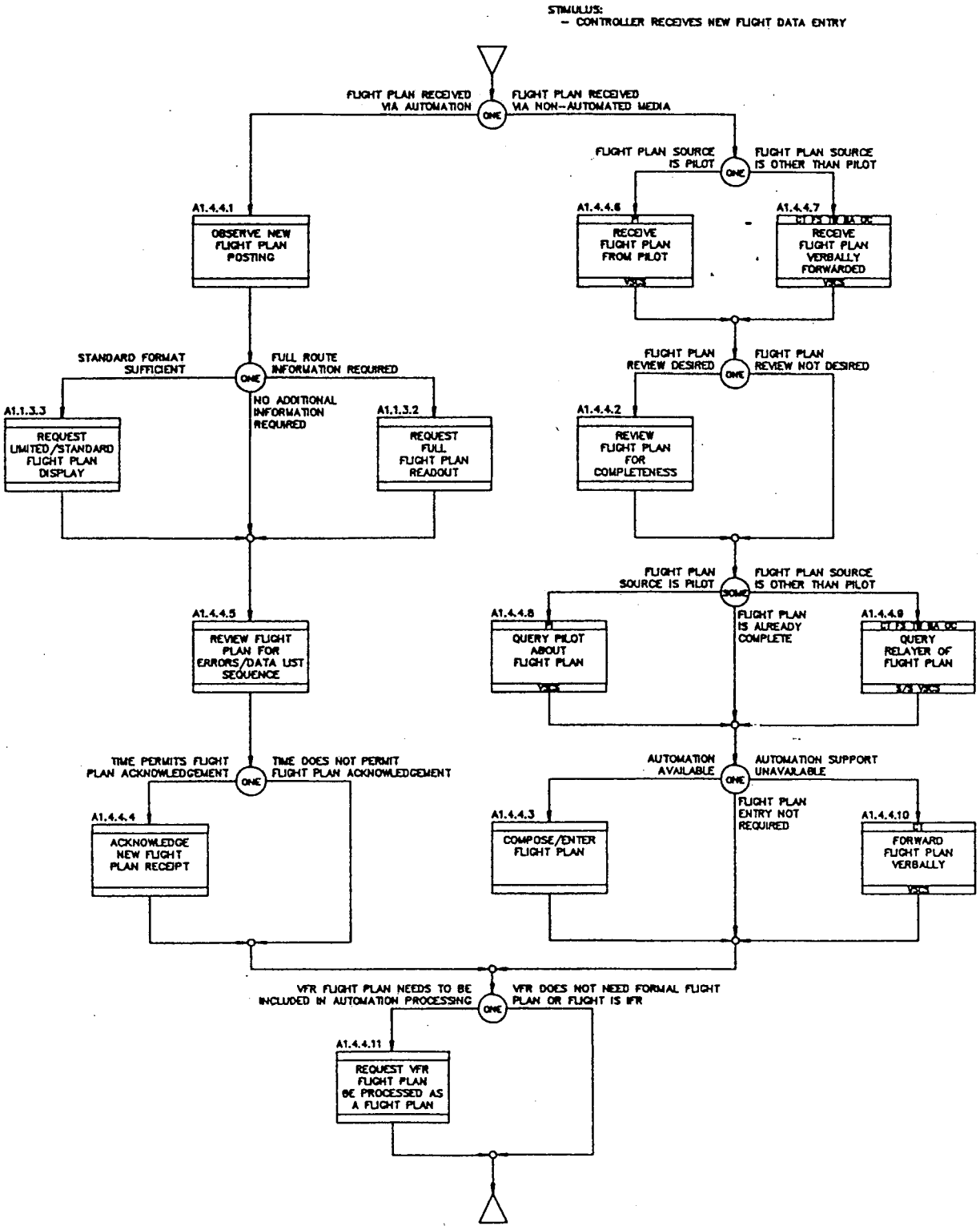

Figure 2-27. Sub-Activity 4.4 - Reviewing New Flight Plans

1/22/86

Sub-Activity 4.6: Receiving Transfer of Radar Identification

Purpose: This sub-activity responds to handoff requests. The handoff request is evaluated and either accepted or rejected.

Function Within AAS/AERA: This sub-activity is executed in response to a handoff request by another controller in sub-activity 4.7 or to a pointout that was rejected in sub-activity 4.9 thereby requiring a handoff. Once the handoff request has been processed, the controller returns to monitoring for problems in sub-activity 1.1.

Walk-Through: Upon entry into this sub-activity, the handoff request is observed or received (A1.4.6.1). Then the handoff is evaluated (A1.4.6.6) assisted perhaps by conferring with the other controller (A1.4.6.5). If the handoff is to be rejected, it is simply rejected and no further processing is performed. Otherwise, the handoff will be accepted either verbally (A1.4.6.3) or via automation (A1.4.6.4). A handoff received via automation may also require the reception of trial and pending plans or accompanying APR constraints forwarded with it (A1.4.1.50, A1.4.6.51). The handoff transaction is then complete.

Notes: This sub-activity does not include receiving control responsibility (4.12) for the aircraft, nor does it include receiving radio communication (4.14) with the aircraft.

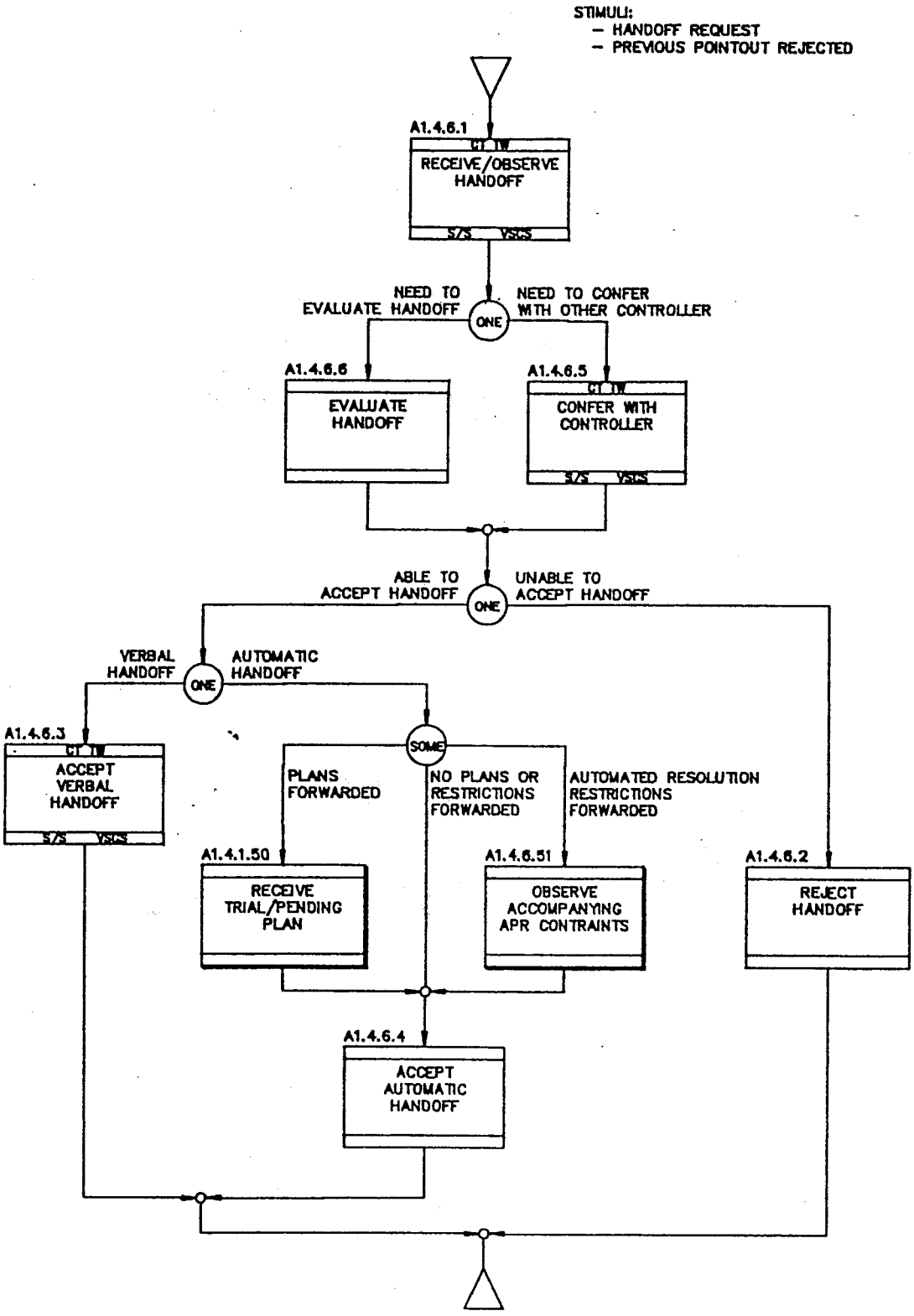

Figure 2-28. Sub-Activity 4.6 - Receiving Transfer of Radar Identification

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Sub-Activity 4.7: Initiating Transfer of Radar Identification

Purpose: This sub-activity deals with transferring radar identification by initiating handoffs. The handoff is normally initiated by the system automatically when the aircraft is within a specified distance from the sector boundary, or it is initiated manually by the controller.

Function Within AAS/AERA: Transfer of radar identification is initiated by requesting a handoff in this sub-activity. The request is then processed in sub-activity 4.6 by another controller. Once the handoff is requested and the response is processed, monitoring continues in sub-activity 1.1.

Walk-Through: As an aircraft is approaching a boundary, the controller may choose to alter what is displayed. Handoff indications may be inhibited or restored for designated tracks (A1.4.7.7, A1.4.7.8) or for a block altitude (A1.4.7.12, A1.4.7.11). The Flight Plan data may then be transferred (A1.4.7.10). At this point, one of three things occurs, the handoff will be initiated verbally (A1.4.7.17), automatic handoff is observed (A1.4.7.2), or handoff will be detected and initiated manually (A1.4.7.9, A1.4.7.1). A trial or pending plan may be designated to be transferred at handoff initiation (A1.4.7.50). After initiation, a handoff rejection may be received (A1.4.7.15), handoff acceptance may be received (A1.4.7.4), handoff failure notice may be received (A1.4.7.16), or the handoff alert may be detected (A1.4.7.13). Finally, the controller may either retract the handoff (A1.4.7.3), or redirect the handoff (A1.4.7.14). If the controller wishes to try the handoff again, the sequence of tasks is repeated, beginning at the handoff initiation tier.

Notes: This sub-activity does not include initiating transfer of control responsibility for the aircraft, nor does it include transferring radio communication with the aircraft (4.14).

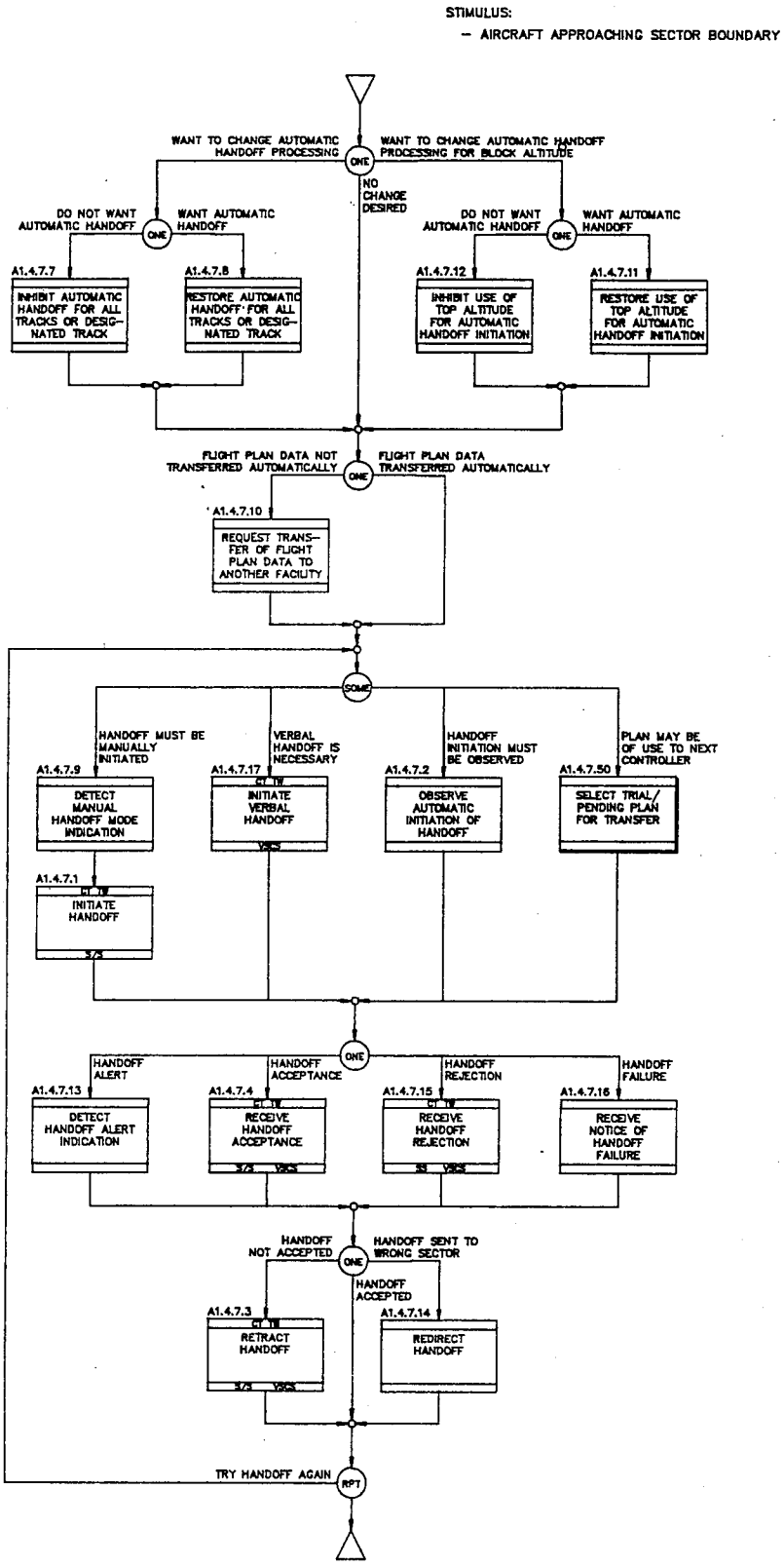

Figure 2-29. Sub-Activity 4.7 - Initiating Transfer of Radar Identification

Sub-Activity 4.8: Initiating Pointouts

Purpose: This sub-activity deals with initiating pointouts, either manually or automatically, when an aircraft approaches an adjacent sector. Coordination with the receiving controller is also performed.

Function Within AAS/AERA: Pointouts are initiated in this sub-activity. The request is then processed in sub-activity 4.9 by another controller. Once the pointout is initiated and a response is received, monitoring continues in sub-activity 1.1.

Walk-Through: As an aircraft approaches a boundary, the controller may choose to alter what is automatically pointed out. Pointouts for a sector or a particular track may be inhibited (A1.4.8.7) or restored (A1.4.8.6). Then the pointout is either initiated (A1.4.8.1) or the automatic initiation is observed (A1.4.8.2). Along with the initiation, the Flight Data Entry may be transferred to the adjacent sector (A1.4.8.3). If the adjacent controller does not respond, this is detected (A1.4.8.8) and a verbal pointout is initiated (A1.4.8.11) instead. If the adjacent controller accepts the pointout, the acceptance is received, perhaps with restrictions (A1.4.8.10, A1.4.8.4). If a pointout is rejection is received, (A1.4.8.5) the other controller may be queried (A.1.4.8.9).

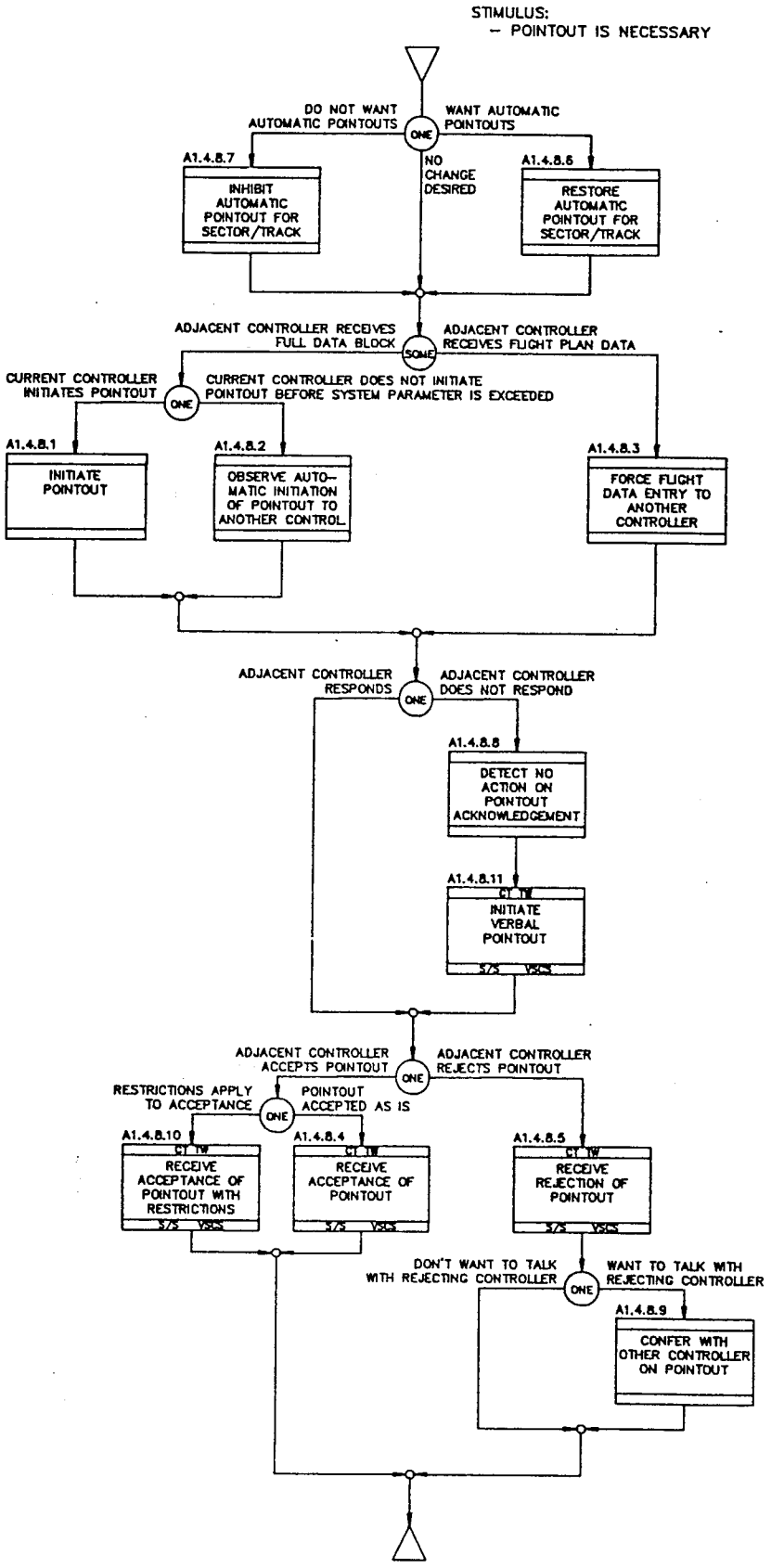

Figure 2-30. Sub-Activity 4.8 - Initiating Pointouts

Sub-Activity 4.9: Receiving Pointouts

Purpose: This sub-activity responds to pointout requests generated either automatically or manually. The pointout request is evaluated and either accepted or rejected.

Function Within AAS/AERA: This sub-activity is executed in response to a pointout request by another controller in sub-activity 4.8. If the pointout is ultimately rejected, then processing may continue with a requested handoff in sub-activity 4.6. If the pointout is accepted, processing continues in the monitoring sub-activity 1.1.

Walk-Through: Upon entry to the sub-activity, the pointout request is first received (A1.4.9.1). Then the pointout request is evaluated (A1.4.9.5) perhaps by conferring with the other controller (A1.4.8.9). If the pointout is to be rejected, it is simply rejected (A1.4.9.3). If it is to be accepted, it is accepted with or without restrictions (A1.4.9.4, A1.4.9.2).

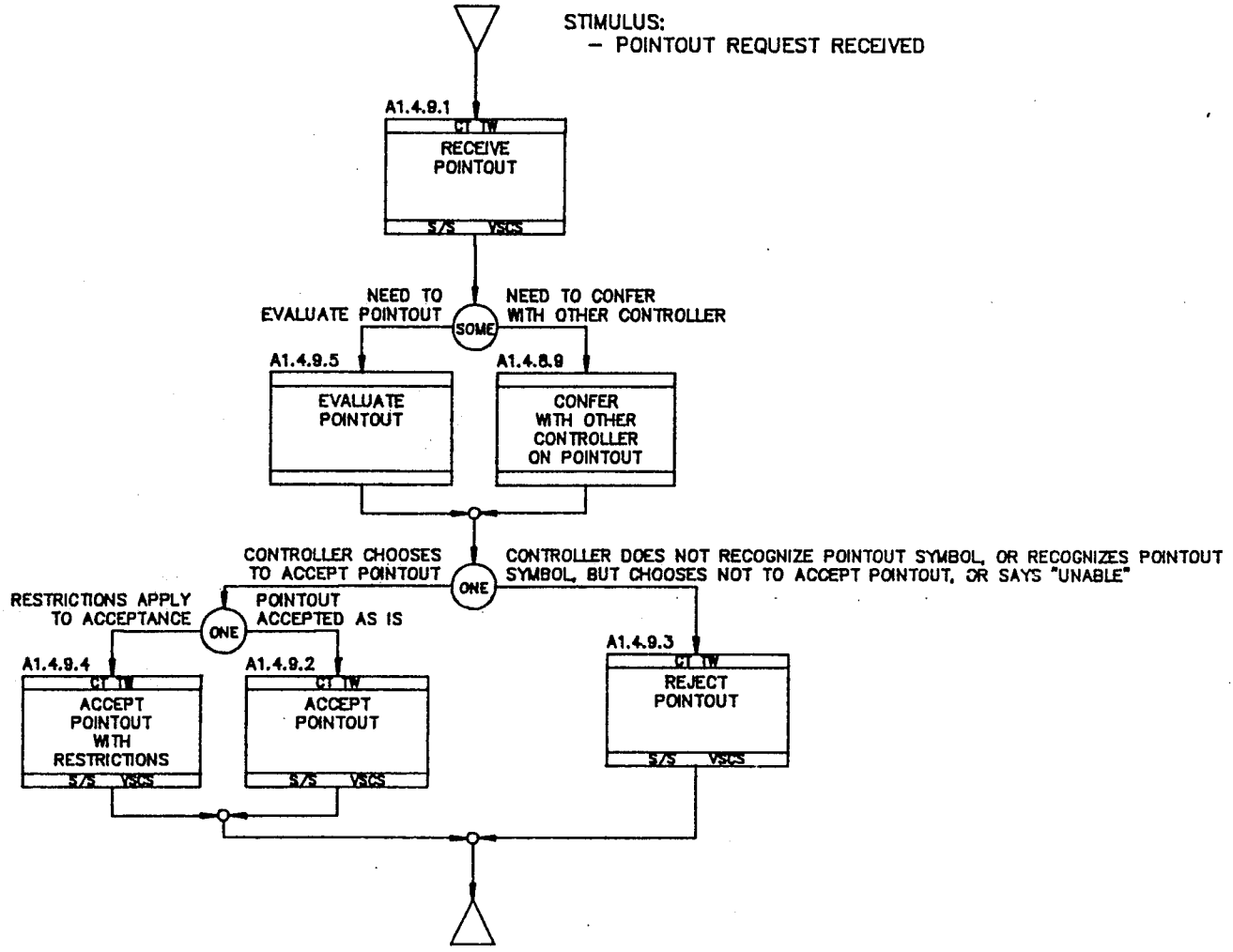

Figure 2-31. Sub-Activity 4.9 - Receiving Pointouts

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Sub-Activity 4.12: Receiving Control Responsibility

Purpose: This sub-activity performs the functions necessary to take legal responsibility for the control of an aircraft. This is normally the result of an aircraft physically entering the sector airspace. It may also occur if the controller needs to maneuver an aircraft with which communication is already established, but which has not yet entered the sector.

Function Within AAS/AERA: This sub-activity is performed when it is necessary to take legal control of an aircraft. It is the complement of sub-activity 4.13 which represents the activities of relinquishing control. Once the control responsibility has been transferred, the controller resumes monitoring in sub-activity 1.1.

Walk-Through: If upon entry to this sub-activity, the aircraft is actually entering the sector, the controller simply observes the event (A1.4.12.3). If not, and another controller wants to maneuver the aircraft, a trial or pending plan is received from the other controller (A1.4.1.50). The Planning macro is included to check the plan against the present and future situation and if the plan is acceptable, it is made current (A1.4.10.50). If the controller perceives a need to maneuver the aircraft, planning is first performed. The other controller may choose to coordinate verbally (A1.4.7.5) or via automated coordination. If at this point the controller is able to take control responsibility, control is received (A1.4.12.6).

Notes: Control responsibility may also be received on an aircraft whose communication has already been transferred and the previous controller needs to maneuver the aircraft.

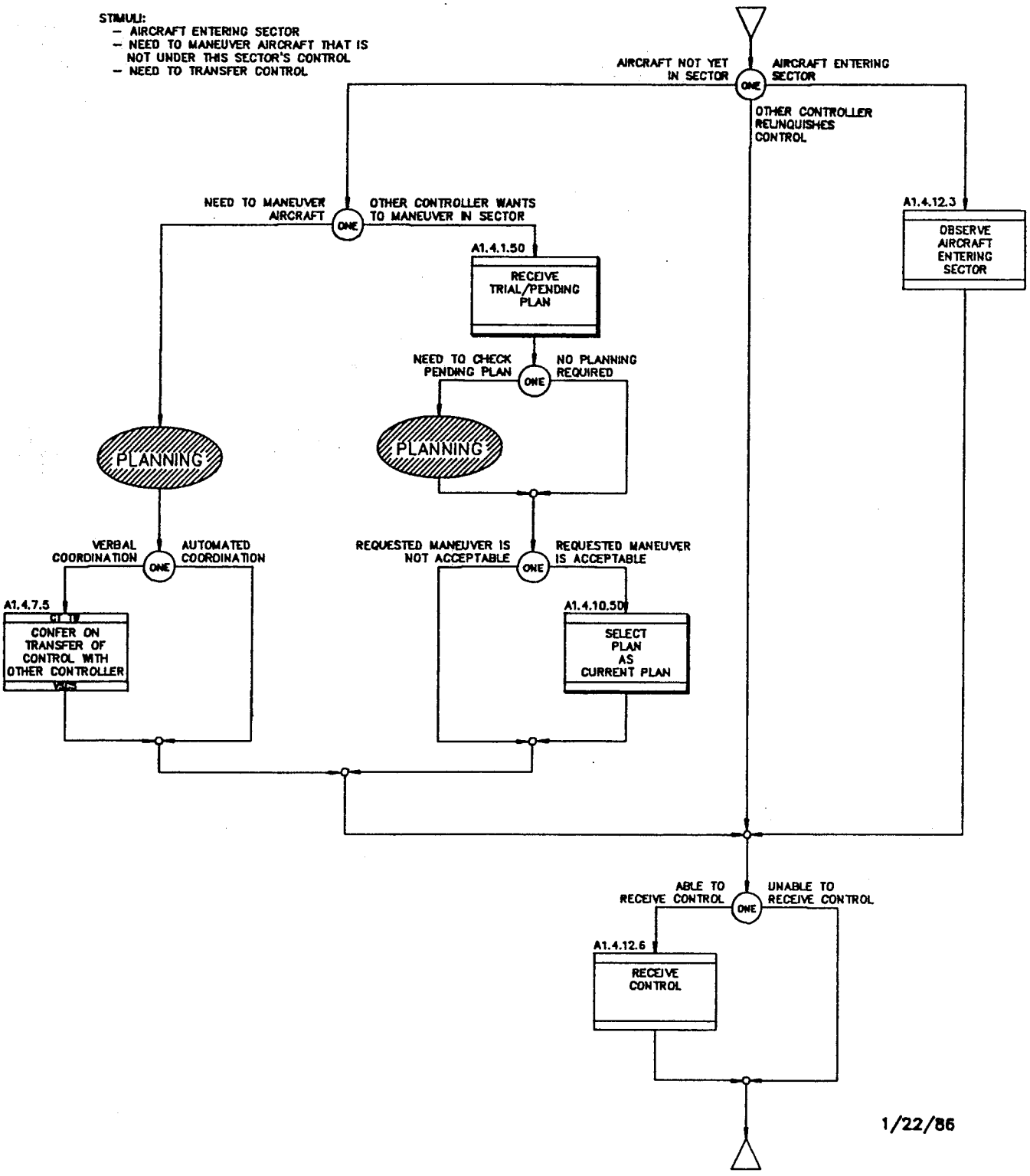

Figure 2-32. Sub-Activity 4.12 - Receiving Control Responsibility

Sub-Activity 4.13: Relinquishing Control Responsibility

Purpose: This sub-activity performs the functions necessary to relinquish legal control of an aircraft. This normally happens when an aircraft exits across a sector boundary.

Function Within AAS/AERA: This sub-activity is performed when it is necessary to relinquish legal control of an aircraft. It is the complement of sub-activity 4.12 which represents the activities of the controller receiving control. Once the control responsibility has been transferred, the controller resumes monitoring in sub-activity 1.1.

Walk-Through: If the subject aircraft is actually crossing the sector boundary, the controller simply observes the event (A1.4.13.3). If not, the controller may receive a request for transfer of control from the other controller (A1.4.13.1). Then, the Planning macro is included to plan air traffic without that aircraft. If no flight plan change is required, control of the plan is simply exchanged (A1.4.13.4). If a change is required, the other controller is consulted verbally (A1.4.7.5) or via automated coordination. If the other controller is able to assume control, legal responsibility is relinquished (A1.4.13.7).

Notes: Control responsibility may also be relinquished in the case where an aircraft's communication has already been transferred, and the next controller needs to maneuver the aircraft.

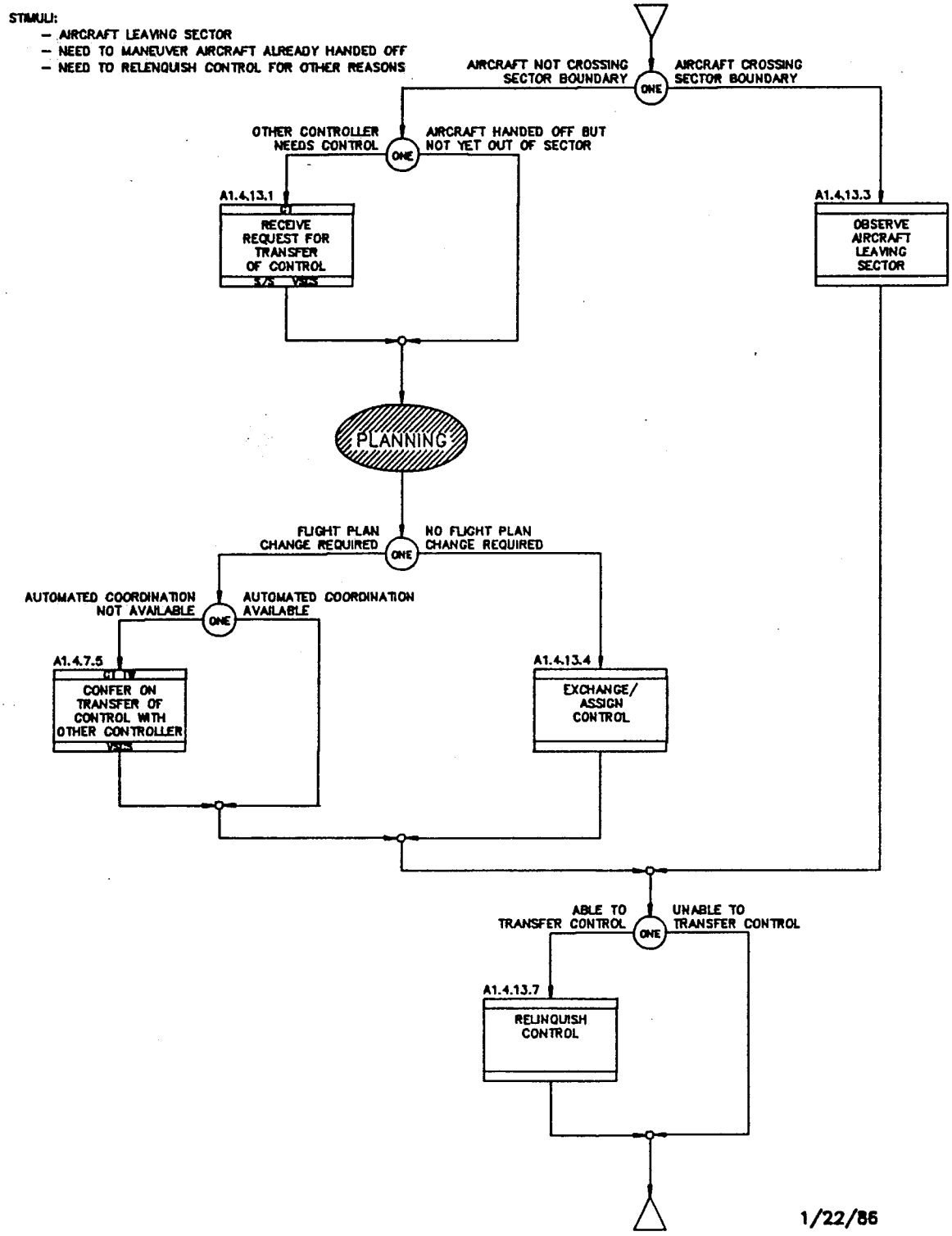

Figure 2-33. Sub-Activity 4.13 - Relinquishing Control Responsibility

Sub-Activity 4.14: Establishing, Maintaining and Terminating Radio Communications

Purpose: This sub-activity performs all the tasks associated with maintaining proper radio communications with an aircraft. This includes the initial establishment of radio communications as well as maintaining and terminating communications. The sub-activity responds to aircraft entering or leaving the sector, aircraft cancelling IFR services, or aircraft arriving at their destination.

Function Within AAS/AERA: This sub-activity is executed whenever the need for radio communications change for an aircraft. Once the change has been properly performed, monitoring resumes in sub-activity 1.1.

Walk-Through: If this sub-activity is invoked by an aircraft cancelling IFR services or an aircraft arriving at its destination, the controller first receives either the "cancel IFR" request (A1.4.14.5) or the "fix arrival" message (A1.4.14.6). Concurrently, radio communications may be terminated. Finally, the flight data entry is deleted from the system (A1.1.6.3). If the stimulus is an aircraft entering the sector, initial radio contact is first received from the pilot (A1.4.14.2). Then, the controller may issue an altimeter setting (A1.4.14.3), enter a reported altitude (A1.3.5.2) and/or validate mode-C altitude (A1.3.5.1) when appropriate conditions exist. When an aircraft is leaving the sector, either the controller receives the handoff acceptance (A1.4.7.4) under radar procedures or observes the aircraft symbol approaching the sector boundary under non-radar procedures. Then, the frequency in use by the receiving sector is determined (A1.4.14.1) and issued to the pilot (A1.4.7.6). Finally, the flight data entry may be suppressed from the Sector Suite.

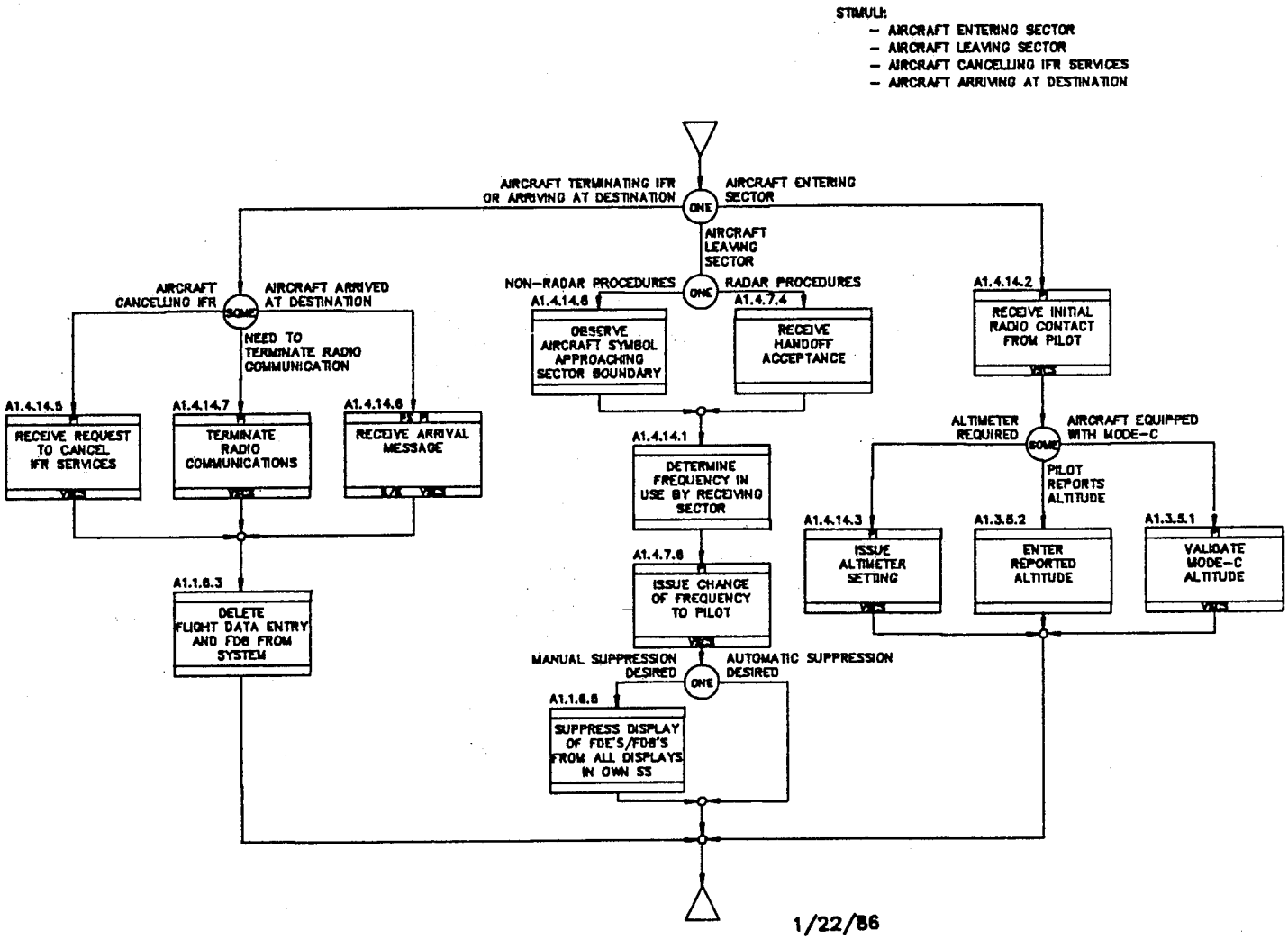

Figure 2-34. Sub-Activity 4.14 - Establishing, Maintaining, and Terminating Radio Communication

1/22/86

Sub-Activity 4.15: Maintaining/Discontinuing Radar Identification

Purpose: This sub-activity performs all the tasks associated with maintaining or discontinuing radar identification of an aircraft receiving radar services in the sector. It is performed routinely to ensure that valid radar targets are associated with correct track data blocks.

Function Within AAS/AERA: This sub-activity is executed when a new aircraft receiving radar services is in the sector. Proper procedures are established as well as maintaining or discontinuing radar identification. It is the complement of sub-activity 4.16 which reflects the tasks required to establish radar identification. Once radar ID is maintained or discontinued, monitoring continues in sub-activity 1.1.

Walk-Through: When a new aircraft receiving radar services is in the sector, the controller first observes the Data Block and track symbol of the aircraft (A1.4.15.1). If the aircraft is in a radar coverage area, the controller must determine whether the Data Block is still in association with the track (A1.4.15.2). If the transponder misses or the radar coverage fluctuates, the Data Block must be re-associated (A1.4.15.3). If the aircraft is in coast mode, or in an area of no radar coverage, the controller may advise the pilot of radar contact lost (A1.5.15.4) and/or initiate non-radar separation standards (A1.4.15.50) as appropriate. If the aircraft is in an area not covered by radar, the pilot is informed that radar services are terminated (A1.4.15.5). Then, if extrapolation does not begin automatically, the controller manually requests flight plan extrapolation (A1.1.4.5) an observes the flight plan position (A1.1.4.6).

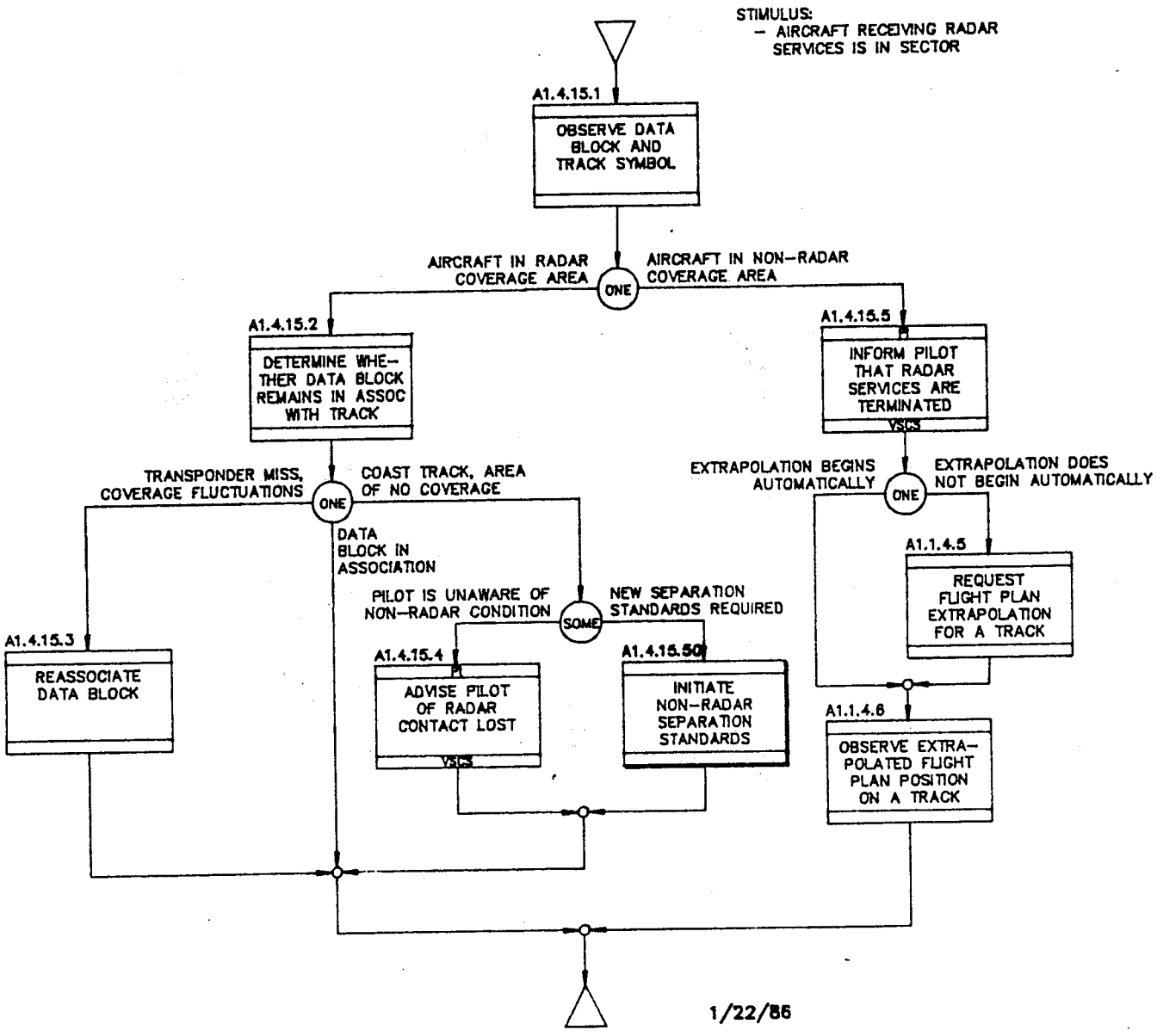

Figure 2-35. Sub-Activity 4.15 - Maintaining/Discontinuing Radar Identification

Sub-Activity 4.16: Establishing/Re-establishing Radar Identification

Purpose: This sub-activity performs the tasks associated with establishing or re-establishing radar identification when an aircraft receiving non-radar services is in the sector.

Function Within AAS/AERA: This sub-activity is executed when a new aircraft receiving non-radar services is in the sector. This sub-activity is the complement of sub-activity 4.15 which reflects the tasks required to maintain and ultimately discontinue radar identification. Once established, monitoring for problems continues in sub-activity 1.1, and maintaining radar identification continues in sub-activity 4.15.

Walk-Through: This sub-activity is invoked when:

- flight following request is received from the pilot or another controller (A1.4.5.2) because VFR needs a radar identification,
- pilot position report is received (A1.4.5.7) which would also require entering the pilot position into the automation (A1.4.5.4),
- departure/enroute time message is received (A1.1.4.4) and entered into the automation (A1.1.4.1), and/or
- target re-entering radar coverage is observed (A1.4.16.4).

If the aircraft has a transponder, a beacon code may need to be assigned (A1.1.5.4) and the reply must be verified (A1:4.16.1). If the aircraft does not have a transponder, non-automated radar identification procedures must be initiated (A1.4.16.2). If the track starts automatically, the controller must verify that it has begun (A1.1.4.3), otherwise, the track must be started manually (A1.1.4.2). Finally, if radar identification notification is required, the aircraft may be informed that radar identification is established (A1.4.16.3) or the controller may initiate radar separation standards if appropriate.

Notes: Incorrect beacon codes are identified and corrected.

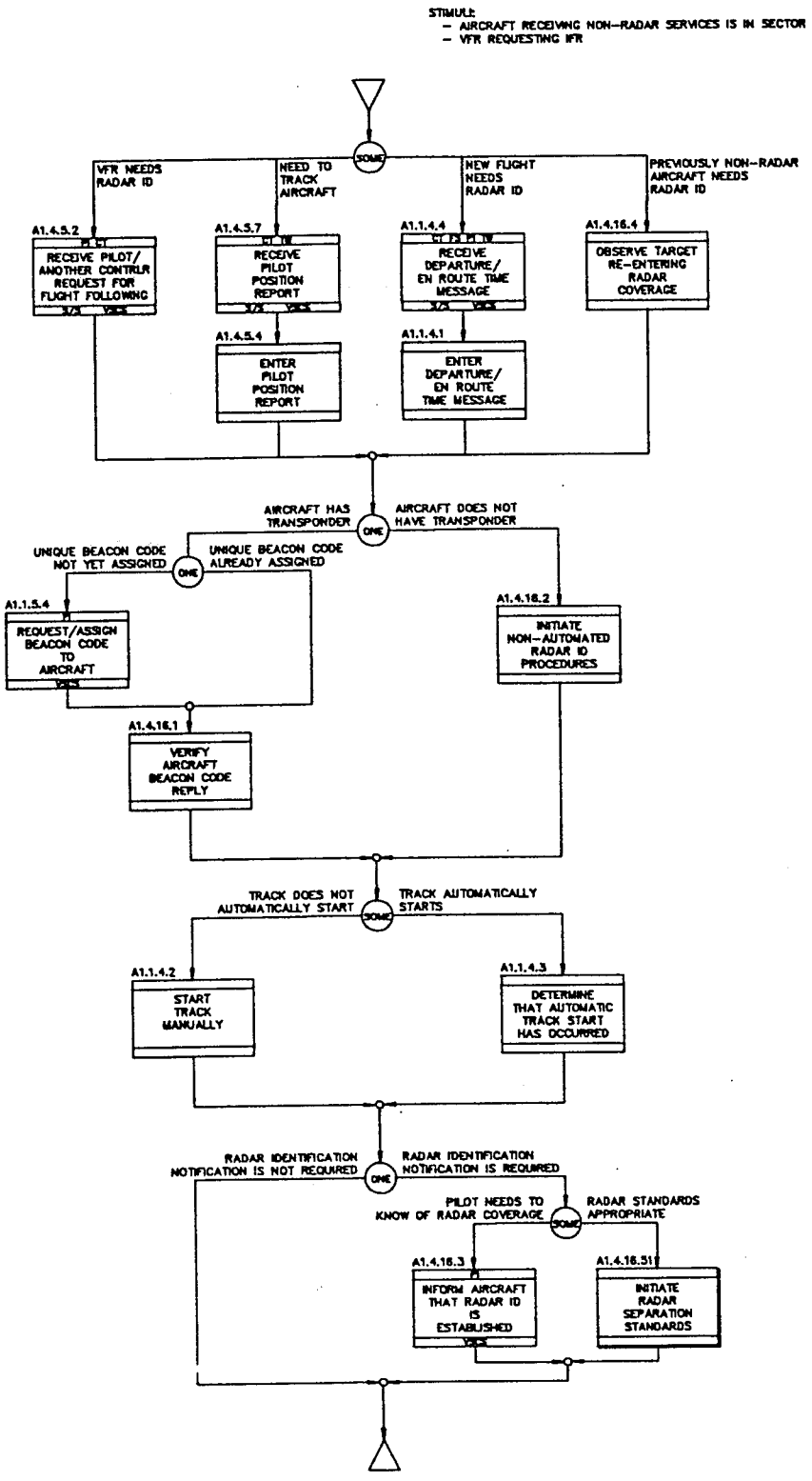

Figure 2-36. Sub-Activity 4.16 - Establishing/Re-Establishing Radar Identification

Sub-Activity 5.1: Responding to Significant Weather Information

Purpose: This sub-activity responds to new weather information about changing conditions which may require expeditious response or may interfere with smooth flow of traffic.

Function Within AAS/AERA: This sub-activity is invoked when new weather information significant to air traffic is received. The controller may be required to reroute traffic around the weather directly or to create a temporary protected airspace which will result in the automatic generation of resolutions to keep traffic clear of weather (sub-activity 2.3). Once the weather information is processed, monitoring continues in sub-activity 1.1.

Walk-Through: Significant new weather information will be received by the controllers as follows:

- weather information is requested (A1.5.1.11) and received as a weather advisory (A1.5.1.12),
- controller request for information is received (A1.5.1.13),
- A&M alerts are detected (A1.5.1.21) and acknowledged (A1.5.1.22),
- weather briefing from the meteorologist is received (A1.5.1.1),
- weather display is observed (A1.5.1.1), or
- PIREPs are received (A1.5.1.8) and entered into the system (A1.5.1.4) if significant.

If the supervisor supplies a new routing for weather avoidance, it is received (A1.5.1.15). If the controller is to assess weather, the impact on routes and flow is determined (A1.5.1.6). If there is weather impact, an altitude or route change is determined to bypass the weather (A1.5.1.7). If a new ATC airspace is required, it is requested to be defined (A1.5.1.23) and a restriction change is either observed (A1.3.3.5) or received verbally (A1.3.3.6). Finally, the following tasks are performed as appropriate:

- weather advisories are issued to pilots and other controllers (A1.5.1.9),
- supervisor or TMU is advised of the weather impact (A1.5.1.10),
- weather information is forwarded to the meteorologist (A1.5.1.14),
- weather advisory is forwarded (A1.5.1.5), and
- recorded weather information is broadcast (A1.5.1.16).

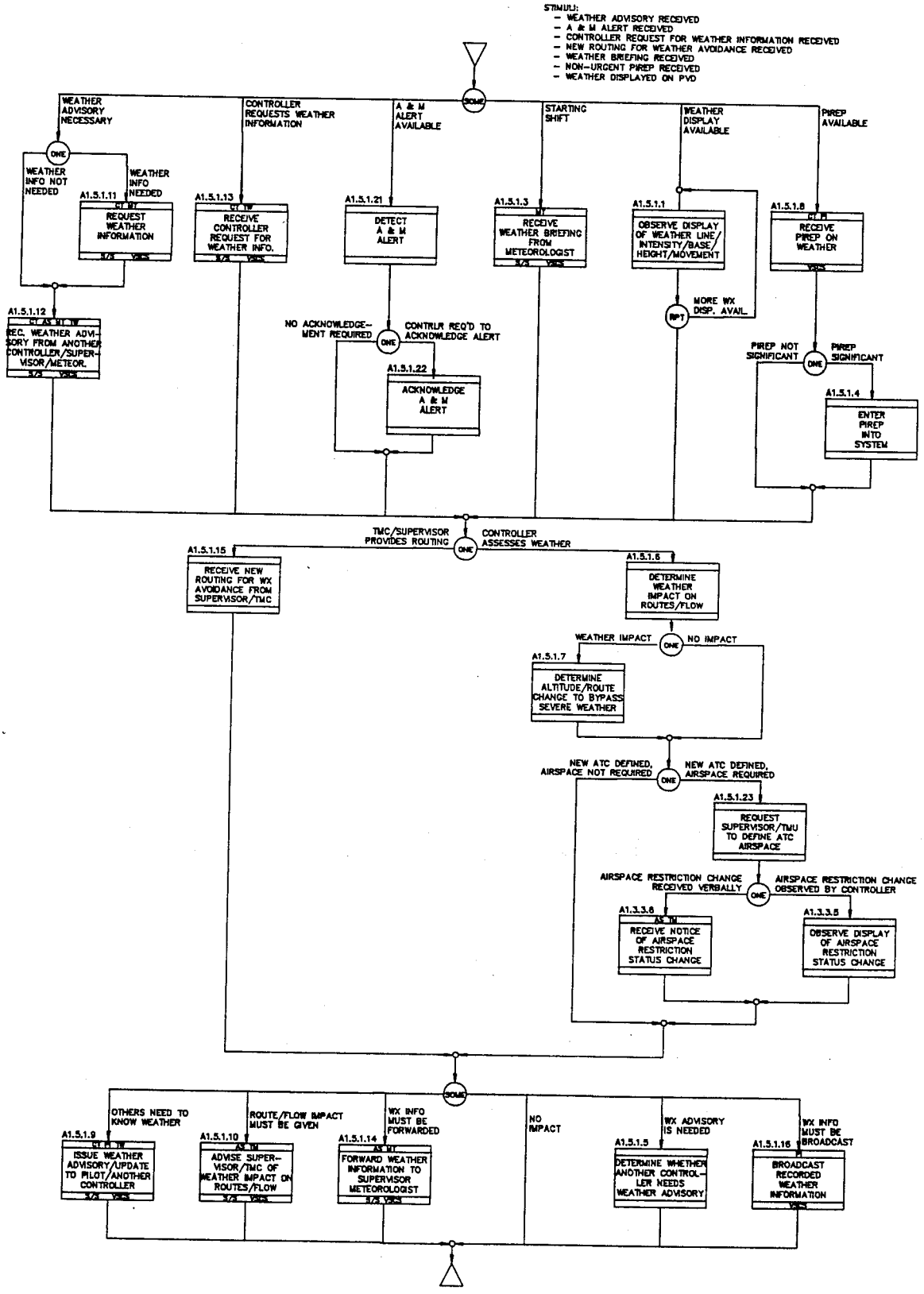

Figure 2-37. Sub-Activity 5.1 - Responding to Significant Weather Information 1/22/86

Sub-Activity 5.2: Processing Weather Reports

Purpose: This sub-activity responds to routine weather information received through normal channels. Routine weather reports often create short-term problems which must be solved to allow a smooth traffic flow.

Function Within AAS/AERA: Routine weather reports are received by the controller in this sub-activity. Appropriate traffic flow changes are made and traffic problems are solved. Once the problems are solved, monitoring continues in sub-activity 1.1.

Walk-Through: This sub-activity is activated upon receipt of the following routine weather information reports:

- weather briefing from the meteorologist (A1.5.1.3),
- weather report update from the meteorologist (A1.5.2.2),
- general NOTAM (A1.5.2.8),
- airport specific NOTAM (A1.5.2.1),
- runway use data (A1.5.2.9),
- ATIS voice recording (A1.5.2.6), or
- environmental data alert (A1.5.2.10).

Then, the following changes may need consideration:

- changes to barometric pressure may alter usable flight levels (A1.5.2.3),
- airport environmental sensor override (A1.1.6.14),
- weather at the airport may effect runway conditions (A1.5.2.4) and may require forwarding of runway use change (A1.5.2.7),
- visibility changes may determine if the control zone should be IFR or VFR (A1.5.2.5).

The Planning macro is included to correct any problems caused by the changes, and if changes are made to the air traffic, they are made current and the pilot is informed in the Formalize Flight Intent macro.

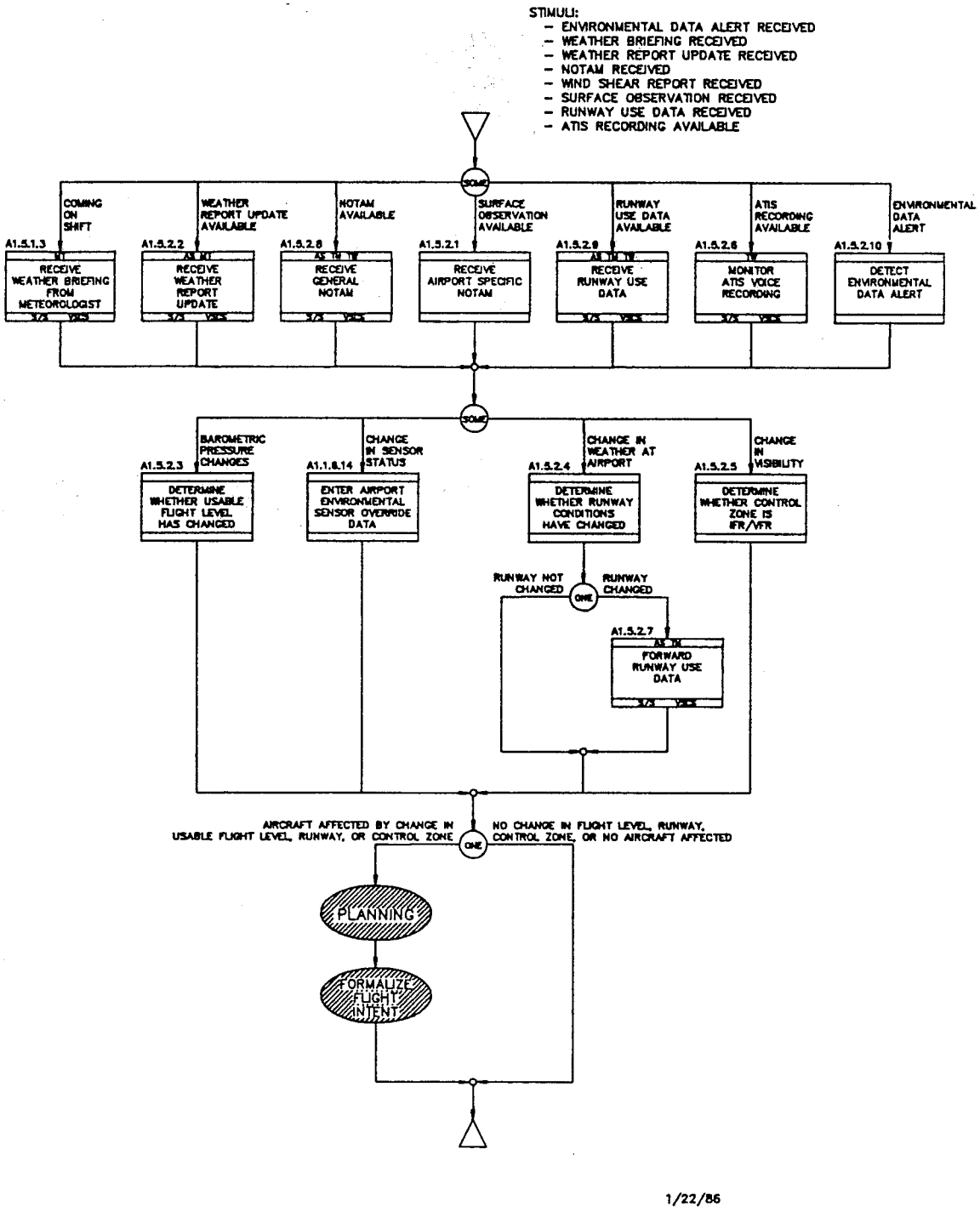

Figure 2-38. Sub-Activity 5.2 - Processing Weather Reports

Sub-Activity 6.1: Briefing Relieving Controller

Purpose: This sub-activity is executed when the controller is relinquishing control of a sector position. This may be the result of a resectorization or a normal relief position change.

Function Within AAS/AERA: When a sector position responsibility is assumed by another controller, as a result of resectorization or normal relief, this sub-activity is invoked. This sub-activity is performed by the controller relinquishing control. It is the complement of sub-activity 6.2 which represents the tasks perfomed by the controller assuming the position. When the two simultaneous sub-activities are complete, no further processing is required and the briefing controller no longer has responsibility for the released airspace.

Walk-Through: If this sub-activity is invoked as a result of resectorization, then the first task is to receive the notice of sector reconfiguration (A1.6.12.2). In either case, the controller performs the standard relief briefing to the assuming controller (A1.6.1.1) perhaps requesting (A1.1.1.53) and evaluating (A1.1.1.54) the Future Situation display to assist in obtaining the traffic picture more easily. When the briefing is complete, the controller performs the log-off sequence at the Sector Suite console (A1.6.1.2).

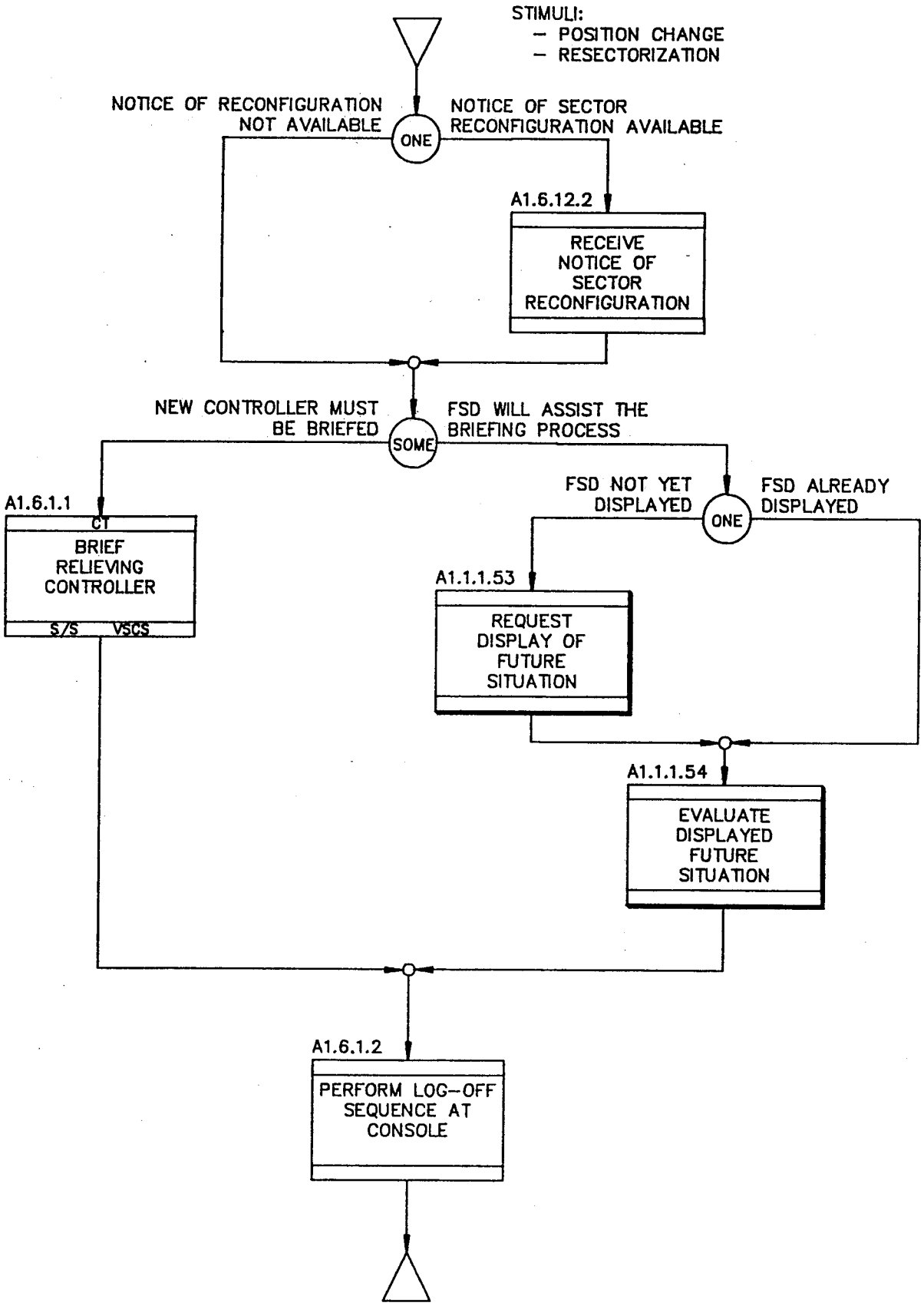

Figure 2-39. Sub-Activity 6.1 - Briefing Relieving Controller

1/22/86

Sub-Activity 6.2: Assuming Position Responsibility

Purpose: This sub-activity is executed when a controller must take responsibility at a position as a result of normal position relief or resectorization. It represents the tasks performed by the controller assuming the position responsibility.

Function Within AAS/AERA: When position responsibility is transferred to another controller, as a result of resectorization or normal position relief, this sub-activity is invoked. The sub-activity is the complement of sub-activity 6.1 which represents the tasks performed by the controller relinquishing responsibility. When this sub-activity is complete, the controller is responsible for traffic in the sector and will begin monitoring in sub-activity 1.1.

Walk-Through: If this sub-activity is invoked as a result of resectorization, the controller first receives the notice of sector reconfiguration (A1.6.12.2). The initial sequence of tasks permits the controller to build a mental picture of conditions on the sector. The controller reviews the current and projected status of traffic and weather (A.16.2.50), reviews the briefing checklist and notes (A1.6.2.51), and then reviews the Sector Suite displays (A1.6.2.52). In support of acquiring the mental picture, the controller will review the system status (A1.6.2.1) and may utilize the Future Situation display (A1.1.1.53, A1.1.1.54) and the Sector Workload Display (A1.6.8.50, A1.6.8.51). Once the controller has the "picture," the Sector Suite switches are checked (A1.6.2.3) and a decision is made whether to accept responsibility (A1.6.2.11). If the decision is to accept, the log-on sequence is performed at the console (A1.6.2.4). Once the log-on procedure is complete, the Sector Suite parameters must be set up. The controller will either request personal parameters stored in the automation (A1.6.2.9) or modify the current existing parameters (A1.6.2.5). Also, the stored personal parameters may be permanently altered to reflect the controller's new preference (A1.6.2.7).

Notes: Task A1.6.2.5, which allows the controller to adjust the current parameters at a Sector Suite, is placed in this sub-activity to allow initial setup. However, this task is intended to provide the controller the capabilities to adjust display characteristics at any time. Adjustments specific to the Situation, Future Situation, Flight Data Block, and Flight Data Entry displays are duplicated in other sub-activities.

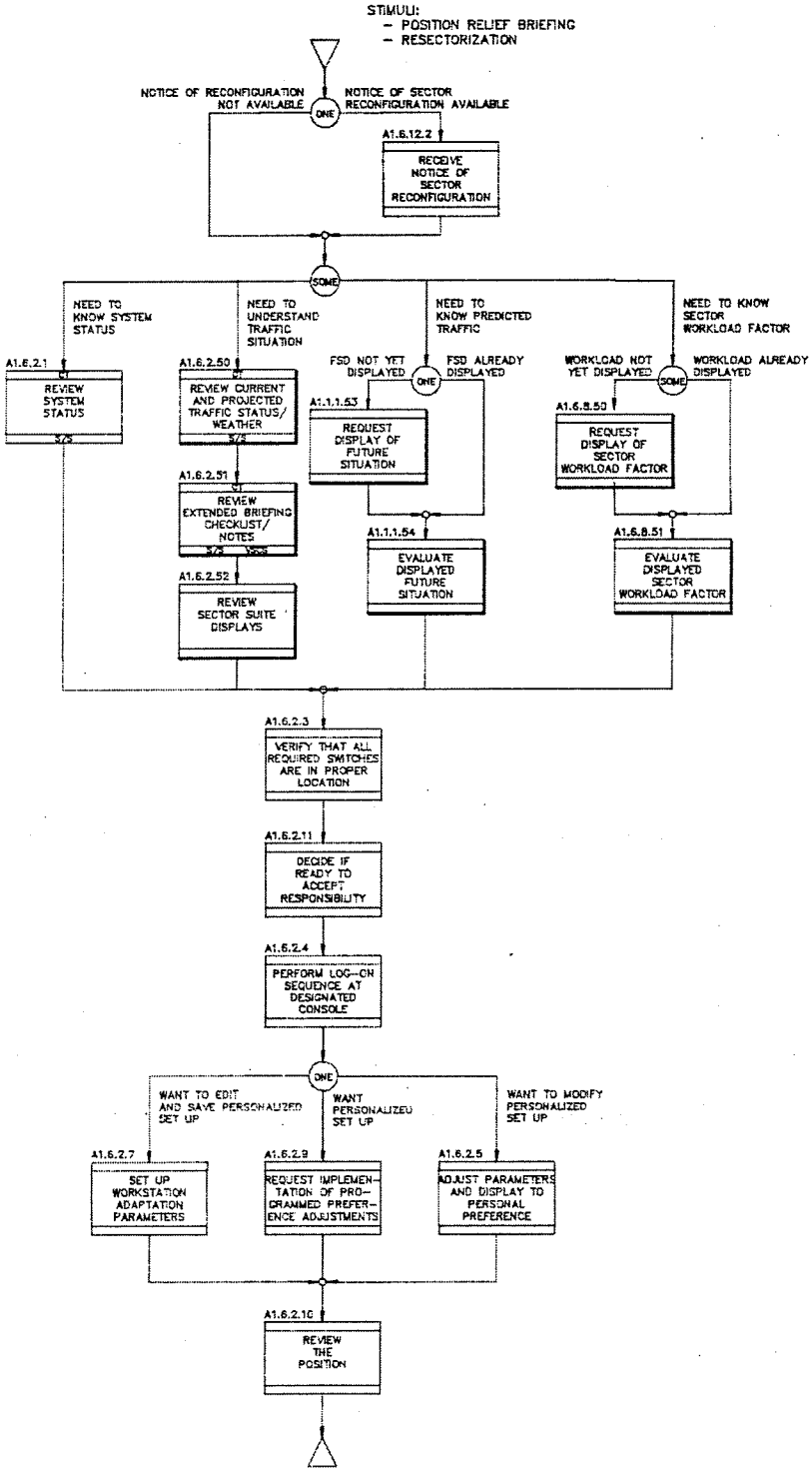

Figure 2-40. Sub-Activity 6.2 - Assuming Position Responsibility

1/22/86

Sub-Activity 6.8: Determining Sector Workload

Purpose: This sub-activity determines the workload in the sector. This information is used in air traffic decision making. If a significant increase in workload is predicted, the controller notifies the supervisor and/or TMC.

Function Within AAS/AERA: The stimulus for this sub-activity is the controller's constant awareness of the need to monitor workload and to predict significant changes early enough to implement preventative actions.

Walk-Through: Upon entry to this sub-activity, the first tier of tasks permits the controller to acquire supplemental information that may assist the workload determination. The display of the future situation (A1.1.1.53, A1.1.1.54) and the display of the sector workload factor (A1.6.8.50, A1.6.8.51) may be used. In addition, other workload factors are considered that are not included in the automation (A1.6.8.5). After review of the supporting information, the impending controller workload is determined mentally (A1.6.8.1). If other personnel need to be informed of the workload, notification of the supervisor and/or TMU will be made (A1.6.8.3).

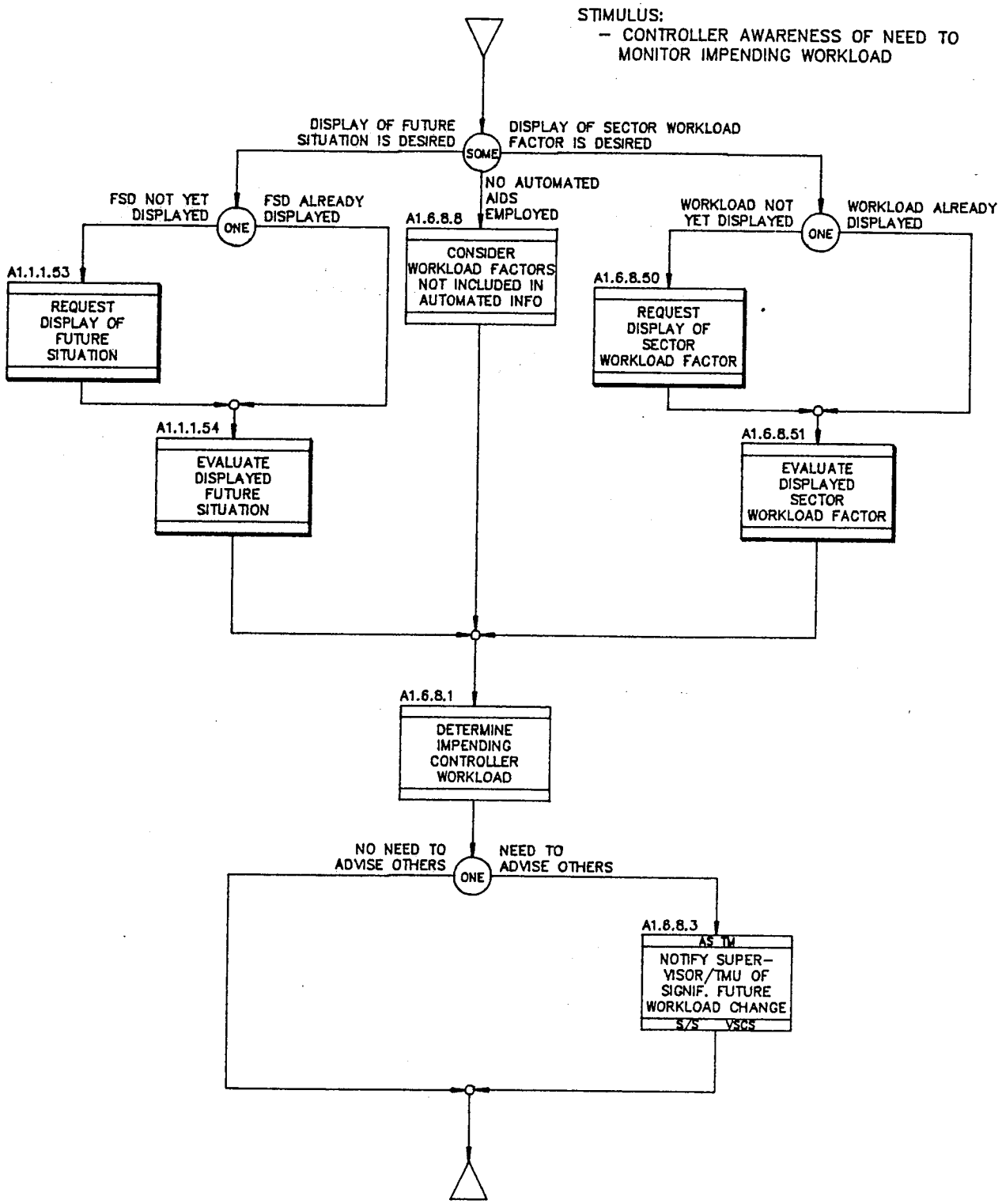

Figure 2-41. Sub-Activity 6.8 - Determining Sector Workload

1/22/86

SECTION 3 - TASK CHARACTERIZATION ANALYSIS FOR AERA 2

A series of human factors engineering analyses, performed on the AERA 2 tasks, has generated information needed by system developers as they go about the task of designing the human-computer dialogue. The AERA 2 tasks are characterized in terms of information requirements, demands on cognitive/sensory abilities, related performance factors, and recommended tools and capabilities to support controller performance. The following sections describe the task characterization methodology. Major analytical results are presented in table format with a concluding discussion of significant points.

3.1 OVERVIEW OF TASK CHARACTERIZATION METHODOLOGY

Four separate analyses contribute to the task characterizations:

- The Task Information Requirements Analysis traces the flow of information through the controller, identifying inputs to the controller, decisions and inferences made, and information output by the controller.

- The Cognitive/Sensory Abilities Analysis associates AERA 2 task demands with human information-processing skills and abilities.

- The Performance Factors Analysis identifies factors related to the successful completion of the tasks and to potential deficiencies in performance.

- The Tools and Capabilities Analysis recommends task-performance aids to assist the controller in processing information, making decisions, and implementing selected actions.

The first step in characterizing tasks is to categorize them according to the following four basic task types:

- Entry (E) - Primarily involves entering data into the computer;
- Receipt (R) - Primarily involves acquiring information from a display or another person;
- Analysis (A) - Primarily cognitive in nature, involving the use of memory, problem solving, or decision making skills; and
- Verbal Coordination (VC) - Coordination/communication using oral techniques.

Categorization of a task as Entry, Receipt, or Verbal Coordination defines the type of interaction that occurs between the controller and the computer or between the controller and another person. Analysis tasks involve mental processes which may require further tasks involving human-computer or human-human interaction.

Some tasks are associated with more than one task type. For example, a task may require both data entry and verbal coordination. Identification of task types permits analysis of AERA 2 tasks in terms of the four basic groupings and their combinations. Each of the basic task types is associated with a particular sub-set of cognitive/sensory abilities and performance factors which suggest one or more kinds of automated tools and capabilities to support controller performance.

3.1.1 RELATIONSHIPS AMONG ANALYSES

The relationships among the task characterization analyses are illustrated in Figure 3-1. Bulleted phrases indicate

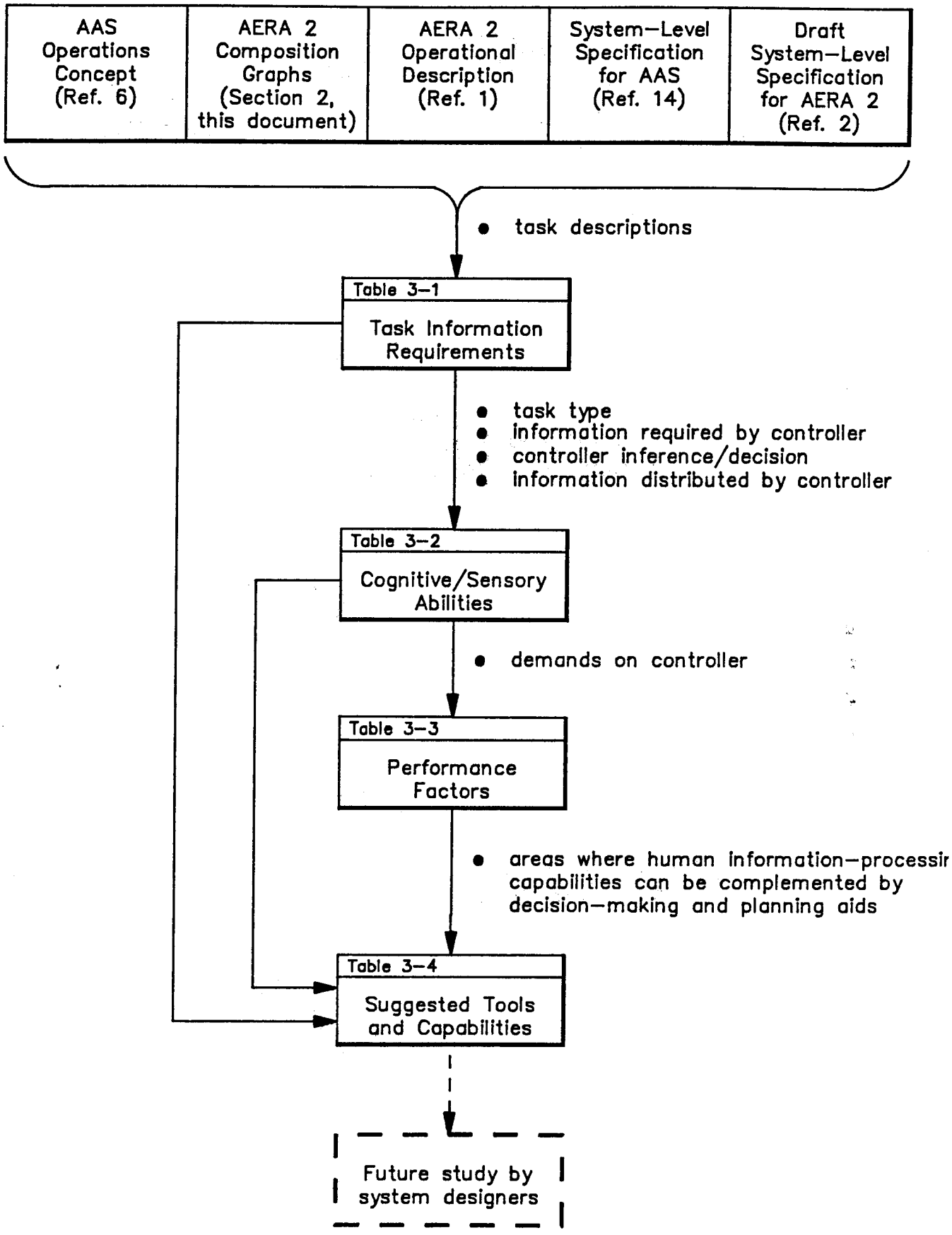

Figure 3-1. Relationships Among Task Characterization Analyses: Tables 3-1, 3-2, 3-3, and 3-4

Table 3-1. AERA 2 Task Information Requirements (cont.)

TASK NO.	TASK STATEMENT	TASK TYPE	INFORMATION REQUIRED BY THE CONTROLLER	LOGICAL DISPLAY	CONTROLLER INFERENCE/ DECISION	INFORMATION OUTPUT BY THE CONTROLLER	NOTES (SUB-ACTIVITY CROSS REFERENCE)
A1.2.07.53	Receive Resolutions to Predicted Problem	R	Resolution	Alert and Resolution; Planning	This is the best information the machine can offer at this time	None	(4.1; RRG)
A1.2.07.54	Evaluate Resolutions to Predicted Problem	R,A	Resolution; Current Overall Situation	Alert and Resolution Situation; Future Situation; Workload	Resolution will be accepted, modified, rejected, or other resolutions requested	None	(RES)

Evaluation of the machine-generated resolution requires the controller to assess the resolution's applicability to current and future situations.

Table 3-2. Cognitive/Sensory Abilities

TASK NO.	TASK STATEMENT	TASK TYPE	E: CODING	R: [illegible]	R: SCANNING	R: PATTERN RECOGNITION	R: [illegible]	A: VISUALIZATION	A: DEDUCTIVE REASONING	A: INDUCTIVE REASONING	A: MATH/PROB REASONING	A: PRIORITIZING	DISCUSSION
A1.2.07.53	Receive Resolutions to Predicted Problem	R			X								
A1.2.07.54	Evaluate Resolutions to Predicted Problem	R,A			X	X		X	X	X	X		Examine machine-generated resolution, create mental picture, and judge appropriateness for situation

To assess the resolution's applicability, the controller samples information from a wide visual field, recognizes developing patterns, creates mental pictures, estimates probabilities, and decides on a course of action.

Table 3-3. Performance Factors

TASK NO.	TASK STATEMENT	TASK TYPE	E: IMPLEMENTATION TIME	R: RECOGNITION TIME	A: DECISION TIME	A: ACC. OF TIME EST.	A: ACC. OF SPATIAL EST.	A: ACC. OF PROB. EST.	A: APPROPRIATENESS OF ACTION	A: APPROPRIATENESS OF TIMING SEQUENCE	VC: COMMUNICATION TIME	DISCUSSION
A1.2.07.53	Receive Resolutions to Predicted Problem	R		X								Requires rapid recognition of the existence of machine-generated resolutions.
A1.2.07.54	Evaluate Resolutions to Predicted Problem	R,A			X	X	X	X		X		Requires timely judgment of resolution appropriateness and correct sequencing of actions based on accurate estimation of time, spatial, and probability parameters

The controller must accurately estimate time, spacial, and probability factors affecting the resolution's appropriateness and make a timely decision on a course of action.

Table 3-4. Tools and Capabilities

TASK NO.	TASK STATEMENT	TASK TYPE	SUGGESTED TOOLS AND CAPABILITIES	RATIONALE
A1.2.07.53	Receive Resolutions to Predicted Problem	R	Emphasis; Sorting; Selective Presentation	Need to reduce scanning demands and speed detection of resolutions.
A1.2.07.54	Evaluate Resolutions to Predicted Problem	R,A	Variable Windows; Look Ahead Display; Sorting; Selective Presentation; Graphical Representation	Need to reduce scanning demands, assist in estimation of time, spatial, and probability parameters, and improve ability to create mental picture of developing situation

The ability to display the future situation is suggested as a means of reducing parameter estimation demands on the controller and speed decision making.

knowledge gained from a particular analysis and passed to a subsequent analysis. Sources of information represented at the top of the figure provided task descriptions for the set of human engineering analyses represented by each of the tables. Results of the Task Information Requirements Analysis provided the basis for identifying cognitive/sensory abilities and performance factors associated with each AERA 2 task. Identification of performance factors was aided by the determination of cognitive/sensory demands on the controller. Suggestions for tools and capabilities to support controller task performance were based on results of the previous three analyses. The tables represented in Figure 3-1 appear in full later in this section. Each table incorporates the results of a particular analysis introduced above. The dashed box at the bottom of Figure 3-1 represents future analyses to be performed by system designers. The success of the suggested tools and capabilities depends on the appropriateness of their design for this application.

The following discussion traces the process of task characterization for two AERA 2 tasks.

3.1.2 SAMPLE ANALYSIS

Two examples of the task characterization analysis are presented in Figure 3-2. This sample analysis illustrates the flow of information through the various steps in the analysis for two AERA 2 tasks. The two related tasks selected for the sample analysis are from the Resolution Macro (Figure 2-6). The first three analyses identify task information requirements, demands on cognitive/sensory abilities, and task-related performance factors. Terms used to label cognitive/sensory abilities on sample Table 3-2 and performance factors on sample Table 3-3 are defined in Appendix D. Text printed outside of the sample tables in Figure 3-2 indicates the intermediate logic in going from one analysis to subsequent analyses. Results of the first three

analyses provide the justification for the recommended tools and capabilities.

Analysis and documentation of the first sample task (A1.2.07.53) resulted in the following entries in sample Table 3-1, TASK INFORMATION REQUIREMENTS, as illustrated in Figure 3-1:

- TASK NO.: A1.2.07.53 is the task number assigned to this task following the task-numbering guidelines described in Section 2. Assigned task numbers remain invariant;

- TASK STATEMENT: RECEIVE RESOLUTION(s) TO PREDICTED PROBLEMS begins with a verb from the list of verbs used to define controller tasks (Appendix A); briefly describes what the controller does but not how the task is performed; implies an interaction between the controller and the AERA 2 capability for Automated Problem Resolution (APR);

- TASK TYPE: "R" indicates that this is a receipt task. Task types provide structure and traceability throughout the analysis;

- INFORMATION REQUIRED BY CONTROLLER: In order to perform this task, the controller must be supplied with the computer-generated RESOLUTION. Information items are defined in the Data Dictionary (Appendix C); a bracket around an item in this column indicates a controller option. For example, in performing another task, the controller may want to limit displayed information for a particular flight. In that case, the required information is the Flight ID. Otherwise, the Flight ID is not required. Identification of information that is sometimes, but not always, required is based on Reference 2;

- LOGICAL DISPLAY: ALERT AND RESOLUTION; PLANNING; identifies the logical display(s), as defined in the AAS SLS (Ref. 14), that provide the information required for task performance; note that this column identifies the source of input to the controller not the logical display for information output by the controller; in this case, resolutions to current plans are displayed on the Alert and Resolution Display, and resolutions associated with trial plans or pending plans are displayed on the Planning Display; and (SL) in this column indicates that the information resides in a special list;

- CONTROLLER INFERENCE/DECISION: Upon receipt of the resolution(s), the controller infers that THIS IS THE BEST INFORMATION THE MACHINE CAN OFFER AT THIS TIME. This inference represents the controller's understanding of AERA 2 capabilities and the mental starting point for the next task, in which the controller will evaluate the resolution(s) received from the computer;

- INFORMATION OUTPUT BY THE CONTROLLER: In this case, there is no information output by the controller. In instances of information output, data items entered in this column are defined in the Data Dictionary (Appendix C); optional information output is indicated by a bracket around the data item. Identification of optional outputs is based on Reference 2; and

- NOTES (SUB-ACTIVITY CROSS REFERENCE): (4.1; RES); for some tasks, explanatory notes are supplied in this column. Numbers entered within parentheses in this column trace the AERA 2 task to the sub-activity and/or macro where it is grouped with other related tasks. This task occurs in Sub-Activity 4.1, Planning and Issuing Clearances, and in the Resolution (RES) macro; other abbreviations used in this column are TP for Trial

Planning Macro and FFI for Formalize Flight Intent Macro. Notes for other tasks identify AAS tasks that have been enhanced by AERA 2 capabilities;

The second sample task, A1.2.07.54, EVALUATE RESOLUTION(s) TO PREDICTED PROBLEMS, is categorized as a Receipt (R) and Analysis (A) task because the controller will need to acquire additional information about the CURRENT OVERALL SITUATION before deciding whether or not to accept, modify, or reject the computer-generated RESOLUTION or to request other resolutions. The controller acquires additional information by receipt of that information from various sources. Decision making requires analysis of the specific situation.

Based on the sample Table 3-1 entries for these two tasks, the analytical inference in proceeding to later tables is that evaluation of the machine-generated resolution requires the controller to assess the resolution's applicability to current and future situations. This logical inference permits the identification of task demands on the controller's cognitive/sensory abilities (sample Table 3-2) and provides the rationale for the recommended tools and capabilities (sample Table 3-4).

Analysis of the two sample tasks identified the following pattern of demands as indicated by the Xs in the column-by-row cells on sample Table 3-2:

- TASK A1.2.07.53: Primary demand is for rapid scanning to locate the appropriate resolution; and

- TASK A1.2.07.54: Primary demands are for scanning of additional displays, recognition of potentially conflicting traffic patterns, mental visualization of the effect(s) of implementing a specific resolution, deductive and inductive reasoning in coming to

conclusions, and mathematical/probabilistic reasoning in selecting the best resolution for the situation. (Note that definitions of these and the other cognitive/sensory abilities are given in Appendix D, Table D-1.) As indicated in the DISCUSSION for this task, the abilities marked on Table 3-2 facilitate the controller's assessment of each resolution's appropriateness.

A logical inference proceeding from the analysis of the cognitive/sensory demands of the two sample tasks is indicated to the right of sample Table 3-2 on Figure 3-2: To assess the resolution's applicability, the controller samples information from a wide visual field, recognizes developing patterns, creates mental pictures, estimates probabilities, and decides on a course of action. This inference leads to identification of performance factors (sample Table 3-3) and recommendations for techniques to facilitate the controller's evaluation of the resolution (sample Table 3-4).

Further analysis of the two sample tasks identified the following significant speed, accuracy, and error factors (sample Table 3-3):

- TASK A1.2.07.53: RECOGNITION TIME, the interval from the first display of the resolution until it has been recognized and understood sufficiently to permit planning a response; and

- TASK A1.2.07.54: PLANNING TIME, the time required to determine a response to the predicted problem for which a resolution is suggested; ACCURACY OF TIME ESTIMATES, as in estimating the time factors associated with the predicted problem; ACCURACY OF SPATIAL ESTIMATES, as in estimating aircraft positions, directions of flight, and distances associated with the predicted problem and the

suggested resolution, if implemented; ACCURACY OF PROBABILITY ESTIMATES, as in estimating the probability that the predicted problem will actually occur; and APPROPRIATENESS OF TIMING/SEQUENCING in deciding on a course of action in regard to this resolution.

The inference that follows from the analysis of performance factors for these two sample tasks is that the controller must accurately estimate time, spatial, and probability factors affecting the resolution's appropriateness and must come to a timely decision on the best course of action.

This and the earlier analytical inferences lead directly to the recommendations for additional tools and capabilities to facilitate the controller's performance (sample Table 3-4). Thus, data presentation and data/display management techniques are recommended for Task A1.2.07.53. Specific recommendations are for emphasis and sorting techniques to be applied to the presentation of data and for a selective presentation capability to provide flexibility in the management of data and multiple displays. These techniques can be expected to call the controller's attention to the displayed resolution, to speed recognition time, and to improve display clarity. Definitions and examples of these techniques are provided in Appendix D (Table D-4).

Various tools and capabilities are recommended to assist the controller in evaluating resolutions (Task A1.2.07.54). They are expected to facilitate the controller's assessment of a resolution's impact on the projected situation. They are also expected to be significant aids in assessing a resolution's appropriateness. For example, the projected situation on a Look Ahead Display is a means of reducing the demands for the controller to estimate changing parameters and a means of speeding decision making.

Each of the identified AERA 2 tasks has been analyzed in the

same way as have the two sample tasks. These analyses are presented in the complete tables provided in this section.

3.2 AERA 2 TASK INFORMATION REQUIREMENTS

This analysis provides an initial description of each AERA 2 task and its information requirements. The purposes of this analysis are to describe the flow of information to and from the controller, to identify the logical display associated with each item of automated information, to categorize each task in terms of the controller's inferential and decision-making processes, and to provide a basis for subsequent analysis.

In order to describe the flow of information through the controller, it is necessary to specify the following three types of information associated with a task: information required by the controller to perform the task, the inference(s) drawn and/or the decision(s) made by the controller during performance of the task, and the information output by the controller in performing and completing the task. It is important to note that information required by the controller may be obtained from one or more of the following sources: a visual display or displays, the controller's memory, or verbal communication with a pilot or another controller.

Identification of the logical display associated with automated information required by the controller will permit evaluation of two important human factors considerations: appropriateness of display content and the number of different logical displays the controller may need to review for a given task.

Controller inferences and decisions represent conclusions the controller comes to while incorporating any new information and its implications into an ongoing mental picture of the

current and expected situation. In addition to guiding problem-solving activities, the controller's inferences and decisions guide the perceived need for and choice of output, if any. Information output by the controller may take one or more of the following forms: information entered into the computer; information passed verbally by the controller to a pilot, another controller, and/or a supervisor; information transmitted electronically or verbally to another system such as the Traffic Management System. In some cases, there will be no information output by the controller.

Table 3-1 presents the results of the information requirements analysis for each AERA 2 task. A summary of quantifiable results from Table 3-1 is presented in the following chart:

Task Type	Total Number of AERA 2 Tasks	Total Number of Information Items	Maximum Number of Logical Displays
E	37	20	9
R	11	18	5
R,A	13	22	18+ any additional displays specified
R,VC	1	2	None
E,VC	1	3	1
R,A,VC	3	9	18+ any additional displays specified

These results indicate that 56 percent of the identified AERA 2 tasks are data entry tasks; 20 percent are Receipt, Analysis tasks; and almost 17 percent are Receipt tasks. Thus, a focus for further effort is to minimize controller workload for these task types, particularly for tasks requiring data entry.

An additional finding is that 48 of the 66 AERA 2 tasks are associated with more than one logical display. Effective data/display management techniques are needed when the controller is required to gather information from multiple logical displays. This need is particularly critical for tasks in which the controller may require information from all or nearly all logical displays. The limits of the human information processing system make it advisable to limit the number of displays to a maximum of three to four per task.

Further inspection of Table 3-1 shows that 34 of the 66 AERA 2 tasks are associated with multiple items of displayed information. In order to limit search time, these items must be made easily distinguishable. Performance of tasks requiring more than one item of displayed information can be facilitated by various data presentation techniques. For example, required data can be emphasized using highlighting, color, intensity, size, and positioning, and meaningful symbols can be assigned to represent several levels of information about a particular item.

Table 3-1 represents ATACT consensus on the controller's information requirements, inferences/decisions, and information outputs for these tasks. The analysis of task information requirements leads directly to analysis of task demands on cognitive/sensory abilities and logically implies the need for various tools and capabilities to facilitate controller performance. Table 3-1 also provides the basis for future assessment of the allocation of information items to specific logical displays. Further, it supplies the basic input to the development of an efficient human-computer dialogue to support controller interaction with AERA 2.

Table 3-1. AERA 2 Task Information Requirements

TASK NO.	TASK STATEMENT	TASK TYPE	INFORMATION REQUIRED BY THE CONTROLLER	LOGICAL DISPLAY	CONTROLLER INFERENCE/ DECISION	INFORMATION OUTPUT BY THE CONTROLLER	NOTES (SUB-ACTIVITY CROSS REFERENCE)
A1.1.01-53	Request Display of Future Situation	E	Trial Plan ID(s); FSD Parameters; Display Adjustments	Planning Future Situation Future Situation	Current and requested trial plans will be displayed for the requested future time	FSD Parameters; [Display Adjustments]; [Trial Plan IDs]	(1.1; 1.5; 2.3; 2.7; 3.1; 3.2; 4.1; 6.1; 6.2; 6.8)
A1.1.01.54	Evaluate Displayed Future Situation	R,A	Future Situation; FSD Parameters; Current Overall Situation	Future Situation Future Situation Situation; Workload	Developing traffic pattern may be a potential problem or impact workload	None	(1.1; 1.5; 2.3; 2.7; 3.1; 3.2; 4.1; 6.1; 6.2; 6.8)
A1.1.01 55	Select Trial Plan to Use in Display of Future Situation	E	Plan ID	Planning	Impact of projected Trial Plan will be seen on the Future Situation Display	Plan ID	(4.1)
A1.1.01.56	Review Data Block for Alert Indications	R	Data Block	Situation	Problem may exist; additional information may be required	None	(1.1)
A1.1.01.57	Review Alert(s) of Predicted Problem(s)	R,A	Predicted Problems; Plan ID; Current Overall Situation	Alert and Resolution; Planning Planning Situation; Future Situation; Workload	Alerts may require action	None	(1.1)

Table 3-1. AERA 2 Task Information Requirements (cont.)

TASK NO.	TASK STATEMENT	TASK TYPE	INFORMATION REQUIRED BY THE CONTROLLER	LOGICAL DISPLAY	CONTROLLER INFERENCE/ DECISION	INFORMATION OUTPUT BY THE CONTROLLER	NOTES (SUB-ACTIVITY CROSS REFERENCE)
A1.1.01.58	Review Flight Data Display for Present/ Future Aircraft Separation	R,A	Flight Data Entries	Flight Data	Problem may exist; additional information may be required	None	Enhanced AAS Task A1.1.1.1 (1.1)
A1.1.06.50	Terminate Reprobe on a Particular Aircraft	E	[Flight ID]	Planning; Situation; Message Comp and Response	Reprobe is no longer needed	[Flight ID]	(1.6)
A1.1.06.51	Restore Notice of Problem Free Reprobed Trial Plan	E	[Plan ID]	Planning; Message Comp and Response	Reprobe notice is needed in this sector	[Plan ID]	(1.6)
A1.1.06.52	Restore Notice of A/C No Longer Affected by Flow/ Airspace Restriction	E	[Flight ID]	Planning	Want to see list	[Flight ID]	(1 6)
A1.2.06.51	Suppress Monitor-Maneuver Information	E	Flight ID; Maneuver Type	Controller Reminder (SL) Controller Reminder (SL)	Controller will no longer see the monitor maueuver information	Flight ID; [Maneuver Type]	No maneuver type implies all maneuvers (2.6)
A1.2.06.52	Restore Monitor-Maneuver Information	E	Flight ID; Maneuver Type	Controller Reminder (SL) Controller Reminder (SL)	Controller will see the monitor maueuver information	Flight ID; [Maneuver Type]	No maneuver type implies all maneuvers (2.6)
A1.2.06.53	Suppress Advisory Alert Resolutions	E	Flight ID	Situation; Flight Data; Planning	Controller will no longer see resolutions to advisory alert predicted problems	[Flight ID]	(2.6)

Table 3-1. AERA 2 Task Information Requirements (cont.)

TASK NO.	TASK STATEMENT	TASK TYPE	INFORMATION REQUIRED BY THE CONTROLLER	LOGICAL DISPLAY	CONTROLLER INFERENCE/ DECISION	INFORMATION OUTPUT BY THE CONTROLLER	NOTES (SUB-ACTIVITY CROSS REFERENCE)
A1.2.06.54	Restore Advisory Alert Resolutions	E	Flight ID	Situation; Flight Data; Planning	Controller will see resolutions to advisory alert predicted problems	[Flight ID]	(2.6)
A1.2.06.55	Suppress Trial Plan Resolutions	E	Flight ID	Situation; Flight Data; Planning	Controller will no longer see resolutions to predicted problems in Trial Plans	[Flight ID]	(2.6)
A1.2.06.56	Restore Trial Plan Resolutions	E	Flight ID	Situation; Flight Data; Planning	Controller will see resolutions for predicted problems in Trial Plans	[Flight ID]	(2.6)
A1.2.06.57	Suppress Advisory Alerts	E	Time Period	Alert and Resolution	Controller will no longer see advisory alert predicted problems	[Time Period]	(2.6)
A1.2.06.58	Restore Advisory Alerts	E	Advisory Alert Suppression Indication		Controller will see advisory alert predicted problems	None	(2.6)
A1.2.07.50	Receive Alert of Predicted Problem	R	Predicted Problem; Plan ID	Alert and Resolution Flight Data; Planning	Validity and priority must be determined and action may be required to solve the problem	None	Enhanced AAS Task (2.3; 2.7; 3.1; 3.2)

Table 3-1. AERA 2 Task Information Requirements (cont.)

TASK NO.	TASK STATEMENT	TASK TYPE	INFORMATION REQUIRED BY THE CONTROLLER	LOGICAL DISPLAY	CONTROLLER INFERENCE/ DECISION	INFORMATION OUTPUT BY THE CONTROLLER	NOTES (SUB-ACTIVITY CROSS REFERENCE)
A1.2.07.51	Evaluate Alert of Predicted Problem	R,A	Predicted Problem; Plan ID; Current Overall Situation	Alert and Resolution Flight Data; Planning Situation; Future Situation; Workload	Validity and priority of alert has been determined; request other displays; need to suppress alert	None	(2.3; 2.7; 3.1; 3.2; TP)
A1.2.07.53	Receive Resolutions to Predicted Problem	R	Resolution	Alert and Resolution; Planning	This is the best information the machine can offer at this time	None	(4.1; RES)
A1.2.07.54	Evaluate Resolutions to Predicted Problem	R,A	Resolution; Current Overall Situation	Alert and Resolution Situation; Future Situation; Workload	Resolution will be accepted. modified. rejected. or other resolutions requested	None	(RES)
A1.2.07.55	Request Rationale for Maneuver Type/Ranking	E	Plan ID	Alert and Resolution; Planning	Additional information will aid in solving problem; clarifies machine resolution; reason for selected manuever will be known	Plan ID	(2.3; 2.7; 3.1; 3.2)
A1.2.07.56	Evaluate Rationale for Maneuver Type/Ranking Type/Ranking	R,A	Resolution; Rationale for Maneuver or Ranking; Current Overall Situation	Alert and Resolution; Planning Alert and Resolution; Planning Situation; Future Situation; Workload	Rationale clarifies resolution or further planning is required	None	Includes receipt of rationale (2.3; 2.7; 3.1; 3.2)

Table 3-1. AERA 2 Task Information Requirements (cont.)

TASK NO.	TASK STATEMENT	TASK TYPE	INFORMATION REQUIRED BY THE CONTROLLER	LOGICAL DISPLAY	CONTROLLER INFERENCE/ DECISION	INFORMATION OUTPUT BY THE CONTROLLER	NOTES (SUB-ACTIVITY CROSS REFERENCE)
A1.2.07.57	Request Explanatory Information About Predicted Problem	E	Flight ID, or Alert Class/ Predicted Problem ID. or Plan ID	Alert and Resolution Alert and Resolution Planning	Additional Information will provide basis for most appropriate action	Flight ID; Alert Class/ Predicted Problem ID	(2.3; 2.7; 3.1; 3.2)
A1.2.07.58	Review Explanatory Information About Predicted Problem	R,A	Predicted Problem; Minimum Miss Distance; Conflict Geometry; Expected A/C Position; Current Overall Situation; Conformance Bounds	Alert and Resolution; Planning Alert and Resolution; Planning Alert and Resolution; Planning Alert and Resolution; Planning Situation; Future Situation; Workload Situation	Explanatory information may aid in selection of appropriate action; helps measure criticality and probability of problem	None	(2.3; 2.7; 3.1; 3.2)
A1.2.07.62	Request Resolutions to Predicted Problems	E	Flight ID; [Predicted Problem ID]	Alert and Resolution; Planning Alert and Resolution; Planning	Resolutions may be available to help solve the problem; additional resolutions may be helpful	Flight ID; [Predicted Problem ID]	For initial and additional resolutions; need Prob ID if more than one (RES)
A1.2.09.50	Receive Notice of Problem-Free Reprobed Trial Plan	R	Plan; No-Problem Indication	Planning Planning	Plan is currently problem- free	None	Results go to current controller (4.1)

Table 3-1. AERA 2 Task Information Requirements (cont.)

TASK NO.	TASK STATEMENT	TASK TYPE	INFORMATION REQUIRED BY THE CONTROLLER	LOGICAL DISPLAY	CONTROLLER INFERENCE/ DECISION	INFORMATION OUTPUT BY THE CONTROLLER	NOTES (SUB-ACTIVITY CROSS REFERENCE)
A1.2.09.51	Receive Notice of A/C No Longer Affected by Flow/Airspace Restriction	R	Flight ID; Airspace ID; Airspace or Flow Indication	Planning Planning Planning	Previous restriction is gone.	None	(4.1)
A1.2.09.53	Inbibit Notice of Problem Free Reprobed Trial Plan	E	[Plan ID]	Planning; Message Comp and Response	Reprobe notice is no longer needed in this sector	[Plan ID]	(1.6)
A1.2.09.54	Suppress Notice of A/C No Longer Affected by Flow/ Airspace Restriction	E	[Flight ID]	Planning	Do not want to see list	[Flight ID]	(1.6)
A1.3.02.50	Receive Monitor-Maneuver Message	R	Flight ID; Expected Maneuver	Controller Reminder (SL) Controller Reminder (SL)	Aircraft has passed nominal maneuver point	None	(3.2)
A1.3.02.51	Evaluate Monitor-Maneuver Message	R.A.VC	Flight ID; Expected Maneuver; Aircraft position; Special Maneuver Information	Controller Reminder (SL) Controller Reminder (SL) Situation A&M Data	Communication with pilot may be required; flight plan may need to be amended	[Questions/ Instructions to Pilot]	(3.2)
A1.3.02.52	Request Display of Conformance Bounds	E	Flight ID	Situation; Alert and Resolution; Controller Reminder (SL); Planning	Display will show conformance bounds relative to aircraft position	Flight ID	(3.2)

Table 3-1. AERA 2 Task Information Requirements (cont.)

TASK NO.	TASK STATEMENT	TASK TYPE	INFORMATION REQUIRED BY THE CONTROLLER	LOGICAL DISPLAY	CONTROLLER INFERENCE/ DECISION	INFORMATION OUTPUT BY THE CONTROLLER	NOTES (SUB-ACTIVITY CROSS REFERENCE)
A1.3.02.53	Evaluate Display of Conformance Bounds	R,A	Aircraft Position; Conformance Bounds; Current Plan	Situation Situation Flight Data	Controller will receive information to aid in maintaining conformance of aircraft	None	(3.2)
A1.3.03.51	Request Supervisor to Desiqnate Airspace as Strategic	E.VC	Airspace ID or Airspace Boundaries; [Time Period]	Situation Situation	Machine will generate resolutions for airspace avoidance	Airspace ID or Airspace Boundaries; [Time Period]	(3.7; 3.8)
A1.3.07.50	Enter Airspace ID for Sector Adjustment	E	Temporary Use Airspace ID; [Time Period]	Static Information; Situation Situation	Area of responsibility is changed; all data is redirected to the appropriate sector	Temporary Use Airspace ID; [Time Period]	(3.7)
A1.4.01.50	Receive Trial/Pending Plan	R	Plan; Originating Sector ID	Planning Planning	Plan may be of intrest to this sector; action may be required	None	(4.1; 4.6; 4.12)
A1.4.01.51	Request Pre-Departure Check	E	Flight ID	Flight Data	Flight Plan will be checked for problems against strategic airspace and flow restrictions	Flight ID; [Estimated Departure Time]	(4.1)
A1.4.01.52	Receive Pre-Departure Check Results	R	Pre-Departure Check Results	Flight Data	Processing is complete; results of check will reflect possible problems	None	(4.1)

Table 3-1. AERA 2 Task Information Requirements (cont.)

TASK NO.	TASK STATEMENT	TASK TYPE	INFORMATION REQUIRED BY THE CONTROLLER	LOGICAL DISPLAY	CONTROLLER INFERENCE/ DECISION	INFORMATION OUTPUT BY THE CONTROLLER	NOTES (SUB-ACTIVITY CROSS REFERENCE)
A1.4.01.55	Receive Automated Coordination Request	R	Automated Coordination Information	Automated Coordination (SL)	Need to approve or deny request and response may be necessary	None	No response implies denial (4.1)
A1.4.01.56	Receive Automated Coordination Response	R	Automated Coordination Response	Automated Coordination (SL)	Clearance may be implemented	None	(4.1)
A1.4.01.57	Enter Response to Automated Coordination	E	Plan ID	Automated Coordination (SL)	Evaluation of Automated Coordination is complete	Automated Coordination Response	(4.1)
A1.4.01.58	Receive Pilot Change to Aircraft Specific Characteristics	R.VC	Aircraft ID; Specific Aircraft Character-istics	None None	Aircraft performance changes may affect projected flight path and problem resolutions	None	(4.1)
A1.4.02.50	Review/Adjust APR Constraints	E	Flight ID; APR Constraints currently in effect: ARP Constraints needed	Situation Flight Data; Planning None	Bounds to APR have been adjusted so that acceptable resolutions are generated	[Flight ID]; [Prohibited Maneuvers]; [Preferred Maneuvers]; [Time Period]	FDB contains preferred and prohibited maneuvers (3.7; 3.8)
A1.4.06.51	Observe Accompanying APR Constraints	R	Aircraft ID; APR Constraints; APR Constraint Indications	Flight Data Flight Data Situation	All possible automated resolutions may not be presented, or restrictions may need to be modified	None	(4.6)

Table 3-1. AERA 2 Task Information Requirements (cont.)

TASK NO.	TASK STATEMENT	TASK TYPE	INFORMATION REQUIRED BY THE CONTROLLER	LOGICAL DISPLAY	CONTROLLER INFERENCE/ DECISION	INFORMATION OUTPUT BY THE CONTROLLER	NOTES (SUB-ACTIVITY CROSS REFERENCE)
A1.4.07.50	Select Trial/Pending Plan for Transfer	E	Plan ID; [Sector ID]	Planning; Message Comp and Response Automated Coordination (SL)	Trial/Pending Plan will be transferred	Plan ID; [Sector ID]	Sector ID defaults for handoffs (4.7)
A1.4.10.50	Select Plan as the Current Plan	E	Plan ID	Planning; Alert and Resolution	Flight plan has been amended or new flight plan has been created	Plan ID	(4.12; FPI)
A1.4.10.52	Evaluate Pre-Departure Check Results	R,A	Aircraft ID; Pre-Departure Check Results	Flight Data; Planning Flight Data	Changes to filed flight plan may be required	None	Results displayed in Flight Data Readout Area (4.1)
A1.4.11 52	Request Automated Reprobe	E	Reprobe Parameters	Planning	Plan may become acceptable at some future time; determine acceptability of default parameters for use with plan	Reprobe Parameters	(TP)
A1.4.11.54	Delete Plan	E	Plan ID	Planning; Message Comp and Response	Plan has no future value	Plan ID	(TP)
A1.4.11.55	Select Plan as Pending Plan	E	Plan ID	Planning; Alert and Resolution; Message Comp and Response	Plan will be subject to periodic problem detection; priority alerts displayed automatically; resolutions must be requested	Plan ID	(TP)

Table 3-1. AERA 2 Task Information Requirements (cont.)

TASK NO.	TASK STATEMENT	TASK TYPE	INFORMATION REQUIRED BY THE CONTROLLER	LOGICAL DISPLAY	CONTROLLER INFERENCE/ DECISION	INFORMATION OUTPUT BY THE CONTROLLER	NOTES (SUB-ACTIVITY CROSS REFERENCE)
A1.4.11.58	Request Reprobe Results	E	Flight ID, or Plan ID	Planning	Controller will determine why no response has been received from Reprobe	Flight ID. or Plan ID	(2.3; 2.7; 3.1)
A1.4.11.59	Evaluate Reprobe Results	R,A	Aircraft ID; Trial Plan; Predicted Problems	Planning Planning Planning	Decide whether to continue Reprobe. modify plan. or delete plan	None	(2.3)
A1.4.11.60	Select Plan for Automated Coordination	E	Plan ID; Designated Sector ID(s)	Planning; Message Comp and Response Automated Coordination (SL)	Coordination is required	Plan ID; [Designated Sector ID(s)]	(TP)
A1.4.11.61	Request Display of All Plans for Aircraft	E	Flight ID	Situation; Flight Data	Plan may be obtained which could be used	Flight ID	(TP)
A1.4.11 62	Request Display of Specified Plan(s) for Aircraft	E	Flight ID; Plan ID; Plan Type	Situation; Flight Data; Planning Planning Planning	Plan may be obtained which could be used	[Flight ID]; [Plan ID]; [Plan Type]	ATACT to finalize requirements (TP)
A1.4.11.63	Update/Revise Retrieved Plan	E	Plan	Planning; Message Comp and Response	A new useable plan will be created	Plan Revisions	(TP)
A1.4.11.64	Review Stored Plan for Correctness to Traffic Situation	R,A	Plan; Current Overall Situation	Planning; Message Comp and Response Situation; Future Situation; Workload	Plan may be suitable to current need; modification may be required	None	(TP)

Table 3-1. AERA 2 Task Information Requirements (cont.)

TASK NO.	TASK STATEMENT	TASK TYPE	INFORMATION REQUIRED BY THE CONTROLLER	LOGICAL DISPLAY	CONTROLLER INFERENCE/ DECISION	INFORMATION OUTPUT BY THE CONTROLLER	NOTES (SUB-ACTIVITY CROSS REFERENCE)
A1.4.11.66	Request Controller Assisted Resolution	E	CAR Parameters	Situation; Future Situation; Alert and Resolution; Planning	Controller Assisted Resolutions will be available for consideration	CAR Parameters	(RES)
A1.4.15.50	Initiate Non-Radar Separation Standards	E	Flight ID	Situation; Flight Data	Detection and resolution of problems will utilize non-radar separation	Flight ID; [Non-radar Area ID]; [Time Period]	(4.15)
A1.4.16.51	Initiate Radar Separation Standards	E	Flight ID	Situation; Flight Data	Detection and resolution of problems will utilize radar separation	Flight ID; [Non-radar Area ID]; [Time Period]	(4.16)
A1.6.02.50	Review Current and Projected Traffic Status/Weather	R,A.VC	Current Overall Situation; Future Situation; Weather Conditions	All Current Displays	Mental picture of the situation is sufficient to continue briefing	Questions/ comments to briefing controller	Enhanced AAS Task A1.6.2.2 (6.2)
A1.6.02.51	Review Extended Briefing Checklist/Notes	R.A.VC	Briefing Checklist Notes	Static Information Controller Notepad	Mental picture of the situation is sufficient to assume position responsibility	Questions/ comments to briefing controller	Enhanced AAS Task A1.6.2.8 (6.2)
A1.6.02.52	Review Sector Suite Displays	R,A	Sector Suite Configuration/ Status	All Current Displays	Configuration and status may be satisfactory	None	Enhanced AAS Task A1.6.2.6 (6.2)

Table 3-1. AERA 2 Task Information Requirements (cont.)

TASK NO.	TASK STATEMENT	TASK TYPE	INFORMATION REQUIRED BY THE CONTROLLER	LOGICAL DISPLAY	CONTROLLER INFERENCE/ DECISION	INFORMATION OUTPUT BY THE CONTROLLER	NOTES (SUB-ACTIVITY CROSS REFERENCE)
A1.6.08.50	Request Display of Sector Workload Factor	E	Time Period; Workload Measure Type	Workload Workload	Graphic display of sector workload factors vs. time will be presented	[Time Period]; [Workload Measure Type]	Enhanced AAS Task A1.6.8.9 (4.1; 6.2; 6.8)
A1.6.08.51	Evaluate Displayed Sector Workload Factor	R,A	Workload Measure(s); Time Period; Current Overall Situation	Workload Workload Situation; Future Situation	Assessment of sector workload demands will facilitate planning of sector duties and priorities	None	Enhanced AAS Task A1.6.8.7 (1.5; 4.1; 6.2; 6.8)

3.3 COGNITIVE/SENSORY TASK DEMANDS IN AERA 2

This analysis is used to identify AERA 2 task demands on the controller's sensory and cognitive resources. An examination of these demands fulfills the following purposes:

- to describe primary variables that affect controller behavior;
- to determine human abilities required on the basis of projected task demands;
- to contribute to an understanding of potential operational errors; and
- to infer needs for tools and capabilities to aid the controller.

Two primary types of human abilities are described by the terms sensory and cognitive. Sensory abilities are physical capacities for detecting external stimuli by means of the various sensing modalities (e.g., vision, hearing, touch). Cognition comprises all the mental operations involved in human information processing: perception, attention, memory, manipulation and transformation of the contents of awareness, and so on (Ref. 15). In general, air traffic control is highly demanding of the controller's sensory and cognitive abilities.

A third type of primary abilities--motor abilities--will be required for performance of some AERA 2 tasks. Motor abilities are physical capacities for rapid, accurate, and coordinated muscular/skeletal movements, such as those required to adjust control devices and to perform keyboard data entry. However, motor abilities have been excluded from this analysis because identification of required motor abilities is design-dependant.

Motor abilities should be assessed later on in the development cycle, during the testing and evaluation of alternative designs.

In order to characterize AERA 2 tasks according to required cognitive/sensory abilities, a set of abilities has been defined. The abilities included in this analysis are defined in Table D-1 (Appendix D). All of the abilities included are to some degree cognitive in nature because they all involve interpretation of perceived stimuli. They are referred to as cognitive/sensory abilities because cognition is based on sensory input. The definitions and examples provided in Table D-1 trace to Table 5-2, Cognitive (Intellectual) Attribute Definitions, and Table 5-3, Perceptual (Sensory) Attribute Definitions, supplied in Reference 6.

When an ability applies to all tasks of a given type or to all task types, it is considered to be a global ability for purposes of this analysis. Other abilities apply only to specific tasks of a given type. These abilities are referred to as task-specific abilities.

Global abilities for all receipt tasks are auditory acuity, color discrimination, sensory multiplexing, and visual acuity. Global abilities for verbal coordination tasks are auditory acuity, interpersonal communication, sensory multiplexing, and verbal fluency. Abilities considered global to all task types are filtering, flexibility, long-term memory, recall from interruption, and short-term memory. The following abilities are considered to be task-specific for the task types listed:

- Entry - Coding

- Receipt - Decoding; movement detection; pattern recognition; scanning

- Analysis - Decoding; deductive reasoning; inductive reasoning; mathematical/probabilistic reasoning; prioritizing; visualization

- Verbal Coordination - None

Task-specific abilities are required by some tasks of a given type but not by other tasks of that type.

Table 3.2 identifies the task-specific abilities associated with each of the AERA 2 tasks. Demands on these abilities are indicated by Xs on the table. For several tasks, analysis indicates that no task-specific abilities are required. However, each of these tasks is associated with several global abilities as listed in the previous paragraph.

The following summary of Table 3-2 lists each of the task-specific cognitive/sensory abilities and the number of AERA 2 tasks associated with a significant demand on each ability:

Ability	Number of AERA 2 Tasks
Coding	5
Decoding	6
Deductive reasoning	16
Inductive reasoning	13
Mathematical/Probabilistic reasoning	8
Movement detection	2
Pattern recognition	6
Prioritizing	1
Scanning	26
Visualization	10

The abilities associated with the highest demands fall into two generic categories. The first category, the ability to extract information from a display, is represented by Decoding, Pattern

Recognition, and Scanning. Because of the demands on these abilities, design decisions related to data organization and data presentation will be critical.

The second category, the ability to plan on the basis of integrated information, is represented by Deductive reasoning, Inductive reasoning, Mathematical/probabilistic reasoning, and Visualization. Demands on these abilities indicate that further effort should be devoted to the design of tools and capabilities that will assist the controller in integrating information and planning. Recommendations on specific performance-aiding techniques are presented later in this document.

The complete set of AERA 2 task demands on cognitive/sensory abilities is presented in Table 3-2. Identification of demands on controller abilities provides a basis for determining significant performance factors and for recommending tools and capabilities to facilitate task performance.

Table 3-2. Cognitive/Sensory Abilities

TASK NO.	TASK STATEMENT	TASK TYPE	E	R				A					DISCUSSION
			CODING	MOVEMENT DETECTION	SCANNING	PATTERN RECOGNITION	DECODING	VISUALIZATION	DEDUCTIVE REASONING	INDUCTIVE REASONING	MATH/PROB REASONING	PRIORITIZING	
A1.1.01 53	Request Display of Future Situation	E	X										Translate desired display parameters for entry.
A1.1.01.54	Evaluate Displayed Future Situation	R,A		X	X	X	X	X	X	X	X		Examine display. extract relevant information. and create mental picture of developing situation.
A1.1.01.55	Select Trial Plan to Use in Display of Future Situation	E											
A1.1.01 56	Review Data Block for Alert Indications	R			X		X						Scan data block. detect and decode alert indicator.
A1.1.01.57	Review Alert(s) of Predicted Problem(s)	R,A			X			X	X	X	X		Examine display. create mental pictures of predicted problems identified by alert and decide on appropriate course of action
A1.1.01.58	Review Flight Data Display for Present/Future Aircraft Separation	R,A			X			X	X	X	X		Examine display. extract relevant information and create mental picture of developing situation.
A1.1.06.50	Terminate Reprobe on a Particular Aircraft	E											
A1.1.06.51	Restore Notice of Problem Free Reprobed Trial Plan	E											

Table 3–2. Cognitive/Sensory Abilities (cont.)

TASK NO.	TASK STATEMENT	TASK TYPE	E	R				A					DISCUSSION
			CODING	MOVEMENT DETECTION	SCANNING	PATTERN RECOGNITION	DECODING	VISUALIZATION	DEDUCTIVE REASONING	INDUCTIVE REASONING	MATH/PROB REASONING	PRIORITIZING	
A1-1.06.52	Restore Notice of A/C No Longer Affected by Flow/ Airspace Restriction	E											
A1.2.06.51	Suppress Monitor-Maneuver Information	E											
A1.2.06.52	Restore Monitor-Maneuver Information	E											
A1.2.06.53	Suppress Advisory Alert Resolutions	E											
A1.2.06.54	Restore Advisory Alert Resolutions	E											
A1.2.06.55	Suppress Trial Plan Resolutions	E											
A1-2-06 56	Restore Trial Plan Resolutions	E											
A1-2-06 57	Suppress Advisory Alerts	E											
A1-2-06-58	Restore Advisory Alerts	E											
A1-2-07-50	Receive Alert of Predicted Problem	R			X		X						Scan displays. detect and decode alert indicator to determine type of alert.
A1-2-07-51	Evaluate Alert of Predicted Problem	R.A			X			X	X	X	X		Scan displays. create mental picture and determine validity of alert based on available information

Table 3-2. Cognitive/Sensory Abilities (cont.)

TASK NO.	TASK STATEMENT	TASK TYPE	E	R				A					DISCUSSION
			CODING	MOVEMENT DETECTION	SCANNING	PATTERN RECOGNITION	DECODING	VISUALIZATION	DEDUCTIVE REASONING	INDUCTIVE REASONING	MATH/PROB REASONING	PRIORITIZING	
A1.2.07.53	Receive Resolutions to Predicted Problem	R			X								
A1.2.07.54	Evaluate Resolutions to Predicted Problem	R.A			X	X		X	X	X	X		Examine machine-generated resolution. create mental picture, and judge appropriateness for situation
A1.2.07.55	Request Rationale for Maneuver Type/Ranking	E											
A1.2.07.56	Evaluate Rationale for Maneuver Type/Ranking	R.A			X			X	X				Examine additional information. visualize the effects on situation, and on the appropriatness of resolution.
A1.2.07.57	Request Explanatory Information About Predicted Problem	E											
A1.2.07.58	Review Explanatory Information About Predicted Problem	R.A			X			X	X	X	X		Examine additional information to allow assesment of potential problem.
A1.2.07.62	Request Resolutions to Predicted Problems	E											
A1.2.09.50	Receive Notice of Problem-Free Reprobed Trial Plan	R			X								

Table 3-2. Cognitive/Sensory Abilities (cont.)

TASK NO.	TASK STATEMENT	TASK TYPE	E	R				A					DISCUSSION
			CODING	MOVEMENT DETECTION	SCANNING	PATTERN RECOGNITION	DECODING	VISUALIZATION	DEDUCTIVE REASONING	INDUCTIVE REASONING	MATH/PROB REASONING	PRIORITIZING	
A1.2.09.51	Receive Notice of A/C No Longer Affected by Flow/Airspace Restriction	R			X								
A1.2.09.53	Inhibit Notice of Problem Free Reprobed Trial Plan	E											
A1.2.09.54	Suppress Notice of A/C No Longer Affected by Flow/ Airspace Restriction	E											
A1.3.02.50	Receive Monitor-Maneuver Message	R			X								
A1.3.02.51	Evaluate Monitor-Maneuver Message	R.A.VC			X			X	X	X	X		Scan displays. create picture of situation identified by alert. and decide on appropriate coures of action.
A1.3.02.52	Request Display of Conformance Bounds	E											
A1.3.02.53	Evaluate Display of Conformance Bounds	R.A		X	X			X	X				Scan displays. determine the relationship of aircraft to conformance bounds in terms of speed and direction and decide on appropriate course of action.

Table 3-2. Cognitive/Sensory Abilities (cont.)

TASK NO.	TASK STATEMENT	TASK TYPE	E	R				A					DISCUSSION
			CODING	MOVEMENT DETECTION	SCANNING	PATTERN RECOGNITION	DECODING	VISUALIZATION	DEDUCTIVE REASONING	INDUCTIVE REASONING	MATH/PROB REASONING	PRIORITIZING	
A1.3.03.51	Request Supervisor to Designate Airspace as Strategic	E.VC											
A1.3.07.50	Enter Airspace ID for Sector Adjustment	E											
A1.4.01.50	Receive Trial/Pending Plan	R			X		X						Scan displays and decode information contained in trial/pending plan.
A1.4.01 51	Request Pre-Departure Check	E											
A1.4.01.52	Receive Pre-Departure Check Results	R			X								
A1.4.01 55	Receive Automated Coordination Request	R			X		X						Scan displays. detect and translate coordination request.
A1.4.01 56	Receive Automated Coordination Response	R			X								
A1.4.01 57	Enter Response to Automated Coordination	E											
A1.4.01.58	Receive Pilot Change to Aircraft Specific Characteristics	R.VC											
A1.4.02.50	Review/Adjust APR Constraints	E											

Table 3-2. Cognitive/Sensory Abilities (cont.)

TASK NO.	TASK STATEMENT	TASK TYPE	E	R				A					DISCUSSION
			CODING	MOVEMENT DETECTION	SCANNING	PATTERN RECOGNITION	DECODING	VISUALIZATION	DEDUCTIVE REASONING	INDUCTIVE REASONING	MATH/PROB REASONING	PRIORITIZING	
A1.4.06.51	Observe Accompanying APR Constraints	R			X								
A1.4.07.50	Select Trial/Pending Plan for Transfer	E											
A1.4.10.50	Select Plan as the Current Plan	E											
A1.4.10.52	Evaluate Pre-Departure Check Results	R.A			X				X	X			Scan displayed checklist and determine status in terms of listed items.
A1.4.11.52	Request Automated Reprobe	E	X										
A1.4.11 54	Delete Plan	E											
A1.4.11.55	Select Plan as Pending Plan	E											
A1.4.11.58	Request Reprobe Results	E											
A1.4.11 59	Evaluate Reprobe Results	R.A							X	X			Examine problems and determine impact on plan.
A1.4.11.60	Select Plan for Automated Coordination	E	X										
A1.4.11.61	Request Display of All Plans for Aircraft	E											

Table 3-2. Cognitive/Sensory Abilities (cont.)

TASK NO.	TASK STATEMENT	TASK TYPE	E	R				A					DISCUSSION
			CODING	MOVEMENT DETECTION	SCANNING	PATTERN RECOGNITION	DECODING	VISUALIZATION	DEDUCTIVE REASONING	INDUCTIVE REASONING	MATH/PROB REASONING	PRIORITIZING	
A1.4.11 62	Request Display of Specified Plan(s) for Aircraft	E											
A1.4.11 63	Update/Revise Retrieved Plan	E											
A1.4.11.64	Review Stored Plan for Correctness to Traffic Situation	R.A			X	X			X				Examine displayed plan and judge appropriatness to existing situation.
A1.4.11.66	Request Controller Assisted Resolution	E	X										
A1.4.15.50	Initiate Non-Radar Separation Standards	E											
A1.4.16 51	Initiate Radar Separation Standards	E											
A1.6.02.50	Review Current and Projected Traffic Status/Weather	R.A.VC			X	X	X	X	X	X	X	X	Examine displays. extract traffic and weather information. create mental picture of developing situation. and determine schedule of activities.
A1.6.02.51	Review Extended Briefing Checklist/Notes	R.A.VC			X				X	X			Scan displayed checklist and determine status of listed items.
A1.6.02 52	Review Sector Suite Displays	R.A			X	X			X	X			Examine displays for desired settings of adjustable parameters.

Table 3–2. Cognitive/Sensory Abilities (cont.)

TASK NO.	TASK STATEMENT	TASK TYPE	E	R				A					DISCUSSION
			CODING	MOVEMENT DETECTION	SCANNING	PATTERN RECOGNITION	DECODING	VISUALIZATION	DEDUCTIVE REASONING	INDUCTIVE REASONING	MATH/PROB REASONING	PRIORITIZING	
A1.6.08.50	Request Display of Sector Workload Factor	E	X										
A1.6.08.51	Evaluate Displayed Sector Workload Factor	R.A			X	X			X	X			Examine displav. identify developing patterns and plan courses of action.

3.4 PERFORMANCE FACTORS ASSOCIATED WITH AERA 2 TASKS

This analysis characterizes controller tasks in terms of performance factors related to successful task completion. The purposes of this analysis are to identify potentially critical difficulties in the performance of individual tasks and to infer needs for tools and capabilities to aid the controller.

The performance factors are defined in Appendix D (Table D-2). They are categorized by timing, accuracy, and potential for operational error. Timing factors measure the interval from initiation to completion of a process. In the case of a verbal coordination task, communication time represents the total time required to complete a verbal transaction, whether the controller is the initiator or receiver of the initial communication input. Communication time includes time for mental generation and physical execution of verbal responses, questions, instructions, and so forth. Accuracy factors measure the correctness of a calculation or estimate.

All of the timing and accuracy factors are associated implicitly with potential errors or failures to meet an established standard. Potential for error exists because of the limitations of human information processing resources (e.g., attention span, short-term memory). Further potential for error may exist because of the design-dependent task demands imposed on the controller. Environmental conditions such as extremely light or heavy traffic can interact with human limitations and design-dependent factors to increase the likelihood of operational error. Potential for error not implied by other performance factors is represented by appropriateness of action and appropriateness of timing or sequencing of actions.

Examples from air traffic control are included in Table D-2 to illustrate each of the performance factors (Appendix D). To facilitate traceability and to structure the analysis, the

performance factors have been categorized by task type and by cognitive/sensory abilities (Appendix D, Table D-3).

Table 3-3 presents the critical performance factors that have been identified for each AERA 2 task. Once again, Xs are used to indicate that a particular performance factor is important to successful task completion. The discussion supplied in the final column describes how the performance factors identified for a task are related to that task. Although some tasks are not associated with any task-specific performance factors, it is possible to suggest tools and capabilities to assist controller task performance. Recommendations for tools and capabilities are based on the other task characterization analyses and supported, where appropriate, by the analysis of performance factors.

The following summary of Table 3-3 lists the task-specific performance factors and the number of AERA 2 tasks for which they are considered important:

Performance Factor	Number of AERA 2 Tasks
Implementation Time	6
Recognition Time	11
Decision Time	4
Accuracy of Time Estimation	8
Accuracy of Spatial Estimation	9
Accuracy of Probability Estimation	6
Appropriateness of Action	2
Appropriateness of Timing/ Sequence	3
Communication Time	0

The most frequently identified performance factors are associated with the extraction of information from displays (e.g., Recognition Time) and with decision making and planning (e.g.

Decision Time, Accuracy of Time Estimation, Spatial Estimation, and Probability Estimation). These results indicate the need for tools and capabilities to promote controller productivity. The complete set of performance factors identified for AERA 2 tasks is presented in Table 3-3.

Table 3-3. Performance Factors

TASK NO.	TASK STATEMENT	TASK TYPE	E	R	A						VC	DISCUSSION
			IMPLEMENTATION TIME	RECOGNITION TIME	DECISION TIME	ACC. OF TIME EST.	ACC. OF SPATIAL EST.	ACC. OF PROB. EST.	APPROPRIATENESS OF ACTION	APPROPRIATENESS OF TIMING/ SEQUENCE	COMMUNICATION TIME	
A1.1.01.53	Request Display of Future Situation	E										
A1.1.01.54	Evaluate Displayed Future Situation	R.A		X			X					Requires quick recognition of developing situations and accurate estimation of spatial relationships.
A1.1.01.55	Select Trial Plan to Use in Display of Future Situation	E										
A1.1.01 56	Review Data Block for Alert Indicators	R		X								Requires quick detection and identification of existing alert indicators.
A1.1.01.57	Review Alert(s) of Predicted Problem(s)	R.A		X	X	X	X	X		X		Requires quick recoqnition of developing situations. timely decision on course of action based on time. spatial and probability parameters.
A1.1.01.58	Review Flight Data Display for Present/ Future Aircraft Separation	R.A		X		X	X	X				Requires quick recoqnition of developing situations and accurate estimation of time. spatial and probability relationships.
A1.1.06.50	Terminate Reprobe on a Particular Aircraft	E										
A1.1.06.51	Restore Notice of Problem Free Reprobed Trial Plan	E										

Table 3-3. Performance Factors (cont.)

TASK NO.	TASK STATEMENT	TASK TYPE	E	R	A						VC	DISCUSSION
			IMPLEMENTATION TIME	RECOGNITION TIME	DECISION TIME	ACC. OF TIME EST.	ACC. OF SPATIAL EST.	ACC. OF PROB. EST.	APPROPRIATENESS OF ACTION	APPROPRIATENESS OF TIMING/ SEQUENCE	COMMUNICATION TIME	
A1.1.06 52	Restore Notice of A/C No Longer Affected by Flow/ Airspace Restriction	E										
A1.2.06.51	Suppress Monitor-Maneuver Information	E										
A1.2.06.52	Restore Monitor-Maneuver Information	E										
A1.2.06.53	Suppress Advisory Alert Resolutions	E										
A1.2.06.54	Restore Advisory Alert Resolutions	E										
A1.2.06.55	Suppress Trial Plan Resolutions	E										
A1.2.06.56	Restore Trial Plan Resolutions	E										
A1.2.06.57	Suppress Advisory Alerts	E										
A1.2.06.58	Restore Advisory Alerts	E										
A1 2 07 50	Receive Alert of Predicted Problem	R		X								Requires timely recognition of alert.
A1.2.07.51	Evaluate Alert of Predicted Problem	R,A			X	X	X	X	X			Requires rapid decision making as to alert validity and selection of action based on accurate estimation of time. spatial. and probability parameters.

Table 3-3. Performance Factors (cont.)

TASK NO.	TASK STATEMENT	TASK TYPE	E	R	A						VC	DISCUSSION
			IMPLEMENTATION TIME	RECOGNITION TIME	DECISION TIME	ACC. OF TIME EST.	ACC. OF SPATIAL EST.	ACC. OF PROB. EST.	APPROPRIATENESS OF ACTION	APPROPRIATENESS OF TIMING/ SEQUENCE	COMMUNICATION TIME	
A1.2.07.53	Receive Resolutions to Predicted Problem	R		X								Requires rapid recoqnition of the existence of machine-generated resolutions.
A1.2.07.54	Evaluate Resolutions to Predicted Problem	R,A			X	X	X	X		X		Requires timely judqment of resolution appropriateness and correct sequencing of actions based on accurate estimation of time. spatial. and probability paraters
A1.2.07.55	Request Rationale	E										
A1.2.07.56	Review Rationale	R.A				X	X					Requires judgment of rationale appropriateness based on accurate estimation of time and spatial parameters.
A1.2.07.57	Request Explanatory Information About Predicted Problem	E										
A1.2.07.58	Review Explanatory Information About Predicted Problem	R.A				X	X	X				Requires accurate estimation of time. spatial. and probability parameters to evaluate potential problem validity.
A1.2.07.62	Request Resolutions to Predicted Problems	E										
A1.2.09.50	Receive Notice of Problem-Free Reprobed Trial Plan	R		X								Requires rapid detection of the existence of problem-free reprobed trial plan.

Table 3-3. Performance Factors (cont.)

TASK NO.	TASK STATEMENT	TASK TYPE	E	R	A						VC	DISCUSSION
			IMPLEMENTATION TIME	RECOGNITION TIME	DECISION TIME	ACC. OF TIME EST.	ACC. OF SPATIAL EST.	ACC. OF PROB. EST.	APPROPRIATENESS OF ACTION	APPROPRIATENESS OF TIMING/ SEQUENCE	COMMUNICATION TIME	
A1.2.09.51	Receive Notice of A/C No Longer Affected by Flow/Airspace Restriction	R										
A1.2.09.53	Inhibit Notice of Problem Free Reprobed Trial Plan	E										
A1.2.09.54	Suppress Notice of A/C No Longer Affected by Flow/ Airspace Restriction	E										
A1.3.02.50	Receive Monitor-Maneuver Message	R		X								Requires rapid detection of a message concerning predicted non-conformance of an aircraft.
A1.3.02.51	Evaluate Monitor-Maneuver Message	R,A.VC			X	X	X	X	X			Requires rapid judgment of predicted non-conformance and that correct action be taken based on accurate estimationoftime. spatial. and probability estimations.
A1.3.02.52	Request Display of Conformance Bounds	E	X									Requires quick entry of request for conformance bounds.
A1.3.02.53	Evaluate Display of Conformance Bounds	R.A										Requires accurate estimation of time and spatial relationships between aircraft and conformance bounds.

Table 3-3. Performance Factors (cont.)

TASK NO.	TASK STATEMENT	TASK TYPE	E	R	A						VC	DISCUSSION
			IMPLEMENTATION TIME	RECOGNITION TIME	DECISION TIME	ACC. OF TIME EST.	ACC. OF SPATIAL EST.	ACC. OF PROB. EST.	APPROPRIATENESS OF ACTION	APPROPRIATENESS OF TIMING/ SEQUENCE	COMMUNICATION TIME	
A1.4.11 62	Request Display of Specified Plan(s) for Aircraft	E										
A1.4.11 63	Update/Revise Retrieved Plan	E										
A1.4.11.64	Review Stored Plan for Correctness to Traffic Situation	R.A				X	X					Requires accurate estimation of time and spa- parameters to assess the applicability of a stored plan to current traffic situation.
A1.4.11.66	Request Controller Assisted Resolution	E										
A1.4.15.50	Initiate Non-Radar Separation Standards	E	X									Requires quick entry of ID of aircraft not covered by radar.
A1.4.16 51	Initiate Radar Separation Standards	E										
A1.6.02.50	Review Current and Projected Traffic Status/Weather	R.A.VC										
A1.6.02.51	Review Extended Briefing Checklist/Notes	R,A.VC										
A1.6.02.52	Review Sector Suite Displays	R,A										

Table 3-3. Performance Factors (cont.)

TASK NO.	TASK STATEMENT	TASK TYPE	E	R	A						VC	DISCUSSION
			IMPLEMENTATION TIME	RECOGNITION TIME	DECISION TIME	ACC. OF TIME EST.	ACC. OF SPATIAL EST.	ACC. OF PROB. EST.	APPROPRIATENESS OF ACTION	APPROPRIATENESS OF TIMING/ SEQUENCE	COMMUNICATION TIME	
A1.6.08.50	Request Display of Sector Workload Factor	E										
A1.6.08.51	Evaluate Displayed Sector Workload Factor	R,A										

Table 3-3. Performance Factors (cont.)

TASK NO.	TASK STATEMENT	TASK TYPE	E	R	A						VC	DISCUSSION
			IMPLEMENTATION TIME	RECOGNITION TIME	DECISION TIME	ACC. OF TIME EST.	ACC. OF SPATIAL EST.	ACC. OF PROB. EST.	APPROPRIATENESS OF ACTION	APPROPRIATENESS OF TIMING/ SEQUENCE	COMMUNICATION TIME	
A1.3.03.51	Request Supervisor to Designate Airspace as Strategic	E.VC	X									Requires rapid entry of request for change in airspace designation.
A1.3.07.50	Enter Airspace ID for Sector Adjustment	E	X									Requires rapid entry of parameters which affect resectorization.
A1.4.01.50	Receive Trial/Pending Plan	R		X								Requires rapid detection and identification of trial/pending plan.
A1.4.01.51	Request Pre-Departure Check	E										
A1.4.01 52	Receive Pre-Departure Check Results	R										
A1.4.01.55	Receive Automated Coordination Request	R		X								Requires rapid detection and identification of coordination request.
A1.4.01.56	Receive Automated Coordination Response	R										
A1.4.01 57	Enter Response to Automated Coordination	E	X									Requires quick entry of response to request for automated coordination
A1.4.01.58	Receive Pilot Change to Aircraft Specific Characteristics	R.VC										
A1.4.02.50	Review/Adjust APR Constraints	E										

Table 3-3. Performance Factors (cont.)

TASK NO.	TASK STATEMENT	TASK TYPE	E	R	A						VC	DISCUSSION
			IMPLEMENTATION TIME	RECOGNITION TIME	DECISION TIME	ACC. OF TIME EST.	ACC. OF SPATIAL EST.	ACC. OF PROB. EST.	APPROPRIATENESS OF ACTION	APPROPRIATENESS OF TIMING/ SEQUENCE	COMMUNICATION TIME	
A1.4.06 51	Observe Accompanying APR Constraints	R		X								Requires rapid detection and identification of restrictions applied to automated resolutions.
A1.4.07.50	Select Trial/Pending Plan for Transfer	E										
A1.4.10.50	Select Plan as the Current Plan	E	X									Requires quick entry for the purpose of identifying plan as current plan.
A1.4.10.52	Evaluate Pre-Departure Check Results	R,A										
A1.4.11.52	Request Automated Reprobe	E										
A1.4.11.54	Delete Plan	E										
A1.4.11.55	Select Plan as Pending Plan	E										
A1.4.11.58	Request Reprobe Results	E										
A1.4.11 59	Evaluate Reprobe Results	R,A										
A1.4.11.60	Select Plan for Automated Coordination	E										
A1.4.11.61	Request Display of All Plans for Aircraft	E										

3.5 RECOMMENDED TOOLS AND CAPABILITIES

Various tools and capabilities have been specified for AAS (Ref. 14) and for AERA 2 (Ref. 2). The set of capabilities known as AERA 2 is itself essentially a set of advanced decision-making and planning aids. This analysis proposes the use of additional system capabilities and supplementary tools to assist the controller in coding or decoding information, problem solving, decision making, or planning. On the basis of demands on controller abilities and potential limitations in performance identified in the preceeding analysis, features are proposed to reduce memory demands and to support controller productivity.

The recommended tools and capabilities were selected from the following categories:

- Data Entry Techniques - system capabilities used to limit manual data entry and to limit the demands on memory that are associated with data entry;

- Data Presentation Techniques - system capabilities used to improve the context, quality, and/or organization of displayed data;

- Data/Display Management Techniques - system capabilities that allow the user to adjust or tailor a display;

- Decision Aids - tools for assisting the user in planning, reasoning, analyzing, or problem solving; and

- Communication Aids - tools to limit the workload associated with tasks that require transmission of messages.

The recommended tools and capabilities can be considered as a set of memory aids because they all help to limit and organize the information that the controller must hold in working memory.

Table D-4 (Appendix D) describes each of the tools and capabilities, including examples illustrating their possible uses. Table D-5 (Appendix D) lists tools and capabilities indicated by the specific performance factors.

The types of tools and capabilities can be categorized by task type as follows:

Tools/Capabilities	Task Type
Entry	Data Entry Techniques; Communication Aids
Receipt	Data Presentation Techniques; Data/Display Management Techniques; Communication Aids
Analysis	Decision Aids
Verbal Coordination	Communication Aids

This categorization by task type provides structure and traceability across the various task characterization analysis. For example, the cognitive/sensory abilities and task-critical performance factors associated with analysis tasks suggest that controller performance of any one such task might be assisted by one or more data presentation techniques, data/display management techniques, and/or decision aids.

Table 3-4 presents the tools and capabilities suggested for AERA 2 tasks. Following the format used in the previous tables, the task number, task statement, and task type appear in the

first three columns. The fourth column identifies the recommended tools and capabilities. These recommendations are based on the results of the previous analyses of task information requirements (Table 3-1), demands on cognitive/sensory abilities (Table 3-2), and performance factors (Table 3-3). The tools and capabilities are stated in generic terms in order to allow flexibility in their design and implementation.

The following summary of Table 3-4 lists each of the specific tools and capabilities and the number of AERA 2 tasks for which each aiding method is recommended:

Tools/Capabilities	Number of AERA 2 Tasks
Default Data Entry	23
Predefined Function Activation	17
Prompted Data Entry	10
Sketching	1
Definition of Display Codes	5
Emphasis	12
Graphical Representation	3
Selective Presentation	11
Sorting	3
Variable Windows	10
Look Ahead Display	11
Automated Ground-to-Air Communications	2

These task-specific tools and capabilities are suggested on the basis of the previous analyses of the controller's AERA 2 tasks. Default data entry, predefined function activation, and prompted data entry are suggested to compensate for the large number of entry tasks and the need to limit data entry demands. Several tools and capabilities are suggested to assist in information gathering, decision making, and planning because of the pattern of cognitive/sensory demands and the potential effects of performance factors.

The complete set of recommended tools and capabilities is presented in Table 3-4. The final column on Table 3-4 provides the rationale or analytical justification for recommending specific tools and capabilities. If the earlier analyses identified high demands on cognitive/sensory abilities or critical performance factors, the rationale is phrased in terms of reducing these demands, speeding task performance, or supporting accuracy. In other cases, the rationale is phrased in terms of limiting demands on the controller.

Table 3-4. Tools and Capabilities

TASK NO.	TASK STATEMENT	TASK TYPE	SUGGESTED TOOLS AND CAPABILITIES	RATIONALE
A1.1.01.53	Request Display of Future Situation	E	Predefined Function Activation; Prompted Data Entry	Need to reduce coding demands as well as limit keyed data entry and memory demands.
A1.1.01.54	Evaluate Displayed Future Situation	R,A	Defintion of Display Codes Look-Ahead Display	Need to reduce data translation demand and assist spatial, time, and probability estimation.
A1.1.01.55	Select Trial Plan to Use in Display of Future Situation	E	Predefined Function Activation	Need to limit keyed data entry.
A1.1.01.56	Review Data Block for Alert Indications	R	Emphasis; Definition of Display Codes	Need to speed detection and identification of alert indicator and reduce data translation demands.
A1.1.01.57	Review Alert(s) of Predicted Problem(s)	R,A	Variable Windows; Look Ahead Display; Emphasis	Need to reduce scanning demands, assist in estimation of time, spatial and probability parameters, and improve ability to create mental pictures of problem situations.
A1.1.01.58	Review Flight Data Display for Present/ Future Aircraft Separation	R,A	Emphasis; Sorting; Selective Presentation; Look Ahead Display	Need to speed problem detection, reduce scanning demands, assist in accurate estimation of time, spatial and probability parameters, and improve ability to create mental picture of aircraft separation.
A1.1.06.50	Terminate Reprobe on a Particular Aircraft	E	Default Data Values	Need to limit keyed data entry.
A1.1.06.51	Restore Notice of Problem Free Reprobed Trial Plan	E	Default Data Values	Need to limit keyed data entry.

Table 3-4. Tools and Capabilities (cont.)

TASK NO.	TASK STATEMENT	TASK TYPE	SUGGESTED TOOLS AND CAPABILITIES	RATIONALE
A1.1.06.52	Restore Notice of A/C No Longer Affected by Flow/ Airspace Restriction	E	Default Data Values	Need to limit keyed data entry.
A1.2.06.51	Suppress Monitor-Maneuver Information	E	Default Data Values	Need to limit keyed data entry.
A1.2.06.52	Restore Monitor-Maneuver Information	E	Default Data Values	Need to limit keyed data entry.
A1.2.06.53	Suppress Advisory Alert Resolutions	E	Default Data Values	Need to limit keyed data entry.
A1.2.06.54	Restore Advisory Alert Resolutions	E	Default Data Values	Need to limit keyed data entry.
A1.2.06.55	Suppress Trial Plan Resolutions	E	Default Data Values	Need to limit keyed data entry.
A1.2.06.56	Restore Trial Plan Resolutions	E	Default Data Values	Need to limit keyed data entry.
A1.2.06.57	Suppress Advisory Alerts	E	Default Data Values	Need to limit keyed data entry.
A1.2.06.58	Restore Advisory Alerts	E	Predefined Function Activation	Need to limit keyed data entry.
A1.2.07.50	Receive Alert of Predicted Problem	R	Emphasis; Defintion of Display Codes	Need to reduce scanning and memory demands as well as speed detection of alerts.
A1.2.07.51	Evaluate Alert of Predicted Problem	R,A	Variable Windows; Look Ahead Display	Need to reduce scanning demands, assist in accurate estimation of time spatial, and probability parameters, and allow assessment of action appropriateness

Table 3-4. Tools and Capabilities (cont.)

TASK NO.	TASK STATEMENT	TASK TYPE	SUGGESTED TOOLS AND CAPABILITIES	RATIONALE
A1.2.07.53	Receive Resolutions to Predicted Problem	R	Emphasis; Sorting; Selective Presentation	Need to reduce scanning demands and speed detection of resolutions.
A1.2.07.54	Evaluate Resolutions to Predicted Problem	R,A	Variable Windows; Look Ahead Display; Sorting; Selective Presentation; Graphical Representation	Need to reduce scanning demands, assist in estimation of time, spatial, and probability parameters, and improve ability to to create mental picture of developing situation
A1.2.07.55	Request Rationale for Maneuver Type/Ranking	E	Predefined Function Activation	Need to limit keyed data entry.
A1.2.07.56	Evaluate Rationale for Maneuver Type/Ranking	R,A	Variable Windows; Look Ahead Display	Need to reduce scanning demands, assist in estimation of time and spatial parameters, and improve ability to create mental picture of developing situation
A1.2.07.57	Request Explanatory Information About Predicted Problem	E	Prompted Data Entry; Default Data Values	Need to limit keyed data entry and memory demands.
A1.2.07.58	Review Explanatory Information About Predicted Problem	R,A	Variables Windows Look Ahead Display;	Need to reduce scanning demands, assist in estimation of time, spatial, and probability parameters, and improve ability to create mental picture of developing situation.
A1.2.07.62	Request Resolutions to Predicted Problems	E	Prompted Data Entry; Default Data Values	Need to limit keyed data entry and memory demands.
A1.2.09.50	Receive Notice of Problem-Free Reprobed Trial Plan	R	Emphasis	Need to reduce scanning demands and speed detection and identification.

Table 3-4. Tools and Capabilities (cont.)

TASK NO.	TASK STATEMENT	TASK TYPE	SUGGESTED TOOLS AND CAPABILITIES	RATIONALE
A1.2.09.51	Receive Notice of A/C No Longer Affected by Flow/Airspace Restriction	R	Emphasis	Need to reduce scanning demands.
A1.2.09.53	Inhibit Notice of Problem Free Reprobed Trial Plan	E	Default Data Values; Predefined Function Activation	Need to limit keyed data entry.
A1.2.09.54	Suppress Notice of A/C No Longer Affected by Flow/ Airspace Restriction	E	Default Values; Predefined Function Activation.	Need to limit keyed data entry.
A1.3.02.50	Receive Monitor-Maneuver Message	R	Emphasis; Selective Presentation	Need to reduce scanning demands and speed detection and identification.
A1.3.02.51	Evaluate Monitor-Maneuver Message	R,A,VC	Selective Presentation; Variable Windows; Automated Air-to-Ground Communication	Need to reduce scanning demands, assist in estimation of time, spatial, and probability parameters and speed decision making.
A1.3.02.52	Request Display of Conformance Bounds	E	Predefined Function Activation	Need to speed data entry.
A1.3.02.53	Evaluate Display of Conformance Bounds	R,A	Variable Windows; Look Ahead Display; Graphical Representation	Need to reduce scanning demands, assisting in accurate estimation of time, spatial and probability parameters, improve ability to create mental pictures, and allow assessment of appropriateness of planned action.

Table 3-4. Tools and Capabilities (cont.)

TASK NO.	TASK STATEMENT	TASK TYPE	SUGGESTED TOOLS AND CAPABILITIES	RATIONALE
A1.3.03.51	Request Supervisor to Designate Airspace as Strategic	E,VC	Prompted Data Entry; Sketching	Need to limit memory demands and speed data entry.
A1.3.07.50	Enter Airspace ID for Sector Adjustment	E	Default Data Values.	Need to speed keyed data entry.
A1.4.01.50	Receive Trial/Pending Plan	R	Emphasis; Definition of Display Codes	Need to reduce scanning and data translation demands and speed detection and identif-cation.
A1.4.01.51	Request Pre-Departure Check	E	Default Data Values	Need to limit keyed data entry.
A1.4.01.52	Receive Pre-Departure Check Results	R	Selective Presentation	Need to reduce scanning demands.
A1.4.01.55	Receive Automated Coordination Request	R	Emphasis; Selective Presentation Definition of Display Codes	Need to reduce scanning and memory demands and speed detection.
A1.4.01.56	Receive Automated Coordination Response	R	Emphasis	Need to reduce scanning demands.
A1.4.01.57	Enter Response to Automated Coordination	E	Predefined Function Activation	Need to limit verbal communication demands.
A1.4.01.58	Receive Pilot Change to Aircraft Specific Characteristics	R,VC	Automated Air-to-Ground Communication	Need to limit verbal communications demands.
A1.4.02.50	Review/Adjust APR Constraints	E	Prompted Data Entry; Default Data Values	Need to limit memory demands and limit keyed data entry.

Table 3-4. Tools and Capabilities (cont.)

TASK NO.	TASK STATEMENT	TASK TYPE	SUGGESTED TOOLS AND CAPABILITIES	RATIONALE
A1.4.06.51	Observe Accompanying APR Constraints	R	Selective Presentation; Emphasis	Need to reduce scanning demands and speed detection.
A1.4.07.50	Select Trial/Pending Plan for Transfer	E	Default Data Values; Prompted Data Entry	Need to limit keyed data entry.
A1.4.10.50	Select Plan as the Current Plan	E	Predefined Function Activation	Need to limit keyed data entry.
A1.4.10.52	Evaluate Pre-Departure Check Results	R,A	Selective Presentation	Need to reduce scanning demands.
A1.4.11.52	Request Automated Reprobe	E	Predefined Function Activation	Need to limit keyed data entry.
A1.4.11.54	Delete Plan	E	Predefined Function Activation	Need to limit keyed data entry.
A1.4.11.55	Select Plan as Pending Plan	E	Predefined Function Activation	Need to limit keyed data entry.
A1.4.11.58	Request Reprobe Results	E	Predefined Function Activation	Need to limit keyed data entry.
A1.4.11.59	Evaluate Reprobe Results	R,A	Look-Ahead Display	Need to assist in determining problem impact.
A1.4.11.60	Select Plan for Automated Coordination	E	Default Data Values	Need to limit keyed data entry.
A1.4.11.61	Request Display of All Plans for Aircraft	E	Predefined Function Activation	Need to limit keyed data entry.

Table 3-4. Tools and Capabilities (cont.)

TASK NO.	TASK STATEMENT	TASK TYPE	SUGGESTED TOOLS AND CAPABILITIES	RATIONALE
A1.4.11.62	Request Display of Specified Plan(s) for Aircraft	E	Predefined Function Activation	Need to limit keyed data entry.
A1.4.11.63	Update/Revise Retrieved Plan	E	Prompted Data Entry; Default Data Values	Need to limit memory demands and limit keyed data entry.
A1.4.11.64	Review Stored Plan for Correctness to Traffic Situation	R,A	Variable Windows; Look Ahead Display	Need to reduce scanning demands and assist in estimation of time and spatial parameters.
A1.4.11.66	Request Controller Assisted Resolution	E	Prompted Data Entry; Default Data Values	Need to reduce coding demands, limit keyed data entry and limit memory demands.
A1.4.15.50	Initiate Non-Radar Separation Standards	E	Predefined Function Activation. Prompted Data Entry Default Data Values	Need to speed implementation, limit keyed data entry, and limit memory demands.
A1.4.16.51	Initiate Radar Separation Standards	E	Predefined Function Activation; Prompted Data Entry; Default Data Values	Need to limit memory demands and keyed data entry.
A1.6.02.50	Review Current and Projected Traffic Status/Weather	R,A,VC	Look Ahead Display; Variable Windows; Selective Presentation.	Need to reduce scanning demands, improve ability to develop mental pictures, and assist in planning activities
A1.6.02.51	Review Extended Briefing Checklist/Notes	R,A,VC	Selective Presentation	Need to reduce scanning demands.
A1.6.02.52	Review Sector Suite Displays	R,A	Variable Windows; Definition of Display Codes	Need to reduce data translation and scanning demands.

Table 3-4. Tools and Capabilities (cont.)

TASK NO.	TASK STATEMENT	TASK TYPE	SUGGESTED TOOLS AND CAPABILITIES	RATIONALE
A1.6.08.50	Request Display of Sector Workload Factor	E	Default Values; Prompted Data Entry	Need to reduce coding demands and limit memory demands.
A1.6.08.51	Evaluate Displayed Sector Workload Factor	R,A	Emphasis; Graphical Representation	Need to reduce scanning demands and assist in recognition of developing patterns.

3.6 CONCLUSIONS

Results of the task characterization analysis show the majority of AERA 2 tasks clustering within three task types: Entry, Receipt, and Receipt/Analysis. More than half of the tasks defined for AERA 2 are associated with data entry. All tasks place demands on the global abilities of short-term memory, long-term memory, recall from interruption, flexibility, and filtering. In addition, specific AERA 2 tasks may place significant demands on task-specific abilities, as indicated in the analysis of cognitive/sensory abilities presented in Table 3-2.

In order to perform the tasks defined for AERA 2, the controller will require specific items of information. Most of these information items are currently assigned to one or more of the logical displays defined in Reference 14. Inspection of Table 3-1, Task Information Requirements, finds that over fifty-one per cent of AERA 2 tasks are associated with multiple items of information. Over seventy-two per cent of AERA 2 tasks are associated with multiple displays.

Additional findings of the task characterization analysis are that demands on task-specific abilities cluster around scanning, deductive reasoning, inductive reasoning, and visualization. The most critical performance factors are expected to be recognition time, estimation of various parameters (time, distance, probability), and implementation time (Table 3-3).

Results of the analyses of task information requirements, task-specific cognitive/sensory abilities, and performance factors indicate the need for a variety of automated tools and capabilities to reduce workload associated with the AERA 2 tasks and to support controller productivity. Specific recommendations are given in Table 3-4. Recommendations are based directly on results of the task characterization analysis.

A general finding of the task-definition and analysis process is that the controller will focus on strategic rather than tactical planning in the AERA 2 environment. If the AERA 2 capabilities work as conceptualized (Ref. 1, 2), the need for tactical maneuvering should be greatly reduced, and the controller should be able to concentrate on planning to prevent the majority of tactical situations from occurring at all. The analysis of AERA 2 tasks indicates the need for a predictive tool, such as a Look Ahead Display, to aid the controller in strategic planning. An automated tool of this kind could help the controller in evaluating the possible effects of plans that have not yet been implemented. However, it is important to note that the usefulness of any tool or capability depends on its design.

There is a need for controlled evaluation of each tool and capability suggested to support controller performance of AERA 2 tasks. Study is needed, for example, on exactly what information to emphasize on a particular display. Specific sequences of controller actions in performing AERA 2 tasks need to be identified as candidates for pre-defined function activation, a technique that reduces manual data entry. Other ways to limit and/or reduce manual data entry should be investigated when more is known about the alternative designs for the Sector Suite HCI. It will also be important for developers and designers to evaluate new technologies (e.g., new interaction techniques and windowing methods) for possible application to AERA 2. The systematic definition and analysis of controller tasks provides the necessary basis for the development and testing needed to produce an efficient and effective human-computer interface design for AERA 2.

SECTION 4 - DIALOGUE DESCRIPTION FOR CONTROLLER TASKS IN THE AERA 2 TIME FRAME

This section consolidates results from preceding analyses and presents information necessary for designing an effective human-computer dialogue. This is conveyed in the Dialogue Description, Table 4-1. In this table the task number, task statement, and task type are repeated from the preceding tables. The next four columns of this table contain the task information requirements from Table 3-1.

The task information requirements include: information required by the controller to perform the task, the inference(s) drawn and/or the decision(s) made by the controller during performance of the task, and the information output by the controller in performing and completing the task.

The identification of the logical display associated with automated information required by the controller permits evaluation of two important human factors considerations: appropriateness of display content and the number of different logical displays the controller may need to review for a given task.

Controller inferences and decisions represent conclusions the controller comes to while incorporating any new information and its implications into an ongoing mental picture of the current and expected situation. In addition to guiding problem-solving activities, the controller's inferences and decisions guide the perceived need for and choice of output, if any. Information output by the controller may take one or more of the following forms: information entered into the computer; information passed verbally by the controller to a pilot, another controller, and/or a supervisor; information transmitted electronically or verbally to another system such as the Traffic

Management System. In some cases, there will be no information output by the controller.

The next two columns list the tools and capabilities recommended to aid controller performance and the rationale for these recommendations from Table 3-4.

These recommendations are based on the results of the previous analyses of task information requirements (Table 3-1), demands on cognitive/sensory abilities (Table 3-2), and performance factors (Table 3-3). The tools and capabilities are stated in generic terms in order to allow flexibility in their design and implementation.

The rationale is the analytical justification for recommending specific tools and capabilities. If the earlier analyses identified high demands on cognitive/sensory abilities or critical performance factors, the rationale is phrased in terms of reducing these demands, speeding task performance, or supporting accuracy. In other cases, the rationale is phrased in terms of limiting demands on the controller.

Finally, Table 4-1 documents the traceability of the operational requirements of each task to the associated paragraph in the draft AERA 2 SLS (Ref. 2).

Table 4-1 is a concise, comprehensive summary of information useful to the specification writer and the system designer. The specification writer can use this information to describe in detail the display and control capabilities of the HCI. The system designer can derive the HCI input and output languages from the information requirements for each task. Strategies for the presentation of information and entry of data can be improved by including the automated tools recommended in Section 3.

TABLE 4-1. DIALOGUE DESCRIPTION

TASK NO.	TASK STATEMENT	TASK TYPE	INFORMATION REQUIRED BY THE CONTROLLER	LOGICAL DISPLAY	CONTROLLER INFEFENCE/ DECISION	INFORMATION OUTPUT BY THE CONTROLLER	SUGGESTED TOOLS AND CAPABILITIES	RATIONALE FOR TOOLS AND CAPABILITIES	DRAFT AERA 2 SLS PARAGRAPH
A1.1.01.53	Request Display of Future Situation	E	Trial Plan ID(s); FSD Parameters; Display Adjustments	Planning Future Situation Future Situation	Current and requested trial plans will be displayed for the requested future time	FSD Parameters; [Display Adjustments]; [Trial Plan IDs]	Predefined Function Activation; Prompted Data Entry	Need to reduce coding demands as well as limit keyed data entry and memory demands.	
A1.1.01.54	Evaluate Displayed Future Situation	R,A	Future Situation; FSD Parameters; Current Overall Situation	Future Situation Future Situation Situation; Workload	Developing traffic pattern may be a potential problem or impact workload	None	Display Code Definition; Look Ahead Display	Need to reduce data translation demand and assist spatial, time, and probability estimation.	Not Applicable
A1.1.01.55	Select Trial Plan to Use in Display of Future Situation	E	Plan ID	Planning	Impact of projected Trial Plan will be seen on the Future Situation Display	Plan ID	Predefined Function Activation	Need to limit keyed data entry.	
A1.1.01.56	Review Data Block for Alert Indications	R	Data Block	Situation	Problem may exist; additional information may be required	None	Emphasis; Definition of Display Codes	Need to speed detection and identification of alert indicator and reduce data translation demands.	3.7.2.1.1.1
A1.1.01.57	Review Alert(s) of Predicted Problem(s)	R,A	Predicted Problems; Plan ID; Current Overall Situation	Alert and Resolution; Planning Planning Situation; Future Situation; Workload	Alerts may require action	None	Variable Windows; Look Ahead Display; Emphasis	Need to reduce scanning demands, assist in estimation of time, spatial and probability parameters, and improve ability to create mental pictures of problem situations.	Not Applicable

TABLE 4-1. DIALOGUE DESCRIPTION (cont.)

TASK NO.	TASK STATEMENT	TASK TYPE	INFORMATION REQUIRED BY THE CONTROLLER	LOGICAL DISPLAY	CONTROLLER INFEFENCE/ DECISION	INFORMATION OUTPUT BY THE CONTROLLER	SUGGESTED TOOLS AND CAPABILITIES	RATIONALE FOR TOOLS AND CAPABILITIES	DRAFT AERA 2 SLS PARAGRAPH
A1.1.01.58	Review Flight Data Display for Present/ Future Aircraft Separation	R,A	Flight Data Entries	Flight Data	Problem may exist; additional information may be required	None	Emphasis; Sorting; Selective Presentation; Look Ahead Display	Need to speed problem detection, reduce scanning demands, assist in accurate estimation of time, spatial and probability parameters, and improve ability to create mental picture of aircraft separation.	Not Applicable
A1.1.06.50	Terminate Reprobe on a Particular Aircraft	E	[Flight ID]	Planning; Situation; Message Comp and Response	Reprobe is no longer needed	[Flight ID]	Default Data Values	Need to limit keyed data entry.	3.7.1.3.3.2
A1.1.06.51	Restore Notice of Problem Free Reprobed Trial Plan	E	[Plan ID]	Planning; Message Comp and Response	Reprobe notice is needed in this sector	[Plan ID]	Default Data Values	Need to limit keyed data entry.	
A1.1.06.52	Restore Notice of A/C No Longer Affected by Flow/ Airspace Restriction	E	[Flight ID]	Planning	Want to see list	[Flight ID]	Default Data Values	Need to limit keyed data entry.	
A1.2.06.51	Suppress Monitor-Maneuver Information	E	Flight ID; Maneuver Type	Controller Reminder (SL) Controller Reminder (SL)	Controller will no longer see the monitor maueuver information	Flight ID; [Maneuver Type]	Default Data Values	Need to limit keyed data entry.	3.7.2.1.1.5.1
A1.2.06.52	Restore Monitor-Maneuver Information	E	Flight ID; Maneuver Type	Controller Reminder (SL) Controller Reminder (SL)	Controller will see the monitor maueuver information	Flight ID; [Maneuver Type]	Default Data Values	Need to limit keyed data entry.	3.7.2.1.1.5.1
A1.2.06.53	Suppress Advisory Alert Resolutions	E	Flight ID	Situation; Flight Data; Planning	Controller will no longer see resolutions to advisory alert predicted problems	[Flight ID]	Default Data Values	Need to limit keyed data entry.	3.7.1.3.4.3-a 3.7.2.1.2.3-a

TABLE 4-1. DIALOGUE DESCRIPTION (cont.)

TASK NO.	TASK STATEMENT	TASK TYPE	INFORMATION REQUIRED BY THE CONTROLLER	LOGICAL DISPLAY	CONTROLLER INFEFENCE/ DECISION	INFORMATION OUTPUT BY THE CONTROLLER	SUGGESTED TOOLS AND CAPABILITIES	RATIONALE FOR TOOLS AND CAPABILITIES	DRAFT, AERA 2 SLS PARAGRAPH
A1.2.06.54	Restore Advisory Alert Resolutions	E	Flight ID	Situation; Flight Data; Planning	Controller will see resolutions to advisory alert predicted problems	[Flight ID]	Default Data Values	Need to limit keyed data entry.	3.7.1.3.4.3-a 3.7.2.1.2.3-a
A1.2.06.55	Suppress Trial Plan Resolutions	E	Flight ID	Situation; Flight Data; Planning	Controller will no longer see resolutions to predicted problems in Trial Plans	[Flight ID]	Default Data Values	Need to limit keyed data entry.	3.7.1.3.4.3-b 3.7.2.1.2.3-a
A1.2.06.56	Restore Trial Plan Resolutions	E	Flight ID	Situation; Flight Data; Planning	Controller will see resolutions for predicted problems in Trial Plans	[Flight ID]	Default Data Values	Need to limit keyed data entry.	3.7.1.3.4.3-b 3.7.2.1.2.3-a
A1.2.06.57	Suppress Advisory Alerts	E	Time Period	Alert and Resolution	Controller will no longer see advisory alert predicted problems	[Time Period]	Default Data Values	Need to limit keyed data entry.	3.7.2.1.2.3-d
A1.2.06.58	Restore Advisory Alerts	E	Advisory Alert Suppression Indication		Controller will see advisory alert predicted problems	None	Predefined Function Activation	Need to limit keyed data entry.	3.7.2.1.2.3-d
A1.2.07.50	Receive Alert of Predicted Problem	R	Predicted Problem; Plan ID	Alert and Resolution Flight Data; Planning	Validity and priority must be determined and action may be required to solve the problem	None	Emphasis; Defintion of Display Codes	Need to reduce scanning and memory demands as well as speed detection of alerts.	3.7.1.3.2.5 3.7.2.1.1.3

TABLE 4-1. DIALOGUE DESCRIPTION (cont.)

TASK NO.	TASK STATEMENT	TASK TYPE	INFORMATION REQUIRED BY THE CONTROLLER	LOGICAL DISPLAY	CONTROLLER INFEFENCE/ DECISION	INFORMATION OUTPUT BY THE CONTROLLER	SUGGESTED TOOLS AND CAPABILITIES	RATIONALE FOR TOOLS AND CAPABILITIES	DRAFT AERA 2 SLS PARAGRAPH
A1.2.07.51	Evaluate Alert of Predicted Problem	R,A	Predicted Problem; Plan ID; Current Overall Situation	Alert and Resolution Flight Data; Planning Situation; Future Situation; Workload	Validity and priority of alert has been determined; request other displays; need to suppress alert	None	Variable Windows; Look Ahead Display	Need to reduce scanning demands, assist in accurate estimation of time spatial, and probability parameters, and allow assessment of action appropriateness	Not Applicable
A1.2.07.53	Receive Resolutions to Predicted Problem	R	Resolution	Alert and Resolution; Planning	This is the best information the machine can offer at this time	None	Emphasis; Sorting; Selective Presentation	Need to reduce scanning demands and speed detection of resolutions.	3.7.1.3.4 3.7.1.3.4.2 3.7.1.3.4.4 3.7.2.1.1.3
A1.2.07.54	Evaluate Resolutions to Predicted Problem	R,A	Resolution; Current Overall Situation	Alert and Resolution Situation; Future Situation; Workload	Resolution will be accepted, modified, rejected, or other resolutions requested	None	Variable Windows; Look Ahead Display; Sorting; Selective Presentation; Graphical Representation	Need to reduce scanning demands, assist in estimation of time, spatial, and probability parameters, and improve ability to to create mental picture of developing situation	Not Applicable
A1.2.07.55	Request Rationale for Maneuver Type/Ranking	E	Plan ID	Alert and Resolution; Planning	Additional information will aid in solving problem; clarifies machine resolution; reason for selected manuever will be known	Plan ID	Predefined Function Activation	Need to limit keyed data entry.	3.7.1.3.4.3 3.7.2.1.2.3
A1.2.07.56	Evaluate Rationale for Maneuver Type/Ranking Type/Ranking	R,A	Resolution; Rationale for Maneuver or Ranking; Current Overall Situation	Alert and Resolution; Planning Alert and Resolution; Planning Situation; Future Situation; Workload	Rationale clarifies resolution or further planning is required	None	Variable Windows; Look Ahead Display	Need to reduce scanning demands, assist in estimation of time and spatial parameters, and improve ability to create mental picture of developing situation	Not Applicable

TABLE 4-1. DIALOGUE DESCRIPTION (cont.)

TASK NO.	TASK STATEMENT	TASK TYPE	INFORMATION REQUIRED BY THE CONTROLLER	LOGICAL DISPLAY	CONTROLLER INFEFENCE/ DECISION	INFORMATION OUTPUT BY THE CONTROLLER	SUGGESTED TOOLS AND CAPABILITIES	RATIONALE FOR TOOLS AND CAPABILITIES	DRAFT AERA 2 SLS PARAGRAPH
A1.2.07.57	Request Explanatory Information About Predicted Problem	E	Flight ID, or Alert Class/ Predicted Problem ID, or Plan ID	Alert and Resolution Alert and Resolution Planning	Additional Information will provide basis for most appropriate action	Flight ID; Alert Class/ Predicted Problem ID	Prompted Data Entry; Default Data Values	Need to limit keyed data entry and memory demands.	3.7.1.3.2.1 3.7.1.3.2.2 3.7.1.3.2.4 3.7.2.1.2.3-n
A1.2.07.58	Review Explanatory Information About Predicted Problem	R,A	Predicted Problem; Minimum Miss Distance; Conflict Geometry; Expected A/C Position; Current Overall Situation; Conformance Bounds	Alert and Resolution; Planning Alert and Resolution; Planning Alert and Resolution; Planning Alert and Resolution; Planning Situation; Future Situation; Workload Situation	Explanatory information may aid in selection of appropriate action; helps measure criticality and probability of problem	None	Variables Windows Look Ahead Display;	Need to reduce scanning demands, assist in estimation of time, spatial, and probability parameters, and improve ability to create mental picture of developing situation.	Not Applicable
A1.2.07.62	Request Resolutions to Predicted Problems	E	Flight ID; [Predicted Problem ID]	Alert and Resolution; Planning Alert and Resolution; Planning	Resolutions may be available to help solve the problem; additional resolutions may be helpful	Flight ID; [Predicted Problem ID]	Prompted Data Entry; Default Data Values	Need to limit keyed data entry and memory demands.	3.7.1.3.4.4 3.7.2.1.2.3-b
A1.2.09.50	Receive Notice of Problem-Free Reprobed Trial Plan	R	Plan; No-Problem Indication	Planning Planning	Plan is currently problem- free	None	Emphasis	Need to reduce scanning demands and speed detection and identification.	3.7.1.3.3.2

TABLE 4-1. DIALOGUE DESCRIPTION (cont.)

TASK NO.	TASK STATEMENT	TASK TYPE	INFORMATION REQUIRED BY THE CONTROLLER	LOGICAL DISPLAY	CONTROLLER INFEFENCE/ DECISION	INFORMATION OUTPUT BY THE CONTROLLER	SUGGESTED TOOLS AND CAPABILITIES	RATIONALE FOR TOOLS AND CAPABILITIES	DRAFT AERA 2 SLS PARAGRAPH
A1.2.09.51	Receive Notice of A/C No Longer Affected by Flow/Airspace Restriction	R	Flight ID; Airspace ID; Airspace or Flow Indication	Planning Planning Planning	Previous restriction is gone.	None	Emphasis	Need to reduce scanning demands.	3.7.1.3.2.3
A1.2.09.53	Inbibit Notice of Problem Free Reprobed Trial Plan	E	[Plan ID]	Planning; Message Comp and Response	Reprobe notice is no longer needed in this sector	[Plan ID]	Default Data Values; Predefined Function Activation	Need to limit keyed data entry.	3.7.1.3.3.2
A1.2.09.54	Suppress Notice of A/C No Longer Affected by Flow/ Airspace Restriction	E	[Flight ID]	Planning	Do not want to see list	[Flight ID]	Default Values; Predefined Function Activation	Need to limit keyed data entry.	
A1.3.02.50	Receive Monitor-Maneuver Message	R	Flight ID; Expected Maneuver	Controller Reminder (SL) Controller Reminder (SL)	Aircraft has passed nominal maneuver point	None	Emphasis; Selective Presentation	Need to reduce scanning demands and speed detection and identification.	3.7.2.1.1.5.1
A1.3.02.51	Evaluate Monitor-Maneuver Message	R,A,VC	Flight ID; Expected Maneuver; Aircraft position; Special Maneuver Information	Controller Reminder (SL) Controller Reminder (SL) Situation A&M Data	Communication with pilot may be required; flight plan may need to be amended	[Questions/ Instructions to Pilot]	Selective Presentation; Variable Windows; Automated Air-to-Ground Communication	Need to reduce scanning demands, assist in estimation of time, spatial, and probability parameters and speed decision making.	Not Applicable
A1.3.02.52	Request Display of Conformance Bounds	E	Flight ID	Situation; Alert and Resolution; Controller Reminder (SL); Planning	Display will show conformance bounds relative to aircraft position	Flight ID	Predefined Function Activation	Need to speed data entry.	

TABLE 4-1. DIALOGUE DESCRIPTION (cont.)

TASK NO.	TASK STATEMENT	TASK TYPE	INFORMATION REQUIRED BY THE CONTROLLER	LOGICAL DISPLAY	CONTROLLER INFEFENCE/ DECISION	INFORMATION OUTPUT BY THE CONTROLLER	SUGGESTED TOOLS AND CAPABILITIES	RATIONALE FOR TOOLS AND CAPABILITIES	DRAFT AERA 2 SLS PARAGRAPH
A1.3.02.53	Evaluate Display of Conformance Bounds	R,A	Aircraft Position; Conformance Bounds; Current Plan	Situation Situation Flight Data	Controller will receive information to aid in maintaining conformance of aircraft	None	Variable Windows; Look Ahead Display; Graphical Representation	Need to reduce scanning demands, assisting in accurate estimation of time, spatial and probability parameters, improve ability to create mental pictures, and allow assessment of appropriateness of planned action.	Not Applicable
A1.3.03.51	Request Supervisor to Designate Airspace as Strategic	E,VC	Airspace ID or Airspace Boundaries; [Time Period]	Situation Situation	Machine will generate resolutions for airspace avoidance	Airspace ID or Airspace Boundaries; [Time Period]	Prompted Data Entry; Sketching	Need to limit memory demands and speed data entry.	
A1.3.07.50	Enter Airspace ID for Sector Adjustment	E	Temporary Use Airspace ID; [Time Period]	Static Information; Situation Situation	Area of responsibility is changed; all data is redirected to the appropriate sector	Temporary Use Airspace ID; [Time Period]	Default Data Values	Need to speed keyed data entry.	3.7.2.1.2.3-i
A1.4.01.50	Receive Trial/Pending Plan	R	Plan; Originating Sector ID	Planning Planning	Plan may be of intrest to this sector; action may be required	None	Emphasis; Display Code Definitions	Need to reduce scanning and data translation demands and speed detection and identifcation.	3.7.1.3.1.1.1 3.7.1.3.1.1.9 3.7.1.3.1.2 3.7.1.3.3.2 3.7.1.3.5.4
A1.4.01.51	Request Pre-Departure Check	E	Flight ID	Flight Data	Flight Plan will be checked for problems against strategic airspace and flow restrictions	Flight ID; [Estimated Departure Time]	Default Data Values	Need to limit keyed data entry.	
A1.4.01.52	Receive Pre-Departure Check Results	R	Pre-Departure Check Results	Flight Data	Processing is complete; results of check will reflect possible problems	None	Selective Presentation	Need to reduce scanning demands.	3.7.1.2.2 3.7.1.3.2 3.7.1.3.2.2 3.7.1.3.2.3

TABLE 4-1. DIALOGUE DESCRIPTION (cont.)

TASK NO.	TASK STATEMENT	TASK TYPE	INFORMATION REQUIRED BY THE CONTROLLER	LOGICAL DISPLAY	CONTROLLER INFEFENCE/ DECISION	INFORMATION OUTPUT BY THE CONTROLLER	SUGGESTED TOOLS AND CAPABILITIES	RATIONALE FOR TOOLS AND CAPABILITIES	DRAFT AERA 2 SLS PARAGRAPH
A1.4.01.55	Receive Automated Coordination Request	R	Automated Coordination Information	Automated Coordination (SL)	Need to approve or deny request and response may be necessary	None	Emphasis; Selective Presentation Display Code Definitions	Need to reduce scanning and memory demands and speed detection.	3.7.1.3.5.4 3.7.2.1.1.5.2
A1.4.01.56	Receive Automated Coordination Response	R	Automated Coordination Response	Automated Coordination (SL)	Clearance may be implemented	None	Emphasis	Need to reduce scanning demands.	3.7.1.3.5.4 3.7.2.1.1.5.2
A1.4.01.57	Enter Response to Automated Coordination	E	Plan ID	Automated Coordination (SL)	Evaluation of Automated Coordination is complete	Automated Coordination Response	Predefined Function Activation	Need to limit verbal communication demands.	3.7.1.3.5.3 3.7.2.1.1.5.2 3.7.2.1.2.3-k
A1.4.01.58	Receive Pilot Change to Aircraft Specific Characteristics	R,VC	Aircraft ID; Specific Aircraft Character-istics	None None	Aircraft performance changes may affect projected flight path and problem resolutions	None	Automated Air-to-Ground Communication	Need to limit verbal communications demands.	
A1.4.02.50	Review/Adjust APR Constraints	E	Flight ID; APR Constraints currently in effect: ARP Constraints needed	Situation Flight Data; Planning None	Bounds to APR have been adjusted so that acceptable resolutions are generated	[Flight ID]; [Prohibited Maneuvers]; [Preferred Maneuvers]; [Time Period]	Display Parameter Status	Need to limit memory demands.	3.7.1.3.4.3-c 3.7.1.3.4.3-d 3.7.2.1.2.3-a
A1.4.06.51	Observe Accompanying APR Constraints	R	Aircraft ID; APR Constraints; APR Constraint Indications	Flight Data Flight Data Situation	All possible automated resolutions may not be presented, or restrictions may need to be modified	None	Selective Presentation; Emphasis	Need to reduce scanning demands and speed detection.	3.7.1.3.4.4 3.7.2.1.1.2

TABLE 4-1. DIALOGUE DESCRIPTION (cont.)

TASK NO.	TASK STATEMENT	TASK TYPE	INFORMATION REQUIRED BY THE CONTROLLER	LOGICAL DISPLAY	CONTROLLER INFEFENCE/ DECISION	INFORMATION OUTPUT BY THE CONTROLLER	SUGGESTED TOOLS AND CAPABILITIES	RATIONALE FOR TOOLS AND CAPABILITIES	DRAFT AERA 2 SLS PARAGRAPH
A1.4.07.50	Select Trial/Pending Plan for Transfer	E	Plan ID; [Sector ID]	Planning; Message Comp and Response Automated Coordination (SL)	Trial/Pending Plan will be transferred	Plan ID; [Sector ID]	Default Data Values; Prompted Data Entry	Need to limit keyed data entry.	3.7.1.3.1.1.9 3.7.1.3.1.2
A1.4.10.50	Select Plan as the Current Plan	E	Plan ID	Planning; Alert and Resolution	Flight plan has been amended or new flight plan has been created	Plan ID	Predefined Function Activation	Need to limit keyed data entry.	3.7.1.3.1 3.7.1.3.1.1.6 3.7.1.3.1.3 3.7.2.1.2.3-be
A1.4.10.52	Evaluate Pre-Departure Check Results	R,A	Aircraft ID; Pre-Departure Check Results	Flight Data; Planning Flight Data	Changes to filed flight plan may be required	None	Selective Presentation	Need to reduce scanning demands.	Not Applicable
A1.4.11.52	Request Automated Reprobe	E	Reprobe Parameters	Planning	Plan may become acceptable at some future time; determine acceptability of default parameters for use with plan	Reprobe Parameters	Predefined Function Activation	Need to limit keyed data entry.	3.7.2.1.2.3-f
A1.4.11.54	Delete Plan	E	Plan ID	Planning; Message Comp and Response	Plan has no future value	Plan ID	Predefined Function Activation	Need to limit keyed data entry.	3.7.2.1.2.3-bc
A1.4.11.55	Select Plan as Pending Plan	E	Plan ID	Planning; Alert and Resolution; Message Comp and Response	Plan will be subject to periodic problem detection; priority alerts displayed automatically; resolutions must be requested	Plan ID	Predefined Function Activation	Need to limit keyed data entry.	3.7.1.3.1.1.1 3.7.1.3.1.3

TABLE 4-1. DIALOGUE DESCRIPTION (cont.)

TASK NO.	TASK STATEMENT	TASK TYPE	INFORMATION REQUIRED BY THE CONTROLLER	LOGICAL DISPLAY	CONTROLLER INFEFENCE/ DECISION	INFORMATION OUTPUT BY THE CONTROLLER	SUGGESTED TOOLS AND CAPABILITIES	RATIONALE FOR TOOLS AND CAPABILITIES	DRAFT AERA 2 SLS PARAGRAPH
A1.4.11.58	Request Reprobe Results	E	Flight ID, or Plan ID	Planning	Controller will determine why no response has been received from Reprobe	Flight ID, or Plan ID	Predefined Function Activation	Need to limit keyed data entry.	3.7.1.3.3.2
A1.4.11.59	Evaluate Reprobe Results	R,A	Aircraft ID; Trial Plan; Predicted Problems	Planning Planning Planning	Decide whether to continue Reprobe, modify plan, or delete plan	None	Look-Ahead Display	Need to assist in determining problem impact.	Not Applicable
A1.4.11.60	Select Plan for Automated Coordination	E	Plan ID; Designated Sector ID(s)	Planning; Message Comp and Response Automated Coordination (SL)	Coordination is required	Plan ID; [Designated Sector ID(s)]	Default Data Values	Need to limit keyed data entry.	3.7.1.3.5.1 3.7.2.1.2.3-j
A1.4.11.61	Request Display of All Plans for Aircraft	E	Flight ID	Situation; Flight Data	Plan may be obtained which could be used	Flight ID	Predefined Function Activation	Need to limit keyed data entry.	
A1.4.11.62	Request Display of Specified Plan(s) for Aircraft	E	Flight ID; Plan ID; Plan Type	Situation; Flight Data; Planning Planning Planning	Plan may be obtained which could be used	[Flight ID]; [Plan ID]; [Plan Type]	Predefined Function Activation	Need to limit keyed data entry.	3.7.1.3.1.4 3.7.1.3.3.1 3.7.1.3.4.4 3.7.2.1.2.3-bd
A1.4.11.63	Update/Revise Retrieved Plan	E	Plan	Planning; Message Comp and Response	A new useable plan will be created	Plan Revisions	Prompted Data Entry; Default Data Values	Need to limit memory demands and limit keyed data entry.	3.7.1.3.3.1 3.7.2.1.2.3-ba
A1.4.11.64	Review Stored Plan for Correctness to Traffic Situation	R,A	Plan; Current Overall Situation	Planning; Message Comp and Response Situation; Future Situation; Workload	Plan may be suitable to current need; modification may be required	None	Variable Windows; Look Ahead Display	Need to reduce scanning demands and assist in estimation of time and spatial parameters.	Not Applicable

TABLE 4-1. DIALOGUE DESCRIPTION (cont.)

TASK NO.	TASK STATEMENT	TASK TYPE	INFORMATION REQUIRED BY THE CONTROLLER	LOGICAL DISPLAY	CONTROLLER INFEFENCE/ DECISION	INFORMATION OUTPUT BY THE CONTROLLER	SUGGESTED TOOLS AND CAPABILITIES	RATIONALE FOR TOOLS AND CAPABILITIES	DRAFT AERA 2 SLS PARAGRAPH
A1.4.11.66	Request Controller Assisted Resolution	E	CAR Parameters	Situation; Future Situation; Alert and Resolution; Planning	Controller Assisted Resolutions will be available for consideration	CAR Parameters	Prompted Data Entry; Default Data Values	Need to reduce coding demands, limit keyed data entry and limit memory demands.	3.7.1.3.4.3 3.7.2.1.2.3
A1.4.15.50	Initiate Non-Radar Separation Standards	E	Flight ID	Situation; Flight Data	Detection and resolution of problems will utilize non-radar separation	Flight ID; [Non-radar Area ID]; [Time Period]	Predefined Function Activation; Prompted Data Entry; Default Data Values	Need to speed implementation, limit keyed data entry, and limit memory demands.	3.7.2.1.2.3-h
A1.4.16.51	Initiate Radar Separation Standards	E	Flight ID	Situation; Flight Data	Detection and resolution of problems will utilize radar separation	Flight ID; [Non-radar Area ID]; [Time Period]	Predefined Function Activation; Prompted Data Entry; Default Data Values	Need to limit memory demands and keyed data entry.	3.7.2.1.2.3-h
A1.6.02.50	Review Current and Projected Traffic Status/Weather	R,A,VC	Current Overall Situation; Future Situation; Weather Conditions	All Current Displays	Mental picture of the situation is sufficient to continue briefing	Questions/ comments to briefing controller	Look Ahead Display; Variable Windows; Selective Presentation	Need to reduce scanning demands, improve ability to develop mental pictures, and assist in planning activities	FSD
A1.6.02.51	Review Extended Briefing Checklist/Notes	R,A,VC	Briefing Checklist Notes	Static Information Controller Notepad	Mental picture of the situation is sufficient to assume position responsibility	Questions/ comments to briefing controller	Selective Presentation	Need to reduce scanning demands.	Not Specified
A1.6.02.52	Review Sector Suite Displays	R,A	Sector Suite Configuration/ Status	All Current Displays	Configuration and status may be satisfactory	None	Variable Windows; Display Code Definitions	Need to reduce data translation and scanning demands.	3.7.2.1.1.1 3.7.2.1.1.2 3.7.2.1.1.3 3.7.2.1.1.4 3.7.2.1.1.5

TABLE 4-1. DIALOGUE DESCRIPTION (cont.)

TASK NO.	TASK STATEMENT	TASK TYPE	INFORMATION REQUIRED BY THE CONTROLLER	LOGICAL DISPLAY	CONTROLLER INFEFENCE/ DECISION	INFORMATION OUTPUT BY THE CONTROLLER	SUGGESTED TOOLS AND CAPABILITIES	RATIONALE FOR TOOLS AND CAPABILITIES	DRAFT AERA 2 SLS PARAGRAPH
A1.6.08.50	Request Display of Sector Workload Factor	E	Time Period; Workload Measure Type	Workload Workload	Graphic display of sector workload factors vs. time will be presented	[Time Period]; [Workload Measure Type]	Default Values; Prompted Data Entry	Need to reduce coding demands and limit memory demands.	
A1.6.08.51	Evaluate Displayed Sector Workload Factor	R,A	Workload Measure(s); Time Period; Current Overall Situation	Workload Workload Situation; Future Situation	Assessment of sector workload demands will facilitate planning of sector duties and priorities	None	Emphasis; Graphical Representation	Need to reduce scanning demands and assist in recognition of developing patterns.	Not Applicable

5.0 SUMMARY

The AERA 2 capabilities will provide new planning and decision-aiding functions to the controller of the future. These capabilities will enhance those provided to the controller in the AAS environment. By their very nature, these enhanced capabilities will change the way controllers do their jobs. Because of the expected changes in human-computer interaction, it is necessary to define an operations concept as an initial basis for understanding the human implications of the AERA 2 capabilities. The operations concept presented in this document defines AERA 2 controller tasks and activities and analyzes the tasks from several perspectives. Recommendations are made to minimize controller workload and to complement human information-processing capabilities.

The process of defining and analyzing tasks for the AERA 2 controller was iterative and systematic. ATACT members reviewed interim engineering products at each of the team's meetings. The final set of composition graphs and the table on task information requirements represents the ATACT's final review in January of 1986.

Additional human factors engineering analyses were performed to estimate the potential cognitive/sensory demands of the AERA 2 tasks and to identify human speed and accuracy factors that may potentially constrain controller performance of AERA 2 tasks. Findings based on the task information requirements analysis (Table 3-1) and the additional analyses (Tables 3-2 and 3-3) imply the need for a variety of supplemental tools and capabilities. Recommendations for automated-aiding techniques are provided in Table 3-4.

Major results of the task characterization analysis are that 1) 56% of the 66 AERA 2 tasks involve data entry; 2) over 51% of the tasks require more than one item of displayed information;

and 3) over 72% of the tasks are associated with more than one logical display.

These results suggest that further development and testing should focus on limiting manual data entry, selecting and displaying only task-relevant information, and organizing information to limit the number of different displays required per task. The goal of human-computer interface design should be to support controller productivity by complementing human information-processing capabilities. The operations concept for AERA 2 provides the information necessary for the development of a human-computer dialogue that makes the best use of human and automated resources.

SECTION 6 - REFERENCES

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APPENDIX A
GLOSSARY OF VERBS USED TO DEFINE CONTROLLER TASKS

INTRODUCTION

This appendix contains the set of verbs used to define controller tasks. This verb set was originally developed and used for defining AAS tasks (Ref. 3).

The purpose of developing a taxonomy of verbs is to standardize meanings and to limit overlap between verbs. Apparent overlap, as between "Choose" and "Select", can be resolved by distinctions implied by the definitions and by the particular task context. In some cases of nearly synonymous meanings, distinctions are based on controller usage (e.g., "Start Track" as compared to "Initiate Handoff"). It is important to note that meanings of verbs are typically given more constrained definitions here than they are in a standard dictionary. These constrained meanings help to clarify what is involved in controller task performance.

A sub-set of this taxonomy has been used in defining AERA 2 tasks. The verbs used most frequently to define AERA 2 tasks are listed with an associated example in Section 2 of this document. Use of these verbs has helped to promote consistency between the AAS and AERA 2 analyses.

ACCEPT - Response to an originating controller or computer that the receiving controller has received or observed the flight information being coordinated and assumes complete or partial responsibility for the action as appropriate.

ACKNOWLEDGE - Response to a request or new entry without further commitment as to what action will be taken.

ADJUST - Changing or fine tuning of the data base, adaptation, display, and/or communication controls.

ADVISE - Offer advice or counsel to another person of information and/or data that the originating controller deems necessary to pass to the receiver.

ALERT - Notification to others that a critical situation may be approaching or impacting the receiver, as in alerting an airport facility of an aircraft having flight difficulties.

ANALYZE - Examine individual items to make a judgment on the entire situation, such as conditions that influence the ability to provide flight following (similar to "Review," but suggests a one-time effort rather than a more repetitious action).

APPROVE - Respond favorably to a request, as in approving a clearance request.

APPROVE/DISAPPROVE - Authoritatively respond to a request by either granting or denying it.

ATTEMPT - Try a course of action without predicting the results, as when trying to establish communications with an aircraft.

BRIEF - Give concise preparatory information concerning all sector activities to another controller.

BROADCAST - Transmit a recording to others via radio.

CANCEL - Remove data from the computer or rescind information passed to another (comparable to "Delete").

CHECK - Visually examine a hardware item for its operational state or condition.

CHOOSE - Make a mental decision on a course of action or mentally pick one of several alternatives, as in choosing a desired flow sequence.

COMPARE - Relating one item to another, as in comparing a maintenance request to a maintenance schedule.

COMPOSE/ENTER - The act of making up a message, including all required elements of the message and providing the message to the computer, as in composing and entering a flight plan amendment.

CONDUCT - A series of related actions designed to achieve a result, as in conducting a radio/radar search.

CONFER - Holding a discussion without necessarily negotiating.

CONFIRM - Make certain that what should have occurred did in fact occur, as in confirming a specific computer action during transition stages.

CONTACT - Establish communications via VSCS with another, informing or discussing matters of concern, as in contacting an overdue aircraft.

DECLARE - State with emphasis that a situation exists, as in declaring the existence of an emergency event.

DELETE - Erase or cancel a previous action, as in deleting the highlighting of an item on a display.

DENY - Refuse a request.

DESIGNATE - A marking or specifying of an area on a display, as in designating airspace in use.

DETECT - Visually or auditorily discerning a fact or item, such as an alarm indicator or action of an aircraft; but also includes observing the occurrence of events or situations such as pilot problems or equipment failures.

DETECT/ACKNOWLEDGE - Discern the occurrence of an event such as an alert and take action to let the system know it has been discerned.

DETERMINE - Process information mentally to reach a decision about a situation, state of affairs, or timing of an action.

DETERMINE/ENTER - A drawing or dimension action input electronically, as in specifying new sector airspace.

DIRECT - Cause a flight data display to appear at another's workstation.

DISCUSS - Holding a conversation on a specified subject without necessarily negotiating.

ENTER - Insert data or text into the computer system.

EVALUATE - Examine and judge the merits of an action or alternative.

EXCHANGE - Replace, transfer, or modify personnel responsibilities/designate a controller to a position.

EXCHANGE/ASSIGN - Replace, transfer, or modify personnel responsibilites; designate a controller to a position.

EXPLORE - Investigate systematically, perhaps by a variety of actions, such as when determining whether other controllers are receiving an aircraft's transmissions.

FLIGHT FOLLOW - Provide advice and information to assist pilots in the conduct of a flight not being otherwise controlled; this includes tracking that flight on the Situation Display.

FORCE/QUICK LOOK - Compel or produce a result on a display, as in forcing a Full Data Block that would not otherwise be presented.

FORMULATE - Mentally devise or prepare the content of a message according to a specific formula, standard, or procedures, such as an advisory or clearance.

FORWARD - Send information verbally or by machine action to another position.

HIGHLIGHT - Provide prominence to an item on a display.

INFORM - Impart information to another.

INHIBIT - Prevent the occurrence of a machine action, as in inhibiting an alert function.

INITIATE - Begin an action, as in initiating a handoff.

ISSUE - Distribute or communicate information, typically involving a pilot or an aircraft, as in issuing clearances or advisories.

MONITOR - Periodically check, keep track of, or maintain awareness of status of something, such as in monitoring the status of a questionable NAVAID.

NEGOTIATE - Discuss in order to come to a mutually acceptable agreement, as when negotiating with a pilot the technique to be used for accomplishing a flight delay.

OBSERVE - Notice or watch attentively a visual display for a message or event, or the occurrence, status, or location of something. (A here-and-now observation, as opposed to "Perceive," an evolving process observation.)

OFFSET - Reassociate the position of a data block in relation to a target on the display.

PERCEIVE - Become aware of an action as it evolves over time, such as an aircraft deviation or a tracking fault.

PERFORM - Carry out a standard procedure or operation, such as logging on at the Sector Suite workstation.

PROJECT - Mentally extend the position and/or path of one or more aircraft in time and space.

QUERY - Inquire of another person or machine to remove doubt, as in querying about some element of a flight plan.

QUICK-LOOK - Produce on one's own display the data or visual presentations that are available at another workstation.

READ OUT - Acquire information from the computer on a specified item, such as range/bearing/time for an aircraft to a fix.

RECALL - Summon or otherwise bring personnel back to their workstation.

RECEIVE - Acquire transmitted information by seeing or listening, without necessarily taking action to express approval.

REDIRECT - Retract handoff and initiate it to another controller.

REJECT - Refuse to accept a usually accepted item, like a handoff.

REMOVE - Cancel information in the computer (comparable to "Delete").

REPLAY - Electronically recreate a prior situation, such as a traffic situation, from a computer recording.

REPOSITION/UPDATE/REASSOCIATE - Reassociate or co-locate a data block and a target and provide current data on the data block.

REQUEST - Ask another for information for approval on, or for receipt of, an item; or direct the system to provide a function such as a route readout.

REQUEST/ASSIGN - Ask another individual or the computer for an item, such as a beacon code for assignment to an aircraft, and commit the result.

RESEQUENCE - Rearrange the order of flight data entries displayed.

RESTORE - Bring back into being or remove an inhibit of a function such as MSAW.

RESTRICT - Provide limits to an activity, such as air traffic in an area.

RETRACT - Take back/negate/withdraw the start of an action such as a handoff.

REVERT - Go to the use of another procedure, such as backup operations.

REVIEW - Look over and study conditions or situations, or examine something again, as in reviewing the completeness of a flight plan.

SEARCH - Scan/look over a display to find something, such as a particular flight plan.

SELECT - Single out an item on a display or panel in preference to others, or indicate to the system one of several available options or items, such as a flight plan sorting priority scheme.

SET UP - Adjust equipment for proper functioning.

SORT - Arrange data by chosen classes or priorities, as in sorting a set of flight data entries by time or fixes.

START - Begin the display of the track of a traget on the Situation Display, as in "start track".

SUGGEST - Offer for consideration another course of action, when a request is not feasible, such as clearance alternatives to a clearance request.

SUPPRESS - Curtail the display of an item, such as a flight Data Block after a pointout.

SUSPEND - Stop the display of an item for an indefinite period, until recalled or restored, such as in "suspend track."

SWITCH - Change a given system condition to another available condition, as when switching communications to a backup frequency.

TERMINATE - Bring an activity to an end, as in terminating radar

service to an aircraft. (A controller term used with pilots, but comparable to "Cancel.")

UPDATE/REVISE - Change or modify text to bring it more up-to-date, as in updating electronic notes/memoranda.

VERIFY - Establish the truth of an activity or matter by confirmation, as in verifying communication contact with an aircraft.

APPENDIX B

GLOSSARY OF TERMS

Activity - A related group of sub-activities which forms one of the five basic duties of the Air Traffic Control job in the AERA 2 time frame.

Active Flight Plan - All flights for which an actual departure time has been entered, whether the flight originates inside or outside any particular Area Control Facility's jurisdictional airspace.

Adaptation - Unique, site-dependent data required by the operational program to provide the flexible capability necessary to allow it to function at individual sites.

Adapted Non-Radar Area - An airspace volume, defined by boundaries adapted or designated by supervisory personnel, that encloses an area of no, or only intermittent, radar coverage.

Adjacent Facility - A facility whose assigned airspace borders that of the facility being discussed.

Advanced Automation System (AAS) - The system to replace all existing en route and terminal ATC systems, as well as provide automation in airport control towers.

Advisory Alert - A notification to the controller of an advisory problem detected in a Current Plan or Pending Plan by the Automated Problem Detection Capability of the Automation Processing Subarea.

Advisory Problem - A problem which is not a priority problem but which is rated by the computer as reasonably likely to occur.

Aircraft-to-Aircraft Conflict - A situation in which the required separation between controlled aircraft may be violated if the aircraft remain in conformance with their trajectories.

Aircraft-to-Airspace Conflict - A situation in which the required separation between a controlled aircraft and a special-use airspace or other designated airspace may be violated if the aircraft remains in conformance with its trajectory.

Aircraft Conflict - See aircraft-to-aircraft conflict.

Airspace - A volume of air or an area of ground (runways and taxiways, for example) of specified dimensions and location.

Airspace Conflict - See aircraft-to-airspace conflict.

Air Traffic Control/ATC - A service that promotes the safe, orderly, and expeditious flow of air traffic, including airport, approach, and en route air traffic control.

Air Traffic Controller - A person authorized to provide air traffic service. Refers to en route and terminal control personnel.

Alert and Resolution Display - A logical display that contains information for the Controllers' immediate attention.

Area Control Computer Complex/ACCC - The equipment and software which provides ATC automation support to controllers located within an Area Control Facility after facility consolidation or an ARTCC prior to facility consolidation. The ACCC is one part of the AAS.

Area Control Facility (ACF) - The facilities that result from consolidation of existing ARTCC and TRACON/TRACAB facilities. An ACF may be formed from an existing ARTCC or may be created in a new building. The number, location and implementation dates of ACFs will be in accordance with the National Airspace System Plan.

ATC-Assigned Airspace - An airspace of defined vertical and laterial limits, assigned by ATC, for the purpose of providing air traffic segregation between the specified activities being conducted within assigned airspace and other IFR air traffic.

Automated Coordination - A capability that supports nonvoice coordination between two or more sector controllers or between a sector controller and a Traffic Management Coordinator (TMC) in the negotiation of trial plans and computer-generated resolutions.

Automated En Route Air Traffic Control (AERA) - The enhanced ATC automation system of the future to be implemented in several segments.

Automated Problem Detection - A subcapability of the Automation Processing which detects problems with, and penetrations of "information only" airspaces by trajectories of, Current Plans, Pending Plans, Trial Plans and Machine Plans, and detect objections in Machine Plans.

Automated Problem Resolution (APR) - An AAS capability that produces computer-generated resolutions to problems detected by the Automated Problem Detection capability.

Automated Reprobe - A subcapability of the Automation Processing Capability Trial Planning which periodically re-evaluates a designated Trial Plan for problems detected by Automated Problem Detection and notifies the current controller when the specified Trial Plan is problem-free.

Clearance - an authorization by air traffic control for an aircraft to proceed under specified traffic conditions within controlled airspace to maintain separation standards between known aircraft.

Conflict - Any situation that exists between two or more aircraft, an aircraft and the airspace, or an aircraft and the terrain, for which applicable separation minima is or may be violated.

Conflict Alert (CA) - An AAS capability that detects conflicts based upon extrapolations of track data.

Conflict Geometry - A description of the relative positions of aircraft and airspaces in a conflict situation (e.g., for an aircraft-to-aircraft conflict, the conflict geometry may be head-on, overtake, crossing, or merging).

Conflict Resolution Advisories (CRA) - Resolutions to a violation detected by the Conflict Alert function or a violation detected by the Minimum Safe Altitude Warning (MSAW) function. Such resolutions provide track conflict resolution and terrain avoidance by recommending a set of resolutions that avert the situation.

Conformance - Current positional agreement (within a parameter) between a track and its associated trajectory (similar to "association" in NAS Stage A), or between an aircraft position/altitude (given by pilot position report or validated altitude encoding transponder return) and the associated trajectory at the given point in time.

Conformance Bound - Standard used to determine if the aircraft is in conformance with the plan based trajectory.

Controller Reminder - A message generated by the system and automatically delivered to the controller at a time related to a particular maneuver or clearance; AERA 2 uses two types of controller reminders: deliver-clearance and monitor-maneuver.

Controlled Aircraft - An aircraft that is participating in and receiving traffic separation services from the ATC system.

Coordination Request - Nonvoice communication to inform affected ATC personnel (controllers or TMC) of proposed changes to a filed Flight Plan.

Current Plan - The plan for an aircraft that the controller has specified to the system as the plan the aircraft is expected to fly.

Data Link - Ground-air communications which can be used (for appropriately equipped aircraft) to send clearances and clearance changes and information (e.g., weather information) to aircraft, and to receive pilot requests, acknowledgements, and aircraft performance data from aircraft.

Deliver-Clearance - A Controller Reminder which reminds a controller to communicate a clearance to a pilot either verbally or via data link; deliver-clearance reminders include Expect Further Clearance (EFC) for leaving a hold, EFC for leaving an interim altitude, and start point of descent.

Dormant Plan - A Plan which is no longer "valid" for some reason (e.g., the Flight Plan upon which it was based has been amended, the Trial Plan reached a system parameter life time limit).

Flight Data Display - A Logical Display that contains flight information for aircraft of interest to Controller positions assigned to the sector.

Flight Data Entry (FDE) - A set of flight data for one aircraft shown on the Flight Data Display. One FDE is analogous to one paper flight progress strip in the current system.

Flight Plan - Specified information relating to the intended flight of an aircraft that is filed orally or in writing with an FSS or an ATC facility.

Flow Restriction - A limitation on air traffic, defined in terms of applicability criteria and constraint, instituted by the Traffic Management System.

Full Data Block - A block of alphanumerics associated with a target shown on the Situation Display. Full Data Blocks are shown for aircraft under the control of the sector or of particular interest to the sector.

Future Situation Display - A logical display, to be implemented with AERA 2, which depicts the predicted aircraft positions and movements at or during a Controller-defined future time period.

Human-Computer Interaction (HCI) - Communication between an automated system and a human operator (end user). This dialogue is supported by the physical human-computer-interface, consisting of visual displays, controls, and any other necessary equipment.

IFR Aircraft - An aircraft conducting flight in accordance with Instrument Flight Rules.

Instrument Flight Rules/IFR - Rules governing the procedures for conducting instrument flight. Also a term used by pilots and controllers to indicate type of flight plan.

Invalid - A term used to signify that a plan's storage will be terminated within a parameter time.

Logical Display - Set of information displayable to the controller as a single entity.

Machine Plan - Resolution maneuver and accompanying information generated by the Automated Problem Resolution capability; note that plans created by Quick Trial Planning are Trial Plans.

Macro - A set of related tasks, some or all of which are performed to accomplish a particular job that is required in multiple sub-activities.

Make Current - The procedure which designates a plan as the current plan for an aircraft.

Maneuver Type - A specified method of implementing a strategy, but lacks detailed data (e.g., start location, turn angle).

Message Composition and Response Display - A Logical Display that contains menus for the composition of messages and an area for the system's response.

Meter Fix - An adapted fix on the converted route of a flight over which the AERA capabilities will assist the controller in delivering aircraft in accordance with the flow restriction for that fix.

Metering Restriction - A schedule for the use of a busy saturable entity (e.g., airport, meter fix, sector boundary), in order to smooth the flow of traffic; the basis for metering plans developed by the terminal or traffic management personnel.

Minimum Safe Altitude Warning (MSAW) - An AAS capability that detects when a controlled Mode C-equipped aircraft is below or is predicted (using track data) to go below a predetermined minimum safe altitude.

Mode C - An interrogation mode in which a beacon transponder automatically reports altitude when interrogated by a ground situation.

Mode S - A future surveillance system which will also provide a digital data link with properly equipped aircraft.

Monitor-Maneuver - A controller reminder delivered if, at a parameter time prior to the last possible maneuver starting point if the aircraft is to remain in conformance, the aircraft has not started the maneuver.

National Airspace System (NAS) - The common network of U.S. airspace; air navigation facilities, equipment, and services; airports or landing areas; aeronautical charts, information, and services; rules, regulations, and procedures; technical information, manpower, and material. Included are system components shared jointly with the military.

Non-Radar Separation - Distances or times greater than the non-radar separation minima applied according to non-radar separation procedures to assure aircraft are properly separated.

Objection (for a Machine Plan) - Undesirable characteristics of Machine Plans, such as one or more problems in the original plan is unsolved, a new problem is introduced, or an aircraft is maneuvered into an extra sector.

Operations Concept - Definition and analysis of user tasks implied by proposed system capabilities; paper simulation or prototype of the human role in an increasingly automated environment.

Out-of-Conformance - An aircraft is out-of-conformance when it is not in conformance laterally, vertically or longitudinally.

Pending Plan - A plan (which was formerly a Machine Plan or Trial Plan) that has been designated as pending in order to obtain continual problem detection (and resolution, where appropriate) services, and Conformance Monitoring; may be in coordination or designated as pending to identify to other controllers an impending change in an aircraft plan.

Plan (see Flight Plan, Machine Plan, Pending Plan, Trial Plan) - All the information necessary about an aircraft to allow AERA capabilities to work with that aircraft; includes the filed Flight Plan, the list of amendments, the trajectory, and conformance criteria.

Pilot Weather Report (PIREP) - A report of meteorological phenomena encountered by aircraft in flight.

Plan Type - A method of classifying plans that allows Automation Processing to provide the capabilities appropriate tothe controller's needs for the plan; the types available are Current, Pending, Trial, Dormant, and Machine.

Planning Display - A logical display that contains plan information for non-current plans associated with the sector.

Point-of-Violation - The location of the predicted loss of separation (for aircraft-to-aircraft and aircraft-to-airspace conflicts), the location of the noncompliance with a flow restriction, or the location of nonconformance.

Predicted Problem - An event detected by the Automated Problem Detection Capability; will be one of the following:

a. Violation of separation standards between aircraft trajectories detected by Aircraft-to-Aircraft Problem Detection

b. Violation of separation standards between aircraft trajectory and protected airspaces detected by Aircraft-to-Airspace Problem Detection

c. Noncompliance of an aircraft trajectory with flow restrictions detected by Flow Restriction Noncompliance Detection

d. Nonconformance of the track position with the trajectory detected by Conformance Monitoring.

Priority Alert - A notification to the controller of a priority problem detected by the Automated Problem Detection capability of the Automation Processing Subarea.

Priority Problem - A problem for which seriousness of the encounter, the certainty of the encounter, and the time to go until loss of separation or until noncompliance are such that the problem is rated by the computer as being very likely to require prompt controller action; nonconformance is a priority problem.

Protected Airspace - An airspace for which separation violations are predicted by Aircraft-to-Airspace Conflict Detection; the following airspaces are protected:

a. Minimum Safe Altitude Warning (MSAW) Area

b. Special-Use Airspace

- Prohibited Area
- Restricted Area
- Warning Area
- Military Operations Area
- Alert Area
- Controlled Firing Area

c. ATC-Assigned Airspace

Quick Look - A feature which provides the controller the capability to display data blocks of tracked aircraft from other control positions.

Quick Trial Planning - Capabilities defined in the AAS System Level Specification, FAA-ER-130-005F, as Resolution Aid and Reconformance Aid.

Radar Pointout (Pointout) - Used between controllers to indicate radar handoff action where the initiating Controller plans to retain communications with an aircraft penetrating the other Controller's airspace and additional coordination is required.

Radar Separation - A term meaning either lateral separation, or longitudinal separation, or both as observed on a radar display.

Reroute - A change to the pilot's filed route; i.e., a new path of points including NAVAIDs, latitude-longitude pairs, and/or DME distances from NAVAIDs on specified radials.

Resectorization - Splitting or rearrangement of geographic sectors including sector stratification.

Resolution - One or more machine plans that are generated to resolve problems identified in another plan.

Resolution Maneuver - The new maneuver (or sequence of maneuvers) incorporated into the Original Plan by APR when generating the Machine Plan.

Resynchronization - The process of updating an aircraft's trajectory estimate as a result of a longitudinal deviation of that trajectory from the aircraft's track position in excess of specified conformance bounds.

Sector Suite (S/S) - Refers to the composition of functions which directly comprise either the Controller MMI or Sector Suite Console/Support processing elements.

Separation - In air traffic control, the spacing of aircraft to achieve their safe and orderly movement in flight and while landing and taking off.

Situation Display - A Logical Display that contains the plan view of a sector and some adjacent airspace. Contains real-time positions of target and weather.

Special Lists - A Logical Display that contains several lists of information in a compact and concise manner. Each Special List can be independently displayed and positioned at the Sector Suite. The lists at each position are tailored to the airspace and traffic of interest to that position. AERA 2 provides an additional special list, the Automated Coordination List, that contains information relevant to non-voice coordination of plans.

Special-Use Airspace - An airspace of defined dimensions wherein activities must be confined because of their natureand/or wherein limitations may be imposed upon aircraft operations that are not a part of those activities.

Static Information Display - A Logical Display that contains graphic and tabular data that are updated infrequently, such as area charts and letters of agreement.

Strategic Airspace - An airspace located outside the local ACF and, by virtue of its size, constancy, or ability to currently affect many aircraft, is judged significant enough that aircraft in other ACFs are tested against it for problems; an airspace is strategic if it is so designated by the TMS.

Strategic Flow Restriction - A flow restriction located outside the local ACF and, by virtue of its size, constancy, or ability to currently affect many aircraft, is judged significant enough that aircraft in other ACFs are tested against it for problems; a flow restriction is strategic if it is so designated by the TMS.

Sub-Activity - A set of related tasks which are performed by the Controller in order to accomplish a specific ATC duty.

System Status Data Display - A Logical Display that contains dynamic information on status of ATC equipment, operational areas, airports, etc.

Target - The indication shown as a radar display resulting from a primary radar return or a radar beacon reply.

Task - An ordered, goal-oriented, time-bounded sequence of human actions.

Track -

1. The projection on the earth's surface of the path of an aircraft.

2. The dynamic data including position and velocity, stored by the system for a flight and maintained by the tracing function.

Traffic Management System (TMS) - Traffic Management Facility and, at each ACF, a Traffic Unit.

Trajectory - A representation of the path an aircraft is expected to take all the way to its destination; a four-dimensional (including time), ground-referenced representation of the nominal aircraft path, based upon the information of flight intent.

Trial Plan - Any plan created by controller action using the Trial Planning Capability.

Trial Plan Alert - A notification to the controller of a problem detected in a Trial Plan by the Automated Problem Detection Capability of the Automation Processing Subarea.

User Preferred Route - Flight plan that the pilot of the aircraft would prefer to be cleared to fly.

VFR Aircraft - An aircraft conducting flight in accordance with Visual Flight Rules.

Visual Flight Rules/VFR - Rules that govern the procedures for conducting flight under visual conditions. The term "VFR" is also used in the United States to indicate weather conditions that are equal to or greater than minimum VFR requirements. In addition, it is used by pilots and controllers to indicate type of flight plan. (See Instrument Meteorlogical Conditions.)

APPENDIX C
DATA DICTIONARY

INTRODUCTION

This appendix contains definitions of data items which appear in Table 3-1 Task Information Requirements in Section 3 of this document. Specifically, all items in the columns labeled "Information Required by the Controller" and "Information Output by the Controller" appear in alphabetical order in this dictionary.

Each data item from the table is defined either as text or as a composite of other data items. Textually defined items are at the element level and can not be further decomposed. Data items which comprise a particular composite item from Table 3-1 are also defined in the dictionary.

The following notations are used to describe how the constituent items comprise the composite item:

=	is defined as
or	exclusive or
and	and
( )	grouping
[ ]	optional
@	document reference.

AERA 2 DATA DICTIONARY (ALPHABETICAL LISTING)

TERM		DESCRIPTION
Activate/Deactivate Trial Plan Resolution	=	Indication which allows controller to display or suppress the resolutions to predicted problems detected in Trial Plans.
Activate/Deactivate Advisory Alert Resolutions	=	Indication which allows controller to display or suppress the resolutions to predicted problems classified as "advisory."
Aircraft ID	=	Callsign (i.e., AA123)
Aircraft Position	= and or	Target coordinates (Mode C Altitude Pilot Reported Altitude)
Airspace Boundaries	= and and	Geographic boundaries Ceiling Altitude Floor Altitude
Airspace ID	=	Unique name given to an area designated as special
Airway	=	A controlled area established in the form of a corridor, the centerline of which is defined by navigational aids.
Alert Class	= or or or	Aircraft-to-Aircraft Conflict Aircraft-to-Aircraft Conflict Flow Restriction Violation Conformance Violation
Alert Type	= or or or	Priority Alert Advisory Alert Predeparture Alert Trial Plan Alert
Amount of Conformance Deviation	=	Measure of distance that the aircraft is beyond the conformance bounds.
Amount of Speed Change	=	Number of knots difference between current speed and maneuver speed
Approval	=	Approval indicator from coordinee of Automated Coordination.

APR Constraints	=	[Activate/Deactivate Trial Plan Resolutions]
	and	[Activatate/Deactivate Advisory Alert Resolutions]
	and	[Prohibited Maneuvers]
	and	[Preferred Maneuvers]
	and	[Flight ID]
	and	[Time Period]
	@	AERA 2 SLS 3.7.1.3.4.3
	@	AERA 2 SLS 3.7.2.1.2.3 - a
APR Cnstraints Indication	=	Indication that the resolution capability is constrained in some manner.
Automated Coordination Information	=	Flight ID
	and	[Flight Plan]
	and	Pending Plan
	and	[Predicted Problems]
	and	Originating Sector ID
	and	In-Coordination Indication
	@	AERA 2 SLS 3.7.2.1.1.5.2
Automated Coordination Response	=	(Approval
	or	Denial)
	and	Orginating Sector ID
	@	AERA 2 SLS 3.7.1.3.5.4
	and	Plan ID
	@	January ATACT
Briefing Checklist		(See Controller Handbooks 7210.3g and 710.65c)
Callsign	=	Flight number
	and	Serial Number
	and	[Coded Military Name]
	and	[ICAO Identifier]
CAR Parameters	=	Flight ID
	or	Plan ID
	or	Predicated Problem ID
	and	[Preferred Maneuvers]
	and	[Start time]
	and	[Start location]
	and	[Turn angle]
	and	[Increase/Decrease Speed Indication]
	and	[Amount of speed change]
	and	[Prohibited Maneuvers]
	and	[Time period]
	@	AERA 2 SLS 3.7.2.1.2.3-e
Ceiling Altitude	=	Highest altitude for which an airspace boundary applies.

Conflict Geometry	=	Description of the relative positions of aircraft and airspace in a conflict situation.
Conformance Bounds	=	Graphic display of Geographic Boundaries of Conformance Area
	and	Altitude Bounds of Conformance Area
Controller Intent	=	The plan the controller has for managing the traffic in the sector whether or not the plan is known to the system.
Current Controlling Sector	=	Sector ID which currently has track control of the aircraft which is the subject of the predicted problem.
Current Overall Situation	=	Target Coordinates
	and	Sector Boundaries
	and	Airways
	and	FDEs
	and	Weather Conditions
	and	Workload Measure(s)
	and	Pilot Intent
	and	Controller Intent
	and	FDBs
	and	Predicted Problems
	and	Future Situation
Current Plan	=	Flight Plan
	and	[Predicted Problems]
	and	Trajectory
Denial	=	Denial indicator or no response from coordinee.
Designated Sector ID	=	Sector ID of sectors to which the controller wishes to forward the plan subject to Automated Coordination. These sectors are additions to or deletions from the default list of recipients.
Display Adjustments	=	Logical Display
	and	Viewport
	and	Visibility
Estimated Departure Time	=	Time the aircraft is expected to become airborne.
Expected Aircraft Position	=	Predicted position of aircraft in relation to conformance bounds.

Expected Maneuver	=	Maneuver which has been cleared by the controller but not yet executed by the pilot.
Fix	=	Symbol used to identify specific NAVAID, Airports, or intersections.
Flight Data Entry (FDE)	=	Flight Plan Data
	@	AAS SLS 3.7.1.2.1.1.2.1
	and	Radar/Non-Radar Indicator
	and	Route of Radar/Non-Radar
	and	[Non-Mode C Indication]
	and	[Automated Reprobe Indication]
	and	[In-Coordination Indication]
	and	[Prohibited Maneuvers]
	and	[Aircraft Expemtion from Problem Detection]
	@	AERA 2 SLS 3.7.2.1.1.2
	and	[UPR Notation]
	and	[Preferred Maneuvers]
	and	[Monitor Maneuver Indication]
	@	January ATACT
Flight ID	=	Target Indicator
	or	Discrete Beacon Code
	or	Callsign
	or	Computer Identification
Flight Plan Data	=	Computer Identification
	and	Callsign
	and	(Heavy Jet Indicator
	or	Aircraft Type
	or	Equipment Qualifier)
	and	(Beacon Code)
	and	True Airspeed
	and	Departure Time/Date
	or	Coordination Time)
	and	Assigned Altitude
	and	[Interim Altitude]
	and	[Reported Altitude]
	and	Mode-C Altitude
	and	Requested Altitude
	and	Route of Flight
	and	[Remarks]
	and	Mode-S Address
	and	(Controlling Sector
	or	Controlling Facility)
	and	(Proposed Status indicator
	or	Active Status Indicator)
	and	[Expect Further Clearance Time]
	and	[Hours and Minutes in Hold]
	and	[Holding Fix]
	and	Approach Type
	and	Altitude Nonconformance Indicator

	and	[Alert Indicator]
	and	Ground Speed
	and	[SID Transition Fix]
	and	[STAR Transition Fix]
	and	Preferential Route
	and	[Sector Identification]
	and	[Previous Fix]
	and	[Time at Previous Fix]
	and	[Posted Fix]
	and	[CTA at Posted Fix]
	and	[Next Fix]
	and	[CTA at Next Fix]
	and	[Next Sector/Next Facility]
	and	[Coordination Indicator]
	and	[Overflight Coordination indcator]
	and	[Arrival Arrow/Departure Arrow]
	and	Truncated Route Indicator
	and	[Mode S Indicator]
	and	Lateral Nonconformance Indicator
	and	[Controller Remarks]
	and	[Pilot Estimate]
	and	[Special Route]
	and	[Actual Time Over Fix]
	and	[Metering/Traffic Management Advisory]
	and	[Expected Departure Clearance Time]
	and	[Destination]
	and	[Departure Point]
	and	[Control Information Symbols]
	@	AAS SLS 3.7.1.2.1.1.2.1
Floor Altitude	=	Lowest altitude for which an airspace boudary applies.
Flow Restriction	=	Altitude Constraints
	or	Miles in Trial
	or	Minutes in Trial
	or	Boundary Crossing Time
	or	Meter Fix Time
	or	Forbidden Location
	or	No Directs
	@	AERA SLS 3.7.1.3.2.3
Flow Restriction Description	=	Identification and description of a flow restriction with which an aircraft may be in violation.
FSD Parameters (Future Situation Display)	=	Future Static Time
	or	Continuous Look-ahead
	and	Number of Minutes in Future
	or	Problem Examination Request
	or	Dynamic Adjustment of Future Time
	or	Rate of future display update
	@	October ATACT consensus on 10/3/85 Mitre Position Paper

Full Data Block	=	Callsign
	and	(Mode C Altitude
	or	Pilot Reported Altitude)
	and	Handoff Indicator
	and	(Assigned Altitude
	or	Interim Altitude)
	and	Altitude Nonconformance Indicator
	and	[Heavy Jet Indicator]
	and	Aircraft Type
	and	MSAW/CA Suppression Indicaton
	and	[Computer Identification]
	and	[Scratch Pad Data]
	and	Exception Beacon Code
	and	Conflict Alert Indicator
	and	MSAW
	and	Aircraft Special Condition and/Or Emergency
	and	Transponder Failure Notice
	and	Mode S Indicator
	and	Handoff Alert Indication
	and	VFR Indicator
	and	([Entry/Exit Fix]
	or	[Overflow Indicator])
	and	Destination Airport
	and	Ground Speed
	and	Pointout indicator
	and	Lateral Nonconformance Indicator
	and	Automation Processing Suppression Indicator
	and	Priority Alert Indicator
	@	AAS SLS 3.7.1.2.1.1.1.3.aa-ay
	and	Data Block Pointout Acknowledge Indicator
	@	AAS SLS 2.7.1.2.1.2.1 - s
	and	Radar/non-Radar Indication
	and	Non-Mode C Indication
	@	AERA 2 SLS 3.7.2.1.1.1
	and	Monitor-Maneuver Indication
	and	Maneuver Type Prohibted Indicator
	and	Priority Alert Indication
	@	January ATACT
Future Situation	=	The controller's prediction of target positions, potential conflicts, etc., which will exist at some point in the future, potentially aided by the Future Situation Display.
Geographic Boundaries	=	Dispay of vertex points or a line with a specified distance either side of the line that denote bounds of an airspace.

In-Coordination Inducation	=	Notation that a particular pending plan is currently the subject of automated coordination.
Increase/Deacrease Speed Indication	=	Indication of wheather an increase or a deacrease in speed is required in a maneuver requiring a speed change.
Logical Display	=	Set of information displayable to the controller as a single entity. Twenty logical displays are specified.
Maneuver	=	Maneuver Type
	and	Maneuver Loction
	and	Time of Maneuver
	and	[Maneuver Parameters]
	@	AERA 2 SLS 3.7.1.3.4.4
Miss Distance	=	The predicated distance between the aircraft trajectory and the airspace or trajectory of conflicting aircraft at closest approach.
Maneuver Type	=	Any of the specified maneuvers that can be used to create a plan. For example, hold, climb, reduce speed, reroute, etc.
Maneuver Type Indication	=	Type of maneuver contained in a plan to be subject to automated reprobe.
Mode C Altitude	=	Equipment reported altitute corrected by altimeter reading.
"No Problem" Indication	=	Notice from the system that a trial plan or pre-departure flight plan has been subjected to problem detection and no problems were found.
No-Resolutions Message	=	Indication that all available machine-generated resolutions have been displayed.
Non-Radar Area ID	=	Identifier of airspace defined as non-radar.
Objections	=	Potential Problems in a resolution.

Originating Sector ID	=	Sector identification of the sector from which a plan or message was received.
Pending Plan	=	Plan where Plan Type indicates pending plan.
Pilot Intent	=	Route the pilot plans to fly whether or not it is known to the system.
Pilot Reported Altitude	=	Altitude reported verbally by the pilot.
Plan	=	Flight ID
	and	Plan Type
	and	[Fix]
	and	[Speed]
	and	[Altitude]
	and	[Route]
	@	AERA 2 SLS 3.7.2.1.2.3
	and	[UPR Notation]
	and	[Originating Sector ID]
	and	[Specific Aircraft Charachteristics]
	and	Plan ID
	@	January ATACT
Plan ID	=	Unique Identifier of a Plan
Plan Revisions	=	Revisions to any data in Plan
Plan Type	=	Current Plan
	or	Pending Plan
	or	Trial Plan
	or	Machine Plan
	or	Dormant Plan
Planning Sector	=	Sector ID which has pending plan on a maneuver aircraft
Predicted Problem	=	Plan Type
	and	Predicted Problem ID
	and	Alert Type
	and	Alert Class
	and	Aircraft ID
	and	Current Controlling Sector
	and	Time of Predicted Conflict
	and	Sector/Facility Containing Conflict
	and	Time until conflict
	and	[Airspace ID]
	and	[Flow Restriction Description]
	and	[Type of Conformance Deviation]
	and	[Amount of Conformance Deviation]
	@	AERA 2 SLS 3.7.1.3.2.1 thru 4

Predicted Problem ID	=	Unique identifier of a predicted problem detected by automation.
Pre-Departure Check Results	=	Aircraft ID
	and	Predicted Problem
	@	AERA 2 SLS 3.7.1.3.2
	and	[Route-around instructions]
	or	[No Problem Indication]
	@	Janaury ATACT
Preferred Maneuvers	=	Maneuvers types to be used by Automated Problem Resolution.
Prohibited Maneuvers	=	Maneuvers types not to be used by Automated Problem Resolution
Question/Comments to Briefing Controller	=	Conversation prior to accepting responsibility for a position
Questions/Instructions to Pilot	=	Conversations between pilot and controller to determine pilot intent or inform pilot of non-conformance with flight plan.
Rationale for Maneuver or Ranking	=	"Simple predetermined comments such as "in conflicts between departure and overflight aircraft, prefer maneuvering the departure aircraft"
	@	AERA 2 SLS 3.7.1.3.4.3
Reprobe Duration	=	The length of time over which the plan is periodically reprobed. A default parameter unless specified by the controller.
Reprobe Frequency	=	How often the plan is to be reprobed (i.e., every two minutes). A default parameter unless specified by the controller.
Reprobe Parameters	=	Plan ID
	and	[Reprobe Duration]
	and	[Reprobe Frequency]
	and	[Starting Fix]
	and	Maneuver Type Indication
	and	Start Point Indication
	@	AERA 2 SLS 3.7.1.3.3.2
	@	AERA 2 SLS 3.7.2.1.2.3

Resolution	=	Maneuver
	and	[Prohibited Maneuvers]
	and	[Planning Sectors]
	and	[Objections]
	@	AERA 2 SLS 3.7.1.3.3.4
	@	AERA 2 SLS 3.7.2.1.1.3
	and	Aircraft ID
	and	Plan ID
	and	[No-Resolutions Message]
	and	[Preferred Maneuvers]
	@	January ATACT
Route	=	Departure Point
	and	Destination
	and	Airways
	and	Fixes
	and	Transition Fixes
	and	Radar Vectors
	and	SID Transition Fix
	and	STARS
Sector Boundaries	=	The geographical boundaries of a sector which define the area of controller responsibility.
Sector ID	=	Unique indentifier of a specific sector
Sector Requiring Coordination	=	Sector(s) designated by the automated coordination function to receive the coordinated plan. The controller may add or delete sectors from the default list.
Sector/Facility Containing Conflict	=	Sector and Facility containing the start of the predicted or actual conflict.
Sector Suite Display Configuration/Status	=	Current setup of the Sector Suite Displays
Special Maneuver Information	=	Information not known to the system, such as maneuver already in progress, pilot intent to comply, aircraft in special situation, local weather conditions.
Specific Aircraft Characteristics	=	[Rate of Climb]
	and	[Rate of Descent]
	and	[Airspeed Envelope]
	and	[Aircraft Weight]
	and	[Airframe ID]
	@	Janaury ATACT

Start Point Indication	=	Indication to designate that automated reprobe is to begin at the aircraft's current position or ata specified fix.
Starting Fix	=	Identification of a fix at which a specific action is to begin (i.e., a maneuver or automated reprobe).
Start Location	=	Fix or other point where an aircraft maneuver should begin.
Start Time	=	Time of day when aircraft maneuver should begin.
Target Coordinates	=	The computer-adapted XY Coordinates defining a target position.
Temporary Use Airspace ID	=	Airspace ID of adapted airspace which may be controlled by different sectors
	or	ATC Defined Airspace
Time of Predicted Conflict	=	Time of day at the start of predicted or actual conflict..
Time Period	=	Amount and/or Bounds oftime during which a particular condition will exist.
Time Until Conflict	=	For current plans, countdown clock of time until conflict. For non-current plans (trial, pending, machine) static time until conflict.
Track Data	=	Track Position and Direction.
Trajectory	=	Four dimensional representation of the expected path of the aircraft based on flight plan as amended.
Trial Plan	=	Plan with Plan Type indicating a trial plan.
Trial Plan ID	=	Unique identifier of a trial plan.
Turn Angle	=	Number of degrees off current course reguired by maneuver.
Type of Conformance Deviation	=	Lift of Course
	or	Right of Course
	or	Above Course
	or	Below Course

UPR Plan	=	One Plan associated with a flight that has been specified as the UPR by the UPR Notation. The plan designated as the "UPR" Plan accompanys the aircraft along the route of flight.
Viewport	=	A designated portion of a physical display upon which a logical display is viewed.
Visibility	=	Display selections including scale, charactersize, geographic area, format, sort, etc.
Weather Conditions	=	The controller's understanding of current weather conditions aided by the situation display and PIREPs (e.g., winds aloft, icing factors, thunderstorms, wind shear, precipitation, turbulence).
Workload Measure Type	=	[Predicted Average Number of controlled aircraft]
	or	[Predicted total number of Aircraft conflicts]
	or	[Predicted total number of Airspace Conflicts]
	or	[Predicted number of planned actions]
	or	[Predicted number of controlled aircraft entering sector]
	or	[Expected clustering measure]
	or	[Composite]
	@	January ATACT
Workload Measure	=	Graphic display of the predicted workload of the type specified by the controller during the specified time period.

APPENDIX D. TASK CHARACTERIZATION METHODOLOGY: DEFINITIONS OF TERMS AND RELATIONSHIPS AMONG ANALYSES

This appendix includes definitions and ATC examples of cognitive/sensory abilities (Table D-1). These abilities were selected from the larger set of cognitive/sensory attributes used as a basis for analysis of AAS tasks (Ref 6). Abilities selected were those considered most relevant to controller tasks in the AERA 2 environment. This set of 21 abilities was used as a basis for identifying task demands proceeding from the controller's interaction with the AERA 2 capabilities (Section 3, Table 3-2).

A second set of definitions and examples is provided for performance factors (Table D-2). The performance factors included in the analysis are based on the performance measurement factors that were used as a basis for assessing AAS controller skill level requirements (Ref. 6). In this case, however, the purpose of the analysis of performance factors was to identify potential constraints on controller performance of the AERA 2 tasks (Section 3, Table 3-3).

In Table D-3, the performance factors are traced to task types and to the task-specific cognitive/sensory abilities on which demands are placed by AERA 2 tasks. Knowledge of the relationships among task types, abilities, and performance factors helped to achieve analytical efficiency. For example, knowing that a particular task is a Receipt task means that only a specific sub-set of abilities needs to be considered and that Recognition Time is the only potential performance factor.

A third set of definitions and examples is provided for the suggested tools and capabilities (Table D-4). Automated tools and capabilities are computer aids that are useful in supporting problem solving, decision making, and task accomplishment (Ref. 6). The tools and capabilities are grouped within five generic categories: Data Entry Techniques, Data Presentation Techniques,

Data/Display Management Techniques, Decision Aids, and Communication Aids. Tools and capabilities already specified for the AAS (Ref. 14) or for AERA 2 (Ref. 2) are not included because they have been identified as operational requirements. The recommended tools and capabilities are suggested as a means of reducing and limiting any additional controller workload associated with use of the AERA 2 functions. The rationale for these recommendations is derived from the analyses of AERA 2 task information requirements (Section 3.2), demands on cognitive/sensory abilities (Section 3.3), and performance factors (Section 3.4). The complete set of recommendations for supplemental tools and capabilities to support controller performance and productivity is provided in Table 3-4.

Table 3-5 lists the performance factors and the tools/capabilities that can aid in correcting for the potential effect(s) of each factor. For example, if Recognition Time is a significant factor in the performance of an AERA 2 task, it can be speeded by capabilities that sort, select, and emphasize the information required by the controller.

The set of tables provided in this appendix supplement the information on the task characterization analyses presented in Section 3.

Table D-1. Cognitive/Sensory Abilities: Definitions and Examples

ABILITY	DEFINITION	ATC EXAMPLE
Auditory Acuity	Perception of relevant sound cues and discrimination between sounds; accurate perception of complex verbal transmissions against a background of noise, static, or interruption.	Discriminating among several aircraft call signs transmitted simultaneously.
Coding	Transformation or translation of information for entry into the system.	Entering a PIREP; adjusting display parameters.
Color Discrimination	Perception of similarities or differences in colors or shades of the same color.	Red/blue pencil notations on flight strips.
Decoding	Transformation or translation of information that is received.	Recognizing a symbol for a handoff; recognizing an alert indicator.
Deductive Reasoning	Ability to reach a conclusion that follows logically from the known facts or data; selection from among alternative answers or methods.	Concluding that two aircraft are on intersecting paths.
Filtering	Selection of inputs on which to focus attention in the presence of distracting stimuli or high workload; selective attention; overload accomodation.	Selecting priority alerts for attention.
Flexibility	Mental adaptability; dealing effectively and confidently with diverse and changing situations.	Handling student and general aviation pilots; changing to a different sector; assuming control of different airspace.
Inductive Reasoning	Generation of an explanation for a set of specific data or instances, giving structure and meaning to the information; generalization of working hypotheses from specific events; discerning basic differences and relationships among symbols, figures, and figure patterns; generating a new solution to a problem; ability to make a knowledgeable assumption even though using insufficient data.	Checking the appropriateness of a proposed aircraft maneuver.
Interpersonal Communication	Correct processing of behavioral information obtained through personal interaction; sensitivity to personal reactions of others.	Talking a lost or foreign pilot to a landing site or position reference; training a new controller.

Table D-1. Cognitive/Sensory Abilities: Definitions and Examples (Cont'd)

ABILITY	DEFINITION	ATC EXAMPLE
Long-Term Memory	Mental storage of knowledge over a period of time and selective recall of what is relevant to a current situation.	Remembering aircraft characteristics; remembering procedural instructions or letters of agreement that are relevant to a seldom-occurring situation, such as for an air show or large flight formation.
Mathematical/ Probabilistic Reasoning	Translation of uncertainty into probability, assigning a subjective probability regarding the likelihood of an event being true; ability to use probabilities to estimate optimal courses of action.	Assessing the probability of an aircraft to aircraft encounter at some future time.
Movement Detection	Recognition of the physical movement of a a visual object; estimation of its direction or speed.	Observing aircraft movement on the visual display.
Pattern Recognition	Perception of spatial patterns and relations among static or dynamic visual inputs. May involve orienting oneself to the position or configuration.	Perceiving aircraft moving in the same direction.
Prioritizing	Ordering of events in sequence; establishing priorities.	Sequencing or ranking pilot requests with controller requests, supervisor requests, and other planned tasks.
Recall from Interruption	Recall of a deferred or interrupted action when priorities permit; maintenance of active situations in working memory.	Discussing separation or traffic sequence with a Controller and being interrupted by another Controller who is on the interphone override; returning to the first Controller without pause after coordination with the second Controller is complete.
Scanning	Rapid identification or detection of objects or events displayed in a wide or complicated visual field.	Observing the display for new aircraft; looking for data in a table; detecting an alert indicator in data block.
Sensory Multiplexing	Capability of perceiving multiple verbal and visual inputs simultaneously.	Listening to and acknowledging many communications which are rapidly occurring and overlapping, while monitoring the visual display.
Short-Term Memory	Mental storage and selective recall of relevant information within a brief period of time.	Briefly retaining and entering an aircraft call sign.

Table D-1. Cognitive/Sensory Abilities: Definitions and Examples (Cont'd)

ABILITY	DEFINITION	ATC EXAMPLE
Verbal Fluency	Ability to express ideas rapidly in spoken or written form and to understand meanings of words, codes and abbreviations.	Talking to a pilot; planning clearance instructions.
Visual Acuity	Perception of pertinent detail in objects or in pictorial or graphic material; fine visual comparisons and discriminations among such characteristics as shapes, shading, or line width/lengths.	Discriminating between two closely adjacent target symbols on the display.
Visualization	Observation of spatial patterns and subsequent mental transformations into other spatial patterns.	Determining the effect of a proposed aircraft maneuver on other aircraft; comparing intended time-position profiles for intersection in position/ altitude/time.

Table D-2. Performance Factors: Definitions and Examples

Category: Factor	Definition	Examples
Timing Factors:		
Recognition Time	The interval from the first manifestation of a specific condition until it has been recognized and understood sufficiently to permit planning a response	Interval from the display of an alert indicator to recognition that an alert exists
Decision Time	The time required to determine a response to a recognized condition. The planning process may involve remembering a pre-planned action; identifying desirable alternative actions to achieve a desirable condition; evaluating the cost of an action in time and effort; evaluating the possible side effects of an action; comparing actions and selecting one	Interval from the recognition of a conflict to the decision on how it shall be resolved
Implementation Time	The time required to implement a selected action once decision time has been completed	Interval from the selection of a conflict resolution to completion of transmission to pilot
Communication Time	The interval from initiation to completion of a verbal transaction; includes time to receive communication inputs and to generate and execute verbal responses	Interval between controller initiation of a query to a pilot and completion of the conversation; interval between controller reception of a pilot-initiated request and completion of respons

Table D-2. Performance Factors: Definitions and Examples (continued)

Category: Criterion	Definition	Examples
Accuracy Factors:		
Accuracy of Time Estimates	The accuracy of estimated times of intervals	Accuracy of an estimate of the time an aircraft will arrive at a fix; accuracy of an estimated time interval required for an aircraft to complete a maneuver
Accuracy of Spatial Estimates	The accuracy of estimated positions, directions, and distances	Accuracy of estimates of lateral or longitudinal separation between aircraft; accuracy of estimates of the closest approach of two aircraft at some future time (involves both time and spatial estimates).
Accuracy of Proability Estimates	The accuracy of an estimate of the probability that an event will occur	Accuracy of an estimate of the likelihood that a pilot will request a reroute around bad weather
Error Factors:		
Appropriateness of Action	Action selected may be performed or omitted; if performed, the action has the desired result	Inappropriate action: an aircraft-to-aircraft conflict resolution that leaves the aircraft still in conflict
Appropriateness of Timing/ Sequencing	Timely implementation of an action in proper sequence with other actions	Inappropriate timing: delivering a clearance to vector around restricted airspace so late that the pilot cannot comply

Table D-3. Performance Factors Associated with Task Types and Cognitive/Sensory Abilities)

Performance Factor	Task Type	Cognitive/Sensory Abilities
Implementation Time	Entry	Coding
Recognition Time	Receipt	Movement Detection, Auditory Acuity, Scanning, Pattern Recognition, Decoding, Sensory Multiplexing, Visual Acuity, Color Discrimination
Decision Time	Analysis	Prioritizing, Deductive Reasoning, Mathematical/Probabilistic Reasoning, Inductive Reasoning
Communication Time	Verbal Coord.	Verbal Fluency, Interpersonal Communication, Sensory Multiplexing, Auditory Acuity
Accuracy of Time Estimates	Analysis	Visualization, Deductive Reasoning, Inductive Reasoning
Accuracy of Spatial Estimates	Analysis	Mathematical/ Probabilistic Reasoning, Visualization
Accuracy of Probability Estimates	Analysis	Mathematical/ Probabilistic Reasoning

Table D-3. Performance Factors Associated with Task Types and Cognitive/Sensory Abilities (Cont.)

Performance Factor	Task Type	Cognitive/Sensory Abilities
Appropriateness of Action	Analysis	Deductive and Inductive Reasoning
Appropriateness of Timing/Sequencing	Analysis	Deductive and Inductive Reasoning; Prioritizing
All Performance Factors	All	Short-Term Memory, Recall from Interruption; Flexibility, Long-term Memory, Filtering

Table D-4. Tools and Capabilities: Descriptions and Examples

Tool/Capability	Description	Examples
Data Entry	System capabilities which assist in the entry of data into the system.	
Default Data Values	The capability for system identification and display of task specific default values of data necessary for task execution.	Allowing controller to suppress information for all maneuver types by confirming "all" rather that requiring entry and confirmation of each maneuver type.
Predefined Function Activation	The capability to initiate a series of system actions by a single user action.	Initiating system activities required in the display of a future situation based on a single controller action.
Prompted Data Entry	The capability for system prompting of parameters needed for action execution. This includes label for data to be entered.	System request for controller to enter reprobe parameters when requesting automated reprobe.
Sketching	By manipulating a locating device as if it were a brush or pen, the user causes an object to be created by free-hand sketching.	Sketching a box on a display; sketching a graph of data on a display; sketching a map of an area on the situation display.
Data Presentation Techniques	System capabilities that are used to improve the content, quality, and or organization of data presented on a display	
Definitions of Display Coding	The capability to request system explanation of codes used in information display.	System explanation of alert indicator.
Emphasis	The capability to employ hardware/software features to make selected data more salient (e.g., color, reverse video, intensity, auditory alarms).	Emphasizing the criticality of a potential problem using color; emphasizing that an aircraft is approach sector by reverse video data block; emphasizing an emergency beacon code by changing size of data block

Table D-4. Tools and Capabilities: Descriptions and Examples (Cont.)

Tool/Capability	Description	Examples
Graphical Representation	The capability to overlay a graphical representation of a pattern on a display.	Providing a graphical representation of conformance bounds an aircrafts nominal path. Graphically representing past, present and future air traffic trends.
Selective Presentation	The capability to display only desired information, through suppression, deletion, or addition.	Selectively present only the 5 most serious problems; selectively display only aircraft at 18,000 feet or above; selectively suppress all VFR aircraft.
Sorting	The capability to arrange presented data by some common parameter(s).	Sort a list of flight data entries by assigned altitude; sort of list of aircraft IDs by ETA; sort a list of potential problems by time to point of violation.
Data/Display Management Techniques	System capabilities that allow the user to adjust or tailor a display.	
Variable Windows	The capability to define multiple display windows of varying sizes for displaying information.	Creating separate windows on a single display for full scale and magnified situation displays; overlaying a window of ATC procedures on a sector map.
Decision Aid	Tools for assisting the user in planning, reasoning analying and problem solving.	
Look Ahead Display	The ability to preview on a display the future status of a sector based on current parameter values.	Display the future consequences of a change in an aircraft's route of flight; display the future location of two more aircraft based on flight plan data.

Table D-4. Tools and Capabilities: Descriptions and Examples (Cont.

Tool/Capability	Description	Examples
Communication Aid	System capabilities which assist in communication between pilot and controller.	
Automated Air-to-Ground Communications	The capability to automatically send data between aircraft and controller.	Automatically sending updated aircraft characteristics to controller without voice communcation.

Table D-5. Tools and Capabilities Related to Performance Factors

PERFORMANCE FACTORS	TOOLS/CAPABILITIES
Implementation Time	Default Data Values Predefined Function Activation Prompted Data Entry Sketching
Recognition Time	Sorting Emphasis Selective Presentation
Planning Time	Sorting Emphasis Selective Presentation Variable Windows Look Ahead Display Graphical Representation Definitions of Display Codes
Accuracy of Time Estimation Accuracy of Spatial Estimation, Accuracy of Probability Estimation, Appropriateness of Action, Appropriate of Timing/Sequencing	Look Ahead Display Graphical Representation
Communication Time	Automated Air-to-Ground Communications