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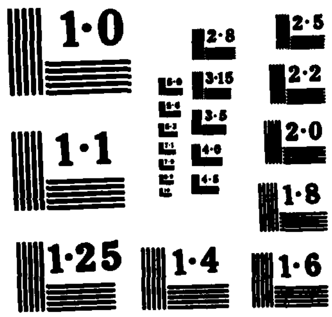

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AD-A145 763

Memorandum

U.S. Department
of Transportation
**Federal Aviation
Administration**

AD-A145763

Date: August 10, 1984 **Reply to Attn. of:**

Subject: INFORMATION: National Airspace System (NAS) Plan Audit Report

From: Donald D. Engen
Administrator

To: The Secretary

The Federal Aviation Administration (FAA) has accepted the attached NAS Plan Audit Report from Martin Marietta. The good effort on this report, which provides the first real measure of the NAS Plan, fulfills a contractual requirement by Martin Marietta, which is the System Engineering and Integration Contractor for implementation of the NAS Plan.

The objective of the 6-month audit was to obtain an indepth, independent review of the objectives, technologies, costs, benefits, and schedules for the NAS Plan. The FAA will review the recommendations in the report with Martin Marietta over the next few months. Appropriate followup actions will be determined, and any program changes that are judged to be necessary will be incorporated in the next revision of the NAS Plan, which will be published early in 1985.

Attachment

ATC-84-0026
Contract DTFA01-84-C-00017

Volume 1

Sections 1.0-4.0, 6.0

NAS Plan
Audit Report

August 1984

SYSTEM ENGINEERING AND INTEGRATION CONTRACT FOR IMPLEMENTATION OF THE NATIONAL AIRSPACE SYSTEM PLAN

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FOREWORD

Martin Marietta Aerospace, Air Traffic Control Division, submits this document to the Department of Transportation, Federal Aviation Administration, in response to Statement of Work, Section 6.2, and Article II, Period of Performance and Delivery, on contract DTFA01-84-C-00017.

Sections 1.0 through 4.0 and section 6.0 are presented in Volume 1. Volume 2 contains section 5.0, the NAS Plan project findings.

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1.0 EXECUTIVE SUMMARY

1.1 INTRODUCTION

When the National Airspace System (NAS) Plan for Facilities, Equipment, and Associated Development was released by the FAA in December 1981, the agency was facing a problem of potentially crisis proportions--that of meeting increasing airspace system demand with dated and deteriorating facilities. At that time, the FAA already had some viable ongoing modernization projects in various stages of planning and development. However, it was not until formulation of the NAS Plan itself that the true scope and urgency of the NAS situation was placed in perspective and made known to the Congress, airspace users, and the nation as a whole.

The release of the NAS Plan was timely in the sense that it received reinforcement from the air traffic controller strike. It was, however, overdue to the extent that airspace system facilities were already being stressed toward capacity, and demanded labor-intensive efforts to sustain aging equipment operation. Consequently, NAS modernization is now faced with over a decade of design, development, replacement, and upgrade activities aggravated by an urgency of completion and an intolerance to error or compromise to safety.

There is little that can be criticized in the purpose or scope of the present NAS Plan. It speaks appropriately to the replacement of vacuum-tube vintage technology equipment and aging computer systems to satisfy its long-term goals and objectives. For the most part, the NAS Plan is properly conservative, in that it applies state-of-the-art technology in its modernization. This is certainly the most reasonable and practical modernization approach in view of the urgent need to sustain at least the present level of capability in the face of increasing demand. We must, however, be aware that technological obsolescence is certain to occur as the modernized NAS evolves. As an example, the average life of new computer systems today is less than 7 years. To cope with this reality, the FAA, through yearly updates to the NAS Plan, has adopted industry's principle of long-range planning to maintain currency of forecast goals, objectives, and requirements to preclude future crisis situations from occurring. Therefore, we can and should expect that through the NAS Plan, the FAA with the continued support of the users and executive and legislative branches of Government will be able to maintain its facilities and equipment in the forefront of appropriate technological development and application with respect to airspace use and safety.

As the System Engineering and Integration (SEI) contractor to the FAA for modernization of the NAS, one of our initial contractual obligations activities has been to audit the NAS Plan. The Plan was reviewed for airspace safety, technical feasibility and validity, schedule and cost credibility, benefit accruals, and methods of accomplishment. The audit included a comprehensive review of related plans and supporting FAA budgetary, system design, and implementation documentation. We were provided access to questions and comments from the Office of Management and Budget, from the transportation committees of the Congress, and from the Congressional Budget Office and user organization testimony to these committees. However, the audit did not involve direct interfacing with other organizations such as the Department of Defense, commercial airlines, Aircraft Owners and Pilots Association, foreign government aeronautical administrations, local airport authorities, or the National Weather Service.

In performing the audit, we received extensive support from the FAA in quests for schedule, cost, benefits, safety, acquisition, usage, related planning, and supporting technical documentation. Our audit, however, was accomplished by independent teams of SEI personnel free from any FAA influence on its results.

1.2 PURPOSE OF THE AUDIT

The purpose of our audit was to verify the overall goals and objectives of the NAS Plan from the standpoint of technical validity and feasibility, system safety, user benefits, methods, costs, and schedule. In essence, the audit was intended to ask and answer the following questions: are the goals and objectives appropriate to satisfy the requirements of both users and operators of the NAS through the year 2000 and beyond; are the planned modernization projects not only technically feasible but valid to satisfy the NAS goals and objectives; will system safety be enhanced through implementation of the modernization projects and uncompromised during the transition to them; are the stated benefits to both the user and operator realistic and achievable; are the estimated costs and funding requests appropriate for accomplishment of the modernization task; are the individual and integrated schedules achievable and properly phased; and is the overall planning, design, development, test, and acquisition methodology proper for the modernization task? It is our intention that the results of the audit become a major factor in the next update to the NAS Plan.

1.3 AUDIT RESULTS

We found the NAS Plan to be a well-conceived plan for effecting an orderly modernization of NAS ground support facilities. It accurately defines the needs of the system, provides approaches to remedy existing system problems, and defines methods to effect an evolutionary growth in system capacity and capability. However, our audit probed beyond these surface reflections to test the credibility and comprehensiveness of the NAS Plan's systems engineering and management approaches, both of which are fundamental to achievement of its stated goals and objectives. In this summary, we provide an overview of our significant findings; and, in the more detailed report that follows, we present all issues we believe need resolution to assure orderly and efficient plan implementation. However, it should be noted that resolution of some issues identified in this report have already been planned for and will be accommodated as a function of the SEI contract. In the sense that we have undertaken this audit several years after inception of the NAS Plan, and in an environment considerably different than that existing at the time of its initial release, the issues and judgements we present should not be considered reflective on the dedicated and substantial efforts involved in its evolution. Table 1-1 highlights our significant audit findings by audit criteria. Subsequent paragraphs provide a summation that embraces the context of our significant findings in a programmatic sense.

Table 1-1 Summary of Audit Findings by Major Audit Criteria

Audit Area	Audit Finding	Ref
Technical Feasibility and Validity	Implementation of the NAS Plan is both technically feasible and valid, although Next Generation Weather Radar (NEXRAD) and AERA projects require extensive engineering and development. AAS is considered to be the highest risk in the NAS Plan.	3.1, Volume 1
Program Schedule	Erosion from various sources is jeopardizing the program schedule. Program master schedule needs to be developed and controlled.	3.2, Volume 1
Program Cost	Funding risk is estimated as an equal chance of overrunning or underrunning. New requirements and significant quantity and/or scope changes will require additional funding. Management controls need to be implemented to protect current funding.	3.3, Volume 1
Benefits	Our audit indicates the benefits, as documented in the NAS Plan, are substantial but somewhat overstated and 10-20% are in jeopardy of being lost. User benefits are substantially larger than anticipated and should be recognized.	3.4, Volume 1
Safety	In general, the projects and their implementation support the NAS safety goals. However, the NAS plan does not provide for a system safety program plan or consistent application of safety requirements across all projects.	3.5, Volume 1

Table 1-1 (concl)

Audit Area	Audit Finding	Ref
Methods and Planning	Overall planning is credible, however, additional supportive plans are recommended. Continued operation of existing systems needs emphasis. NAS external interfaces are not totally defined. Viable acquisition strategy alternatives exist.	3.6, Volume 1
Integration	Several significant integration concerns that are not related to technical feasibility and validity, schedule, cost benefits, safety methods and planning, or specific projects were surfaced during the audit. For example, the test and evaluation role of the FAATC is not clearly defined. These issues are summarized in Table 1-2.	4.0, Volume 1
Project	Findings at the individual project level are provided in detail in Volume II, Section 5.0, and primarily indicate issues in one or more of the other audit areas. Table 1-3 provides a summary of the more significant findings.	5.0, Volume 2

1.3.1 Technical Feasibility and Validity (Report Section 3.1, Volume 1)

The NAS Plan presents summary descriptions and schedules for the 88 projects planned for interim or final enhancement of the current NAS. Implementation of these projects are considered both technically feasible and valid and will facilitate less constrained and safer use of the airspace, while significantly reducing operating and maintenance costs. These reductions in cost will be achieved by consolidating functions and sites, replacing outmoded (vacuum tube) and expensive-to-maintain equipment, and using remote maintenance and monitoring techniques made possible by current-day technology. The development and implementation of advanced automation concepts during the 1990's will allow a significant reduction in controller work force by eliminating many of the mundane, repetitive tasks and redefining and enriching the controllers' role.

Technical feasibility and validity of the NAS Plan were examined from two aspects during this audit. First, the collection of NAS Plan projects as a multisegment NAS was viewed for overall reasonableness of approach and likelihood of meeting stated goals and objectives. Second, the design/implementation approach for the individual projects was considered in light of current technology.

Results of the audit indicate that all projects are within state-of-the-art technology, although the Next Generation Weather Radar (NEXRAD) and the Automated En Route Air Traffic Control (AERA) projects, will require extensive engineering and development efforts. Additionally, the size and complexity of AERA-2/3 and Traffic Management System (TMS) Phase III projects appear to be underestimated and are experiencing difficulty with concept development and definition of project requirements and consequently should be combined and turned into a major acquisition.

The NAS Plan provided for the integration of many ongoing NAS projects and permitted development of networking concepts in radar, weather, communications, and remote maintenance monitoring systems to further improve system efficiencies. However, system engineering efforts to provide appropriate system designs in these areas has yet to be completed, with the consequence that the flowdown of requirements to individual projects has yet to be accomplished. This lack of front-end system design has resulted in some proliferation of system equipment contrary to the NAS Plan's standardization objectives. Solutions to this concern are not evident, and we have recommended increased system design activity to minimize perturbations to existing projects and to preclude system fragmentation. For the RMMS specifically, we have made several recommendations beneficial to its integration and implementation.

Because of its significant interface, software and integration complexities AAS exerts the most leverage on and therefore represents overall the highest risk of any single project to the NAS Plan success.

1.3.2 Program Schedule (Report Section 3.2, Volume 1)

For varying reasons (delineated in section 3.2), we found that significant erosion to the positive schedule slack contained within individual projects has occurred since the original NAS Plan was published. This erosion has placed the overall program schedule in jeopardy. In addition, we found that a program master schedule, except as contained within the NAS Plan, is not in place, and many project schedules are in need of expanded detail. The implication of this finding is that schedule visibility for management attention at both the total program and individual project levels is not currently adequate. Consequently, we recommend implementing a system to allow more management visibility and control into program and project activities.

To provide a capability to forecast and resolve schedule conflicts, a critical-path analyses should be performed and maintained in several of the more major system areas, with emphasis on the 9020 Rehost, Initial Sector Suite, Advanced Automation System (AAS), AERA, and Area Control Facility (ACF) evolution. The steps leading to and including full ACF implementation requires four major transitions in the online ATC system within a period of approximately 10 years. These transitions, which are preceded by dual-design competition contracts, essential FAA Technical Center (FAATC) testing, and major production efforts, inherently indicate significant schedule containment concerns and warrant special attention. In instances where, as part of the audit, we expanded schedule detail below the project level, we found additional dependencies not generally visible at the NAS Plan project description or project resume level. Based on this perspective, we are convinced of the need for program planning and scheduling in increasing levels of detail from a master schedule level to individual system and/or capability levels and, with FAA support, are putting such methods into place.

1.3.3 NAS Plan Cost (Report Section 3.3, Volume 1)

The results of our audit indicate that the projected NAS funding requirements through FY 1992, as defined in the NAS Plan, are adequate, although some redistribution of funds between projects is required. This audit determination is based on an assessment that risk to the planned funding of $11.8B (including prior year funding) has an equal chance of overrunning or underrunning. The assessment includes some consideration for growth items such as program change growth, inflation, and risk in various contracting arrangements. However, it does not include consideration for new, as yet unvalidated, NAS Plan requirements such as terminal weather systems or for significant quantity requirement increases as potentially exist for long-range radars. Planned management systems that allow for accurate prediction, tracking, and reporting of program costs should be implemented as soon as possible to provide enhanced cost management capabilities. We further recommend that early identification of risk should be made and management controls established on each procurement. It is the opinion of the cost audit team that initial procurement costs are well understood. However, there are conditions unique to the NAS modernization process (lack of early program controls, firm system baselines, and the introduction of totally new test and implementation approaches) that could force the funding requirements up as much as $2.3B. Consequently, we believe that success in not exceeding current planned NAS funding lies in developing an understanding of these programmatic unknowns so that proper controls can be implemented.

1.3.4 Benefits (Report Section 3.4, Volume 1)

The treatment of benefits in the NAS Plan relates primarily to reductions to air traffic (AT) and airway facilities (AF) operations costs.

Our audit indicates that the cost savings of $19.9B, as presented in the NAS Plan, is overstated by 5-10%. In addition, further delays in facility consolidations, program schedule slips (notably the Flight Service Automation System), and program start-up delays would continue to erode the near-term operations and maintenance (O&M) savings stated in the Plan. Another 10-20% of the benefits will require strong management initiatives if they are to be realized. This latter potential shortfall in benefits achievement would derive from the need for detailed plans that relate NAS Plan enhancements and facility consolidations and replacements to FAA human resource plans and budget goals. It must also be noted that to the extent that influences external to the FAA delay program implementation, facility consolidations, etc., benefits will also erode.

The NAS Plan provides estimates of its positive effect on FAA operations, but user benefits are addressed only briefly. However, analysis of related FAA documents and our own preliminary estimates suggest that the economic benefits to the users exceed those of FAA cost reductions and total nearly $30B. Thus, the total NAS Plan benefits are in the order of $47B.

1.3.5 System Safety (Report Section 3.5, Volume 1)

System safety considerations are unquestionably embedded in NAS Plan objectives and in the project capabilities to be implemented. Enhanced capabilities for detection and resolution of conflicts, improvements in terminal approach guidance, improved weather detection, forecasting and dissemination for improved surveillance coverages, and more effective communications with pilots certainly indicates pursuits in the interest of improved system safety.

Although there is little doubt that safety will be enhanced in the completed system, maintenance of system safety during system transitions (particularly within automation systems) supporting ATC operations is a definite concern. This problem is difficult to assess until detailed plans of individual equipment transitions can be developed. Significant program focus needs to be directed toward minimizing potential hazards involved in transition activities.

In summary, system safety is appropriately considered in NAS Plan efforts for final system capabilities. Interim system configurations and transitions need close supervision and analysis to assure that system safety levels are not degraded. In addition, it is felt that a comprehensive safety program based on a NAS safety plan should be established to provide impetus, coordination, and visibility to achieve safety goals.

1.3.6 Methods and Planning (Report Section 3.6, Volume 1)

As we perceive the NAS Plan, additional planning documents (some already in draft form), finalized interface requirements definitions, increased emphasis on continued operation of existing systems, consolidation of some projects, and special attention to procurement strategies would enhance success of the modernization process. The NAS Plan for Facilities, Equipment, and Associated Development is only one element of the planning required to achieve modernization goals. As the keystone plan, it cites objectives, defines system growth demands, and embraces benefits that can only partially be achieved by replacement and enhancement of ground support facilities and equipment. For example, traffic demand growth in terminal areas can be accommodated by provisioning new approach guidance and control equipment only if supported by corresponding improvements in terminal airspace definitions and approach procedures, expansion and improvement of airport facilities, and user acceptance and incorporation of associated flight support equipment. Similarly, ACF, TMS, and AERA concept implementation must be supported with corresponding airspace and procedure changes. The concept of maintenance management can only be effective with supportive data processing systems to develop the necessary statistical information to provide management of logistics resources.

In answer to these requirements, the FAA is furthering the development of plans to accommodate the necessary supportive resources and procedures. However, to make a truly comprehensive NAS capable of achieving the objectives and benefits described in the NAS Plan will require that NAS planning emphasis be broadened to highlight use of other planning elements, such as the FAA Plan for Engineering and Development; FAA Plan for Maintenance and Operations (existing draft); National Plan for Integrated Airport Systems (late 1984); Information Resource Management Plan; and a System Operations Plan (new). Also required as a subtier plan to the NAS Plan is a system transition plan to specify the interrelationships of projects and to provide for geographic site-by-site evolution of the system.

In addition to these planning recommendations, the audit concluded that the following activities need special attention to mitigate risk to the modernization methodology:

1) Because implementation momentum is accelerating, increased emphasis on all interface requirements definitions is required to preclude future adverse impacts on cost, schedule, equipment configurations, and operations.

2) FAATC operations are serially in the critical path for much of the project implementation, and we recommend:

    a) Development of a definitive test and integration plan,

    b) Development of a resource plan to manage, develop, schedule allocate, operate, and maintain essential resources.

3) Efforts already underway to assure continued operation and availability of existing systems should continue and expand.

4) Consolidation of some projects within the NAS Plan is recommended to assure integration and preclude discontinuities or omissions in project descriptions.

5) Procurement strategies should receive special attention to assure optimized procurement efficiency. For example, if a dual procurement is required, assure a down select at the earliest possible point. (Support of OST and FAA procurement officials in authorizing such strategies is required.)

1.3.7 Integration Findings (Report Section 4.0, Volume 1)

In performing the audit, several significant integration concerns were surfaced. These concerns were not singularly related to technical feasibility and validity, schedule, cost, benefits, safety, or methods. The specific nature of these concerns are provided in section 4.0 of this report. For emphasis, Table 1-2 provides a summary of the key integration findings.

1.3.8 Individual Project Findings (Report Section 5.0, Volume 2)

Assessments of each individual project revealed many issues of varying significance. However, most issues of significant concern fell into one or more of the other audit areas and have been delineated therein as well as in Section 5.0, Volume 2. Table 1-3 provides a summary of the more significant issues, and all findings are delineated by project in NAS Plan order within Section 5.0, Volume 2.

1.3.9 Executive Summary Conclusions

We find the NAS Plan to be a viable document with a purpose and scope that should be unquestioned. The findings, concerns, issues, and recommendations contained within this audit report are all intended as constructive and supportive of the dedicated and substantial efforts that have gone into its generation, evolution, and ultimate success.

Table 1-2 Key Integration Findings Summary

Finding	Risk	Recommendation	Ref
There is a need to integrate projects into programs in the area of weather, communications, and surveillance.	Dispersed treatment of these functions as individual projects rather than integrated systems may result in reduced system flexibility, duplication of hardware/software, and reduced benefits.	Provide the system-level support necessary to force integration of these related projects; develop the necessary system-level documentation (specifications, transition plans, etc).	4.12, 4.13, 4.14
The test and development role of the FAATC in the NAS upgrade is not clearly established.	As the system test bed for the NAS, the FAATC is in the critical schedule path for many projects. A well thought out plan is required to preclude delays in fielding upgrades, thereby reducing benefits.	Clearly delineate the role of the FAATC, and with SEI support, develop a test and integration plan compatible with program and project needs by January 1, 1985.	4.6
Quantities of primary radar noted in the NAS Plan may not meet coverage requirements.	Additional quantities, if required, will impact program cost and schedule.	Accelerate the ongoing coverage analysis to obtain data required for management review and action.	4.16
Transition planning is not visible in the NAS Plan.	More detailed transition planning is required in the near term to prevent schedule impact.	SEI should develop such a transition plan and submit to the FAA by January 1, 1985.	4.8
Remote maintenance monitoring system (RMMS) is not well defined and falling behind schedule.	Late completion of RMMS will result in reduction in O&M cost benefits.	Complete the ongoing development of system requirements and architecture and issue a detailed procurement plan.	4.15

Table 1-3 Summary of Significant Project Findings

Finding	Risk	Recommendation	Para Ref
AERA Program Acceleration	Delays in implementation of AERA would severely erode projected O&M cost savings since controller staffing could not decrease.	Expedite requirements definition/validation of AERA-2 and-3 and treat AERA as a major acquisition in the NAS; include TMS phase III in AERA-2/3.	5.1.1.13
Traffic Management System (TMS)	Delays in implementation of TMS would delay user benefits and increase restrictions.	Integrate TMS III into AERA-2/3.	5.1.1.6
RMMS System Level Design and Integration	Late completion of RMMS will result in reduction in projected O&M cost benefits.	Complete the ongoing development of system requirements and architecture and issue a detailed procurement plan.	5.4.1
FSAS Model 1 Software Development Delays	Late deployment of FSAS will erode planned cost benefits.	Develop a comprehensive monitoring status plan; apply the resources necessary to implement any necessary recovery operations.	5.1.3.1
Advanced Automation System Implementation	Technical interface dependencies, software, and integration complexities create inherent cost/schedule risks.	Place early emphasis on establishing interface and developing formal IFSs and ICDs.	5.1.1.12
Area Control Facilities Establishement for Offshore ARTCCs	Transition from PVD mode to ISSS cannot be made at Honolulu and Anchorage ARTCCs.	Include transition planning for Honolulu and Anchorage in ACF program.	5.1.1.15

2.0 INTRODUCTION

2.1 SCOPE

The SEI contract statement of work (SOW) states that the SEI contractor shall audit, study, assess, and verify the overall goals and objectives of the NAS Plan from the standpoint of technical validity and feasibility, schedule, cost, benefits, safety, and methods. Included in this effort is an objective review of NAS historical data, funding commitments, user data, functional allocations, fiscal program and project requirements, and NAS goals, objectives, and performance requirements.

This report provides the results of the SEI audit activities. The audit is limited to the NAS Plan for Facilities, Equipment, and Associated Development document dated April 1984. The earlier NAS Plan editions, NAS Plan for Engineering and Development, NAS Plan for Maintenance and Operations, NAS Design Documentation, National Airspace Review, and program/project plans were reviewed and discussions were held with the FAA program/project managers as a function of performing the audit.

The audit team also reviewed existing reports of the Office of Management and Budget (OMB) and the Congressional Budget Office, testimony of budget hearings, and reports of the National Airspace Review. However, there was no attempt to independently solicit comments from other government agencies or user groups.

The anticipated growth in the number and types of aircraft operations will place certain demands on the NAS. This growth will, in some measure, be a determining factor in the overall effectiveness of NAS modernization. In this regard, all evaluations conducted for the audit used the aviation growth forecast listed in the NAS Plan.

2.2 PURPOSE

The NAS Plan audit is intended to provide an independent assessment of FAA planning for modernization of the NAS. Its purpose is to verify the feasibility and validity of technical approaches, schedules, costs, and methods for achievement, and a confirmation of goals, objectives, and benefits. Results of the audit will provide a major input into future NAS Plan updates and will be a significant factor in determining SEI mission accountability.

The NAS Plan is the primary NAS program summary document for congressional review and planning, system user review, and public information. The NAS Plan audit will provide an independent assessment based on assumptions of future system requirements and goals, existing requirements, and historical data. The high-level visibility of the plan mandates that all data presented be accurate and timely.

2.3 APPROACH

In performing the NAS Plan audit, specific functions were assigned to SEI organizational elements. This distribution of tasks assured that all SEI/FAA counterparts were involved in issue resolution, and that the SEI organizational elements rapidly became involved with the NAS development process.

Figure 2-1 shows the overall flow of activities performed during the audit process. The goals, objectives, and requirements were assembled by the Systems Engineering group as a function of the Level I audit to assure consistency between the two parallel audits.

The Level I SEI design audit reviewed the FAA system architecture developed by the FAA from operational and functional requirements. The purpose of the Level I audit was to further identify the architectural design required to satisfy those requirements and to provide a hierarchy of requirements that

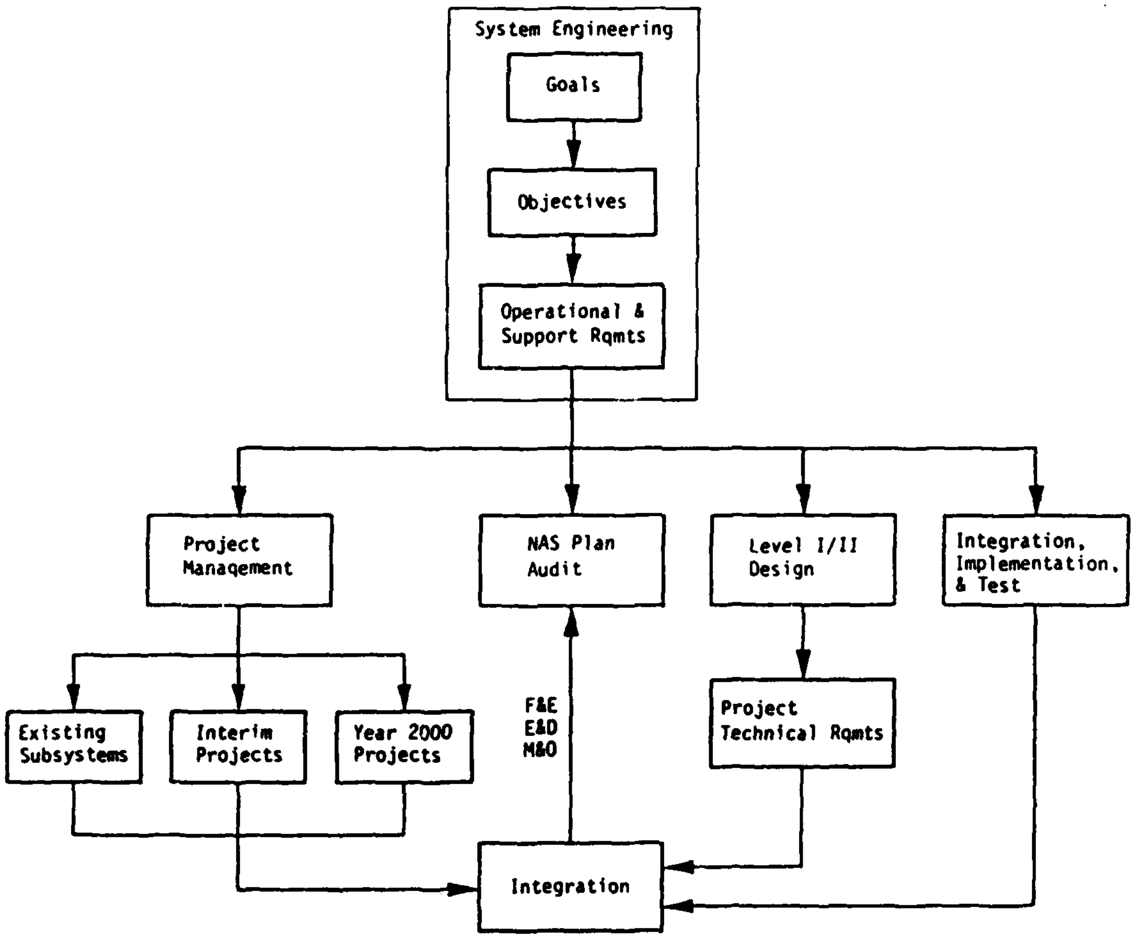

Figure 2-1 NAS Plan Audit Analysis Flow

includes NAS goals and objectives, operational requirements, allocated subsystem-level functions, and the functional requirements to be used for more detailed design.

The current, interim, and future systems projects analysis was conducted by both the SEI Project Management and Advanced Automation Program organizations to provide a bottoms-up analysis of each of the facilities and equipment (F&E) projects. The Level I design audit was conducted by the SEI Systems Engineering organization and provided a supportive analysis specifically aimed at the 1995 NAS. The implementation and test analysis of maintenance and operations projects was performed by the Integration, Installation, and Test organization. All engineering and development (E&D) projects were assessed by appropriate personnel from the Program Management and Systems Engineering organizations. Documented results from these bottoms-up activities were then assessed for compatibility by the Systems Engineering organization before being provided to the NAS Plan audit group as valid issues/concerns. In parallel with these bottoms-up activities, the NAS Plan audit organization performed a top-down assessment of F&E activities with specific emphasis on their programmatic aspects. As the top-down assessment was being performed, a "strawman" set of programmatic findings was developed for comparison against issues/concerns coming from the compatibility analysis for either confirmation or rejection of the programmatic finding. Through this approach, a check-and-balance was provided between and across all SEI organizational elements and programmatic functions. The results were then documented to provide traceability across the audit activities.

This documented data summarized both project- and system-level problems, uncertainties, and needs and were developed from project- and system-level reviews. These data thus formed a data source of NAS Plan concerns and were used as an input in developing the major findings presented in various sections of this report.

In the following sections, the results of the audit are presented by category in section 3.0, integration findings in section 4.0, individual project findings in section 5.0, and a summary of all recommendations is presented in section 6.0.

3.0 NAS PLAN ASSESSMENT

This section essentially draws on the findings presented in sections 4.0 and 5.0 to provide the basis for a top-down assessment of the NAS Plan in 6 areas. Each area is discussed separately with findings and recommendations presented as appropriate.

3.1 TECHNICAL FEASIBILITY AND VALIDITY

3.1.1 Overview

The technical feasibility and validity of the NAS Plan were assessed in two aspects during the audit. Initially, individual projects and grouping of projects were reviewed to validate their appropriateness for the particular application envisioned and to assure that the technical approach chosen will satisfy the NAS Plan goals and objectives. Second, feasibility of the design and implementation approach for each of the individual projects was considered in relationship to the current state-of-the-art technology.

The results of these assessments indicate that all NAS Plan projects are feasible and valid to meet the NAS Plan's goals and objectives and can be implemented with current state-of-the-art technology.

The projects which make up the NAS Plan vary significantly in terms of their complexity, required development, and levels of required integration and transition planning. Many of the projects provide for uncomplicated but very necessary update of aging, difficult to maintain equipment, and little difficulty is expected in their implementation. However, other projects, such as the AAS, FSAS, CWP, AWOS, NEXRAD, VSCS, RMMS, Mode-S, and MLS are in general more and complex represent significant advancements in the functional capability of the NAS, and will therefore exhibit the highest risk to schedules, benefits, and budgets.

We have identified the AAS as the single most significant risk to the entire NAS due to AAS's significant leverage. It is not only the most complex project in terms of new hardware, software development, and technical interface dependencies, but from the operational aspects of automating the currently manual flight data processing procedures. Many other projects are dependent on the AAS, thus highlighting and increasing the impact of any significant AAS perturbations. AWOS is also considered as a high risk from the standpoint of its weather data distribution processing requirements and functional requirements for future applications such as Mode S data link to replace the WCP concept and the issues of non-towered airport information inputs. Interfaces for AWOS are in the process of being defined and yet many operational policy considerations potentially impacting interface requirements have yet to be decided. Among the most significant of these considerations are the ground-air communications policy, VHF Omnidirectional Radio Range (VOR) coverage criteria, and issues related to user (pilot) impact and acceptance of revisions to flight and weather data distribution techniques and procedures. Consequently, continued and enhanced management actions must stress early identification and resolution of all interface problems to ensure timely and complete requirements baselining.

In the case of Surveillance Systems, Weather Systems, Communications Systems, and the Remote Maintenance Monitor System (all of which require multiple projects and/or interfaces to achieve a system capability), our audit indicates that system level planning and integration is either inadequate or not yet completed. Consequently, the ability to minimize hardware/software proliferation and optimize interfaces is rapidly being lost. Because of the potential cost, schedule, and benefits impacts inherent in this situation, the system level planning and integration tasks should be accomplished as rapidly as possible for maximum risk mitigation.

The Automated En Route Air Traffic Control (AERA) and Traffic Management System (TMS) projects require final concept definition and requirements validation. We have recommended (as described in section 5.0) expediting these activities because of the potential software impacts they could have if their concepts and requirements are not considered during early AAS development.

The Joint Development Next Generation Weather Radar (NEXRAD) has significant development effort remaining principally because the operational concept is not finalized, preventing the weather algorithms from being fully defined. Because the FAA's operational use of NEXRAD is independent of the other development agencies, we recommend expediting finalizing the operational concept to allow the weather algorithm definition task to proceed.

Additionally, untimely development of operational procedures and techniques has the potential for significant impact on project performance with regard to schedule, cost, and benefits achievement. Therefore, detailed operational procedure and performance requirements need to be specified in a timely manner, especially for automation of new or added functions. Some development activity, as well as Operation Test and Evaluation, will most probably be required to support validation and/or identification for projects such as AERA, TMS, FSAS, AAS, and CWP. Consequently, comprehensive planning for these activities should be accomplished to preclude, anticipate, or mitigate schedule and cost risk to these projects.

Transition and implementation of the major NAS Plan projects will require additional AAT and AAF resources to accomplish site preparation, implementation training, shakedown testing, and operational testing activities. Recent reports indicate a requirement for approximately 1000 additional positions just to support regional F&E activities. Consequently, in-depth studies should be performed to accurately scope the total resource requirement during these critical periods.

3.1.2 Findings, Risks, and Recommendations

The findings, risks, and recommendations as they relate to the technical feasibility and validity are drawn directly from the detailed discussions presented in sections 4.0 and 5.0, and are presented in Table 3.1-1.

Table 3.1-1 Summary of Technical Feasibility and Validity Findings

Finding	Risk	Recommendation	Para Ref
AERA Program Acceleration	Delays in implementation of AERA would severely erode projected O&M cost savings since controller staffing could not decrease	Expedite requirements definition/validation AERA-2 and -3	5.1.1.13
Traffic Management System (TMS)	Delays in implementation of TMS would delay user benefits and increase restrictions	Integrate TMS Phase III with with AERA Phase II and Phase III	5.1.1.6
Primary Radar Coverage May Not Be Adequate	Dilution of cost benefits; inadequate equipment quantities	Accelerate effort to coordinate, complete, and and approve national network plans	3.15
Terminal Weather Radar System	Inadequate handling of terminal area severe weather	Expedite requirements validation	4.13.1
Terminal Automation (e.g., NY TRACON)	Inadequate capacity to handle demand until AAS implementation	Develop interim terminal area solution	4.3.1
RMMS System Level Design and Integration	RMMS is not being treated as an integrated system; late completion of RMMS will result in severe reduction in projected O&M cost benefits	Complete the ongoing development of system requirements and architecture and issue a detailed procurement plan	5.4.1

Table 3.1-1 (concl)

Finding	Risk	Recommendation	Para Ref
Software Development and Maintenance	Delays in implementation of key program elements	Develop a comprehensive software standard, design development, and maintenance system	4.7
FSAS Model 1 Software Development Delays	Late deployment of FSAS will erode planned cost benefits	Develop a comprehensive monitoring status plan; apply the resources necessary to implement any necessary recovery operations	5.1.3.1
Advanced Automation System Implementation	Technical interface dependencies, software, and integration complexities create inherent cost/schedule risks.	Place early emphasis on establishing interface and developing formal IFSs ICDs	5.1.1.12
Area Control Facilities Establishment for Offshore ARTCCs	Transition from PVD mode to ISSS cannot be made at Honolulu and Anchorage ARTCCs	Include transition planning, for Honolulu and Anchorage in in ACF program	5.1.1.15

3.2 PROGRAM SCHEDULE

3.2.1 Overview

The basic schedule data used to conduct the schedule audit included the latest smart sheet information, the MITRE Corporation VISION data base, system/subsystem contractor schedules (where available), and interviews with the FAA program managers. The depth and quantity of the information varied considerably across the 88 F&E projects, and therefore required augmentation based on both past experience and technical judgement. This activity provided considerably more visibility into overall schedules than was available in the NAS Plan Facilities and Equipment book and was the basis for our schedule assessments.

In general, we found that most of the positive schedule slack contained within the individual project schedules has been eroded, thereby placing the overall NAS Plan schedule in jeopardy. In addition, the critical path represented by the 9020 Rehost effort, Initial Sector Suite, the AAS, and AERA down to final ACF implementation must accommodate four major transitions, but contains little slack to accommodate unanticipated problems.

3.2.2 Programmatic Capabilities and Dependency Findings

To broaden our perspective of program-level activities and their associated project dependencies, an independent effort was undertaken to develop a NAS Plan programmatic capabilities and dependencies schedule. This schedule (Figure 3.2-1 in the back of this document) was expanded below the project level in the major areas of interest. The schedule shows only the implementation phase of the projects. Project dependencies supporting the upgrade and evolution of major systems and services of the NAS are shown as they aggregate to achieve major capabilities of the NAS. We adhered to NAS Plan schedule data except in instances where more expanded detail was desired. Where required, additional schedule detail was derived from project resumes. The schedule served several purposes as follows:

1) It substantiated the validity of the NAS Plan evolution charts.

2) It emphasized the need for development of a program plan providing visibility of project contributions to system evolution and capability goals. In instances where we expanded detail below the project level, we found additional dependencies not generally recognized in NAS Plan project descriptions or project resumes. These included:

   a) TRACON consolidation dependencies on ACF airspace redistributions and relocated radar data and voice communication interfaces.

   b) ASR-9 terminal radar and ASR-7 and -8 leapfrog dependencies associated with secondary surveillance radar and ARTS interface equipment.

   c) Special transition equipment interfaces particularly in the AAS project to permit Initial Sector Suite System (ISSS) interfacing and switchovers. Examples are:

      - Host/CDC/PAM interface switching between existing R-A-D controller positons and the ISSS

      - DARC interface switching between existing R-A-D controller positions and the sector suite consoles

      - Radar data receiver group interfacing to the ISSS

      - Model 300/VSCS switching to interfacility and A/G voice communications systems

      - Data and voice recorder interface switching between R-A-D controller positions and sector suite consoles.

   d) Microwave Landing Systems (MLS) dependencies on Engineering and Development project (page III-14, 15 - E&D document) efforts to develop new and appropriate approach procedures and criteria before realization of full MLS benefits.

3) It provided an overview of some of the more critical paths to program accomplishment. While many of the smaller projects can be dismissed as having only minimal impact on system capabilities and benefits, others such as long-range radar and terminal radar programs, Mode-S, AAS, ACF, and the weather and interfacility communications system projects unquestionably stand in the mainstream of program accomplishment. The path through the 9020 System Processor Rehost effort, Initial Sector Suite, AAS, and AERA to final ACF implementation is a critical path of major concern.

Based on this perspective, we are convinced of the need for program planning and scheduling in increasing level of detail from a master schedule level to individual system and/or capability levels. Planning must then be broadened to expand purely functional relationships into the physical aspects of site installation phasing to minimize transition impacts and optimize benefit accruals.

3.2.3 Individual Project Schedule Findings

Thirty percent of the NAS Plan project schedules have slipped 1 to 3 years since the first NAS Plan was published. As a result, a majority of positive schedule slack contained within the individual project schedules at the outset has been eroded for a number of reasons, i.e. better project definition, scope increase, technical problems, etc.

Table 3.2-1 contains a project-by-project tabulation showing our assessment of the 1984 NAS Plan project schedules expressed in terms of low, medium, or high risk. A low-risk schedule is one that contains sufficient schedule slack to accommodate problems. Medium risk means that there is sufficient slack to accommodate minimal problems. High risk means that there is little or no positive slack available to accommodate a problem. Another category shown in the schedule assessment column is "rescheduling required." This term is used when the more detailed supporting schedules are showing activity beyond the schedules in the 1984 NAS Plan. In summary, Table 3.2-1 indicates 46 low schedule risk projects, 13 medium schedule risk projects, 11 high schedule risk projects, and 18 projects that require rescheduling.

Table 3.2-1 Schedule Assessment

No. Title	1984 NAS Plan Schedule Risk Assessment	Impact Assessment
I. En Route Air Traffic Control		
1. En Route Automation Hardware Improvements & Enhancements	Low	No NAS Plan impact
2. Flight Data Entry & Printout Devices	Medium - Installation and checkout span is optimistic	No overall NAS program impact; could delay FAA benefit realization
3. Direct Access Radar Channel System	Low	
4. EARTS Enhancements	Low	No NAS Plan impact
5. Oceanic Display & Planning	Reschedule Required - Detail schedules are 5 months beyond NAS Plan schedules	No overall NAS program impact; will delay user and safety benefits
6. Traffic Management System	Reschedule Required - Detail schedules show Phase I and II each 1-year beyond NAS Plan schedules	
7. Modern ATC Host Computer	Medium - Installation and checkout at sites appear to be 3 to 5 months optimistic	Delayed implementation could impact traffic handling capacity
8. En Route Metering-II	Low	No NAS Plan impact
9. Conflict Resolution Advisory	Low	No NAS Plan impact

Table 3.2-1 (cont)

No. Title	1984 NAS Plan Schedule Risk Assessment	Impact Assessment
10. Conflict Alert IFR/VFR Mode-C Intruder	Low	No NAS Plan impact
11. Voice Switching and Control System	High - Installation and checkout span time is optimistic	Delayed implementation could impact Initial Sector Suite project
12. Advanced Automation System	Medium - Time between go-ahead and SRR (6 mo) is optimistic	Delayed implementation could impact ACF project; high leverage on entire NAS
13. Automated En Route Air Traffic Control	High - Software for operational test bed is currently expected to be 10 months late	No overall NAS program impact, delayed implementation will delay user safety, productivity benefits
14. Integration of Non-Radar Approach Control	Low	No NAS Plan impact
15. Area Control Facilities	High - This project integrates other projects and is slave to other project schedules; no project manager assigned	Delayed implementation would impact user, safety, productivity benefits
II. Terminal Air Traffic Control		
1. Provide Enhanced Terminal Conflict Alert	Reschedule Required - Technical Center implementation is 1 month late and overall project *is 6 months* late to NAS Plan schedule	No overall NAS program impact; will delay enhancements
2. ARTS-IIIA Assembler	Reschedule Required - Present approach is buying a GP data processing system rather than just software as described in 1984 NAS Plan	No overall NAS program impact; will delay enhanced software built capability

Table 3.2-1 (cont)

No. Title	1984 NAS Plan Schedule Risk Assessment	Impact Assessment
3. Enhanced Target Generator (ETG) Displays	Medium - Contract award is approximately 1 year late	No overall NAS program impact; delayed implementation could affect productivity improvements
4. Additional ARTS-IIIA Memory	Low	No NAS Plan impact
5. Additional ARTS-IIIA Support System - Tech Center	Low	No NAS Plan impact
6. ARTS-IIA Enhancements	Low - Based on timely resolution of timing problem	No NAS Plan impact
7. Provide ARTS-II Displays	Low - Project is in installation and checkout phase	No NAS Plan impact
8. ARTS-II Interfacility Interface	Low - Project essentially complete	No NAS Plan impact
9. ARTS-II Interface with Mode-S/ASR-9	Low	No NAS Plan impact
10. Automated Terminal Interface System	Low	No NAS Plan impact
11. Multichannel Voice Recorders	Reschedule Required - Center recorders will require development (higher capacity units not currently manufactured); specification is promised in mid-1986; project is currently 1-1/2 to 2 years late to NAS Plan schedules	Delayed implementation may jeopardize installation and use of VSCS
12. Tower Communications System	Low	No NAS Plan impact

Table 3.2-1 (cont)

No. Title	1984 NAS Plan Schedule Risk Assessment	Impact Assessment
13. ATCT/TRACON Establish, Replace, and Modernization	High - Politically sensitive	Delayed implementation will result in delayed benefits
14. VFR ATCT Closures	High - Politically sensitive	Delayed implementation will result in delayed benefits
15. Combine Radar Approach Control into ARTCC	Low	Delayed implementation will result in delayed benefits
16. BRITE Radar Indicator Tower Equipment	High - Joint specification is 2 months late; acquisition span time appears to be 3 to 5 months optimistic	No overall NAS Program impact; delayed implementation could have operational impact
17. TPX 42 Replacement	Low	No NAS Plan impact
III. Flight Service		
1. Establish Flight Service Automation	High - Model 1 software is currently 6 months late	Delayed implementation will delay consolidation, hence benefits
2. Central Weather Processing	Low	No NAS Plan impact
3. Consolidated NOTAM System	Low	No NAS Plan impact
4. Weather Message Switching Center (WMSC) Replacement	Low	No NAS Plan impact

Table 3.2-1 (cont)

No. Title	1984 NAS Plan Schedule Risk Assessment	Impact Assessment
5. Weather Communications Processor (WCP)	High - Backup schedules need to be developed	Delayed implementation may impact AAS
6. Interim Voice Response System	Low	No NAS Plan impact
7. High Altitude En Route Flight Advisory Service (EFAS) Frequencies	Low	No NAS Plan impact
8. Hazardous Inflight Weather Advisory Service (HIWAS)	Reschedule Required - Test and Evaluation effort is expected to be complete in 4th quarter 1984, approximately 1 to 1-1/2 years later than NAS Plan schedules	No overall NAS program impact; delay of user and productivity benefits
9. Automated Weather Observation System (AWOS)	Reschedule Required - KDM 4 is delayed approximately 1 year	No overall NAS program impact; delay of safety and productivity Benefits
10. Radar Remote Weather Display System	Low	No NAS Plan impact
11. Geostationary Operational Environmental Satellite (GOES)	Low	No NAS Plan impact
12. Wind Shear Efforts	Low	No NAS Plan impact
13. Integrated Communication Switching System	Low	No NAS Plan impact

Table 3.2-1 (cont)

No. Title	1984 NAS Plan Schedule Risk Assessment	Impact Assessment
IV. Ground-to-Air Systems		
1. Air/Ground (A/G) Communications Equipment Modernization	Low	No NAS Plan impact
2. Communications Facilities Consolidation	Reschedule required - Detail schedules are out of bed by approximately 10 months	No overall NAS program impact; delay of user, safety benefits
3. VORTAC	Reschedule Required - VOR/DME and VORTAC behind schedule 4 to 6 months	No Overall NAS program impact; delay of User, safety benefits
4. Nondirectional Beacon (NDB)	Medium - Acquisition process 2 months late; installation and checkout optimistic	Delayed implementation will delay user, safety benefits
5. Supplemental Navigation System Monitors	Low	No NAS Plan impact
6. Instrument Landing System (ILS)	Low	No NAS Plan impact
7. Microwave Landing System (MLS)	Medium - Build rate for 708 units appears to be optimistic; installation and checkout rate will require multiple crews	Delayed implementation will delay user benefits
8. Runway Visual Range (RVR)	High - Acquisition phase is currently behind schedule. This complex system, with new sensor development, is going into a CDR within 2 months after award	Delayed implementation will delay user, productivity benefits

Table 3.2-1 (cont)

No. Title	1984 NAS Plan Schedule Risk Assessment	Impact Assessment
9. Visual Navaids	Low	No NAS Plan impact
10. Approach Lighting System Improvement Program (ALSIP)	Low	No NAS Plan impact
11. Direction Finder (DF)	Medium - 15 months from award to first delivery is tight; inexperienced contractor	Delayed implementation will affect benefits
12. Mode-S Data Link	Medium - En route antenna requirements are not fully defined; hardware and software development span appears to be optimistic	Delayed implementation will delay user benefits
13. Terminal Radar (ASR) Program	Medium - Software specification is inadequate for development; specification rework is needed	Delayed implementation will delay needed replacement of ASR 4-/-5/-6 radars
14. Airport Surface Detection Equipment (ASDE 3) Radar	Medium - Tower modifications build schedules are not available; need to be developed	Delayed implementation will delay user, safety benefits
15. Long-Range Radar Program	Reschedule Required - Detailed schedule for last tube-type upgrade is 10 to 12 months beyond the NAS Plan schedules	No Overall NAS program impact; delay of FAA benefits
16. Weather Radar Program	Medium - Presently in Research and Development phase; a limited production award is scheduled for September 1986 which overlaps the R&D phase	Delayed implementation will delay user, safety benefits

Table 3.2-1 (cont)

No. Title	1984 NAS Plan Schedule Risk Assessment	Impact Assessment
V. Interfacility Communications Systems		
1. RML Trunking	Low	No NAS Plan impact
2. Data Multiplexing	Low	No NAS Plan impact
3. RML Replacement & Expansion	Low	No NAS Plan impact
4. Television Microwave Link	Low	No NAS Plan impact
5. Airport Telecommunications	Low	No NAS Plan impact
6. National Data Interchange Network (NADIN) 1A	Reschedule Required - System cutover expected 3 months later than current NAS Plan depicts	No overall NAS Plan program; delayed FAA benefits
7. National Data Interchange Network (NADIN) 2	Reschedule Required - Phase I behind 1984 schedule by 7 months; Phase II, 4 months behind schedule	No overall NAS Plan program impact; however, additional delay could impact CWP, FSDPS, AAS, etc.
8. Radio Control Equipment	Reschedule required - Detail schedules approximately 6 months out of bed	No overall NAS Program impact; delay in FAA benefits
9. Teletypewriter Replacement	Low	No NAS Plan impact
VI. Maintenance & Operations Support Systems		
1. Remote Maintenance Monitoring System (RMMS)	Reschedule Required - Detail schedules are 1 year plus beyond 1984 NAS Plan; system definition requires additional effort	No overall NAS program impact; delays FAA benefits
2. Computer-Based Instruction	Low	No NAS Plan impact

Table 3.2-1 (cont)

No. Title	1984 NAS Plan Schedule Risk Assessment	Impact Assessment
3. Central Repair Facility	Reschedule Required - Numbers locations, functional descriptions required for implementation	No overall NAS program impact
4. Maintenance Control Center	Low - Numbers, location, functional descriptions required for implementation	No NAS Plan impact
5. Airport Power Cable Loop System	Low	No NAS Plan impact
6. Power Conditioning System for Automated Radar Terminal System (ARTS-III)	Reschedule Required - Delay caused by bid protest (Resolution promised 7-84); will delay overall schedule approximately 6 months	No overall NAS program impact; delay to operational benefit
7. Power Systems	Low	No NAS Plan impact
8. Unmanned FAA Airway Facility Buildings and Plant Equipment	Medium - Program Plan is approximately 6 months late; facility consolidation study is running behind schedule by 4 months	Delayed implementation will delay FAA benefits
9. ARTCC Plant Moderni[illegible]tion	Reschedule Required - Detail schedule drives 4 years beyond 1984 NAS Plan schedule	
10. Acquisition of Flight Service Facilities	Low	No NAS Plan impact
11. Aircraft Fleet Conversion/ Flight Inspection Modernization	High - TSARC approval late approximately 9 months	No Overall NAS program impact; delay of FAA cost benefits
12. Aircraft and Related Equipment	Low	No NAS Plan impact

Table 3.2-1 (concl)

No. Title	1984 NAS Plan Schedule Risk Assessment	Impact Assessment
13. System Engineering and Integration Contract	Low	No NAS Plan impact
14. National Radio Communications System	Reschedule Required - Detail schedule is 10 months beyond 1984 NAS Plan schedule	No overall NAS Plan program impact
15. NAS Spectrum Engineering	Medium - Amount and criticality of work	Critical to radar networking, communication facilities consolidation, EFAS, etc.
16. General Support	Low	
17. System Support Laboratory	High - Firm identification of systems for testing not defined; detail schedules are almost non-existent	Delayed implementation could cause severe impact to test program
18. General Support Laboratory	Low	

Our overall assessment of NAS Plan schedules is that the overall program schedule is in jeopardy because of the significant erosion of positive project schedule slack.

3.2.4 Critical-Path Findings

The series of events leading to AAS/ACF implementation is unquestionably of major significance in the achievement of NAS Plan goals. It is the keystone for the realization of the major portion of new and enhanced system capabilities.

Schedule risks in the on time completion of events leading to AAS/ACF implementation is considered to be high because of the complexity of individual program efforts and the four transitions that must be effected in an operating system environment.

3.2.5 Recommendations

The analysis of NAS Plan F&E schedules and the perspectives gained from the work on programmatic capabilities and dependencies (section 3.2.2) indicate a requirement for the following actions:

1) Development and monitoring of a hierarchy of schedules from the master schedule (NAS Plan) level down to individual system and/or capability levels.

2) Initiation of critical path analyses on all major programs/projects to determine windows of opportunity for significant future decision events.

3) Readjustment of individual NAS Plan project schedules as appropriate to reflect current NAS Plan status.

3.3 NAS PLAN COST

3.3.1 Overview

A cost analysis audit was performed on the 10-year F&E funding plan associated with 72 of the 88 NAS Plan Facilities and Equipment projects. Sixteen projects were reviewed and excluded from cost analysis because no funding requirements during the 10-year plan period of performance (FY 83 through FY 92) were indicated. Table 3.3-1 lists project title and reason for exclusion. The results of our audit indicate that the projected NAS funding requirements of $11.448 billion for the 10-year plan (1983-1992) are adequate. Prior 1983 FY funds were also considered, where applicable, to make this determination. Some redistribution of funds between projects is required. The audit determination is based on an assessment that risk to the planned funding of $11.448B has an equal chance of overrunning or underrunning. The $332.5 million cost underrun shown in Table 3.3-2 is considered to be within the limits of estimating uncertainty.

A cost audit summary, at the system level, is shown in Table 3.3-2. The cost audit validation approach, findings, risks, (including potential growth to the NAS Plan) and recommendations are discussed below.

3.3.2 Cost Validation Approach

Two approaches (Figure 3.3-1) were used in assessing costs associated with the NAS Plan. Approach 1 defined technical parameters associated with each system and used them as inputs to the PRICE parametric cost model to provide predictions of system costs predicated on conceptual descriptions. These cost predictions were then compared to actual programs and systems taken from our experience with similar systems. This approach was used primarily on those projects for which we were unable to arrive at a definitive basis for the estimate.

Approach 2 involved an in-depth collection and assessment of estimating data and technical parameters gathered from the project managers and technical support personnel.

Table 3.3-1 Projects Excluded from Audit

Project Number	Project Title	Reason
1-08	En Route Metering-II	E&D Funding Only
1-09	Conflict Resolution Advisory Function	E&D Funding Only
1-10	Conflict Alert IFR/VFR Mode-C Intruder	E&D Funding Only
1-13	Automated En Route ATC	E&D Funding Only
2-02	ARTS-IIIA Assembler	$2.3M - Funded before FY 83; not part of $11.448B 10-year plan
2-03	ETG Displays (ARTS-III)	$7.2M - Funded before FY 83; not part of $11.448B 10-year plan
2-05	Additional ARTS-IIIA at FAA Tech Center	$2.2M - Funded before FY 83; not part of $11.448B 10-year plan
2-08	ARTS-II Interfacility Interface	Completed Project
2-09	ARTS-II Interface with Mode-S/ASR9	E&D Funding Only
3-03	Consolidated NOTAM System (CNS)	No F&E
3-06	Interim Voice Response System (IVRS)	Funded within the FSAS
3-10	Radar Remote Weather Display System (RRWDS)	Not part of 10-year plan
3-11	Geostationary Fax Recorders (GOES)	$1.9M - Funded before FY83; not part of $11.448B 10-year plan
5-05	Airport Telecommunications	Part of Cable Loop System
6-17	System Support Laboratory	Not separately Funded
6-18	General Support Laboratory	Not separately Funded

Table 3.3-2 *Cost Summary Overview - Estimate Comparisons (Dollars in Millions)**

	NAS Plan			Audit	
	Prior Year Dollars	FY83-FY92 Plan	Inception thru FY92 NAS Plan	Total Estimate thru FY92	Variance
1. En Route Systems	$ 34.2	$2,855.5	$2,889.7	$3,165.1	$(275.4)
2. Terminal Systems	11.7	600.3	612.0	608.7	3.3
3. Flight Services	155.1	676.2	831.3	835.6	(4.3)
4. Ground-to-Air Systems	207.4	4,209.7	4,417.1	3,795.1	622.0
5. Interfacility Communications Systems	0	535.0	541.4	541.4	(6.4)
6. Maintenance and Operations Support	19.5	2,571.3	2,590.8	2,597.5	6.7
Total Estimated Cost	$427.9	$11,448.0	$11,875.9	$11,543.4	$332.5

*All costs are shown in then-year dollars and use OMB rates for escalation.

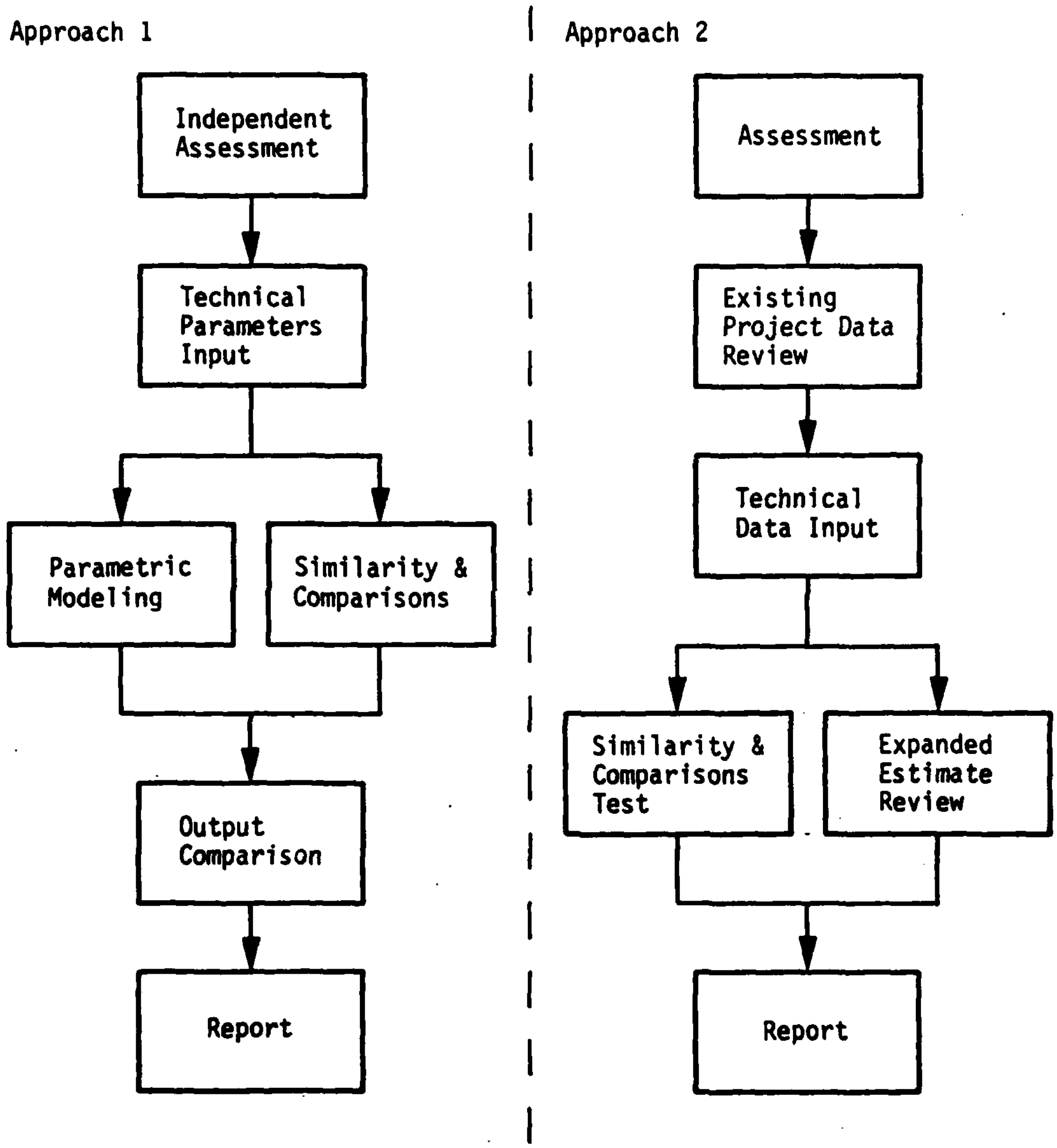

Figure 3.3-1 Approach to Establish Estimate Accuracy

We feel the use of these two estimating approaches provided a reasonable check and balance in the preparation of early estimates of project costs against which to test the credibility of NAS Plan funding requirements.

3.3.3 Findings

The total NAS funding plan gives appropriate consideration for growth items such as program change, growth, inflation, and risk in various contracting arrangements. However, it does not give consideration for new NAS Plan requirements such as terminal weather systems or for significant quantity requirement increases as potentially exist for long-range radars. Planned management systems allowing accurate prediction, tracking, and reporting of program costs should be implemented as soon as possible to provide enhanced cost management capabilities. We further recommend that early identification of risk should be made and management controls established on each procurement. It is the opinion of the cost audit team that initial procurement costs are well understood. However, program growth could exceed those amounts currently held for future unknowns. Consequently, we believe that success in not exceeding current planned NAS funding lies in developing an understanding of these programmatic unknowns so that proper controls can be implemented.

In summary, the likelihood of completing the program within the planned funds is considered to have an equal chance of overrun or underrun. The auditor's view is that an additional $2.3B of funding would be required to increase the success probability to an 80/20 level for the NAS 10-year plan.

Because there are unique conditions potentially existing above currently considered uncertainties in the NAS Plan and its implementation, it is possible the NAS Plan costs could increase. For example, cost increases could result from the lack of early program controls and firm system baselines, and the introduction of totally new system test and implementation approaches.

3.3.4 Risk

Consideration should be given to potential areas of growth currently not included in the NAS funding plan. A summary of potential cost growth items are shown below.

Project 1-03	Direct Access Radar Channel	$ 15.0M
Project 1-07/1-12	ATC Host Computer/AAS	438.2
Project 2-11	Replacement of Multichannel Recorders	12.0
Project 2-17	Replacement of TPX-42 Systems	6.0
	Terminal Weather Radar	438.3
Project 4-15	Long Range Radar Program	192.0
Project 6-13	Systems Engineering and Integration	125.0
Project 6-14	National Radio Communications	10.0
Total Potential Growth Currently Identified		$ 1,236.5M

The following is a brief description of each item.

Project 1-03 Direct Access Radar Channel (DARC)

During the early stages of implementation, specific DARC enhancements were identified. The associated costs are not considered to be part of the NAS funding plan. These are as follows:

Weather Contours	$3.9M
D-Position Keyboard	4.0
Conflict Alert & Min. Safe Alert Warning	5.1
Interfacility Communications	2.0
Total Estimated Cost Growth	$15.0M

Project 1-07/1-12 ATC Host Computer/Advanced Automation System

This item is the hardware maintenance support (spares) not currently considered to be a NAS Plan requirement. There is a possibility the FAA-proposed maintenance concept will be included in the F&E budgets when FY 86 funding requirements are determined.

Total Estimated Cost Growth	$438.2M

Project 2-11 Replacement of Multichannel Recorders

This is potential growth item identified by the FAA program manager as a new requirement for field activities. The high capacity voice recorder (HCVR) is a new concept that has not been designed.

Requirement - Add 171 channel recorders (Type 10/20)	$10.0M
- Replace 150 channel recorders with a high capacity channel recorder	$2.0M

Project 2-17 Replacement of TPX-42 Systems

The number of hardware tracking systems may be increased from 35 to 41. In addition, this is a replacement of TPX-42 Systems by the ARTS-IIA tracking system.

Total Estimated Cost Growth	$6.0M

Terminal Weather Radar

A requirement for 100 terminal weather radar systems has been identified (not in current NAS Plan).

The best estimate for equipment costs (per JSPO) and associated installation, training, spares provisioning, documentation, and other regional costs are shown below (detailed BOE not available):

(F&E Costs Only - Includes Escalation)

100 Terminal Weather Radars at $3.0M ea	$300.0M
Other Costs (Breakout not available)	138.3M
Total Potential Growth	$438.3M

Finally, the projected F&E funding requirements for the $438.3M shown above is as follows:

FY	$M	
1986	10.0	
1987	10.0	
1988	90.7	
1989	94.7	
1990	99.0	(Delivery of first system)
1991 thru 1994	133.9	
Total	$438.3	

Project 4-15 Long Range Radar Program

A potential requirement exists for 65 new En Route Radar Systems ($325.0M) to provide continuous radar coverage.

Preliminary regional studies performed by the FAA concluded that continuous coverage radar (identified in a study by MITRE) was not required. Air Traffic (FAA - Washington Office) said continuous coverage was required; therefore, current status shows the regional offices revisiting the MITRE study conclusions to yield revised estimates of their actual needs. These regional estimates (an AES network study) are due in late July 1984 and should give concrete data to project funding requirements (Source - Discussions with APM program management).

If the network study validates a requirement for these additional long-range radars, the following is the anticipated impact on the NAS Plan funding.

65 new En Route Radar Systems at $5M each	$325.0M
Offsetting Reductions:	
ASR-9s (23 fewer required at 4.49M each)	(103.3)
ASR Relocations (20 fewer at $1.37M each)	(27.4)
ASR-9 Site Prep (23 fewer at $0.1M each)	(2.3)
Net Potential Growth	$192.0M

Note: The PRICE parametric model yielded an independent estimate of the above impact at $164.3M.

Project 6-13 Systems Engineering and Integration

Potential changes which would consolidate activities from other contracts into the SEI contract are estimated to increase this contract by $125.0M.

Project 6-14 National Radio Communications

The Program Manager has indicated that a $10.0M increase could occur due to an expansion of the Regions' network radio linking capability in FY 84. A decision by FAA management should occur within the next year.

Total Estimated Cost Growth $10.0M

3.3.5 Recommendations

An estimating methodology and system should be developed which can then be applied consistently across all projects to assure traceability and establish a consistent confidence level.

The estimating level of detail should be set for each cost analysis being prepared and only that level or estimates prepared at a lower level should be accepted.

All cost estimates should conform to the cost breakdown structure contained in FAA Order 1810.3.

Regional offices should be provided an estimating methodology, including actions to be accomplished to standardize a consistent approach and level across all offices inputting to the NAS funding plan.

An estimating filing system should be established, maintained for traceability, and monitored periodically for conformance. An estimating guidebook should be published and issued to all project offices.

A variance analysis in accordance with FAA Order 1810.3 should be conducted for each successive cost estimate.

3.4 BENEFITS

3.4.1 Overview

The treatment of benefits in the NAS Plan relates primarily to reductions to air traffic (AT) and airway facilities (AF) operations costs while user community benefits are discussed very briefly. This section presents a summary of our detailed analysis and addresses both the benefits to the aviation users and the FAA as a result of NAS Plan implementation.

Our audit indicates that the cost savings of $19.9B, as presented in the NAS Plan (page 1-37), is overstated by approximately 10%. Further delays in facility consolidations, program schedule slips (notably the Flight Service Automation System), and program start-up delays would continue to erode near-term operations and maintenance (O&M) savings as stated in the Plan. Another 10-20% of the benefits will require strong management initiatives if they are to be realized. This potential shortfall in benefits achievement is due to the need for detailed plans that relate NAS Plan enhancements and facility consolidations and replacements with departmental human resource plans and budget goals.

3.4.2 Benefits to Users Findings

The NAS Plan provides estimates of its positive effect on FAA operations, but user benefits are addressed only briefly. Our analysis of existing FAA benefits documentation and our own preliminary estimates suggest that the economic benefits to the users exceed those of the FAA, totalling nearly $30B. Continuing research directed toward the measurement of user benefits is part of our benefit analysis system and data base work, which will be completed in the first quarter of 1985.

Estimates of the benefits to the users due to increased fuel efficiency provided by automated ATC functions, reduced delays due to microwave landing systems, and concepts for increased runway use could exceed $24B. Increased fuel efficiency for peacetime use of the NAS by the military could save another $5B.

Safety benefits are discussed in the NAS Plan and supporting documents, but are not quantified except in a few specific project benefit studies. The economics of safety implications are more difficult to quantify for a system already the safest in the world. A quantitative estimate of economic benefits resulting from safety enhancements is not significant in the overall benefits picture. However, maintaining and/or enhancing safety in the increasingly busy NAS is of the greatest concern and benefit to the user community.

3.4.3 Benefits to Operations Findings

The O&M cost analysis performed by the FAA is based on the best engineering data available to the FAA staff. The cost savings estimates were found to be approximately 10 percent lower than the $19.9B cumulative savings stated in the NAS Plan when tested against more conservative staffing forecast methods and after correction for relatively minor numerical errors. A further check was carried out to assess the savings in ATC personnel due to NAS Plan implementation, independent of the reduction in controller staffing due to the 1981 strike. Even then, the O&M savings are within 15 percent of the NAS Plan benefits estimates. These considerations give the analysis credibility even for the very difficult task of forecasting O&M costs to the FAA up to the next century.

The following is a discussion of some methodology issues for each major cost-benefit category.

<u>Analysis of Air Traffic Control (ATC) Benefits</u>

An analysis of the 1984 NAS Plan programs reveals 19 programs that contribute to ATC cost reductions.

The major benefits to the cost of ATC operations come from five major programs--AAS, AERA, ACF, Mode-S, and FSAS. Management initiatives are also required that include the appropriate milestones to ensure that steps leading to the reductions outlined in Table 3.4-1 for each program element are achieved. The table shows the ranking of the 19 programs with high, medium, or low potential for staffing reductions.

Table 3.4-1 Potentials for Air Traffic Staffing Reductions

Program	Potential	Reason
En Route		
AAS	High	VSCS/ISSS potential to reduce workload and positions; AAS needed as base for AERA
AERA	High	Potential to reduce number of sectors and reduce workload; needs AAS, TMS, and Mode-S data link
ACF	High	Savings in operational and overhead positions due to consolidation
ERM II	Medium	Increased sector efficiency; user benefits and fuel savings
ODAPS	Low	Savings on operational positions in oceanic centers; increases system efficiency for users
E-DARC	Low	Savings and workload during primary computer system outage
EARTS enhancement	Low	Productivity savings in offshore centers
Integration of Non-Radar Approach	Low	Savings in terminal site that gives up the function
Terminal Programs		
Combined Radar Approach Control ARTCC	Medium	Same as ACF

Table 3.4-1 (concl)

Program	Potential	Reason
ARTS-II Interface	Medium	Productivity and efficiency increase in both terminal and effected center
VFR Tower Closure	Medium	Obvious personnel savings
TPX42R	Medium	Productivity and efficiency increase in 37 facilities
ARTS-IIa	Low	Increase efficiency
Flight Services Program		
FSAS	High	Base for future enhancements, consolidation
IVRS	Medium	Redûce specialist workload
WMSC-R	Low	Reduced ATC positions
AWOS	Low	Reduced specialist workload
Ground-to-Air Programs		
Mode-S/Data Link	High	Reduction in sectors, higher efficiency when tied to AERA, reduction in A/G communications time
M&O Support Programs		
CBI	Low	Possible overhead reduction, increase in training efficiency

Table 3.4-2 presents our evaluation of the ATC staff reductions contributed by the 19 programs through 1997. When compared to the NAS Plan, controller positions for 1990 and 2000, respectively, our evaluation indicates a requirement for 1044 and 3106 additional controllers.

To achieve NAS Plan projections for the year 2000 will require expediting the design of the AERA program and ensuring that the AAS, ACF, and AERA programs are properly integrated and implemented. The 1990 projections are not achievable unless the ISSS part of AAS can be expedited.

Table 3.4-2 NAS Plan Programs Projected AT Staff Reductions by Year

	85	86	87	88	89	90	91	92	93	94	95	96	97
En Route													
1) AAS								400	400				
2) AERA											400	400	400
3) ACF a)										200	200		
b)											200	200	
c)										300	360	400	340
4) ODAPS		20											
5) ERM-II					200	200							
6) EDARC													
7) EARTS													
8) Integration of NRA		40											
Other			100	100									
Total		60	100	100	200	400		400	400	500	1160	1000	740
Terminal													
1) Combined Radar A/C - ARTCC													
2) ARTS-II Interface			100										
3) VFR TWR Closure	300												
4) TPX-42R				50									
5) ARTS-IIa		60											
Other		50											
Total	300	110	100	50									
FSS													
1) FSAS Model 2			78	333	255	314							
2) VRS										200	200	200	198
Total			78	333	255	314				200	200	200	198

(Equivalent Positions Shown)

To achieve the potential benefit of these programs, management must take initiatives to validate program benefits, gain user and operator acceptance, and accomplish the necessary implementation planning actions.

3.4.4 Other O&M Benefit Findings

Minor Discrepancies

Eight numerical discrepancies were noted. The range of deviation is small and automated computing tools or procedures should eliminate these minor discrepancies.

Methodology Issues

The O&M cost elements are derived by different methods based on staffing standards, engineering studies, and data availability. These methodologies and suggested improvements are discussed below.

Air Traffic Personnel

The top-down analysis of ATC personnel requirements needs further detailed validation. The SEI team evaluated Plan estimates also using the top-down techniques to reflect the latest changes in the status of the NAS Plan projects and to discretely include the ATC operations forecast. Continuing work to develop ATC workload measurement criteria must be completed to validate these top-down analyses.

Airway Facilities

In the AF area, the major reductions in staffing come from reductions in the number and type of facilities, replacements with solid state equipment, and through the Remote Maintenance Monitoring System (RMMS) program.

The FAA staff developed a simplification of the very detailed AF workload forecasting system for the purpose of carrying out workload estimates through the year 2000. Alternate methods and aggregation levels must be examined to reach an optimum level of detail for planning and budgeting accuracy.

Other Cost Factors

Better quantitative tools are needed in this area. The multiplier approach used should reflect more sensitivity to changes over time and mix of equipment.

The energy usage and price forecasts may need to be tied to the Energy Management Reporting System recently presented (June 1984) to the FAA by TSC, Cambridge.

3.4.5 FAA Operations Summary Findings

The benefit curves in the 1984 NAS Plan, page I-36, were revised based on updated ATC staffing estimates, AF workload forecasts, and some of the suggested methodology improvements. The revised curves are superimposed on the NAS Plan curve and are shown in Figure 3.4-1. The major elements embedded in our computation are:

1) Addition of ATC personnel to the NAS Plan representing approximately $0.78B for the last 10 years of the NAS Plan.

2) Increase of AF personnel to reflect conservative workload levels derived from AF staffing standards. This amounts to an increase of $1B in O&M costs for the 20 years of the NAS Plan.

3) The "without system plan" curve has been replaced by a more traceable derivation that corrects a $0.5B underestimate (in our opinion) of ATC personnel cost over the time span of the NAS Plan.

4) Application of multipliers for other costs consistent with those used for the "with plan" curve.

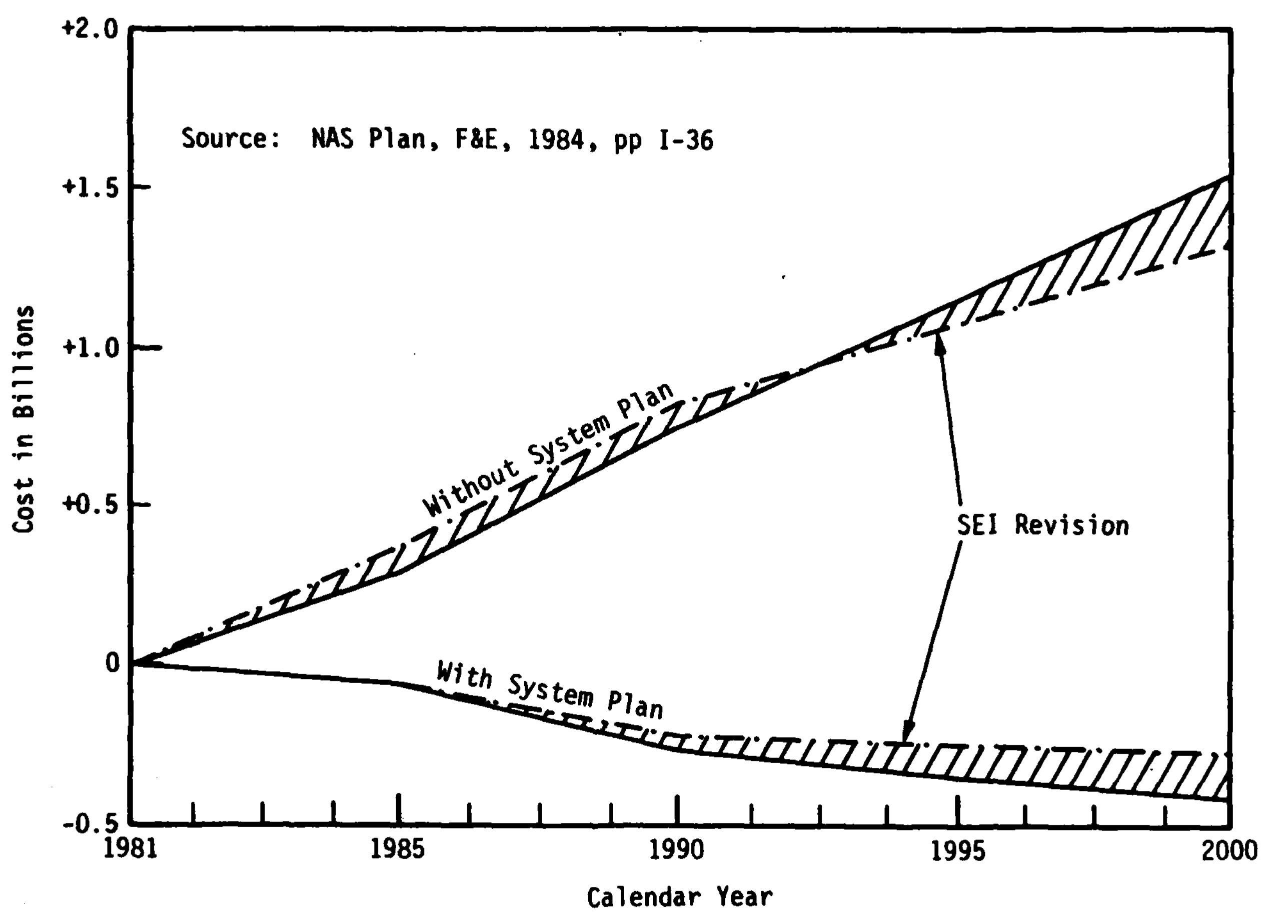

Figure 3.4-1 Change in Annual Air Traffic and Airway Facilities Operations Costs

The cumulative savings are computed graphically and add up to $17.9B, which corresponds to a decrease of 10 percent with respect to the $19.9B in the NAS Plan.

3.4.6 Recommendations

The management initiatives required to prevent further loss of benefits to the FAA and users during the remainder of this century include:

1) Management action committees in the areas of personnel and community involvement in consolidation and transition plans.

2) Integration of human resource planning with NAS Plan commissioning schedules to facilitate top-down management of labor force reductions.

3) Continuing improvement of the traceability of FAA and user benefits to specific project actions, functional enhancements, and equipment transitions.

4) Incorporation of detailed, quantitative treatment of the benefits to users by class in order to provide users with a basis for acceptance.

5) Incorporation of mutually agreed upon assumptions and forecasting techniques with ATC and AF planning departments.

6) The benefits to ATC and AF direct workloads is explicitly defined by project. To realize the full benefits of the NAS Plan, management attention should also focus on support and overhead position requirements to assure that reductions are taken consistent with actual remaining support workload. For example, organization structures, maintenance policies, and ATC and AF staffing standards must be aggressively reviewed to avoid continuing practices made unnecessary by NAS Plan implementation.

7) Increased emphasis on schedule management to preclude further schedule erosion and loss of benefits.

3.5 SYSTEM SAFETY

3.5.1 Overview

An overall system safety assessment was conducted to determine if the NAS Plan, as portrayed by the 88 Facilities and Equipment projects, would collectively satisfy the stated goals and objectives. In general, the projects and the phasing of project implementation were found to be consistent with the basic NAS safety goals; however, it was felt that additional management focus should be applied in the areas of overall system safety assessment and monitoring and system safety transition planning.

Each of the projects and subsystems, which are components of the NAS, requires a system safety analysis as part of the design, test, and installation process. Measures of reliability, availability, and effects on safety are needed for various safety-critical functions, such as approach and landing guidance. The details of the project design process are not a part of the NAS Plan; and, therefore, the system safety discussion that follows will focus on the overall airspace system safety and the safety contributions of each project.

3.5.2 Safety Goals and Objectives

The NAS Plan states that providing for the safe use of the airspace is an overriding goal. In addition, specific safety objectives are: (1) development of more accurate classification and counting of operational errors and the reduction of these by 80% from 1983 to 1995, (2) reducing the risk of midair and surface traffic collisions, (3) reducing landing accidents, (4) reducing weather-related accidents, and (5) reducing aircraft collisions with the ground. These objectives focus upon well known critical aspects of aviation operations as reflected in the accident and incident statistics and associated safety analysis. They are appropriate and representative of user and public concerns.

The NAS Plan goals include the reduction of operational errors and the reduction of midair collision risk. Operational errors, if properly interpreted, can provide one measure of collision risk. In particular, incremental changes or trends associated with operational errors may be useful safety assessment parameters. Additional metrics for safety quantification and analysis are needed. Developing these should be part of the NAS Plan.

A global assumption of the NAS Plan, which underlies the specific safety objectives, is that "No change to the system will be permitted to reduce safety or increase risk." This most fundamental goal of the Plan places a great deal of safety responsibility on the transition planning and execution process. The NAS Plan however has limited coverage of the transition process.

3.5.3 Safety Benefit Estimation and Monitoring

The measurement or estimation of safety benefits has always been subjective. In particular, assessing the value of the accident that was prevented is extremely judgemental. In spite of this, and because aviation safety tends to be very emotional, there will continue to be a large number of safety assessments made by FAA organizations, National Transportation Safety Board (NTSB), the aviation industry (for example, ALPA), and the Congress.

There is a complex interrelationship between system safety and system measures of reliability and availability which must be recognized. The Advanced Automation Program treats this subject area more explicitly than most other elements of the NAS. Reliability and availability of NAS functions affect safety in two basic ways: (1) if a function such as precision landing guidance is not available (perhaps a reflection of unreliable components), then potential safety benefits are not available; however, risk may not necessarily be of concern, because of compensating operational procedures, and (2) if there is a sudden loss of a critical function such as secondary surveillance information, safety will depend upon failure detection and revision to backup modes of operations. This second availability deficiency presents a different form of risk, and consequently a different design challenge.

It follows that the criticality of system function must be well defined. Monitoring methods can then be designed, based on the safety dependance of functions and, in turn, on the subsystems that support those functions. This approach will permit safety estimates and identify adverse trends in an area which supports the NAS Plan goals.

3.5.4 Project Contributions to NAS Safety

Three broad categories of safety risk; aircraft collision, weather-related accidents, and landing accidents are addressed by corresponding sets of projects. Collision between aircraft, airborne and on-the-ground, will be reduced by implementation of improved radar systems (including the ASDE), specialized software such as conflict resolution and conflict alert to support controller functions, and the complementary development of an independent Threat Collision Avoidance System (TCAS). Collectively, these programs provide the hardware and software basis for achieving the safety objectives of the NAS Plan related to aircraft separation.

Reducing the risk of weather-related accidents will be supported by improvements to weather measurement systems and weather information disseminations. The NEXRAD, Automatic Weather Observing/Reporting System (AWOS), Central Weather Processor (CWP), Low Level Wind Shear Alert System (LLWAS), and Geostationary Operational Environmental Satellite (GOES) development provide better, more meaningful weather data. It is essential that a total system view of avoiding weather hazards be maintained. Improved measurements of weather will not provide any safety enhancement unless useful information reaches pilots and controllers in a timely fashion, and the operational knowledge and concepts are in place to properly respond to the information. Dissemination of information is, therefore, a vital part of the issue. Consequently, projects such as the Flight Service Automation System (FSAS), Central Weather Service (CWS), Interim Voice Response System (IVRS), En Route Flight Advisory Service (EFAS), and Hazardous Inflight Weather Advisory Service (HIWAS) are important links in the chains of projects which address weather-related hazards.

The risks associated with approach and landing will be significantly reduced by development and installation of several systems in the NAS Plan. Increased availability of precision approach guidance will be a major contributor to risk reductions. Other aids to the landing phase of operations, such as the RVR system and approach lights are very important to safety enhancement.

Overall, most of the known critical safety areas are well addressed by the various NAS Plan projects. Basic information needed to reduce hazards will become available as the NAS is upgraded in accordance with the plan. These projects provide the necessary data gathering and information transmission essential to operation of a safe system. However, the utilization of new technology for NAS Plan implementation increases man-machine interdependencies to significantly higher levels than are currently experienced. This important aspect of NAS development affects the safety, efficiency, and economy of NAS operations, but is not addressed in NAS Plan documentation.

Projects were evaluated and the safety matrix (Figure 3.5-1) was developed using the form categories of safety enhancement listed below.

Category	Definition
1. Major	A new or expanded capability affecting flight or ground safety in a potentially substantial manner
2. Moderate	Enhancement of an existing capability or a new function which affects flight or ground safety in a moderate way
3. Slight	Improvement indirectly affecting flight or ground safety, or a project required to maintain current safety levels with increased capacity
4. No Effect	Has no direct effect on flight or ground safety

En Route Systems	Major	Moderate	Slight	No Effect	Remarks
En Route Automation Hardware			X		Maintains Current Safety
FDIO-FDEP Implementation		X			Improves Flight Plan Data Transfer
DARC Enhancements		X			Improves Controller Productivity
EARTS Enhancements	X				Provides Conflict Alert, MSAW
Oceanic Display & Planning System (ODAPS)			X		Structures Oceanic Flight Control
Upgrade Traffic Management System (TMS)			X		Reduces Congestion
ATC Host Computer			X		Must Not Disrupt System during Transition
En Route Metering - 2			X		Reduces Congestion
Conflict Resolution Advisory		X			Provides Possible Conflict Resolution
Conflict Alert Mode-C Intruder	X				Enhances Conflict Alert Capabilities
Voice Switching & Control System (VSCS)		X			Critical to AAS Operation
Advanced Automation System (AAS)		X			Transition Critical
Automated En Route Air Traffic Control (AERA)		X			Needs Analysis of Safety Features
Integration of Non-Radar Appr C			X		Reduces User Delays through Radar Techniques
Area Control Facilities (ACF)			X		Transition Critical

Figure 3.5-1 NAS Plan Projects

Terminal Systems	Major	Moderate	Slight	No Effect	Remarks
ARTS-III Enhanced Terminal Conflict Alert		X			Near Completion
ARTS-IIIA Assembler				X	
ETG Display				X	Better Control Training
Additional ARTS-III Memory			X		Maintains Current Safety
Additional ARTS-IIIA Support System at the FAATC				X	
ARTS-II Enhancements	X				Provides Conflict Alert, MSAW
ARTS-II Display			X		
ARTS-II Interfacility Interface			X		Better Hand Off Capability
ARTS Interface with Mode-S			X		Better Radar Data
Replace ATIS Recorders				X	Improved Reliability
Replace Multichannel Recorders				X	Improve Reliability
Tower Communications Switching System				X	AAS Related
ATCT/TRACON Establish, Replace, Modernize, & Federalize		X			Transition Critical
VFR Tower Closures				X	Defederalization
Combine TRACONs into ARTCC				X	Transition Critical
Replace BRITE Displays			X		Adds Some New Displays
Replace TPX-42 System		X			Upgrade to ARTS-IIA

Figure 3.5-1 NAS Plan Projects (cont)

Flight Service Systems	Major	Moderate	Slight	No Effect	Remarks
FSAS Implementation		X			Improves Weather & User Access
Central Weather Processor (CWP)	X				Process and Disseminate Weather Data
Consolidated NOTAM System			X		Speeds up NOTAM Process
Weather Msg Switching Center Replacement (WMSCR)			X		Improved Weather Switching
IVRS		X			Call in for Weather, Primarily G/A
EFAS			X		Improved Weather Comm
HIWAS			X		Automates Weather Broadcast
Automated Weather Observing System (AWOS)	X				Better Weather Coverage
Radar Remote Weather Display System (RRWDS)	X				More Weather Data Available
GEOSTAT			X		Satellite Weather Data
Wind Measuring Equipment/Efforts (LLWAS)	X				Wind Shear Data
Integrated Comm Switching System (ICSS)				X	Economic
Weather Comm Processor (WCP)			X		Process Mode-S/Data Link Data

Figure 3.5-1 NAS Plan Projects (cont)

Ground-to-Air-Systems	Major	Moderate	Slight	No Effect	Remarks
Replace Air/Ground Comm Equipment			X		RFI Rqmts Need Better Definition
Comm Facilities Consolidation				X	Coverage Must Be Maintained
VORTAC			X		Coverage Must Be Maintained
Nondirectional Beacon (NDB)		X			Coverage Must Be Maintained
Supplemental Navigational System Monitors			X		GPS Monitors
Instrument Landing System (ILS)		X			See Comment Below
Establish MLS	X				See Comment Below
RVR Establish/Upgrade	X				Major Improvement & Expansion
Establish Visual NAVAIDS	X				Expanded Safety Facilities
Approach Lighting System Improvements	X				Safety Upgrade
Direction Finder (DF) Modernization		X			Expanded Coverage
Mode-S/Data Link	X				More & Better Data for Pilots & Controllers
Terminal Radar (ASR) Program		X			Transition Critical
Airport Surface Detection Equipment (ASDE)-3	X				Low Visibility Surface Tracking
Long Range Radar Program		X			Surveillance Improvements
Next Generation Weather Radar (NEXRAD)	X				Better Weather Data

Figure 3.5-1 NAS Plan Projects (cont)

Interfacility Communication Systems	Major	Moderate	Slight	No Effect	Remarks
RML Trunking				X	Economic
Data Multiplexing Network				X	Economic
RML System Replacement/Expansion/Modernization			X		Improved Radar Transmission
Television Microwave Link			X		Radar Data Transmission
Airport Telecommunications				X	Economic
NADIN 1A			X		Improved Comm Capability
NADIN		X			Expanded Comm Capability
Tone Control Equipment Replacement				X	Economic
Model 28 Teletype Replacement Program (M28 TTY-R)				X	Economic

Figure 3.5-1 NAS Plan Projects (cont)

Maintenance & Operations Support Systems	Major	Moderate	Slight	No Effect	Remarks
Remote Maintenance Monitoring System (RMMS)				X	Economic Maintenance
Computerbased Instruction (CBI)				X	Economic Training
Central Repair Facility				X	-
Maintenance Control Center				X	-
Modernize Airport Cables into Loop System			X		Enhances Reliability
Provide Power Conditioning System for ARTS-III		X			Improved Availability
Power Systems			X		Enhanaces Reliability
Modernize & Improve Unmanned FAA Airway FAC Bldgs			X		Meet OSHA
ARTCC Building Modernization			X		Must not Affect Operations
Acquisition of Flight Service Facilities				X	-
Aircraft Fleet Conversion				X	-
Aircraft and Related Equipment			X		NAS Related Test Equipment
System Engineering and Integration				X	-
National Radio Communications				X	-
NAS Spectrum Engineering				X	Critical to Transition Coverage
General				X	-
System Support Laboratory				X	-
General Support Labortory				X	

Figure 3.5-1 NAS Plan Projects (concl)

3.5.5 System Safety During Transition

System test and implementation will present additional requirements for system safety analysis. These steps will also introduce new human factor considerations as projects begin to interface actual hardware and software with operational procedures and personnel. Human engineering must be accomplished early in the design phase so that human operability is assured when systems are integrated.

The safety issues raised by various transition steps are not necessarily the same as those which must be analyzed for the new NAS after implementation is completed. For example, there will be many points in time where mixed capabilities exist, that is, old and new systems will both be elements of the NAS. This mixture will result in special human factors issues which are part of the transition process. Questions of training and user understanding must also be answered.

Detailed system safety analyses must be a part of the test and implementation process and must include analysis of equipment safety, personnel safety during test, and installation and operational safety for each of the NAS projects. Further, the safety impact on the NAS of each project implementation must receive a detailed and independent safety assessment.

3.5.6 Conclusions

The NAS Plan establishes important safety goals and safety-related assumptions. These are translated into operational needs and the technical developments to respond to those needs. In general, the projects and the phasing of project implementation support the basic NAS safety goals. However, the NAS Plan does not provide a project or projects for the systematic analysis of overall NAS safety.

The system safety issues cut across several FAA organizations, in particular ADL, AVS, AAT, and the Office of Aviation Safety. Consequently, there is a growing need for a more visible planning of NAS safety analysis. The NAS Plan as it evolves should contain more explicit discussion of safety analysis plans and methods as well as the organizational mechanisms for accomplishing the required safety analysis effort and implementing any required changes and/or modifications.

3.5.7 Major Findings

The absence of a single independent safety focal point and a NAS Plan safety program are not in keeping with NAS Plan goals and objectives. Safety enhancement of the NAS through improved and expanded user services is a primary goal of the NAS Plan. Maintenance of NAS safety during all phases of system development, test, and transition may be the single most significant task during NAS Plan implementation.

The NAS modernization represents one of the very few major system upgrades which requires complete operation of the system throughout all stages of the transition process. Further, it is a modification to a system having large numbers of life-critical functions which cannot be jeopardized at any time during system changes. Very few, if any, projects such as NAS modernization have been undertaken in the past. Therefore, the management of the implementation of modifications and the overall system transition requires careful definition and focus, particularly in the following areas:

1) The NAS Plan does not address the techniques for monitoring the transition process in a system sense, particularly those aspects of the transition which could have safety consequences. The NAS Plan, in addition to defining the components of the new system and the timing of each program element, should also explicitly address the plans for measuring the effects of each incremental change, the early detection of potential problems, and the methods and organizational structure to take any required corrective action.

2) The ultimate NAS safety depends upon uninterrupted critical functions, such as traffic separation. In some cases, particularly the AAS, a high level of analysis of critical functions has taken place. The NAS Plan and supporting documentation does not treat this issue consistently. Analyzing safety levels and monitoring safety during transition require a baseline safety assessment and an understanding of the criticality of overall NAS functions. This process and its evolution are needed in the plan.

3.5.8 Risk

The risks of not applying additional resources to safety analysis and providing more planning to this subject are:

1) Discovery of potential safety problems late in the development, test, and installation cycle which will result in delays and added costs.

2) Delays caused by concerns of the user community. Without a visible safety analysis process, including transition, there will be pressure to delay transition steps to add special analysis or trial programs.

The risk in not having an improved understanding of the safety character of the NAS is the inability to detect variations from expected performance and to provide for timely alerts to any adverse trends. Measurements of safety benefit or risk are dependent upon functional criticality. The value of any such measurements are greatly diminished without baseline and criticality information. For example, ATC system errors provide insight into safety performance. A recent change to the counting procedure has increased the count. Interpreting this information depends upon an understanding of the baseline and the criticality of the separation criteria.

The most important and most difficult issues related to aviation safety for aircraft are associated with flight crew performance. The new NAS interface with flight crew members cannot be ignored or safety benefits will not be realized. Also, the modernized NAS will present new data and new tasks to the controllers. It will substantially alter the role that future controllers will play. If the controller/NAS interface is not treated properly from a safety perspective, overall NAS operational risks may be increased.

3.5.9 Recommendations

A comprehensive safety program based on a NAS Safety Plan needs to be established to provide impetus, coordination and visibility to achievement of the safety goals and to define the authority, responsibility, schedule, and methodology for implementation of NAS safety tasks.

A defined safety program will provide better visibility of safety achievement through establishment of a measurable safety baseline for comparing and reporting safety status and problems and will significantly benefit in achieving NAS safety goals.

The first step in setting up a NAS safety program should be the establishment of an FAA/SEI safety working group responsible for defining NAS Plan safety criteria, requirements, and tasks; and planning, scheduling, and providing resources to accomplish said tasks. Some of the tasks to be defined are to:

1) Prepare a NAS safety program plan based on requirements from the FAA/SEI safety working group and the FAA office of aviation safety

2) Prepare a NAS Plan related safety standard similar to MIL-STD-882 (called for on the AAS contract) to provide uniform safety requirements to NAS Plan projects

3) Determine requirements for establishing and quantifying a safety baseline as a means of measuring safety accomplishments

4) Determine requirements for independent safety assessment and monitoring of the transition process.

3.6 METHODS AND PLANNING

3.6.1 Overview

This section provides a summary of the audit finding for the methods and planning aspects of the NAS Plan implementation. More specific findings, descriptions and recommendations for these as well as other integration concerns, are contained in section 4.0.

The NAS Plan for Facilities, Equipment, and Associated Development is one of several counterpart plans necessary to accomplish the upgrade of the NAS. The Facilities and Equipment plan is the most visible of the NAS Plans because it is the trendsetter of the group providing the facilities and equipment capabilities required to support the evolution to the new NAS. The National Plan of Integrated Airport Systems, to be released later in 1984, will define needs and provide recommendations for the improvement of municipally owned airport facilities. Airport system improvement plans will complement the Facilities and Equipment Plan efforts to increase airport arrival and departure rates. These plans, however, will be incomplete without corresponding efforts to fully use the new resources they provide. The Maintenance and Operations Plan provides planning for maintenance of the new NAS using the new remote maintenance monitoring and computer-based instruction capabilities provided as part of F&E activities. An operations plan to provide system operators with the regulatory and procedural tools essential to the operation of new system equipment in a new airspace environment has yet to be published. Another plan, with less visibility but perhaps no less significance, is the Information Resources Management Plan, which will provide modernized data processing capabilities for support of system operations, maintenance, and administration. Without any one of these key ingredients, the full value of system benefits detailed in the Facilities and Equipment Plan will not be realized.

Supportive of these development plans is the Engineering and Development Plan, which encompasses projects for the research and evaluation of advanced technologies, new equipment, and new procedures. Other related activities that influence NAS planning are the National Airspace Review and conceptual planning such as included in the Rotorcraft Master Plan. The National Airspace Review is actively engaged in the review and evolution to more efficient airspace structures, aircraft routings, procedures, and regulations. The Rotorcraft Master Plan provides precursor planning for accommodation of rapidly expanding helicopter operations. This concept of plan relationships and dependencies is shown in Figure 3.6-1.

The association of NAS plans, as described above, established the context for our review of the NAS Plan for Facilities, Equipment, and Associated Development. Without this context, it is difficult to visualize how the benefits of F&E implementation could be fully realized. The primary objective of the F&E Plan is to provide an efficient ground support system which, in conjunction with better airport facilities, can be used to improve air safety, support growth in air traffic operations, and constrain operating costs. The many stated objectives of the F&E Plan—efficiency, productivity, standardization, robustness, flexibility, reduction in user constraints, etc—are supportive of these three primary goals. The extent to which these goals are achieved is dependent on the operational use of the capabilities provided in the ground support system.

In our audit of the NAS Plan for Facilities, Equipment, and Associated Development, we have reviewed the goals, objectives, approaches, and evolution plans provided in the F&E Plan overview and as prefaces to each chapter and/or major section. We have also performed an independent assessment of each F&E project and its schedule and dependency relationship to the major systems and services of the NAS. Our purpose in an independent analysis of project planning and system relationships was to validate the evolution diagrams of the NAS Plan and to provide a program schedule basis for evaluation of individual project schedules.

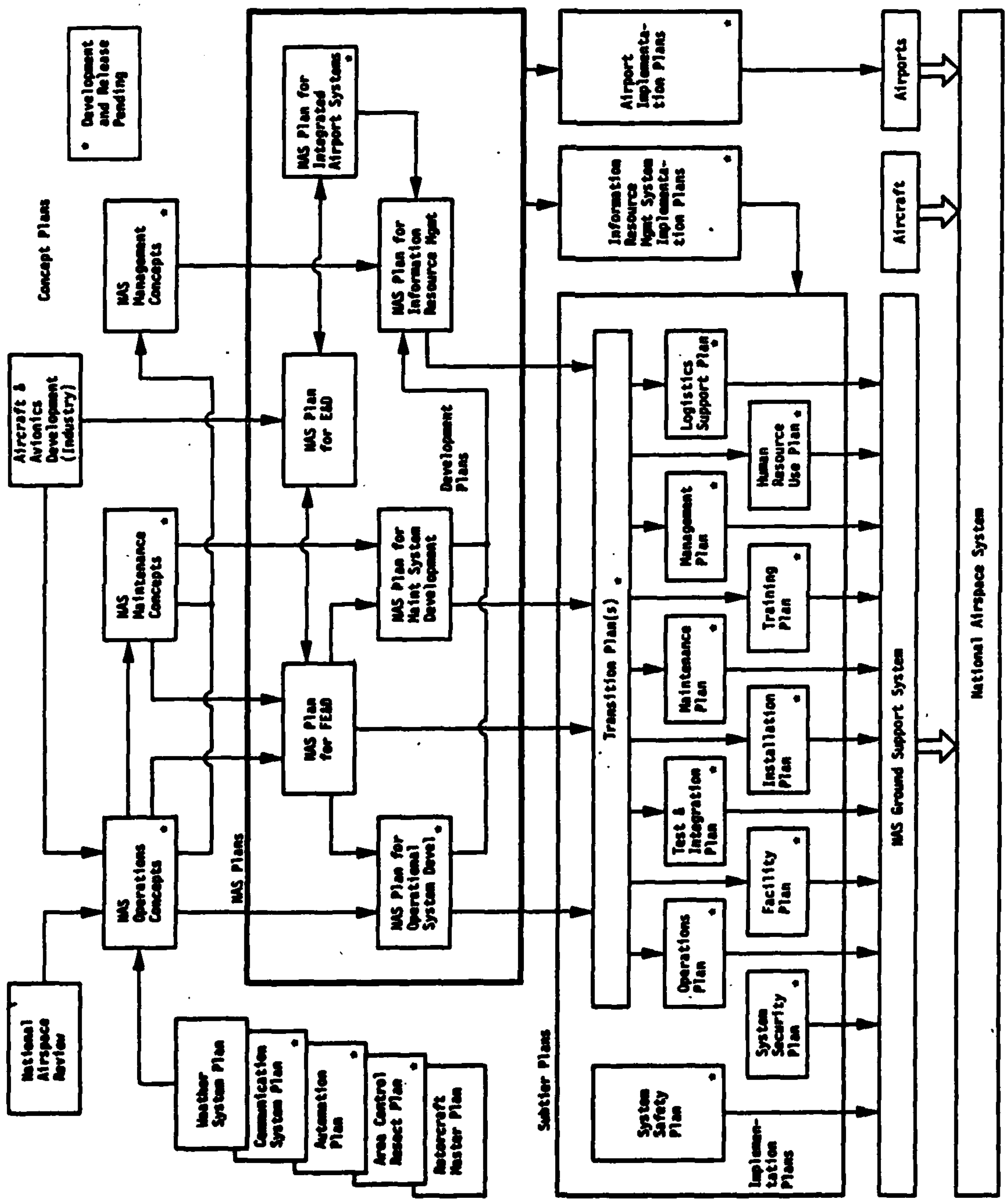

Figure 3.6-1 NAS Plan Relationships

The evolution of this schedule (reference Figure 3.2-1 in rear pocket) was independent in the sense that only project data derived from the NAS Plan itself was used in its assembly except for some of the more expanded detail which was beyond NAS Plan level of definition. Following its completion, comparisons were made to the evolutionary diagrams of the NAS Plan with favorable results. This effort convinced us of the credibility of NAS planning as a whole and in the definition of major program dependencies. Individual project schedule analysis results are presented in section 3.2.

As a further extension of our program scheduling effort, and in conjunction with other audit activities, we have examined some further aspects of NAS planning and implementation methods. Our resulting observations are discussed below.

3.6.2 Operational Requirements Findings

The audit review of the NAS Plan included an assessment of Plan comprehensiveness with respect to operational requirements and needs of the NAS. The Plan was found to be sufficient in all areas except for some potential equipment obsolescence and growth concerns in terminal and EARTS systems. For example, the ARTS-IIIA system in the New York TRACON is experiencing response timing problems under present traffic loadings. In addition, other ARTS-IIA and IIIA systems may soon exceed current processing capacity as growth demands increase. In EARTS and CERAP facilities, System 7/1130 processors used for flight plan processing will not be supported by IBM after 1985. Several individual efforts not under NAS Plan auspices are being worked to investigate and resolve these problems.

The audit also exposed a considerable number of inconsistencies between the NAS F&E Plan, the Engineering and Development Plan, and other working documentation. These inconsistencies exist primarily in schedules, equipment or facility quantities, and related project definitions. They occur, in most instances, because of development activities that expand project detail. Annual updates of the NAS F&E Plan are too infrequent to maintain currency of project definitions with this dynamic development environment. While such changes can eventually be incorporated in the NAS Plan, a more pertinent issue is the formality and control of working level documentation needed to provide management visibility and authorization of such changes. For audit purposes, we could only accept the current NAS Plan definitions as the authoritative baseline for the program.

3.6.3 System Interface Findings

In the audit efforts to determine objective and programmatic dependencies, it was observed that little formal documentation existed for both internal and external interfaces of the NAS. Similar to subtier planning, interface documentation normally evolves as program definition is expanded. For NAS Plan projects, however, particularly those for which development contracts have been awarded, or which are soon to be awarded, interfaces to other projects or external systems must be clearly and explicitly defined to avoid adverse schedule and cost effects at a future time. Incompleteness in system requirements and design is the apparent deterrent to more adequate interface definitions at this time. While efforts are on-going to fill gaps in requirements definition, system design, and interface specification, the award of contracts with incomplete specification of interfaces must be considered a risk issue for audit purposes. Problems have already been identified in ongoing projects that interface to automation, communications, weather, and remote maintenance monitor systems. These problems are identified more specifically in project assessments of section 5.0.

3.6.4 Acquisition Strategy Findings

The FAA has historically used development approaches that depend heavily on contractor support for definition and implementation of required subsystems/equipment and software for the NAS. It is being further extended in the NAS Plan to invoke dual-development concepts for the Modern ATC Host Computer and AAS projects. Planning is also underway to solicit dual-procurement contracts for the VSCS, and the Automated Weather Observation System, and the Center Weather Processor. In general, we support contracting of efforts for concept development and full-scale engineering and development for facilities, subsystems/equipment, and related software/firmware. For enhancements to existing software systems, however, it is difficult to visualize competitive contracting advantages over more knowledgeable in-house implementation. Further, we can conceive of few instances where dual full-scale developments can be used effectively. In the case of the AAS, the opportunity afforded by a dual-design run-off to evaluate architecture efficiencies and implementation costs, while maintaining a competitive environment for large-scale equipment procurements, may provide an option to single-source procurement. Conversely, there are schedule risks that will require sophisticated management and integration approaches to avoid or mitigate.

In some cases, it appears that acquisition strategy is driven to some extent by limitations on in-house resources. An area where this will become of more increasing concern will be in the maintenance of software systems for a NAS that is growing in complexity and sophistication. The FAA must continue to develop and maintain its in-house expertise in ATC systems and can not afford a default to less knowledgeable contractors for development of acceptable concepts and requirements.

3.6.5 System Security

The NAS is a national resource that in times of national emergency can be commandeered by the military in the interest of national defense or disaster support. This requires that consideration be given to make the NAS secure from sabotage, terrorist, and counter-intelligence activity. We have found no evidence in NAS planning of any conscious consideration of this factor, except in the National Radio Communications System. Operationally, the FAA provides access security to its facilities.

Security factors that need to be considered are:

1) Physical security of facilities including communication transmission lines and facilities,

2) Data security in automation and communication systems,
3) Radio frequency intrusion/jamming,
4) Operational security.

We recommend the initiation of a NAS Plan support effort to investigate security concerns and to develop planning and requirements for protection of system resources and operations.

4.0 INTEGRATION FINDINGS

As a result of our project-by-project audit, several items surfaced that were on a broader level than an individual project. These broader findings (integration findings) are listed in Table 4-1 and are described in more detail in subsections below.

4.1 NAS PLANNING STRUCTURE

4.1.1 Overview

In section 3.6, we discussed the relationship and dependencies of the NAS Plan for Facilities, Equipment, and Associated Development to other NAS planning activities. To establish these relationships in a more meaningful way, we suggest that all elements of the NAS Plan be given formal recognition to relate activities necessary for full realization of NAS goals and objectives. The NAS Plan should be structured to include the following element plans:

- NAS Plan for Facilities, Equipment, and Associated Development
- NAS Plan for Integrated Airport Systems
- NAS Plan for Operational System Development
- NAS Plan for Maintenance System Development (M&O Plan)
- NAS Plan for Information Resource Management
- NAS Plan for Engineering and Development.

These NAS Plan elements will then provide a total definition of all projectized activities needed to achieve a fully implemented and coordinated NAS.

4.1.2 Risk

Without a complete and visible plan that encompasses both required equipment capabilities and the associated operational implementation and management of these capabilities, full realization of NAS modernization benefits may be delayed significantly. While there are, and have been, FAA mechanizations in

Table 4-1 Integration Findings

Finding	Risk	Recommendation	Ref
1. NAS Planning Structure	*Without a complete and visible* plan, full realization of the NAS modernization benefits, goals, and objectives may not be achieved.	Develop a planning tree that depicts the relationship of existing plans and develop a new systems operations plan. (Modify existing plans as required)	4.1
2. NAS Plan Project Consolidations	The proliferation of projects within the NAS Plan complicates system design and implementation, increases the number of formal interfaces, and increases costs.	Consolidate compatible projects to reduce risk. A candidate list is provided in section 4.2.	4.2
3. Additional NAS Plan Project Requirements	Several required projects are not covered in the NAS Plan (for example, projects that would assure operation of ARTS and EARTS facilities in TRACONs and offshore facilities until ACF consolidation).	Scope effort and include in future revisions of the NAS Plan.	4.3
4. Operational System Development Plan	Without definitive plans for development of operational plans and procedures, system acceptance will be slowed, resulting in reduced benefits.	Develop and implement a system operations plan under the auspices of Air Traffic Services.	4.4
5. Interface Coordination	Inadequate treatment of NAS external interfaces will result in the development of improper/incomplete interfaces affecting system performance, cost, and schedule.	Establish the interface working group including external interfaces. AES and SEI must be key working group members.	4.5

Table 4-1 (cont)

Finding	Risk	Recommendation	Ref
6. FAA Technical Center Planning	The role of the FAATC in the area of system integration testing is not well established. FAATC resources are limited and detailed planning is yet to be accomplished. Development of a well thought out plan is essential for timely program accomplishment.	FAA, with SEI support, must develop a test and integration plan compatible with project needs.	4.6
7. System Software Maintenance Planning	Lack of a system software maintenance concept/facility will result in higher costs, potential schedule impacts, and erosion of benefits.	A system software maintenance plan should be developed as a subtier document to the system operations plan. Air Traffic Service should be the lead for plan development.	4.7
8. Transition Planning	More detailed transition planning is required immediately to prevent schedule impacts, improper interface definition, and erosion of cost benefits.	SEI should develop such a plan and submit to FAA by January 1, 1985.	4.8
9. Acquisition Strategy	Parallel, full-scale development of subsystems by multiple contractors is difficult to manage and will adversely drive both cost and schedule.	Examine the acquisition strategies, particularly for AWOS and VSCS, after establishing/examining selection criteria.	4.9
10. NAS Operations Concept	Lack of an approved, controlled, system-level operations concept could result in an improper system design, with potential negative impact to cost, schedule, benefits, and technical performance.	Immediate development of a NAS Operations Concept Document (FAA, SEI, and MITRE).	4.10

Table 4-1 (cont)

Finding	Risk	Recommendation	Ref
11. NAS Maintenance Concept	Lack of an approved, controlled, system-level maintenance concept could result in an improper system design, with potential impact to cost, schedule, benefits, and technical performance.	Immediate development of a NAS maintenance concept document (FAA, SEI, and MITRE).	4.11
12. Surveillance System Integration	Dispersed treatment of the surveillance system (rather than as an integrated system) could result in reduced system flexibility, duplication of hardware, reduced benefits, and schedule delays.	Provide the system design support to force integration of the surveillance projects at the system level (system specification, transition plan, etc) (SEI and FAA action).	4.12
13. Weather System Integration	Dispersed treatment of the weather system (rather than as an integrated system) could result in reduced system flexibility, duplication of hardware, reduced benefits, and schedule delays.	Provide system design support to force integration of the weather projects at the system level (system specification, transition plan, etc) (SEI and FAA Action).	4.13
14. Communications System Integration	Dispersed treatment of the communication system (rather than as an integrated system) could result in reduced system flexibility and reduced benefits.	Develop a top-down communication system design and a communication system specification (FAA and SEI).	4.14
15. Remote Maintenance Monitoring System Integration	Late completion of RMMS will result in reduction in O&M cost cost benefits.	Complete the ongoing development of system requirements and architecture and issue a detailed procurement plan.	4.15

Table 4-1 (concl)

Finding	Risk	Recommendation	Ref
16. Primary Radar Coverage	Quantity of primary radars identified in the NAS Plan may not satisfy coverage requirements. Additional quantities will impact cost/schedule and, therefore, erode benefits.	Accelerate effort to complete the ongoing coverage analysis.	4.16

place to provide the necessary activity correlation, the scope of NAS modernization efforts is so large that past procedures and resources may be insufficient to provide needed products in a timely manner.

4.1.3 Recommendations

Adoption of the planning structure proposed is recommended to provide better visibility and association of all needed NAS program activities. It will require the development of a new Operational System Development Plan and potential modifications of other related plans to focus all associated organizational efforts into a group of comprehensive and integrated NAS program plans. Subsidiary benefits will be more mutual recognition of objectives, better definition of needed resources, and user participation early in the system development process.

4.2 NAS PLAN PROJECT CONSOLIDATIONS

4.2.1 Overview

In our review of the NAS F&E Plan, we occasionally found cause to question the logic of project scope and definition with the Plan. Project grouping for management attention vs budget considerations are often conflicting requirements and can lead to apparent discontinuity or apparent omission of effort. The following instances are cited.

1) ARTCC facility expansion was determined to be included under the modernize ATC Host computer project presumably because of its first need to support this program. However, its identity was lost and was misplaced with respect to other related facility efforts.

2) The Communication Facility Consolidation project in Chapter IV indicates a requirement for 175 new buildings. The Unmanned FAA Airway Facilities Buildings and Plant Equipment project in Chapter VI provide design support. Common building standards for new and combined facilities are not apparent.

3) Power control systems for Unmanned FAA Airway Facilities and for ARTS-III TRACONs have been established as separate projects despite their direct facility association. They are used to provide primary power backup and normally interface to primary power sources and distribution systems. Although procured separately, as is other facility equipment, they must be engineered into facility power systems to assure proper interfacing, installation, and operation.

4) Airport Telecommunications has been separated in the 1984 NAS Plan from Airport Power Cable Loop Systems despite common installation requirements at airport facilities. They differ primarily in the functions they serve - control, data, voice versus power. If cable systems are used, they will probably share common underground routings, trenches, ducts, and termination points. It is not apparent within either project how common efforts are to be achieved.

5) The Long-Range Radar Program, Terminal Radar Program, and the Weather Radar Program contain many efforts, which in themselves, could be justified as individual projects. For these programs, neither the F&E Plan nor supporting documentation identifies where construction budget exists for required new facilities. Standard facility designs for new radar installations are identified as part of the Unmanned FAA Airway Facilities Buildings and Plant Equipment project, but no new facility construction is identified for these new installations, nor is it obvious where funding exists to cover new facility construction.

6) The AERA-2/3 project elements and the TMS Phase III project elements have many common and integrated requirements. It is our recommendation that they be combined as block upgrade to the NAS.

4.2.2 Risk

Our concern is with a potential lack of visibility of essential activities, lack of schedule coordination, and budget overlaps or deficiencies. Further, there is the hazard that responsible organizations do not clearly understand their roles and responsibilities in support of other project efforts.

4.2.3 Recommendations

While many of discontinuities and/or omissions in project descriptions can be corrected in future updates to the NAS Plan, we believe that improved management insight for definition and program integration can be achieved by consolidating some of the functional or discipline-related project efforts. Candidate project consolidations are:

A.1. Unmanned FAA Airway Facilities Buildings and Plant Equipment (6-08)
  2. Power Systems (6-07)
  3. Communication Facilities Consolidations (4-02)

B.1. ATCT/TRACON Establishment, Replacement, and Modernization (2-13)
  2. VFR Tower Closures (2-14)
  3. Power Conditioning Systems for Automated Radar Terminal Systems III (ARTS-III) (6-06)

C.1. ARTCC Plant Modernization (6-09)
  2. ARTCC Plant Expansion (Part of 1-07)

D.1. Airport Telecommunications (5-05)
  2. Airport Power Cable Loop Systems (6-05)

Whether project consolidations are adopted or not, there is a need to:

1) Expand NAS Plan project scope, schedule, and dependency definitions

2) Provide or revise internal FAA working documentation to further develop interface dependency milestones and schedules.

4.3 ADDITIONAL NAS PLAN PROJECT REQUIREMENTS

4.3.1 Overview

The NAS F&E Plan is quite comprehensive in its coverage of system needs to support modernization and enhancement of NAS ground support facilities and equipment. We were unable, however, to identify projects that would assure continued operation of ARTS and EARTS facilities in TRACONS and offshore facilities (Alaska, Honolulu, San Juan, Guam) until ACF consolidation in the 1993 through 1998 period. Some of the hardware involved in these facilities is at or near the end of its expected life. The FAA has already received notice that IBM will discontinue support for System 7 processors used in offshore facilities. In addition, growth forecasts indicate increased operational loadings of up to 40 percent by 1998. Even at this time, the New York TRACON is experiencing processing response slowdowns, and other facilities are approaching processing capacity limits. Additional memory provided at ARTS-III facilities will provide an enhanced data storage capacity, but is apt to aggravate processing response times. Consequently, both maintenance and operations problems can be anticipated at these facilities before ACF assumption of the operational loads of these facilities.

4.3.2 Risk

ARTS and EARTS systems will very probably experience availability and performance degradation problems as time goes on.

4.3.3 Recommendations

We understand that APM has efforts underway to develop recommendations for alleviation of these conditions at the NY TRACON and ARTS-III facilities and for System 7 flight data processing equipment replacement at EARTS facilities. We suggest continuation and expansion of these efforts as necessary to include solutions for all affected facilities and to expedite system enhancements via new NAS Plan project definitions.

4.4 OPERATIONAL SYSTEM DEVELOPMENT PLAN

4.4.1 Overview

The NAS Plan for Facilities, Equipment, and Associated Development contains many projects that will deliver new systems equipment having different operating characteristics and increased capabilities. The increased capabilities that will evolve as new equipment is installed include more flight plan filing automation, automated weather advisories, improved and expanded surveillance coverages, better air-ground communications, improved approach control and landing aids, etc. Further, the Area Control Facility (ACF) project will consolidate TRACONs into ACF facilities, and will provide a new concept of flight surveillance and control coverage. New system capabilities, facility consolidations, and airspace redistributions will significantly alter air route structures, airspace sectorizations, and associated regulations, standards, and procedures. The Air Traffic and Aviation Standards organizations normally accommodate requirements for revised regulations, standards, and operating procedures as normal operational activity. Because of this informality, no formal plan has been developed to correlate specific standards and procedure efforts with NAS F&E Plan project activities. There are projects within the Engineering and Development Plan to support standards and procedure development, but these are indeterminate in scope and apparently unfunded.

4.4.2 Risk

New NAS development activities will impose major workloads on Air Traffic and Aviation Standards personnel to develop revised flight and ground support system operational standards and procedures. Airport improvements funded under the National Plan for Integrated Airport Systems will add to this burden. Further, plans for comprehensive integration and test of new system equipment at the FAA Technical Center will require availability of new operating standards and procedures well in advance of first site operations. Without visibility of plans for development of these operational standards and procedures, not only for the final system configuration but also for the interim configurations of the evolving system, risks to program accomplishment must be considered high.

4.4.3 Recommendations

An operational system development plan to define standards and procedure development efforts is needed for correlation with NAS F&E and Airport Improvement project activities. Development of such a plan under Air Traffic

Service auspices is highly recommended to assure timely availability of needed standards and procedures and early involvement of standards and procedures personnel in NAS modernization activities.

4.5 INTERFACE COORDINATION

4.5.1 Overview

Proper interface coordination and documentation is generally recognized as an essential prerequisite to successful program accomplishment. It has been recognized by the FAA for the NAS and made a significant part of our system design activity. Predecessor work to define programmatic dependencies has been performed by MITRE. In our audit assessment, however, many interface definition concerns were identified in project reviews (reference section 5.0). In system-level efforts to identify project dependencies, a similar absence of interface definition and documentation was observed. We attributed this deficiency, in part, to ongoing system design activities that have yet to complete needed internal and external functional interface requirements. Project to project efforts have resulted in definition of some of the more direct project-level interfaces. A lack of formality in the documentation and control of interface definitions also contributes to a low level of visibility of available interface documentation.

Interface requirements are classified into two major categories: internal and external. Internal interfaces are those that exist between NAS system elements, subsystems, and equipment. External interfaces are those that exist between the NAS and aircraft users, the military, the National Weather Service, foreign Air Traffic Control Systems, etc.

Internal interfaces are usually easier to develop and control because they are dependent only on internal resources and activity coordination. For the NAS, however, interface development efforts are more complex because the new NAS projects must interface with the existing operating systems, either as a direct enhancement, or for transitioning from old to new equipment. System engineering efforts will develop requirements for new system interfaces as a function of system design. The definition and specification of incremental

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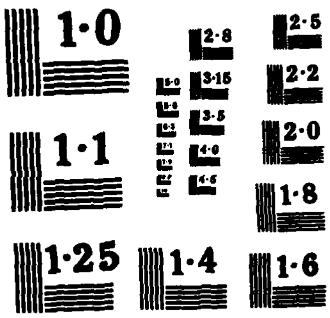
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configuration and transition interfaces are more problematical. It depends largely on the availability of existing system interface specifications that may or may not exist in acceptable form for project contractor use.

The definition of external NAS interfaces requires coordination between FAA organizations and other government agencies, and foreign ATC organizations. We are confident that in many of these areas meaningful work is being accomplished. There is military representation within the FAA; the ACF program has initiated coordination with foreign ATC organizations; NEXRAD is an ongoing project under joint sponsorship; etc. On the other hand, there appears to be a set of issues such as DOD interfacing to the new NAS; lack of radar network plans that include military radar coverages; and, the absence of any visible system requirements for emergency preparedness such as secure communications, physical system security, and operational integration with military operations.

4.5.2 Risk

Implementation momentum is accelerating on almost all NAS project activities with major project contract awards completed or close to completion. Lack of complete interface specifications will impact schedules, costs, equipment configurations, and possibly system operations, if not recognized or if deferred for later implementation.

4.5.3 Recommendations

We suggest that interface activities be assigned to an interface working group. This working group should have a basic FAA/SEI membership supplemented by representatives of FAA organizations responsible for internal and external interface coordination as appropriate for each interface. For external interfaces, it should be chartered to develop agreements and definitions of required interfaces to schedules consistent with program needs. For internal interfaces, it should oversee, manage, and approve interface definition and specification documents generated by Level I design activities. It should also schedule, review, and approve detailed interface control documents (ICD) generated internally or by subcontractors. Products of the working group should be approved ICDs for release, control, and distribution under the configuration management system.

4.6 FAA TECHNICAL CENTER PLANNING

4.6.1 Overview

The NAS F&E Plan contains two projects that provide for increased resources at the FAATC. These are the System Support Laboratory and General Support Laboratory projects. The descriptions of these projects appears to be appropriately encompassing; however, in the schedule of activities for the System Support Laboratory, only a small number of F&E Plan projects are shown. Because of the criticality of the FAATC to the success of the new NAS, further investigation was initiated. FAATC plans (1983 version) did not provide the same sense of scope and focus as did the F&E Plan description for either the System Support Laboratory or the General Support Laboratory. In fact, FAATC planning was basically a 5-year plan that did not include the major thrust of NAS activities. A review of 5-year budget planning reinforced concerns that there may be insufficient resources planning to support NAS system integration. Facility space planning was more comprehensive but seemed to give insufficient emphasis to general support system and software development growth requirements. Even without these added facility requirements, space usage within the FAATC appears to be at a maximum.

In our review, we attempted to understand how the FAATC supported project activities in the past and relate them to what is needed for system integration of new NAS systems. We believe that the FAATC is cast into a significantly expanded role—that of system integration, as opposed to the more restricted projectized activities. We believe further, that to fulfill the expanded requirements of system integration, software maintenance, and configuration baseline control, that all project operational equipment exclusive of facility support equipment must be hosted at or interfaced to the FAATC. This can include the conjunctive use of Atlantic City airport equipment and other more remote facility equipment connected by data link to

FAATC automation systems. The continued availability of the FAATC Airport as a dedicated measure will contribute significantly to the timely execution of integration testing.

FAATC planning appears to be constrained by past procedures wherein it has been responsive only to program manager direction. In the context of operations that we visualize, past procedures will be insufficient. What is needed is a total program approach that recognizes:

1) Project-level development and acceptance testing;

2) System integration testing of new systems and equipment;

3) Software development, validation, and support for both software and firmware;

4) Establishment and maintenance of configuration baselines--hardware, software, firmware;

5) Change incorporation, test, and baselining;

6) User evaluation of new capabilities and configurations;

7) Field support including FAATC problem simulation with growth to remote site diagnostic support via interfacility data communication channels.

This expanded FAATC role is a challenge that will strain personnel, facility, and support system resources. It places the FAATC clearly in the mainstream of program activity with responsibility to assure the acceptability and compatibility of all fielded equipment. To fulfill this role effectively, FAATC operations cannot be resource limited without serious compromises in program schedules. FAATC planning must also consider the problem of both system transitioning and maintenance of configuration support capabilities for both old and new system equipment until final decommissioning. For example, this means concurrent support to the existing 9020 en route system with new

Host computers; the Initial Sector Suite System; ARTS-II and ARTS-III systems along with new TCCC systems until completion of TRACON consolidations; and PVD-M1 console operations room equipment along with new sector suite configurations.

4.6.2 Risk

FAATC operations are serially in the critical path of all project implementation activities. Given the composite of all F&E Plan projects converging into a single system integration facility, there appears to be little question that FAATC operations must be assigned very high risk factors. Plans for mitigation of these risks require early attention so that required resources can be made available before risk effects impact program implementation.

4.6.3 Recommendations

Mitigation of risks at the FAATC requires a multistep approach:

1) Development of a Test and Integration Plan to define required FAATC system integration tasks and responsibilities for each of the F&E Plan projects. The Plan must incorporate realistic schedules that reflect project dependencies and capability milestones. It should define configuration requirements and dependencies on System Support Laboratory and General Support Laboratory resources including any new resource requirements needed. It should also provide estimates of operational loadings on each of the FAATC facilities with planning for mitigation of overload conditions.

2) Development of a resource plan to manage, develop, schedule, allocate, operate, and maintain essential resources. Resource definition must include requirements for personnel, facilities, utilities, communications--voice and data, data processing, simulation, configuration switching, instrumentation, data storage/retrieval, transportation, etc.

3) Development and submittal of budget requirements and implementation plans.

4) Procurement, installation, checkout, and validation of expanded resources and associated operating procedures.

We recommend that the FAATC be designated lead organization for these critical activities. The basis for FAATC planning should be the NAS Plans for Facilities, Equipment, and Associated Development; for Engineering and Development; and for Operational System Development; and the System Transition Plan. The unavailability of some of these plans should not, however, delay an immediate start on FAATC planning, since much productive work can be accomplished with those plans presently available.

4.7 SYSTEM SOFTWARE MAINTENANCE PLANNING

4.7.1 Overview

Projects included within the NAS Plan for Facilities, Equipment, and Associated Development will produce a considerable number of new computer systems and application software that must be validated, baselined, and maintained for operational use. New or modified computer system software is required for Host, ISSS, AAS, FSAS, CWP, WCP, AWP, AWOS, NADIN, VSCS, ARTS-IIA, ARTS-IIIA, EARTS, RMMS, etc. In addition, it is anticipated that new state-of-the-art systems will use a wide variety of microprocessor-based equipment to achieve required system flexibility and versatility. This implies a significant requirement for the validation, baselining, and maintenance of operational firmware for such applications.

Although new software will be developed by project subcontractors, the burden of certifying software for operational use and for baselining and maintenance of the software, will eventually be an FAA responsibility. It is anticipated that operationally required changes in the initial years of new system operation will be of such magnitude and complexity that a considerable expansion of existing facility, equipment, and personnel resources will be required. To achieve the required flexibility and versatility in the new NAS, System equipment will be logically driven by software, and far more complex software relationships and interfaces will exist to integrate the many individual functional elements of the system.

In our audit review, we have been unable to identify projects (except for the AAS-provided System Support Computer Complex and the Research and Development Computer Complex) that would provide supporting facilities for software/firmware development and maintenance, or that identify efforts needed to support fielding of new operational systems.

When contractors are employed to develop new system functional capabilities, contractor-provided products are seldom directly usable in operationally fielded software. They require validation, integration with other changes, and assembly into site-specific software versions for release under the configuration management system. To accomplish these essential operations, supporting software-oriented equipment and personnel resources are required. Many projects will deliver equipment to the FAA Technical Center for test and evaluation. This equipment, as configured for operational use, may be insufficient to accommodate software maintenance, and extension of peripheral input-output capabilities may be necessary. For microprocessor firmware maintenance, special microprocessor development station capabilities will be required. Ideally, common resource facilities for mainframe and microprocessor-based computer systems would reduce the amount of special development equipment and personnel skills required for software and firmware maintenance. The individuality of NAS projects, however, is expected to result in a diversity of system processors, associated operating systems, and high-level language applications that will make common development facilities impractical.

4.7.2 Risk

This is considered to be a major activity that should receive early consideration to develop the necessary facilities and expand available resources. The allocation of responsibilities for software/firmware maintenance of the many NAS equipment systems must be clearly established.

The consequence of insufficient planning will be expanded costs to maintain contractor support, difficulty in maintaining configuration definitions and control, and potential schedule delays and benefits erosion.

4.7.3 Recommendations

Development of a system software plan is recommended as a subtier document to the operational system development plan. The software plan should identify needed resource and implementation projects for inclusion in the operational system development plan. Software responsibilities are presently divided between the Air Traffic Service and Program Engineering and Maintenance (within ADL) for operational system software and maintenance system software, respectively. New system design concepts, which will merge equipment diagnostics and remote maintenance monitor data acquisition and formatting with operational system programming, will render these former distinctions obsolete. We recommend that a single software development and maintenance organization be established. It should be operationally oriented with strong technical support from System Engineering and Program Management.

To develop the system software plan, we recommend a composite team of Air Traffic, System Engineering, Program Maintenance, and SEI contractor personnel. The software plan should address methods, procedures, required resources, tasks, and management of both software and firmware start-up and ongoing maintenance activities. The plan should also define roles and responsibilities of development contractors relative to turnover procedures, configuration baselining, documentation requirements, etc.

4.8 TRANSITION PLANNING

4.8.1 Overview

The NAS F&E Plan has evolved rapidly in the few years since its inception to the point where the majority of its projects are firmly established and development activities well underway. There now appears to be a need for more definitive planning for the operational implementation of mid-term and far-term projects. These projects have many functional interdependencies that must be satisfied before planned operational capabilities can be achieved. (The near-term projects do not exhibit similar dependency characteristics.) The F&E Plan provides a meaningful overview of project dependencies via the evolution diagrams. In our review of F&E Plan project dependencies (see Figure 3.2-1), it was observed that additional dependencies become apparent at increasingly lower levels of planning detail. For example, in the Terminal Radar Program, several equipment dependencies affecting ASR-9 installations and ASR-7/8 leapfrog activities were identified. These dependencies involved radar data interface equipment (BDAS, SRAP, SCIP, ARTS-II interface, CD) necessary to maintain/establish interface compatibility with ARTS-II, ARTS-III, and eventually the AAS. Additional planning detail is also needed to identify ATCBI installations associated with new ASR-9 and leap-frogged ASR-7/8 radars, assuming the decommissioning of older ATCBI 1, 2, 3 systems as Mode-S systems become available. This example flags a need for more definitive interface definition. Further, an analysis of supporting project data failed to indicate any coordinated field-site staging plans that recognized the functional dependencies between projects or the requirements for special transition equipment/software. An exception to this is the ACF implementation plan in which an integrated approach has been developed for the geographic evolution of ACF-dependent Host, Initial Sector Suite, AAS, and TRACON consolidation efforts. This is a most appropriate starting point for expansion to a broader plan that encompasses interfacility and air-ground communications, radar networking, and weather and flight service systems capabilities. The need for an integrated transition/implementation plan is immediate to provide project implementation guidance and to establish the needed basis for development of facility, test and integration, installation, operations, maintenance, logistics, and, in particular, human resource utilization plans.

4.8.2 Risk

An integrated transition/implementation plan is essential to ongoing activities for implementation of the NAS upgrade. Delay in its preparation will seriously compromise schedules for capability and benefit achievement.

4.8.3 Recommendations

The lack of an integrated plan that provides guidance for evolution to a modernized NAS is recognized even at this time. Many planning activities will, of necessity, be limited in scope until an overall plan for phasing of NAS capabilities into the existing system can be marketed. As SEI contractor with responsibilities to prepare such a plan, we propose acceleration of our Level III design processes to expedite its preparation.

4.9 *ACQUISITION* STRATEGY

4.9.1 Overview

In selected circumstances, the FAA is using an acquisition strategy that involves parallel full-scale development of subsystems by multiple contractors. It is being applied to the Modernize ATC Host Computer, Advanced Automation System, and Automated Weather Observation System projects, and is being considered for the Voice Switching and Control System. The decision logic leading to selection of a multiple-procurement strategy must conclude that one or more of the following factors to override the inherent cost, schedule, and management concerns of this procurement approach:

1) Reduction of development risk;

2) Promotion of a competitive environment;

3) Development of alternate procurement sources.

For system acquisitions requiring advanced state-of-the-art technology and/or complex design problems, it is not unusual to use a multiple source procurement approach for concept and requirements development. However, significantly more justification is needed to further its use through full-scale engineering development because of cost, schedule, and management considerations.

Assuming a commitment to a dual-source procurement strategy for some projects, these concerns require early and continuing attention to the following:

1) The adequacy of the existing specification and impacts of future specification changes;

2) The limitations on FAA options for directing contractor efforts toward more preferred configurations because of the competitive environment and risk of proprietary data transfers;

3) The selection process to be used in the competitive run-off of proposed system designs;

4) The potential need to merge portions of competitive contractor designs to achieve a preferred end-point design configuration;

5) The potential requirement for normalization of contractors and the need to repropose to the preferred design configuration;

6) The impact of the above concerns on project and program schedule.

In the specific case of the Automated Weather Observation System (AWOS), the current plan is to award two contracts with separate design, production, and installation efforts. Each contract will be for full turn-key installations of half the required 745 units. This approach will introduce equipment of different designs into the FAA's inventory with the negative effect of necessitating redundant training and logistics support efforts.

4.9.2 Risk

The risk associated with multiple-contract development strategies is in being able to manage the separate contracts effectively, to develop optimized designs, maintain program schedules, and constrain development costs.

4.9.3 Recommendations

When multiple-contract strategy appears to be advantageous after a thorough examination of objectives and factors involved, steps should be taken to assure the availability of sufficient resources to properly manage contract activities, to finalize results into preferred approaches, and to reduce development risks. Specifically, we recommend the following actions:

1) Evaluate acquisition strategies, particularly for AWOS and VSCS.

2) Review and finalization of specifications to establish definitive ba[illegible]ne requirements before contract awards. After award, the competitive environment may be altered, cost proposals may be divergent, and negotiations complicated by differences in design and implementation approaches.

3) Development and implementation of a management plan to address concerns described in the preceding findings discussion.

4) Dedication of appropriate personnel resources to adequately support management plan implementation.

5) Inclusion in contract conditions of the necessary options to reduce or terminate part, or all, of contract efforts at selected milestone points (PDR, CDR) if design and implementation approaches appear unacceptable or nonproductive.

6) Reprocurement of production engineering documentation for high production projects to establish options for multiple source production and to maintain a competitive environment.

7) Consideration a third-party effort, if necessary, to merge divergent design and/or implementation approaches into a preferred configuration with specifications and design products sufficient for production contracting.

8) Development of a comprehensive run-off criteria document for distribution to contractors and evaluation teams. The criteria should focus on design validity and acceptability, support system requirements and designs, implementation approaches, projected life-cycle costs, and contractor performance. In addition, the criteria should define how run-off assessments will be weighted with respect to production proposal evaluations.

Not all of these recommendations are necessarily pertinent to all proposed multiple source procurements, and application may vary by project complexity and risk.

4.10 NAS OPERATIONS CONCEPT

4.10.1 Overview

The bridge from NAS objectives and operational requirements to the specification of functions and performance requirements for the deliverable end items that make up the NAS subsystems is a definitive concept of operations for the NAS.

While there is evidence of much good conceptual operational planning for the NAS, a formally documented operations concept that can be applied at the NAS system level and then allocated to the projects is not in evidence among the NAS system-level documentation.

The proper function of an operations concept is to explain, from the system user/operator viewpoint, how the system under development will function to meet the operational requirements for the provision of products and services to the user. In the case of the NAS, it would explain, principally from AAT's view, what exactly goes on in the process of controlling aircraft within the NAS. It would present the operational view of the NAS functions and design information pertinent to the operator/user. It would delineate the actual/envisioned operator tasks and information processing to accomplish the control of aircraft. In this manner, it would, with the operations requirements, form the basis of system analysis that identifies the necessary functions the system must perform to meet the operational requirements, and allocates them to system elements, subsystems, and eventually to operator/procedure hardware or software. This analysis is greatly aided by knowledge of the concept of operations. Early incorporation of this valuable input from the operator/user view can greatly enhance operator/user acceptance of the eventual design of the system.

4.10.2 Risk

The risk in proceeding with NAS design in the absence of a documented operations concept lies chiefly in the possibility of functional allocation that is incompatible with, or contributes to imbalances in operator workload, requires significant new or revised operator training and/or procedures, or complicates the interface between the system and the user.

While difficult to quantify, the results of proceeding without an operations concept would almost certainly increase the implementation cost of the NAS, erode the planned maintenance and operation cost benefits, and at least complicate the user/operator acceptance of the NAS.

4.10.3 Recommendations

We recommend that the FAA immediately direct the preparation of a NAS operations concept document to communicate to all personnel involved in the design and development of the NAS and its subsystems, the operator/user view, and how the various hardware and software portions of the envisioned NAS are expected to operate in the satisfying the Operations Requirements.

This task should be led by the System Engineering Service with significant assistance from the Air Traffic Service. It is recommended that the SEI contractor be given responsibility for gathering and integrating data from the Air Traffic Service, and the publication and maintenance of the document, under control of the NAS Configuration Control Board. Significant assistance in this effort would be anticipated from the MITRE Corporation, who has responsibility for the publication and maintenance of the operational requirements document that drives the operations concept.

The operations concept for the NAS being developed (the 1995 NAS) would be greatly enhanced by development of an operations concept for the current system (the 1984 NAS), and the development of such a document is a secondary recommendation. Such a set of documents would show the evolution of system operations as the new subsystems and enhancements are fielded.

In addition, it would be valuable for the subsystem developers to have an expansion of the NAS concept of operations that addresses the envisioned operation of the subsystem within the NAS framework. Martin Marietta, together with the appropriate AAP/APM program manager, should develop operations concepts for each of the new NAS subsystems to be furnished to the bidding contractors at the time the procurement package is issued. The operations concept bears on the development of new subsystem hardware and software analogously to the effect existing design has a constraint on new development.

The en route/terminal ATC operations concept prepared for AAP by Computer Technology Associates is a good model of an operations concept for a subsystem with extensive operator-system interfaces, and has been well received by the Air Traffic Service as a valuable aid to the development of the AAS. This document could be used as the basis for an overall NAS current system concept of operations and for subsystems requiring extensive operator interfaces.

4.11 MAINTENANCE CONCEPT DEVELOPMENT

4.11.1 Overview

As a result of findings pertaining to the Central Repair Facility (CRF) project, additional effort is needed to further develop the maintenance concept of the future to maximize savings described in the NAS Plan. An integrated approach to developing design requirements for the maintenance system and its component projects should be identified and documented.

4.11.2 Risk

The risk of not redefining the current maintenance concept at this time is that the opportunity to further reduce costs and manpower as stated in the NAS Plan would not be realized. Redefining the maintenance concept after implementation of current projects as described in the NAS Plan could have significant cost impacts, especially if the requirement for facilities already planned for development in the 1985 era was eliminated.

4.11.3 Recommendations

A top-down set of system design requirements need to be developed for the maintenance system designed to be in effect in the 1995 era when the NAS Plan has been accomplished. The maintenance system referred to herein is the set of projects (RMMS, CBI, CRF, MCC, and the logistics elements of the general support projects) that must be integrated with each other and with other NAS Plan projects (telecommunications, etc) to transition into the maintenance system of the 1995 era. The maintenance system design must be structured about and driven by a maintenance concept that must be thoroughly analyzed, evaluated, and defined at the earliest possible date.

The maintenance summary information contained in Chapter 6, pages 1 through 3 of the NAS Plan, should be expanded/updated to incorporate a summary of the findings of the maintenance steering group (reference FAA Order 6000.27A). These findings should be used to develop a maintenance concept of the 1990s.

The maintenance and operation documentation should be completed and issued by November 1984 to provide additional guidance for project contract definition. Significant issues such as the number of CRFs, structured maintenance, relationship between LIS and MMS, etc, should be worked by an FAA/user/SEI maintenance steering group(s).

With the finalization of the maintenance concept definition, the system design requirements should be defined and allocated to the individual projects within the set. Design requirements for each project need to be defined to assure an integrated maintenance system evolves that is an integral part of the NAS system and supportive of the goals and objectives of the NAS Plan.

4.12 SURVEILLANCE PROGRAMS

4.12.1 Overview

The NAS network plan for radar surveillance facilities remains under development, therefore, adequacy of planned equipment quantities and locations to meet surveillance coverage requirements is uncertain. Communications, primary and secondary radar, and weather sensor programs are affected by lack of an approved system baseline.

4.12.2 Risk

The risks are potential schedule slippage relative to published NAS timetables, significant cost escalation if planned equipment quantities are inadequate for operational coverage requirements, and dilution of the expected cost-to-benefits ratio upon which the NAS Plan is based.

4.12.3 Recommendations

To mitigate the potential risk, we recommend an acceleration of the agency-wide effort to coordinate, complete, and approve all National Network Plans now being developed. This will provide a baseline against which currently planned facilities and equipment quantities may be compared so that necessary changes can be effected by the individual projects on a timely basis. Any necessary adjustments to previously computed cost benefit ratios should be made and reflected in the next annual NAS Plan update.

4.13 WEATHER SYSTEM INTEGRATION

4.13.1 Overview

Adverse weather conditions are a significant factor in aircraft accidents and in air traffic delays. The FAA has been working with other government agencies and with aviation user groups to develop improvements in weather forecasting and detection and dissemination of weather data. Recent developments in weather detection technology, coupled with National Weather Service system changes and the NAS Plan implementation, should yield substantial improvement to the quality and timeliness of badly needed weather information.

Recent development of some of the technology to be used has limited the pace of the system design effort. New concepts used in interfacing elements such as FSAS, Mode-S, CNS, and the dual WMSRs further complicate the weather system design.

Significant effort remains to complete development and design of weather system elements. Finalization of functional allocation and design is an interdependent exercise, and action taken concerning a weather system element may result in changes in several other elements. Thus the total weather system must be the result of a system-level design if interface definitions, communications, and processing requirements are to become firm. Examples are as follows:

AWOS - Although sensor development has progressed satisfactorily, the interfaces and uses of AWOS remain in doubt. Decisions have not been firmed up concerning the data acquisition, land-line transmission media, or data destination and distribution for use by the ground system. Also, no decision has been made concerning the radio broadcast of these data and the methodology by which the data would be aired.

Terminal Weather - The Terminal Weather program is in the advanced concept phase. Although it is a derivative of NEXRAD, there are significant differences. There is concern over the frequency to be used and over potential interference. Its use, in conjunction with surveillance radar, is also of concern. The use of the TDR data has not yet been resolved. The primary purpose of TDR is to provide information on fast changing weather; and, these data are expected to be used at the terminal facility in a yet undetermined manner. A study is currently underway to determine the operational and functional requirements for terminal weather. The results of this study are expected in the fall of 1984. These results will be used to determine the requirement for Terminal Doppler Radar.

WCP - The Weather Communications Processor, only recently added to the NAS Plan, is also in the early design phase. Expected to interface with Mode-S, FSDPS, CWP, and AWOS, it is thus dependent on their designs as well as the actual message definition, data rates, and potential use of graphic products. An interface with UHF/VHF would require a voice generation capability. A working level program manager has not been assigned to the WCP.

Additional weather system problems remain to be solved concerning the processing and display of NEXRAD data in the CWP. Weather system design decisions also need to taken regarding exact definition of weather products, message structure, display technique, processor sizing, communication requirements, system interfaces, and system control.

The weather system elements are being managed by personnel from several organizations with overall direction provided by the Deputy Associate Administrator for Engineering, whose staff provides weather systems coordination within FAA, intergovernment, and international. The splintering of the projects complicates the system design and development.

4.13.2 Risk

The FAA has efforts underway to continue the development of the weather system. The current level of effort being provided in this area, however, may not be sufficient to resolve the total weather system design within the existing NAS Plan schedule. This could result in erosion of the early benefits expected from improved weather products, over or under specification of the elements, an inability to achieve the full range of anticipated weather products due to an inadequate system design, or redundant capabilities developed by separate program offices.

4.13.3 Recommendations

A working group should be established to complete the weather system design. This group should address the allocation of functions to weather system elements, the interfaces for each element, the methodology for use of NEXRAD data, weather system architecture issues, processing and display requirements, transition planning, development of a schedule including dependencies, and development of appropriate documentation for the total weather system.

4.14 COMMUNICATION SYSTEM INTEGRATION

4.14.1 Overview

The NAS Plan states that an integrated network, the NAS Interfacility Communications System (NICS), will be established to replace the current Interfacility Communications System. However, the Plan does not take an integrated approach to the development of the communications system. The Plan defines a number of communications projects, but does not fully address integration of the individual projects into a system. Further, these projects are not described in a single chapter of the Plan. User requirements and interface/connectivity among projects are not clear. Overall communications systems program planning is needed.

The NAS Plan proposes a communications utility that will serve all users and permit better service, increased capability, and cost avoidance rather than solving each communication requirement on a case-by-case basis. NICS will accomplish these improvements by combining compatible traffic, planning for strategic and tactical switching, and providing connectivities for all users. The NAS Plan does not, however, address the means by which the concept of NICS will be implemented. The result may be less than cost-effective use of resources, schedule slippage, and technical and management problems.

NICS is composed of nine projects in the NAS Plan organized into four areas:

1) Transmission - RML Trunking, Data Multiplexing, RML Replacement and Expansion, TML, and Airport Telecommunications;

2) Switching - NADIN 1A, NADIN 2;

3) Radio Control - Radio Control Equipment;

4) Terminal Devices - Teletypewriter Replacement.

Each of the nine projects is individually funded, scheduled, and managed.

Almost all NAS projects relate to NICS. Most projects will require communications service. Voice switching projects such as VSCS, ICSS, TCS, and TMS will directly affect communications planning because they will determine interface network design. Communication users such as RMMS and weather will affect NICS by demanding service at many locations. In all cases, NICS should be available before other projects in order to be a service.

The NICS concept will be evaluated in this section rather than the individual projects that comprise the NICS. The evaluation addresses the ability of the NAS Plan projects to satisfy requirements and related goals.

Communications System Planning

A program plan for an integrated communications system is needed. The Level I design (draft, February 1984) describes a communications system that has characteristics of an integrated system, but it does not address integration of communications projects. Program plans have been written for several communications subsystems. These include:

1) Interfacility Communications System/Switching Subsystems (February 1984, discusses NADIN and ICSS);

2) Interfacility Communications System/Transmission Subsystem (draft, April 1984, discusses RML and data multiplexing);

3) Air/Ground Communications (draft, September 1983, discusses RCE along with other A/G communications projects for facility consolidation equipment replacement and voice recorder replacement).

None of the above program plans reviewed during the audit adequately address transition or implementation planning.

Communications systems projects are not all grouped in a single chapter of the NAS Plan. Chapter V includes several of the communications systems projects. However, three projects that should form a part of the integrated communications system--the VSCS, ICSS, and TCS projects--are contained in Chapter III with each appearing in a different section. The ICSS and TCS are labeled communication projects, while the VSCS is labeled an automation project. Also, the Advanced Automation System (AAS) project described in Chapter I of the NAS Plan contains a communications subsystem, the Local Control Network(s) (LCN). The LCN subsystem is a part of the total communications system and will provide for interprocessor communications for AAS and non-AAS elements as an ACF, as well as serve other interfacility and gateways functions. Additionally, the National Radio Communications Systems (NARACS) project is contained in Chapter VI, Maintenance and Operation Support Systems. The NARACS will be an independent radio network and will provide an emergency communications network between NAS facilities. It will also be available for routine uses. This treatment in separate chapters detracts from a clear presentation of an integrated approach to a communications system in the NAS Plan.

We recognize that projects such as VSCS, ICSS, TCS, and AAS LAN also provide functions outside the communications area. However, the communications functions they do provide should be addressed or referred to in an integrated communications plan.

Flexibility and Growth Potential

The communications network will need to adapt to the many changes planned for NAS systems. Facilities are being reconfigured or moved, new services such as weather are developing, and new technologies such as satellites and fiber optics will be considered. New but presently unidentified or envisioned operational requirements may develop. These FAA needs should be accommodated by the NICS without costly retrofit or recapitalization of the communications system. These impacts of relocated facilities, new services, and new technologies must be assessed with a knowledge of the NAS communications requirements. A communications needs analysis should be performed for an integrated communications system. The analysis is particularly important for new NAS Plan projects to provide future projections of communications system loading. Information is required from all users on the kind of communications needed, with whom and where they need to communicate, the volume of traffic, the message lengths, the perishability of the information, how long it can remain in the communications system, when the capability is needed, etc, so that an integrated design can be performed. Such information will also assist in identifying interface and connectivity requirements, and can be used as an input to individual subsystems designs.

The full spectra of requirements for backup and alternate communications networking have not as yet been completely defined. Consideration of and providing a flexibility in the system design for including Tandem Switching would be desirable.

Integrated Communications System Design

An integrated communications systems approach should be addressed in the NAS Plan. For example, it is not clear in the Plan whether data and voice services should be designed separately or jointly.

Within the data services category, it is not clear what subdivisions should exist between low-speed message switched data service, packet switched data service, and dedicated-line data service. Data communications requirements exist within the NAS which are each optionally transmitted by dedicated circuits, message switching systems, and packet switching systems. This approach places greater emphasis on logical connectivity across a serving network, as opposed to always having a described physical connectivity between two user locations. The optimal combination of these capabilities in an integrated system need to be accomplished.

The VSCS, ICSS, and TCS all perform similar functions of voice channel switching and reconfiguration. The size requirements of each are different, but the technology used for VSCS, and possibly elements of the VSCS itself, might be used to meet TCS requirements.

The distinction between TML and RML is unclear. The NAS Plan states that the TML links may be used to carry voice and data as extensions of the RML. Resiting of RML links could provide some connectivity now project for the TML project.

Only limited analysis of communications system interfaces and protocol requirements has been accomplished (reference MITRE working paper, Preliminary Interfaces Description Document, dated February 6, 1984). In some cases, interface control and protocol documents have not been written, and requirements for such documents have not been fully identified.

Integrated Network Schedule

There is a need for an integrated schedule that shows the interrelationships of the various elements (projects) for NICS, and the dependence of the various user projects on the communication system. Inevitably, both user projects and communications projects will encounter problems that may cause delays or interface changes. If NICS is to be ready as needed by the users, an integrated schedule must be developed and rigorously maintained. A vertically integrated schedule would be especially useful in examining design alternatives and integration of subsystems. Further, it would be useful in managing the implementation of the communications system projects and those projects that are communications system users. Current MITRE VISION schedules contain project schedule data and limited project dependency data. However, the emphasis is by project and no integrated communications system dependency is identified. Accordingly, it is not possible, with the current schedule, to identify the interdependency of NAS Plan projects with the communications system. This is an essential requirement since a large number of NAS Plan projects are, in some way, users of the communications system. We plan during the next few months to transfer the VISION schedule data base to ARTEMIS. This will provide the opportunity to develop a vertically integrated system.

4.14.2 Risk

The risks of proceeding with the NAS Plan without a communications system plan that includes analysis of flexibility and growth requirements, an integrated system design, and an integrated network schedule, lie mainly in the area of lost opportunities. The present communications projects in the NAS Plan will reduce costs, provide future cost avoidances, and provide a more flexible, reliable, and responsive NICS. However, there is potential for achieving even better results.

The risk associated with schedule delays or interface changes can result in cost impacts. These are of two natures: (1) anticipated cost savings for NAS Plan projects that will use the NICS may be delayed if the NICS is not in place with the proper interfaces, and (2) a risk of additional cost if interface devices or software must be developed to accommodate additional NAS projects not yet identified.

Although it is difficult to measure the effects of these lost opportunities, additional cost savings and capabilities are potentially available through an integrated communications system plan and design.

Another risk factor is that if the NICS is not made available to the users on a timely scheduled basis, vis-a-vis user schedules, user acceptance of the NICS might be jeopardized. Any reluctance of the users to use the NICS, and instead use dependent commercial carrier systems for their communications needs, could cause FAA communications cost to be unacceptably high.

4.14.3 Recommendations

Specific recommendations for each of the findings are outlined below.

1) Communications System Planning - Prepare a program plan for a total integrated communications system, including transition and implementation planning or develop separate transition/implementation plan(s). The program plan should include all projects that comprise the integrated communications system network (VCSS, AAS/LCN, ICSS, TCS, Data Multiplexing, RML, TML, NADIN, and RCE), and should discuss the relationship of the NARACS in an integrated communications system. The NICS program plan should show how the goals stated in the NAS Plan flow down to specific projects and schedules. The NICS program plan will serve as a focus for all communications functions and will provide an integrated system approach. Specific objectives of the NICS program plan should to be:

a) List all communications projects and describe functional relationships and hierarchies and projected communications flows;

b) Provide an integrated transition and implementation plan that includes each NICS project;

c) Provide for a communications requirements data base;

d) Provide for the development of interface control and protocol documents based on standards;

e) Provide for the development and maintenance of an integrated project schedule.

The projects listed in the above recommendation should be treated as a system in the NAS Plan, Chapter V, and the title of Chapter V changed from "Interfacility Communications System" to "Integrated Communications System" to more properly reflect an integrated approach. The AAS/LAN should be referenced as a communications project in the Integrated Communications System chapter.

2) Flexibility and Growth Potential - A needs analysis should be conducted that is based on requirements input from all users of the integrated communications system. To aid in delineating user requirements, a communications system user requirements survey form should be developed that identifies all desired requirements data. The results of the needs analysis should be used to develop a data base for an integrated communications system.

3) Integrated Communications System Design - System-level planning and user requirements should be incorporated into a detailed top-down integrated communications system design with a system-level specification. The specification should include the details of interface control and protocol document requirements derived from a comprehensive analysis of the connectivity of NAS Plan projects with the integrated communications system. This planning should recognize the current status of the various communications projects and address the means for an efficient integration into a total system. This effort would establish a common set, or family, of interfaces for user access and interconnectivity to the NAS.

4) Integrated Network Schedule - The transfer of the schedule data base from VISION to ARTEMIS should be expedited, and a vertically integrated schedule should be developed to include the relationship/interdependence of the communications system projects and other NAS Plan projects.

5) Expedite backup and alternate communications networking policy so that the need for Tandem Switching can be determined.

4.15 REMOTE MAINTENANCE MONITORING SYSTEM INTEGRATION

4.15.1 Overview

There has been considerable RMMS development accomplished over the past several years. The development to date has not been driven by a firm/controlled set of system-level requirements. Procurement of new equipment (MLS, Mode-S, ASR-9, etc) is underway with only top-level interface to RMMS, such as physical connection and message protocol currently defined. These items, coupled with the cancellation of the RCAG-RMM contract, have created a schedule impact to Phase I as defined in the NAS Plan.

4.15.2 Risk

The absence of well-defined, system-level requirements, architecture, interfaces, and implementation planning during the development of the RMMS could result in mismatched monitoring techniques, system throughput limitations, and capacity incompatibilities. These incompatibilities could lead to and possibly require some redevelopment.

Major delays in the RMM implementation would impact the manpower savings and benefits gained through remotely monitoring and controlling equipment and could ultimately impact our ability to maintain the equipment to its present level of operational availability.

4.15.3 Recommendations

It is recommended that the RMMS system-level requirements, architecture, interface, and implementation planning be fully documented, reviewed, controlled, and approved as a priority item. The ongoing RMMS development efforts should continue as good concept definition data are being obtained. Production procurements for RMMS equipment should be gated to the approval of the system level documentation identified above. Specific emphasis should be placed on providing RMMS interface information as early as possible to the various NAS subsystems being procured to minimize potential retrofit cost impacts. This system lead effort should be the responsibility of AES and the SEI contractor.

4.16 PRIMARY RADAR COVERAGE

4.16.1 Overview

The NAS Plan long-range radar program is made up of the following elements to achieve en route surveillance requirements:

1) 47 new military 3-D radars for joint use sites
2) 23 ARSR-IIIs
3) Remote data from 34 existing terminal radars
4) 23 ASR-9 gap fillers (to be established)
5) Solid-state mods to existing vacuum tube equipment to be made before the above measures.

It was perceived that this program would meet the Air Traffic search radar coverage requirements throughout the CONUS. This requirement (en route) is 6000 ft (or MEA) to 20,000 ft referenced to MSL. Subsequent analysis indicates that coverage requirements cannot be met with this plan, i.e., the gap filler and the terminal radars do not have sufficient maximum range capability, and the resulting coverage shortfall is significant. A quick study by MITRE indicated that the shortage could require as many as 75 new long-range radars. The procurement cost would far exceed the money set aside for 23 ASR-9 gap fillers.

A network coverage analysis has been initiated with regional analytical support. This work is scheduled to be completed by the end of June 1984.

4.16.2 Risk

The results of the network coverage analysis will provide insight to the shortfall of primary radar coverage and the resulting additional radars required.

4.16.3 Recommendations

The requirement for en route search radar coverage is specifically stated by Air Traffic. It is felt that there is, potentially, some relief from this on a CONUS-wide basis. This is based on the fact that in high-altitude regions the requirement is a shallow coverage depth and in fact radar data may not be used or practical because of clutter. Other regions may have so little traffic that is not warranted. The recommendation, in part, is to challenge the requirement on a regional basis.

We also recommend consideration of a measurement on existing radars of the actual coverage that can be obtained in high-altitude region at the MEA to FL200. The basis for this is that the radar is a line-of-sight device and the low altitude coverage can be difficult to meet, i.e., there may be regions where the MEA to FL200 requirement cannot, in a practical sense, be met.

5.0 NAS PLAN PROJECT FINDINGS

See Volume 2

6.0 RECOMMENDED ACTIONS

This section lists the recommendations developed in sections 3.0, 4.0, and 5.0 and as sections 6.1, 6.2, and 6.3 below, respectively. The listing is a restatement of the recommendations. The section in which each recommendation is developed is provided for easy reference. The number of recommendations for each section is shown in parentheses.

It is anticipated that all validated recommendations will be dispositioned for action by a review board chaired by an appropriate member of FAA senior management. Following disposition, the SEI contractors actions items tracking system will be used to monitor progress of dispositioned actions to closure.

Note: In cases where recommendations have already been planned for and are a part of the SEI statement of work, no dispositioning action will be required.

6.1 RECOMMENDATIONS FROM SECTION 3.0 - NAS PLAN ASSESSMENT (13)

6.1.1 Recommendations from 3.1 - Technical Feasibility and Validity (1)

Recommendations that relate to technical feasibility and validity are presented in section 4.0.

6.1.2 Recommendations from 3.2 - Program Schedule (3)

The analysis of NAS Plan F&E schedules and the perspectives gained from the work on programmatic capabilities and dependencies (section 3.2.2) indicate a requirement for the following actions to:

1) Develop and monitor a hierarchy of schedules from the Master Schedule (NAS Plan) level down to individual system and/or capability levels.

2) Initiate critical path analyses on all major programs/projects to determine windows of opportunity for significant future decision events.

3) Readjust individual project schedules as appropriate to reflect current NAS Plan status.

6.1.3 Recommendations from 3.3 - Program Cost (4)

1) A consistent estimating system and methodology to be applied to each project should be developed. A well-documented basis of estimate is necessary to ensure traceability and establish a consistent confidence level of each project.

2) Each project should be reviewed to determine completeness and accuracy of the statement of work as currently defined.

3) Systematically categorize all hardware and software by low, medium, or high risk of specification and/or contract change.

4) As the program matures, each type of project contract arrangement must be individually addressed and assigned a weighting factor commensurate with the associated risk.

6.1.4 Recommendations from 3.4 - Benefits (6)

The management initiatives required to prevent further loss of benefits to the FAA and users during the remainder of this century include:

1) Management action committees in the areas of personnel and community involvement in consolidation and transition plans.

2) Integration of human resource planning with NAS Plan commissioning schedules to facilitate top-down management of labor force reductions.

3) Continuing improvement of the traceability of FAA and user benefits to specific project actions, functional enhancements, and equipment transitions.

4) Incorporation of detailed, quantitative treatment of the benefits to users by class to provide users with a basis for acceptance.

5) Incorporation of mutually agreed upon assumptions and forecasting techniques with ATC and AF planning departments.

6) The benefits to ATC and AF direct workloads are explicitly defined by project. To realize the full benefits of the NAS Plan, actions to proportionately reduce support and overhead positions must also be identified. For example, organization structures, maintenance policies, and ATC and AF staffing standards must be aggressively reviewed to avoid continuing practices made unnecessary by NAS Plan implementation.

6.1.5 Recommendations from 3.5 - Safety (1)

A comprehensive safety program based on a NAS safety plan needs to be established to provide impetus, coordination, and visibility in achieving the safety goals and defining the authority, responsibility, schedule, and methodology for implementation of NAS safety tasks.

A defined safety program will provide better visibility of safety achievement through establishment of a measurable safety baseline for comparing and reporting safety status and problems and will significantly benefit in achieving NAS safety goals.

The first step in setting up a NAS safety program should be the establishment of an FAA/SEI safety working group responsible for defining NAS Plan safety criteria, requirements, and tasks; planning; scheduling; and providing resources to accomplish these tasks. Some of the tasks to be defined are to:

1) Prepare a NAS safety program plan

2) Prepare a NAS Plan related safety standard similar to MIL-STD-882 (called for on the AAS contract) to provide uniform safety requirements to NAS Plan projects.

3) Determine requirements for establishing and quantifying a safety baseline as a means of measuring safety accomplishments.

4) Determine requirements for independent safety assessment and monitoring of the transition process.

6.1.6 Recommendations from 3.6 - Methods and Planning (1)

Recommendations are presented in sections 4.0.

6.2 RECOMMENDATIONS FROM SECTION 4.0 - INTEGRATION FINDINGS (31)

6.2.1 Recommendations from 4.1 - NAS Planning Structure (1)

Adoption of the planning structure proposed is recommended to provide better visibility and association of all needed NAS program activities. It will require the development of a new Operational System Development Plan and potential modifications of other related plans to focus all associated organizational efforts into a group of comprehensive and integrated NAS program plans. Subsidiary benefits will be more mutual recognition of objectives, better definition of needed resources, and user participation early in the system development process.

6.2.2 Recommendations from 4.2 - NAS Plan Project Consolidations (1)

While many of the discontinuities and/or omissions in project descriptions can be corrected in future updates to the NAS Plan, we believe that improved definition and program integration can be achieved by the consolidation of some of the functional or discipline-related project efforts. Candidate project consolidations are:

A.1. Unmanned FAA Airway Facilities Buildings and Plant Equipment (6-08)
2. Power Systems (6-07)
3. Communication Facilities Consolidations (4-02)

B.1. ATCT/TRACON Establishment, Replacement, and Modernization (2-13)
  2. VFR Tower Closures (2-14)
  3. Power Conditioning Systems for Automated Radar Terminal Systems III (ARTS III) (6-06)

C.1. ARTCC Plant Modernization (6-09)
  2. ARTCC Plant Expansion (Part of 1-07)

D.1. Airport Telecommunications (5-05)
  2. Airport Power Cable Loop Systems (6-05)

Should project consolidations be undesirable, clarifications to project descriptions will be proposed during SEI NAS Plan update efforts.

6.2.3 Recommendations from 4.3 - Additional NAS Plan Project Requirements (1)

We understand that APM has efforts underway to develop recommendations for alleviation of conditions at the NY TRACON and ARTS-III facilities and for System 7 flight data processing equipment replacement at EARTS facilities. We suggest continuation and expansion of these efforts as necessary to include solutions for all affected facilities and to expedite system enhancements via new NAS Plan project definitions.

6.2.4 Recommendations from 4.4 - Operational System Development Plan (1)

An operational system development plan to define standards and procedure development efforts is needed for correlation with NAS F&E and Airport Improvement project activities. Development of such a plan under Air Traffic Service auspices is highly recommended to assure timely availability of needed standards and procedures and to assure early involvement of standards and procedures personnel in NAS modernization activities.

6.2.5 Recommendations from 4.5 - Interface Coordination (1)

We recommend that interface activities be assigned to an interface working group (IWG). This working group should have a basic SES/SEI membership supplemented by representatives of FAA organizations responsible for internal and external interface coordination as appropriate for each interface. For external interfaces, it should be chartered to develop agreements and definitions of required interfaces to schedules consistent with program needs. For internal interfaces, it should oversee, manage, and approve interface definition and specification documents generated by Level I Design activities. It should also schedule, review, and approve detailed ICDs generated internally or by subcontractors. Products of the working group should be approved ICDs for release, control, and distribution under the Configuration Management System.

6.2.6 Recommendations from 4.6 - FAA Technical Center Planning (4)

Mitigation of risks at the FAATC requires a multistep approach:

1) Development of a Test and Integration Plan to define required FAATC tasks and responsibilities for each of the F&E Plan projects. The plan must incorporate realistic schedules which reflect project dependencies and capability milestones. It should define configuration requirements and dependencies on System Support Laboratory and General Support Laboratory resources including any new resource requirements needed. It should also provide estimates of operational loadings on each of the FAATC facilities with planning for mitigation of overload conditions.

2) Development of a resource plan to manage, develop, schedule, allocate, operate, and maintain essential resources. Resource definition must include requirements for personnel, facilities, utilities, communications—voice and data, data processing, simulation, configuration switching, instrumentation, data storage/retrieval, transportation, etc.

3) Development and submittal of budget requirements and implementation plans.

4) Procurement, installation, checkout, and validation of expanded resources and associated operating procedures.

We further recommend that the FAATC be designated lead organization for these critical activities. The basis for FAATC planning should be the NAS Plans for Facilities, Equipment, and Associated Development; Engineering and Development; and Operational System Development; and System Transition. The unavailability of some of these plans should not, however, delay an immediate start on FAATC planning since much productive work can be accomplished with those plans presently available.

6.2.7 Recommendations from 4.7 - System Software Maintenance Planning (1)

1) Development of a system software plan is recommended as a subtier document to the Operational System Development Plan. The software plan should identify needed resource and implementation projects for inclusion in the Operational System Development Plan. Software responsibilities are presently divided between the Air Traffic Service and Program Engineering and Maintenance (within ADL) for operational system software and maintenance system software respectively. New system design concepts, which will merge equipment diagnostics and remote maintenance monitor data acquisition and formatting with operational system programming, will render these former distinctions obsolete. We recommend that a single software development and maintenance organization be established. It should be operationally oriented with strong technical support from system engineering and program engineering.

2) To develop the system software plan we recommend a composite team of Air Traffic, System Engineering, Program Maintenance, and SEI contractor personnel. The software plan should address methods, procedures, required resources, tasks, and management of both software and firmware startup and ongoing maintenance activities. The plan should also define roles and responsibilities of development contractors relative to turn-over procedures, configuration baselining, documentation requirements, etc.

6.2.8 Recommendations from 4.8 - Transition Planning (1)

The lack of an integrated plan which provides guidance for evolution is recognized even at this time. Many planning activities will, of necessity, be limited in scope until an overall plan for phasing of NAS capabilities into the existing system can be marketed. We recommend the development of a program transition plan on a expedited basis.

6.2.9 Recommendations from 4.9 - Acquisition Strategy (7)

When multiple-contract strategy appears to be advantageous after a thorough examination of objectives and factors involved, steps should be taken to assure the availability of sufficient resources to properly manage contract activities, to finalize results into preferred approaches, and to reduce development risks. Specifically, we recommend the following actions:

1) Evaluation of acquisition strategies, particularly for AWOS and VSCS

2) Review and finalization of specifications to establish definitive baseline requirements prior to contract awards. (After award, the competitive environment may be altered, cost proposals may be divergent, and negotiations complicated by differences in design and implementation approaches.)

3) Development and implementation of a management plan to address concerns described in the preceding findings discussion.

4) Dedication of appropriate personnel resources to adequately support management plan implementation.

5) Inclusion in contract conditions of the necessary options to reduce or terminate part, or all, of contract efforts at selected milestone points (PDR, CDR) if design and implementation approaches appear unacceptable or nonproductive.

6) Procurement of production engineering documentation for high production projects to establish options for multiple-source production and to maintain a competitive environment.

7) Consideration of a third-party effort, if necessary, to merge divergent design and/or implementation approaches into a preferred configuration with specifications and design products sufficient for production contracting.

8) Development of a comprehensive run-off criteria document for distribution to contractors and evaluation teams. The criteria should focus on design validity and acceptability, support system requirements and designs, implementation approaches, projected life-cycle costs, and contractor performance. In addition, the criteria should define how run-off assessments will be weighted with respect to production proposal evaluations.

6.2.10 Recommendations from 4.10 - NAS Operations Concept (1)

We recommend that the FAA immediately direct the preparation of a NAS operations concept document to communicate to all personnel involved in the design and development of the NAS and its subsystems the operator/user view and how the various hardware and software portions of the envisioned NAS are expected to operate in the satisfaction of the operations requirements.

6.2.11 Recommendations from 4.11 - Maintenance Concept Development (3)

1) A top-down set of system design requirements need to be developed for the maintenance system desired to be in effect in the 1995 era when the NAS Plan has been accomplished. The maintenance system referred to herein is the set of projects (RMMS, CBI, CRF, MCC, and the logistics elements of the general support projects) that must be integrated with each other and with other NAS Plan projects (telecommunications, etc) to transition into the maintenance system of the 1995 era. The maintenance system design must be structured about and driven by a maintenance concept that must be thoroughly analyzed, evaluated, and defined at the earliest possible date.

2) The maintenance summary information contained in Chapter 6, pages 1 through 3 of the NAS Plan, should be expanded/updated to incorporate a summary of the findings of the maintenance steering group (reference FAA Order 6000.27A). These findings should be used to develop a maintenance concept of the 1990's. Significant issues such as the number of CRFs, structured maintenance, relationship between LIS and MMS, etc, should be worked by an FAA/user/SEI maintenance steering group(s).

3) With the finalization of the maintenance concept definition, the system design requirements should be defined and allocated to the individual projects within the set. Design requirements for each project need to be defined to assure that an integrated maintenance system evolves that is an integral part of the NAS system and supportive of the goals and objectives of the NAS Plan.

6.2.12 Recommendations from 4.12 - Surveillance Programs (1)

To mitigate the potential risk, we recommend an acceleration of the agency-wide effort to coordinate, complete, and approve all National Network Plans now being developed. This will provide a baseline against which currently planned facilities and equipment quantities may be compared so that necessary changes can be effected by the individual projects on a timely basis. Any necessary adjustments to previously computed cost benefit ratios should be made and reflected in the next annual NAS Plan update.

6.2.13 Recommendations from 4.13 - Weather System Integration (1)

A working group should be established to complete the weather system design. This group should address the allocation of functions to weather system elements, the interfaces for each element, the methodology for use of NEXRAD data, weather system architecture issues, processing and display requirements, transition planning, development of a schedule including dependencies, and development of appropriate documentation for the total weather system.

6.2.14 Recommendations from 4.14 - Communication System Integration (5)

1) Communications System Planning - A program plan should be prepared for a total integrated communications system. Include transition and implementation planning in the program plan should be included, or separate transition/implementation plan(s) should be developed. The program plan should include all the projects which comprise the integrated communications system network (VSCS, AAS/LCN, ICSS, TCS, Data Multiplexing, RML, TML, NADIN, and RCE) and should discuss the relationship of the NARACS in an integrated communications system. The NICS program plan should show how the goals stated in the NAS Plan flow down to specific projects and schedules. The NICS program plan will serve as a focus for all communications functions and provide an integrated system approach. Specific objectives of the NICS program plan should be to:

   a) List all communications projects and describe functional relationships and hierarchies and projected communications flows.

   b) Provide an integrated transition and implementation plan that includes each NICS project.

   c) Provide for a communications requirements data base.

   d) Provide for the development of interface control and protocol documents based on standards.

   e) Provide for the development and maintenance of an integrated project schedule.

The projects listed in the above recommendation should be treated as a system in the NAS Plan, Chapter V, and the title of Chapter V changed from "Interfacility Communications System" to "Integrated Communications System" to more properly reflect an integrated approach. The AAS/LAN should be referenced as a communications project in the Integrated Communications System chapter.

2) Flexibility and Growth Potential - A needs analysis should be conducted and should be based on requirements input from all users of the integrated communications system. To aid in delineating user requirements, a communications system user requirements survey form should be developed that identifies all the desired requirements data. The results of the needs analysis should be used to develop a data base for an integrated communications system.

3) Integrated Communications System Design - System level planning and user requirements should be incorporated into a detailed top-down integrated communications system design with a system level specification. The specification should include the details of interface control and protocol document requirements derived from a comprehensive analysis of the connectivity of NAS Plan projects with the integrated communications system. This planning should recognize the current status of the various communications projects and address the means for an efficient integration into a total system. This effort would establish a common set, or family, of interfaces for user access and interconnectivity to the NAS.

4) Integrated Network Schedule - The transfer of the schedule data base from VISION to ARTEMIS should be expedited, and a vertically integrated schedule developed that will include the relationship/interdependence of the communications system projects and other NAS Plan projects.

5) A backup and alternative communications networking policy should be expedited so that the need for Tandem Switching can be determined.

6.2.15 Recommendations from 4.15 - Remote Maintenance Monitoring System Integration (1)

It is recommended that the RMMS system-level requirements, architecture, interface, and implementation planning be fully documented, reviewed, controlled and approved as a priority item. The ongoing RMMS development efforts should continue as good concept definition data are being obtained.

Production procurements for RMMS equipments should be gated to the approval of the system-level documentation identified above. Specific emphasis should be placed on providing RMMS interface information as early as possible to the various NAS subsystems being procured to minimize potential retrofit cost impacts. This system level effort should be the responsibility of AES and the SEI contractor.

6.2.16 Recommendations from 4.16 - Primary Radar Coverage (2)

1) The requirement for en route search radar coverage is specifically stated by Air Traffic. It is felt that there is, potentially, some relief from this on a CONUS-wide basis. This is based on the fact that in high-altitude regions the requirement is a shallow coverage depth and, in fact, radar data may not be used or practical because of clutter. Other regions may have so little traffic that it is not warranted. The recommendation, in part, is to challenge the requirement on a regional basis.

2) Consideration of a measurement on existing radars of the actual coverage that can be obtained in high altitude region at the MEA to FL200. The basis for this is that the radar is a line-of-sight device and the low altitude coverage can be difficult to meet, i.e., there may be regions where the MEA to FL200 requirement cannot, in a practical sense, be met.

6.3 RECOMMENDATIONS FROM SECTION 5.0 - NAS PLAN PROJECT FINDINGS

6.3.1 Summary of En Route Recommendations (31)

6.3.1.1 Recommendations from 5.1.1.1 - En Route Automation Hardware Improvements

None

6.3.1.2 Recommendations from 5.1.1.2 - FDIO (2)

1) Plans for limiting the impact of simultaneous operations during transition should be prepared.

2) Close monitoring for schedule compliance during both the production and installation phases must be maintained because of obvious risk implications.

6.3.1.3 Recommendations from 5.1.1.3 - E-DARC (1)

The schedule adjustment relating to the new E-DARC software functions as they impact the Host Computer project should be ascertained.

6.3.1.4 Recommendations from 5.1.1.4 - EARTS Enhancements

None

6.3.1.5 Recommendations from 5.1.1.5 - ODAPS (2)

1) Expedite the decision relating to the IBM 4341 versus the IBM 4381 as the main processor and provide funding increases as necessary.

2) Perform a technical/operational analysis to verify the planned incorporation of ODAPS into the future AAS.

6.3.1.6 Recommendations from 5.1.1.6 - TMS (2)

1) Ensure close coordination and requirements continuity between the Phase II and Phase III project offices.

2) Combine TMS Phase III with AERA-2/3 into a single project. The new project would become a block upgrade to AAS.

6.3.1.7 Recommendations from 5.1.1.7 - Host Computer (5)

1) Since the Host computer system is an essential first step in meeting the NAS plan goals (capacity and maintainability), it is necessary to assure that the Host computer system is installed and made operational at the 20 sites on schedule. To assure this, detailed planning and coordination are necessary and should include contingency and backup/recovery plans to avoid unnecessary delays. Key aspects are (1) starting the acquisition phase on schedule, (2) assuring the 20 sites are ready to accept the new Host, and (3) meeting the site installation schedules.

2) Reconsider the Host software test philosophy. The current plan indicates that FAATC Host software testing will terminate at the beginning of Site 1 installation. A tradeoff analysis should be performed to determine the benefits and cost/schedule impact of expanding the FAATC test activities to include site specific testing prior to the site specific software delivery and concurrent with site specific hardware installation. (See Figure 6.3-1.) This will allow for additional testing at the FAATC without impacting the site installation schedule and would minimize the number of problems encountered in the field.

3) Particular emphasis should be placed on the capacity margins actually being gained versus the predicted capacity margins. Budgets should be assigned to measurement parameters associated with storage, throughput, and timing. The current performance monitor software should continue to be analyzed to assure its integrity and viability to provide capacity measures. If deficiencies are found, then studies should be performed to determine the cost effectiveness of implementing additional software monitor routines to assure the measurement of data integrity. As a minimum, monthly technical reviews of the capacity margins should be planned. The FAA's Modeling and Simulation Program Element (MSPE) addresses the Host computer in these capacity areas. We recommend that the MSPE activity be expanded to include all components of the Host system. This extension should identify system margin and response times actually delivered and should predict system margin and response times with various enhancements added.

4) Capacity requirements for En Route Metering-II, Conflict Advisory, and Conflict Alert IFR/VFR Mode-C Intruder Software should be baselined and tracked in relation to the Host software development effort.

5) Project schedule for the Host and Host compatibilities among Host, FDIO, and E-DARC should be tracked quarterly to define any changes and to determine appropriate corrective action.

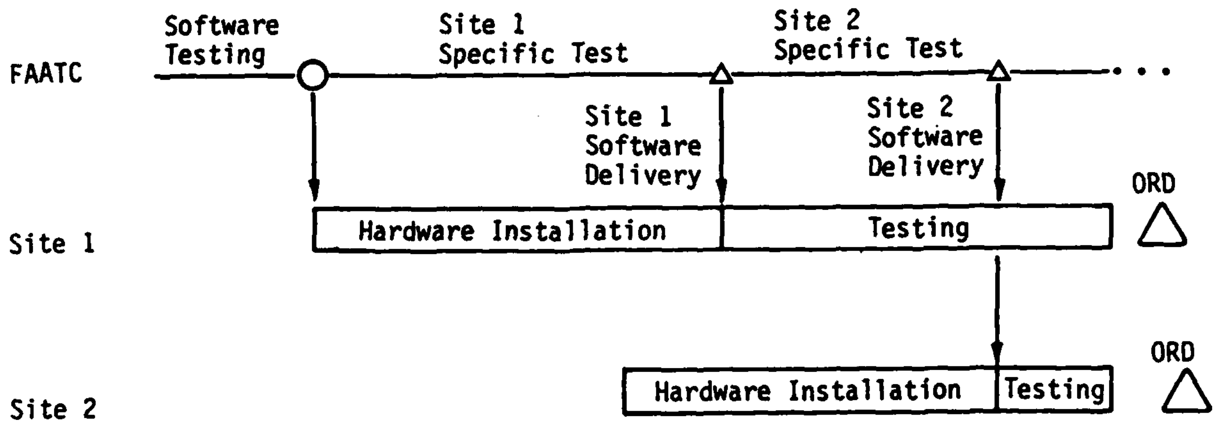


Figure 6.3-1 FAATC Test Activities

6.3.1.8 Recommendations from 5.1.1.8 - En Route Metering-II (1)

Review the requirements of ERM-II in the context of functional capabilities of ERM-IA.

6.3.1.9 Recommendations from 5.1.1.9 - Conflict Resolution Advisory Function (1)

FAA should formulate policy for the use of CRA in IFR/VFR conflicts before the CRA operational evaluation. Existing CRA requirements should then be reviewed for compatibility to facilitate operational evaluation.

6.3.1.10 Recommendations from 5.1.1.10 - Conflict Alert IFR/VFR Mode-C Intruder (1)

Close attention must be given to the algorithm/parameter aspect to assure an operationally acceptable level of false alarms.

6.3.1.11 Recommendations from 5.1.1.11 - Voice Switching and Control System (3)

1) The VSCS Operational Requirements Team effort should be combined with the Sector Suite Requirements Validation Team and the Transition Requirements Validation Team so that a common assessment is made of both the sector suite console and VSCS panel.

2) Select a procurement strategy and contractual vehicle supported by a Prime Item System Development (B-1) specification of requirements.

3) Modify the VSCS procurement strategy to a dual competition phase through CDR and select a single contractor for production phase.

6.3.1.12 Recommendations from 5.1.1.12 - Advanced Automation System (5)

1) Continue the AAS working group activities beyond the NAS Level 1 Design baselining. The charter should be expanded and be the single focal point for AAS external interfaces to other projects as well as NAS design activities (Levels II, III, IV, and standards). This should also include participation of AAS working group members on other parallel working groups such as Weather, TMS, etc.

2) Establish a single operational team which supports both the Sector Suite and the VSCS panel design/development activities. This team should consist of some mix of the current SSRVT and VSCS ORT. The team's involvement in both procurements should include, as a minimum, the establishment of specific man-machine interface requirements/guidelines, monitoring of contractor design documentation, attendance at appropriate technical reviews, and involvement in tests/evaluations of mockups and prototype equipment.

3) Provide a change summary package (with Change #8) to the DCP contractors that provides more detail on change rationale and interpretation of new/changed requirements. This document should decrease RFA traffic and help reduce the schedule risk associated with completion of SRR.

4) Analyze the new VSCS schedule for compatibility with the AAS schedule. In particular, potential impact to the "ISSS evaluation at FAATC" span time should be assessed in view of dual VSCS evaluations.

5) Perform contingency planning as a part of the ACF project to supplement the effort by the AAS DCP competitors in looking at the impact of the possible eventuality of TRACONs not being consolidated into the ACF.

6.3.1.13 Recommendations from 5.1.1.13 - AERA (4)

1) AT has recently issued an order for ACRA 1 requirements. The FAA is now preparing an AERA 1 specification update to reflect the order. After the update has been coordinated and accepted by the AAS CCB, the AAS contract will be modified. Consequently, all MITRE effort associated with the development and testing of AERA 1 can be terminated.

2) Effort should be initiated immediately to develop a strawman A specification of the AERA 2 functions.

3) A multidisciplined team representing all applicable organizations should be formed (similar to the existing Sector Suite Requirements Validation Team) with the charter to establish and document the development, procurement, and implementation strategy of AERA 2/3 (i.e., produce a program plan).

4) The selected acquisition phase AAS contractor should be required to accommodate an interface with AERA 2/3 functions to help simplify the eventual integration of AERA 2/3 into AAS.

6.3.1.14 Recommendations from 5.1.1.14 - Integration of Nonradar Approach Control into Radar Facilities

None

6.3.1.15 Recommendations from 5.1.1.15 - Area Control Facilities (ACF) (4)

1) An ACF program team, including a permanent ACF program manager, should be put in place as rapidly as possible.

2) An improved interface between the ACF Implementation Plan and the NAS design and implementation cycle must be established.

3) A more comprehensive ACF development and implementation master schedule and supporting project schedules suitable for use by the ACF program manager as baselines for managing and achieving the objectives of the ACF implementation program must be established.

4) An independent, detailed audit of the ACF project implementation plan should be undertaken along the lines of the NAS Level I Design Audit, including a reassessment of the Honolulu and Anchorage ARTCCs and the New York TRACON to determine their operational capacities through full ACF implementation.

6.3.2 Summary of Terminal System Recommendations (24)

<u>6.3.2.1 Recommendations from 5.1.2.1 - ARTS-III Enhanced Terminal Conflict Alert (1)</u>

Detailed planning between APM and the ATS needs to be completed at the earliest possible time with reference to the installation/deployment portion of this project.

<u>6.3.2.2 Recommendations from 5.1.2.2 - ARTS-III Assembler</u>

None

<u>6.3.2.3 Recommendations from 5.1.2.3 - ETG Display (ARTS-III) (3)</u>

1) Since this is a new competition, the procurement process should be monitored for cost and schedule performance, particularly if the decision is made to use D-BRITE displays.

2) The decision to proceed with either the FDAD or D-BRITE systems must be made soon to preclude schedule slippage.

3) Integration of the two programs (2-03 and 2-16) should be considered if the decision is in favor of D-BRITE.

6.3.2.4 Recommendations from 5.1.2.4 - Additional ARTS-IIIA Memory (1)

An analysis concerning terminal automation system upgrades should be undertaken.

6.3.2.5 Recommendations from 5.1.2.5 - Additional ARTS-IIIA Support System at the FAATC

None

6.3.2.6 Recommendations from 5.1.2.6 - ARTS-IIA Enhancements (1)

The testing program should be closely monitored so that potential processor capacity and cost/schedule impacts are immediately identified and corrective action initiated.

6.3.2.7 Recommendations from 5.1.2.7 - ARTS-II Displays

None

6.3.2.8 Recommendations from 5.1.2.8 - ARTS-II Interfacility Interface

None

6.3.2.9 Recommendations from 5.1.2.9 - ARTS-II Interface with Mode-S/ASR-9 (5)

1) The FAA-SEI team needs to track the technical adequacy and completeness of each Mode-S/ASR-7/8/9 ICD. This should commence with tracking Mode-S/ASR-9 interface details that are forthcoming from APM.

2) Software development should be tracked as an area of concern from an initial development, field implementation, and system integration viewpoint.

3) The FAA-SEI team needs to track the Mode-S schedule as a key dependency and also to track ASR-9, ASR-7/8 and ARTS-II schedules.

4) A detailed review of the cost aspect is required.

5) The methodology recommended for accomplishment of these recommendations is the formation of a ICD working group. This project should be scrutinized as part of a general effort to look at "control of NAS project interfaces." An ICD working group could provide a major portion of this scrutiny as well as establishing a vehicle for disciplined configuration control for each interface.

6.3.2.10 Recommendations from 5.1.2.10 - ATIS (1)

The effect of a combined ATIS/HIWAS procurement should be reviewed for impact on unit costs and schedules.

6.3.2.11 Recommendations from 5.1.2.11 - Multichannel Voice Recorders (3)

1) The quantities of ATCT/FSS recorders to be procured and procurement cost estimates should be made consistent.

2) The NAS Plan should be revised to reflect a realistic schedule for ARTCC/ACF recorder procurement on a projected availability data of June 1986 for the specification.

3) The FAA should solicit advice from potential suppliers during the preparation of the specification.

6.3.2.12 Recommendations from 5.1.2.12 - TCS (1)

The TCS technical requirement and associated schedules and cost aspects should be evaluated in the future in the context of the VSCS program development.

6.3.2.13 Recommendations from 5.1.2.13 - ATCT/TRACON Establishment, Replacement, and Modernization (1)

A reassessment of the scope and schedule aspects of this project should be performed in the context of the modernization/relocation policy and handbook.

6.3.2.14 Recommendations from 5.1.2.14 - VFR ATCT Closures (2)

1) Consideration should be given to removing this project from the NAS Plan. Any future opportunities for tower closures could be addressed on a case-by-case basis as they meet criteria and are identified by the regions.

2) The benefits attributed to the freeing-up of some 200 Air Traffic Service positions should be reassessed in view of the current direction of this project.

6.3.2.15 Recommendations from 5.1.2.15 - Combine Radar Approach Control into ARTCC (1)

This project should be reviewed carefully to determine whether future TRACON/ARTCC consolidations are likely to occur prior to implementation of the ACF concept. If such consolidations are not likely, it is recommended that this project be dropped from future editions of the NAS Plan.

6.3.2.16 Recommendations from 5.1.2.16 - BRITE (3)

1) Program should be monitored to define and minimize impact of schedule slippage.

2) The implementation (site activation) sequence should be reexamined to provide for first deliveries to those sites not having radar display capability today to improve ATC system safety and efficiency at these locations.

3) The decision (FDAD or D-BRITE system) in the ARTS-III ETG project (2-03) should be monitored so that those requirements could be integrated into this project if the decision is to go with the D-BRITE system.

6.2.3.17 Recommendations from 5.1.2.17 - TPX-42 Replacement (1)

The quantity required must be changed and the requested budget must be obtained.

6.3.3 Summary of Flight Service System Recommendations (25)

6.3.3.1 Recommendations from 5.1.3.1 - FSAS (5)

1) Continue to monitor Model 1 system testing for indications of the contractor's ability to perform prior to rescinding the Model 2 stop work order.

2) Complete the planning for and assure that the scheduled Tandem Computer timing/sizing risk analysis for Model 1 and Model 2 is accomplished; also, take into consideration the results of the contractor's Model 1 performance tests.

3) Establish an FAA resident team at E-Systems and implement improved schedule, earned-value, and technical performance monitors into the modified Model 2 contract.

4) Continue planning for the early implementation of Model 2 enhancements.

5) Assure required ICDs are promptly identified and implemented early in Model 2 design cycle.

6.3.3.2 Recommendations from 5.1.3.2 - CWP (3)

1) Continue the support to the NAS Level I Design Weather working group in defining and coordinating the weather program interfaces.

2) Reconcile the three independent software sizing estimates (e.g., MITRE, JPL, and SEI) and reconcile them to support a project planning baseline.

3) Emphasize the development of processes and software to be used in conjunction with weather radar mosaiking.

6.3.3.3 Recommendations from 5.1.3.3 - CNS (2)

1) Develop a plan to complete the domestic CNS implementation.

2) Perform a detailed review of all APM CNS program interfaces.

3) Prepare a formal transition plan for CNS relocation.

4) Add CNS processor relocation to the NAS Plan.

6.3.3.4 Recommendations from 5.1.3.4 - WMSC-R (2)

WMSC-R interface planning and documentation requirements pertaining to other NAS Plan projects must be resolved prior to SRR.

6.3.3.5 Recommendations from 5.1.3.5 - WCP (1)

It is recommended that further planning efforts be delayed, subject to the working group recommendations for WCP functional requirements.

6.3.3.6 Recommendations from 5.1.3.6 - IVRS (1)

IVRS funding and operations schedule should be carefully reviewed to ensure that it is not terminated prematurely.

6.3.3.7 Recommendations from 5.1.3.7 - High Altitude EFAS Frequencies (1)

The nationwide frequency allocation study should be expedited and the schedules reviewed to reflect the anticipated study completion date. As soon as the results of the study are available, the project cost should be reviewed to ensure that they accommodate the required number of outlets.

6.3.3.8 Recommendations from 5.1.3.8 - HIWAS (2)

1) Controls should be implemented to ensure that the current testing program is completed in a timely manner to preclude further project slippage and to take advantage of any feasible economies to be gained through a combined equipment buy with the ATIS project.

2) Available funding should be reviewed to ensure that the fiscal year slippage has not affected spending authorization.

6.3.3.9 Recommendations from 5.1.3.9 - AWOS (4)

1) The NAS Plan should be updated to accommodate/clarify the selected acquisition strategy and schedule the number of systems to be deployed and the related projects/activities.

2) The planned acquisition of two different AWOS designs and the required duplicate logistics support should be reconsidered. The FAA should procure the AWOS design and engineering data and require both production contractors to produce and install equipment to identical design and engineering data.

3) The FAA should accomplish a cost-benefits analysis for towered airports to serve as the basis for selecting towered airports to receive AWOS and provide the same level of justification as developed for untowered airports.

4) The strategy for locating and selecting the appropriate radio transmitter for distribution of AWOS information to pilots should first include a site specific survey. Some guidelines for selecting the strategy are as follows:

a) Primary distribution through VHF discrete transmitter.

b) Secondary distribution through the VOR serving the airport as the primary approach aid. The TVOR is preferred because it is collocated at the airport. VORs greater than approximately 10 nm from the AWOS airport should be eliminated from selection because of decreasing signal strength.

c) Clustering of AWOS data from more than one airport should primarily be transmitted over a centrally located VHF discrete transmitter and secondarily over a VOR. For safety and time constraints a maximum of two AWOS stations transmitting data from one facility is recommended.

d) AWOS voice over the NDB should not be considered because of FCC restrictions on low frequency voice bandwidth and on voice transmissions on NDBs.

6.3.3.10 Recommendations from 5.1.3.10 - RRWDS (1)

The FAA should investigate the potential to upgrade the flexibility of the RRWDS to be more useful at the workstation.

6.3.3.11 Recommendations from 5.1.3.11 - GOES (1)

The FAA should perform a trade study to compare costs and data quality of alternative approaches to improve antennas/receivers at each GOES recorder site.

6.3.3.12 Recommendations from 5.1.3.12 - Wind Shear Efforts

None

6.3.3.13 Recommendations from 5.1.3.13 - ICSS (1)

The contracting arrangement, through DECCO, for this leased service--within the context of a Program Plan that places the bulk of site integration, TELCO coordination, and cutover responsibility on the Regions--is a major contributing factor in the problems cited above. It is recommended that the FAA Headquarters assume an expanded role in the ICSS project by providing more centralized coordination for project implementation and configuration management.

6.3.4 Summary of Air/Ground Communications System Recommendations (32)

6.3.4.1 Recommendations from 5.2.1 - Air/Ground (A/G) Communications

None

6.3.4.2 Recommendations from 5.2.2 - Communications Facilities Consolidation (2)

1) The number of locations required for 2000-foot coverage developed by the networking study has more validity than the 1118 planning figure used in the NAS Plan. This number (2165) should be used to recompute the costs and benefits to be achieved through the consolidation of facilities.

2) The specific isolation devices and installation techniques required to achieve satisfactory channel quality have not been identified. These devices should be identified and demonstrated at the FAA Technical Center (FAATC) to provide installation standards for consolidated facilities. This project should include evaluation of dielectric antenna structures.

6.3.4.3 Recommendations from 5.2.3 - VORTAC (1)

RMM development should be monitored to ensure that an appropriate interface with VORTAC is established.

6.3.4.4 Recommendations from 5.2.4 - Nondirectional Beacon (3)

1) Perform frequency interference studies to validate need for additional NDB frequencies and subsequent bandwidth changes.

2) Resolve the quantity disagreement between the NAS Plan and current NDB site listing.

3) Continue monitoring closely RMM development so that appropriate interface equipment can be provided to retrofit the existing NDBs. (All the NDBs have RMM capabilities incorporated.)

6.3.4.5 Recommendations from 5.2.5 - Supplemental Navigation System Monitors (3)

1) Perform an analysis to determine the operational requirements for GPS monitoring and verify/modify the currently planned monitoring system design as needed to meet the operational requirements.

2) Perform a similar analysis/design for Loran-C and Omega VLF.

3) Define RMM requirements in the monitor for each type of system.

6.3.4.6 Recommendations from 5.2.6 - Instrument Landing System (2)

1) Update the NAS Plan to reflect quantities of ILS actually provided to date and presently planned for.

2) Finalize ILS/MLS networking plans to determine additional ILS required.

6.3.4.7 Recommendations from 5.2.7 - Microwave Landing System (2)

1) Monitor progress of frangibility designs through analysis and testing to support the extension of the frangibility concept to MLS equipment.

2) Develop program controls to assure schedules and resource allocations.

6.3.4.8 Recommendations from 5.2.8 - Runway Visual Range (2)

1) The cost/technical advantages of combining AWOS and RVR at airports which are scheduled to receive both systems should be evaluated, especially for those airports which do not require Category B systems. The visual range sensor technology being considered for AWOS should be evaluated to determine if it is capable of meeting category IIIB requirements.

2) The RVR Program milestones may require rescheduling due to delay in release of the Request for Proposal. The comparative cost of retaining old technology RVR systems (which do not have an RMM interface and retain the high maintenance cost sensors) versus replacing all RVRs with a new technology should be evaluated.

6.3.4.9 Recommendations from 5.2.9 - Visual NAVAIDs - None.

6.3.4.10 Recommendations from 5.2.10 - Approach Lighting Improvement Program

None

6.3.4.11 Recommendations from 5.2.11 - Direction Finder (5)

1) Establish a study program to evaluate the technical and operational impact, if any, of the planned collocations with other navigation and communications facilities.

2) Revise NAS Plan schedule to reflect impact of 3-month slippage in approval process.

3) Finalize DF network plan to determine quantities for the planned procurement.

4) Finalize cost data after quantities are determined.

5) Coordinate the DF program, which provides an interface for the FSAS, with the FSAS design.

6.3.4.12 Recommendations from 5.2.12 - Mode-S/Data Link (2)

1) Increased management emphasis is recommended to ensure the timely development of data link uses and services so that full benefits of the system, as stated in the NAS Plan, will be realized.

2) A structured ICD process should be established with each interfacing project.

6.3.4.13 Recommendations from 5.2.13 - Terminal Radar (ASR) Program (2)

1) The ASR-9 design has anticipated interface requirements with other NAS Plan projects. It is recommended that these external interfaces be reviewed and formal interface control be established. Since ASR-9 CDR is imminent (9/84), interface issues must be resolved quickly to avoid cost and schedule impact to the ASR-9 program.

2) Similar interface control should be established for the leapfrog program.

6.3.4.14 Recommendations from 5.2.14 - Airport Surface Detection Equipment (ASDE-3) Radar (1)

The NAS Plan project description should be updated to reflect the requirement for some dual ASDE-3 installations and the currently planned number of system installations.

6.3.4.15 Recommendations from 5.2.15 - Long Range Radar Program (3)

1) The NAS Plan should be updated to remove references to the ASR-9 as a gap filler.

2) Priority should be given to finalizing the national surveillance network study to determine the impact on the LRR program. If the results of the study indicate additional LRR are needed, the coverage requirements should be analyzed for possible adjustment on an area-by-area basis with the goal of reducing the number of radars necessary, consistent with flight safety.

3) The FAA should promptly establish the 3-D radar program office and finalize the joint procurement agreement with the Air Force. Following these actions, close coordination between the FAA program office and the Air Force will be required to ensure a timely procurement of 3-D radars.

6.3.4.16 Recommendations from 5.2.16 - Weather Radar Program (4)

1) An adequate working relationship between FAA, DOC and DOD should be ensured and development of NEXRAD should be continued.

2) NEXRAD's operational use in the Air Traffic Control System should be defined and developed.

3) The NAS Plan should be updated to reflect the change from 11 to 13 non-CONUS NEXRADs.

4) Weather algorithms should be fully defined.

6.3.5 Summary of Interfacility Communications Systems Recommendations (11)

6.3.5.1 Recommendations from 5.3.1 - RML Trunking

None

6.3.5.2 Recommendations from 5.3.2 - Data Multiplexing (1)

The Data Multiplexing project should continue as scheduled. It should continue to meet and exceed its original objectives. As computer tools and models become available from BDM Corporation to the SEIC, multiplex systems engineering should be used to attempt to derive even greater cost savings and operational benefits.

6.3.5.3 Recommendations from 5.3.3 - RML Replacement and Expansion

None

6.3.5.4 Recommendations from 5.3.4 - Television Microwave Link (2)

1) The current FAA philosophy is aiming toward an integrated nationwide system, making maximum use of FAA-owned microwave transmission links. This is being accomplished under the RML Replacement and Expansion project. It is suggested that TML project be integrated into the RML Replacement and Expansion project and use the same standards, specifications, and procurement. The RML project already requires transmission of a wideband analog circuit such as the BRITE television signal. In this manner, equipment standardization will be obtained, and the TML can act as local extensions of the RML carrying common user circuits that are currently leased wherever it is cost effective.

2) Analyses/tests should be performed to assure that TML will support the BRITE display requirements. Requirement should be verified/modified based on the results of these analyses/tests.

6.3.5.5 Recommendations from 5.3.5 - Airport Telecommunications

None

6.3.5.6 Recommendations from 5.3.6 - National Data Interchange Network (NADIN) 1A (3)

1) Determine system capacity, interfaces, and features necessary to support new or changed user requirement in the 1985-1988 timeframe. This effort should also address the issue of which users, and when, will transition to X.25 Packet Mode on X.25 PAD service, and which users will be handled by store-and-forward service.

2) Determine the proper roles and requirements for network management and resource management for NADIN. Develop a plan to provide such support by FAA organizational responsibility or by subcontracting.

3) Update NAS Plan to agree with schedule in the smart sheets.

6.3.5.7 Recommendations from 5.3.7 - National Data Interchange Network (NADIN) 2 (2)

1) A network integration effort needs to be added to the program schedule.

2) An activity needs to be identified to do NADIN 2 transition planning prior to network implementation. This activity will identify when and how network users will be serviced by NADIN 2, and what users not serviced by NADIN 1A are to be included.

6.3.5.8 Recommendations from 5.3.8 - Radio Control Equipment (3)

1) The quantity discrepancies between NAS Plan, the smart sheets, and the RCE Specification should be resolved.

2) The RCE specification defines both physical and functional partitioning of the equipment, which must be followed by the developer to be responsive to the specification. This level of detail should be reevaluated to determine if it unduly restrains the developer or increases the uncertainty of cost or schedule performance by the contractor.

3) The contract should include development of special module-to-module interface controls for the design and test of the RCE, as well as more-frequent-than-usual contract progress milestones and FAA reviews.

6.3.5.9 Recomendations from 5.3.9 - Model 28 Teletypewriter Replacement

None

6.3.6 Summary of M&O System Support Recommendations (29)

6.3.6.1 Recommendations from 5.4.1 - Remote Maintenance Monitoring Systems (RMMS) (7)

1) The FAA should augment present project management authority by establishing a charter for the program manager that would provide him with the direction and latitude to tie all facets of the overall RMM program together.

2) An in-depth systems requirements analysis should be undertaken to define the program needs and compare the results to the NAS-MD-792, "RMMS Operational Requirements."

3) A Systems Requirements Review (SRR) and/or a Systems Baseline Review (SBR) should be held subsequent to the requirement definition. These reviews should address both the Transition (Phase II) and Final (Phase III) Systems.

4) An end-to-end procurement strategy for the RMMS final system should be prepared and a Program Implementation Plan written. Effect on the Transition Phase of such final system strategy should be examined.

5) An in-depth telecommunications study should be undertaken to identify data flow needs and technical and programmatic requirements for the communications system.

6) Further study on the Tandem Computer's current and growth capability to meet the requirements of the final system is required.

7) Interface controls need to be implemented. Formal ICDs and ICD working groups should be established. Monitoring philosophy and guidance should be prepared for all program managers of equipment to be monitored.

6.3.6.2 Recommendations from 5.4.2 - CBI (2)

1) CBI training should be expanded and used to the extent possible. This is for existing systems within the FAA as well as new systems that are contractor maintained.

2) Existing equipment should be updated to take advantage of FAA-owned links on a cost versus benefit basis.

6.3.6.3 Recommendations from 5.4.3 - CRF (1)

A formal review team should be established to perform a systems requirements analysis and define those requirements necessary for a viable CRF program. The review areas would include determination and resolution contract versus FAA maintenance issues, determination of appropriate number of CRFs, and investigation of calibration laboratories and their disposition.

6.3.6.4 Recommendations from 5.4.4 - MCC (1)

The results of the Fredericksburg maintenance conference to define system maintenance requirements to support the goals of the NAS Plan, especially as they pertain to the role of the MCC should be evaluated. Results of other current engineering studies and the SEI/FAA maintenance role definition should be merged with the Fredericksburg maintenance conference results.

6.3.6.5 Recommendations from 5.4.5 - Airport Power Cable Loop Systems (1)

The candidate airports should be analyzed in more depth and the number of systems recommended on the basis of need and cost/benefit in lieu of current basis of available funding.

6.3.6.6 Recommendations from 5.4.6 - Power Conditioning Systems for ARTS-III (2)

1) Identify facility modifications to mechanical and electrical systems required to support this program.

2) Revise schedule to reflect delay in equipment procurement and lengthened installation period.

6.3.6.7 Recommendations from 5.4.7 - Power Systems (1)

Compression of the installation and upgrading schedule should be considered to replace some obsolete equipment sooner.

6.3.6.8 Recommendations from 5.4.8 - Unmanned Airway Facilities Buildings and Plant Equipment

None

6.3.6.9 Recommendations from 5.4.9 - ARTCC Plant Modernization

None

6.3.6.10 Recommendations from 5.4.10 - Acquisition of Flight Service Facilities

None

6.3.6.11 Recommendations from 5.4.11 - Aircraft Fleet Conversion

None

6.3.6.12 Recommendations from 5.4.12 - Aircraft and Related Equipment (1)

Senior FAA management should aggressively pursue convening the TSARC to preclude further schedule delays and attendant loss of revenues.

6.3.6.13 Recommendations from 5.4.13 - SEI Contract (2)

1) Review and adjust, as necessary, SEI contractual schedule to NAS Plan schedules.

2) Review major system milestones in light of project procurement activities and propose changes as necessary.

6.3.6.14 Recommendations from 5.4.14 - NARACS

None

6.3.6.15 Recommendations from 5.4.15 - NAS Spectrum Engineering (2)

1) A determination should be made on whether there is a need to use ELA services in providing coverage charts and, if affirmative, submit cost estimates for funding.

2) FAA management should consider budgeting for additional people to assist in implementing NAS Plan (Level IV Design/siting of equipments) specifically as required for spectrum changes and/or analyses of spectrum compatibility.

6.3.6.16 Recommendations from 5.4.16 - General Support (1)

The LIS design should be reviewed to ensure that no unnecessary duplication of data bases is contained in the MMS.

6.3.6.17 Recommendations from 5.4.17 - System Support Laboratory (5)

1) Detail requirements must be defined in Level III Design and preliminary requirements that identify long-lead items that must be procured early.

2) Project updates and changes should be assessed for potential FAA Technical Center requirements and transmitted to ACT as soon as possible.

3) Projects selected for the SSL test bed will be determined by system complexity, interfaces, etc., and will be determined on a case-by-case basis. Those projects so selected should be directed to schedule their first prototype/production article into the SSL test bed for full development and system integration testing. Exceptions may be necessary, but only when precoordinated and approved by the NAS program director (ADL-2). If currently contracted projects are not complying with these objectives/goals, units must be scheduled into the test beds as early as possible to increase the fidelity of the test bed for future system testing and troubleshooting of field-related problems.

4) The "Strategic Plan for FAA Technical Center Facilities" needs to be expanded in scope to specify development of a FAATC/SSL specification/documentation tree in support of NAS Plan implementation.

5) Development of a test and integration plan to define required FAATC tasks, roles and responsibilities, and responsibilities for each of the F&E Plan projects.

6.3.6.18 Recommendations from 5.4.18 - General Support Laboratory (3)

1) Detail requirements must be defined in Level III Design and preliminary requirements that identify long-lead items that must be procured early.

2) Authority to acquire long-lead items must be provided.

3) Project updates and changes should be assessed for potential FAA Technical Center requirements and transmitted to ACT as soon as possible.

ABBREVIATIONS AND ACRONYMS

A/C	Air Conditioning
A/G	Air to Ground
AAP	Advanced Automation Program
AAS	Advanced Automation System
ACCC	Area Control Computer Complex
ACF	Area Control Facility
AERA	Automated En Route Air Traffic Control
AF	Airway Facilities; Air Force
AFSS	Automated Flight Service Station
AFTN	Aeronautical Fixed Telecommunications Network
AIF	Airport Improvement Fund
ALPA	Airline Pilots Association
ALSF	High Intensity Approach Lighting System with Sequenced Flashers
ALSIP	Approach Lighting System Implementation Program
AOPA	Aircraft Owners and Pilots Association
AP	Acquisition Phase
ARF	Airport Reservation Function
ARSR	Air Route Surveillance Radar
ARTCC	Air Route Traffic Control Center
ARTS	Automated Radar Terminal System (ARTS-II, ARTS-III)
ASAR	Automatic Storage and Retrieval System
ASDE	Airport Surface Detection Equipment
ASR	Airport Surveillance Radar
AT	Air Traffic
ATC	Air Traffic Control
ATCRBS	Air Traffic Control Radar Beacon System
ATCT	Air Traffic Control Tower
ATIS	Automatic Terminal Information Service
ATS	Air Traffic Service
AUSDS	Automated Utilization Screening and Disposal System
AWOS	Automatic Weather Observing/Reporting System
AWP	Aviation Weather Processor

BAN	Beacon Alphanumerics
BASOPS	Base Operations (Flight)
BDAS	Beacon Data Acquisition System
BOE	Basis of Estimate
BRITE	Bright Radar Indicator Tower Equipment
C	Completion
CA	Conflict Alert
CAB	Civil Aeronautics Board
CARF	Central Altitude Reservation Facility
CBI	Computer-Based Instruction
CCB	Configuration Control Board
CD	Common Digitizer
CDC	Computer Display Channel
CDR	Critical Design Review
CDRL	Contract Data Requirements List
CERAP	Combined Center/Radar Approach Control
CFCF	Central Flow Control Facility (Function)
CFWP	Central Flow Weather Processor
CFWSU	Central Flow Weather Service Unit
CNS	Consolidated NOTAM System
CONUS	Contiguous (Conterminous) United States
CRA	Conflict Resolution Advisory
CRF	Central Repair Facility
CRT	Cathode-Ray Tube
CSC	Computer Science Corporation
CWP	Center Weather Processor
CWS	Central Weather Service
CWSU	Center Weather Service Unit
CY	Calendar Year
DARC	Direct Access Radar Channel
DCP	Design Competition Phase
DECCO	Defense Commercial Communications Ordering Office

DF	Direction Finder
DME	Distance Measuring Equipment
DMSA	Designated Major System Acquisition
DOC	Department of Defense
DOD	Department of Defense
DUAT	Direct User Access Terminal
DVOR	Doppler Very-High Frequency Omnidirectional Range
E&D	Engineering and Development
E-DARC	Enhanced-Direct Access Radar Channel
EARTS	En Route Automated Radar Tracking System
ECAC	Electromagnetic Compatibility Analysis Center
EDCT	Estimated Departure Clearance Time
EFAS	En Route Flight Advisory Service
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
ERM	En Route Metering
ERM-Ia	En Route Metering-Ia
ERM-II	En Route Metering-II
ETG	Enhanced Target Generator
F&E	Facilities and Equipment
FAA	Federal Aviation Administration
FAATC	FAA Technical Center
fac	Facility
FAX	Facsimile
FDAD	Full Digital ARTS-III Display
FDEP	Flight Data Entry and Printout
FDIO	Flight Data Input/Output
FSAS	Flight Service Automation System
FSDPS	Flight Service Data Processing System
FSP	Flight Strip Printer
FSS	Flight Service Station
FY	Fiscal Year

G/A	Ground to Air
GFE	Government-Furnished Equipment
GMT	Greenwich Mean Time
GNAS	General National Airspace System
GOES	Geostationary Operational Environmental Satellite
GPS	Global Positioning System
GSA	General Services Administration
GSL	General Support Laboratory
HCS	Host Computer System
HCVR	High Capacity Voice Recorder
HF	High Frequency
HIWAS	Hazardous Inflight Weather Advisory Service
Host	Air Traffic Control Host Computer
HVAC	Heating, Ventilating, and Air Conditioning
ICD	Interface Control Document
ICSS	Integrated Communications Switching System
IDAT	Interfacility Data
IFB	Invitation for Bid
IFR	Instrument Flight Rules
ILS	Instrument Landing System; Integrated Logistics Support
IOCS	Input-Output Computer Systems
ISSS	Initial Sector Suite System
IVRS	Interim Voice Response System
JAWS	Joint Aviation Weather Studies
JPL	Jet Propulsion Lab
JSS	Joint Surveillance System
LCN	Local Communication Network
LIS	Logistics Inventory System
LLWAS	Low Level Wind Shear Alert System
LORAN	Long-Range Navigation (System)

LRI	Line Replaceable Item
LRR	Long-Range Radar
LRU	Line Replaceable Unit
M&O	Maintenance and Operations
MALSR	Medium Intensity Approach Lighting System with Runway Alignment Indicator Lights
MCC	Management Control Center
MCS	Maintenance and Control Software
MCVR	Multichannel Voice Recorder
MEA	Maintenance Engineering Analysis
MLS	Microwave Landing Systems
MMC	Maintenance Monitor Control
MMS	Maintenance Management System
Mode-C	Altitude Reporting Mode of Secondary Radar
Mode-S	Discretely Addressable Secondary Radar System with Data Link
MPS	Maintenance Processor Subsystem
MSAW	Minimum Safe Altitude Warning
MSL	Mean Sea Level
MSPE	Modeling and Simulation Program Element
MTBF	Mean Time between Failure
MTD	Moving Target Detection
MTI	Moving Target Indicator
NADIN	National Data Interchange Network
NARACS	National Radio Communications System
NAS	National Airspace System
NAVAID	Navigation Aid
NDB	Nondirectional Beacon
NEXRAD	Next Generation Weather Radar
NICS	National Interfacility Communications System
NOTAM	Notice to Airmen
NSDD	National Security Decision Directives

NTIA	National Telecommunications Information Agency
NTSB	National Transportation Safety Board
NWS	National Weather Service
O&M	Operations and Maintenance
ODALS	Omnidirectional Airport Lighting System
ODAPS	Oceanic Display and Planning System
OMB	Office of Management and Budget
OMEGA	VLF Navigation System
ORD	Operational Readiness Demonstration
ORT	Operational Requirements Team
OSHA	Occupational Safety and Health Administration
PAM	Peripheral Adaptor Module
PAPI	Precision Approach Path Indicator
PCS	Power Conditioning System
PD	Program Directive; Presidential Directive
PDR	Preliminary Design Review
PMMS	Project Materiel Management System
PPI	Plan Position Indicator
PPIMS	Personal Property In-Use Management System
PVD	Plan View Display
R&D	Research and Development
R&M	Reliability and Maintainability
RANK	Replacement Alphanumeric Keyboards
RCAG	Remote Communications Air/Ground Facility
RCE	Remote Control Equipment; Radio Control Equipment
RCIU	Remote Control Interface Units
RCO	Remote Communications Outlet
RDCC	Research Development Computer Complex
REIL	Runway End Identification Lights
RF	Radio Frequency

RFA	Request for Action
RFI	Radio Frequency Interference
RFSP	Replacement Flight Strip Printers
RMA	Reliability, Maintainability, and Availability
RML	Radar Microwave Link
RMM	Remote Maintenance Monitoring
RMMS	RMM System
RRWDS	Radar Remote Weather Display System
RTCA	Radio Technical Commission for Aeronautics
RTR	Remote Transmitter/Receiver
RVR	Runway Visual Range
RVV	Runway Visibility Value
S	Start
SB/SDB	Small Business/Small Disadvantaged Business
SBA	Small Business Administration
SBR	Systems Baseline Review
SCIP	Surveillance and Communication Interface Process
SEI	System Engineering and Integration
SEIC	System Engineering and Integration Contractor
SIAP	Standard Instrument Approach Procedure
SOW	Statement of Work
SRR	System Requirements Review
SSALF	Simplified Short Approach Lighting System with Sequenced Flashers
SSALR	Simplified Short Approach Lighting System with Runway Alignment Lights
SSALS	Simplified Short Approach Lighting System
SSB	Single Sideband
SSCC	System Support Computer Complex
SSL	System Support Laboratory
SSRVT	Sector Suite Requirements Validation Team
T&E	Test and Evaluation
TACAN	Tactical Air Navigation Facility

TBD	To Be Determined
TCAS	Threat Collision Avoidance System
TCCC	Tower Cab Computer Complex
TCS	Tower Communications System
TELCO	Telephone Company
TIC	Test Integration Command and Control Complex
TML	Television Microwave Link
TMS	Traffic Management System
TMU	Traffic Management Unit
TPL	Transportation Procurement List
TPX-42	Radar Beacon Decoder
TRACAB	Terminal Radar Approach Control in Tower Cab
TRACON	Terminal Radar Approach Control Facility
TRVT	Transition Requirements Validation Team
TSARC	Transportation Systems Acquisition Review Council
TSC	DOT Transportation Systems Center
TSSF	Terminal System Support Facility
TTG	Training Target Generator
TTY	Teletypewriter
TVOR	Terminal VOR
TWEB	Transcribed Weather Broadcast
twr	Tower
VASI	Visual Approach Slope Indicator
VFR	Visual Flight Rules
VHF	Very-High Frequency
VLF	Very-Low Frequency
VOR	VHF Omnidirectional Radio Range
VORTAC	Collocated VOR and TACAN Facility
VOT	VOR Test Signal
VRS	Voice Response System
VSCS	Voice Switching and Control System
WCP	Weather Communications Processor
WMSC	Weather Message Switching Center
WMSC-R	Weather Message Switching Center-Replacement
WRP	Weather Radar Program

NOTE: The schedules as shown on the attached figure were extracted directly from the April 1984 NAS Plan for Facilities, Equipment, and Associated Development, and are not intended to represent the current available schedule information.

Figure 3.2-1 NAS Plan Programmatic Capabilities and Dependencies Schedule

Early in our audit of NAS Plan schedules, it became obvious that a simple review of independent project schedules would be insufficient to establish the credibility of NAS planning. In overview sections of the NAS Plans, the FAA provides meaningful discussions of problems within the existing NAS, of modernization objectives, of capabilities to be achieved, and, of program dependencies upon the various project activities. The evolutionary diagrams provided as part of these overview sections are particularly enlightening for describing the relationship of projects to the various systems and capability goals of the new NAS. In order to evaluate this data, and because we found no FAA working-level schedules which established the program-project dependencies shown in the evolution diagrams of the NAS Plan, we undertook an effort to develop a program schedule to reflect major NAS program objectives and related project dependencies. This was done as a new bottoms-up effort based only on the project schedules shown in the NAS plan and focused to show project relationships to major systems and capability goals of the NAS. The result of this effort is shown in Figure 3.2-1.

At the major subject level the schedule is organized in the same context as the NAS Plan, i.e. it has, as major subjects, the same titles as chapters of the NAS Plan. Below this major subject level, NAS Plan organization has been expanded first, to show the major systems of the NAS (second-level indenture) and then, to identify the functional facilities or services which compose the major systems (third-level indenture). Following this, projects are shown as a function of their implementation span times only, i.e. design development and production spans have not been included.

The purpose of the schedule is to functionally relate project efforts first, to facilities or services, then to the major system capabilities which they support (shown as numbered triangles on major system bars). Another purpose of the schedule is to show the phased evolution of the NAS from the existing systems to the new or enhanced systems of the future NAS. For this reason, the Traffic Management System and the Area Control Facility projects have been shown as systems because they evolve to absorb the existing Enroute and Terminal system functions and create a national traffic management capability. The transition to this final capability involves, not only, a complex evolution of projects into systems, but also, of systems to systems.

As projects are implemented they are phased into facilities or services to either enhance or replace existing capabilities. In many instances, projects are sequentially implemented to phase to desired system upgrades. This establishes project prerequisite dependencies upon other projects. In other instances, multiple projects must phase to each other, or into the facility, service or system concurrently before a capability can be achieved. The schedule shows many of these relationships. A further complexity is introduced when projects have relationships to more than one facility, service, or system. In these instances, dependent projects are frequently shown as broken lines with a referenced project number to indicate a dependency, not only where shown, but more pertinently, in another system where it is shown by a solid line.

A legend and notes are provided to explain symbology, approach, and milestone-project relationships. The schedule has been very useful in establishing a perspective relative to project relationships to other projects, facilities/services, systems and capability objectives. When projects are expanded to lower levels of detail, as has been done on this schedule, a surprising number of additional dependencies can be identified. The schedule also serves as a meaningful baseline from which to evaluate schedule changes. We believe that, if the schedule were to be reorganized to develop a hierarchy of plans, and further expanded at facility and project levels, a very meaningful program baseline and basis for performance evaluation would be achieved.

In summary, the schedule, and the associated analyses performed in its construction, have been productive in the validation of NAS Plan schedules and in the development of further insight into program objectives and dependencies as a basis for NAS Plan audit activities.

NAS PLAN PROGRAMMATIC CAPABILITIES AND DEPENDENCIES LEGEND

This capability and dependency schedule shows project installations only and is based on NAS Plan schedules. Project resume schedules were used only to support detail amplification.

The program milestone dates represent final completion of dependent projects. These milestones were generated to establish a *minimum number* of capability goals for performance evaluation reporting. A set of sub-tier capability events is needed to provide more reporting granularity.

LEGEND: △ Twenty three major milestones: functional groupings of related and dependent programs and projects that represent a NAS Plan capability objective. The 23 milestones are:

1 Provide an Efficient NAS Design - 1985
- System Engineering and Integration Contract (6-13)
- NAS Spectrum Engineering (6-15)

2 Develop Effective System Integration Planning - 1987
- System Engineering and Integration Contract (6-13)
- NAS Spectrum Engineering (6-15)

3 Interim Enroute ATC Capacity and Capability Enhancements - 1987
- ARTCC Facility Expansion (Part of 1-07)
- Modern ATC Host Computer (1-07)
- En Route Metering II (ERM II) (1-08)
- Conflict Resolution Advisory Function (CRAF) (1-09)
- Conflict Alert IFR/VFR Mode C Intruder (1-10)

4 Maintain and Upgrade Enroute System Capabilities - 1988
- ARTCC Plant Modernization (6-09)
- En Route Automation Hardware Improvements and Enhancements (1-01)
- Flight Data Entry and Printout Devices (FDEP)(1-03)
- Direct Access Radar Channel System (DARC)(1-03)
- En Route Automated Radar Tracking System (EARTS) Enhancements (1-04)
- Oceanic Display and Planning System (ODAPS) (1-05)
- Combine Radar Approach Control Into ARTCC (2-15)

5 Maintain and Upgrade Terminal Radar Approach Capabilities - 1988
- Provide Enhanced Terminal Conflict Alert (ARTS III) (2-01)
- ARTS IIIA Assembler (2-02)
- Enhanced Target Generator (ETG) Displays (ARTS III) (2-03)
- Additional ARTS IIIA Memory (2-04)
- Power Conditioning Systems (PCS) for ARTS III (6-06)
- ARTS IIA Enhancements (2-06)
- Provide ARTS II Displays (2-07)
- ARTS II Interfacility Interface (2-08)
- TPX 42 (Military Beacon Decoder) Replacement (with ARTS II) (2-17)
- Integration of Non-Radar Approach Control into Radar Facilities (1-14)

6 Maintain and Upgrade ATCT Capabilities - 1990
- Automatic Terminal Information System (ATIS) Recorders (2-10)
- Multichannel Voice Recorders (2-11)
- Integrated Communications Switching System (ICSS) (3-13)
- Bright Radar Indicator Tower Equipment (BRITE) (2-16)

7 Modernize and Consolidate A/G Comm Equipment - 1990
- Air/Ground (A/G) Communications Equipment Modernization (4-01)
- Communications Facilities Consolidation (4-02)

8 Expand and Enhance FAATC Development Support Capabilities - 1990
- System Support Laboratory (6-17)
- Additional ARTS IIIA Support System at the FAA Technical Center (2-05)
- General Support Laboratory (6-18)
- General Support (Part of 6-16)

9 Provide Improved Flight Service System - 1991
- Acquisition of Flight Service Facilities (6-10)
- Establish Flight Service Automation System (FSAS) (3-1)
- Interim Voice Response System (IVRS) (3-04)
- High Altitude En Route Flight Advisory Service (EFAS) Frequencies(3-07)
- Hazardous In-Flight Weather Advisory Service (HIWAS) (3-08)
- Consolidated NOTAM System (CNS) (3-03)
- Integrated Communications Switching System (ICSS) (3-13)
- Direction Finder (DF) (4-11)

10 Provide Upgraded FAA Interfacility Comm System - 1991
- National Data Interchange Network (NADIN) IA (5-06)
- National Data Interchange NEtwork (NADIN) 2 (5-07)
- Remote Microwave Line (RML) Trunking (5-01)
- Data Multiplexing (5-02)
- Radio Control Equipment (5-08)
- Television Microwave Link (5-04)
- Teletypewriter Replacement (5-09)
- National Radio Communication System (NARACS) (6-14)

11 Provide Operational System Support Capabilities - 1991
- Computer Based Instruction (CBI) (6-02)
- Aircraft Fleet Conversion/Flight Inspection Modernization (6-11)
- Aircraft and Related Equipment (6-12)
- General Support (Part of 6-16)

12 Increase Controller Productivity - 1992
- (ISSS) Initial Sector Suite System (Part of 1-12)
- (VSCS) Voice Switching and Control System (1-13)

13 Improve Maintenance Operations and Services - 1992
- Remote Maintenance Monitor System (RMMS) (4-01)
- Central Repair Facility (CRF) (6-03)
- Maintenance Control Center (MCC) (6-04)

14 Provide Improved Weather Products - 1992
- Central Weather Processor (CWP) 3-02
- Weather Communications Processor (WCP) (3-05)
- Weather Message Switching Center (WMSC) Replacement (3-04)
- Automated Weather Observation System (AWOS) (3-09)
- Radar Remote Weather Display System (RRWDS) (3-10)
- Geostationary Operational Environmental Satellite (GOES) Recorders (3-11)
- Wind Shear Efforts (3-12)
- Weather Radar Program (4-16)

15 Modernize and Automate the Air Traffic Control System - 1995
- (AAS) Advanced Automation System (1-12)
- (AERA) Automated En Route Air Traffic Control (1-13)

16 Upgrade Traffic Management Capabilities - 1995
- Traffic Management System (TMS) (1-06)

17 Provide Surveillance Coverage and Networking to 6000' - 1995
- Long Range Radar Program (4-15)
- Terminal Radar Program (4-13)
- Mode S/Data Link (4-12)
- ARTS II Interface with Mode S/ASR-9 (2-09)

18 Provide Ground-Air Data Link - 1995
Mode S/Data Link (4-12)
Automated En Route Air Traffic Control (AERA) (Part of 1-13)
Advanced Automation System (AAS) (1-13)

19 Consolidate ATC System Operations - 1998
Area Control Facilities (ACF) (1-15)
Terminal Sector Suites (Part of 1-12)
Tower Cab Computer Complex (TCCC) (Part of 1-12)
Tower Communication System (TCS) (2-12)

20 Provide Enhanced Data & Display Automation at Non-Radar Tower Facilities - 1999
(TCCC) Tower Cab Computer Complex (Part of 1-12)
(TCS) Tower Communication System (2-12)

21 Improve and Expand Landing Aid Services - 1999
Instrument Landing System (ILS) (4-06)
Microwave Landing System (MLS) (4-07)
Runway Visual Range (RVR) (4-08)
Visual Aids (4-09)
Approach Lighting System Improvement Program (ALSIP) (4-10)

22 Upgrade Navigational Aid Equipment and Air Space Coverage - 2000
VHF Omni-Range Radio Tactical Air Navigation (VORTAC) (4-03)
Non-Directional Beacon (NDB) (4-04)
Supplemental Navig ion System MOnitors (4-05)

23 Establish, Replace, Modernize NAS Facilities -2000
ATCT/TRACON Establishment, Replacement and Modernization (2-13)
VFR Traffic Control Tower (ATCT) Closures (2-14)
Airport Power Cables Loop System (6-05)
Airport Telecommunications (5-05)
Unmanned FAA Airway Facilities Buildings and Plant Equipment (6-08)
Power Systems (Unmanned Facilities) (6-07)

These milestones are "project completion" oriented. They describe when benefits should accrue from new systems.

NAS PLANS PROJECT NUMBERING

NAS Plan Chapter and Section	Derived Project Group Prefix	+	Project No.	=	SEI Project No.
Chapter III, ATC Systems					
Enroute Section	1		12		1-12
Terminal Section	2		14		2-14
Flt. Serv. Section	3		1		3-01
Chapter IV, Ground-to-Air Systems	4		3		4-03
Chapter V, Interfacility Comm. Systems	5		9		5-09
Chapter VI, Maint. and Ops. Support Systems	6		18		6-18

Note: Where no project number is shown, there is no identifiable corresponding F&E project.

//////////////////	Highlights major NAS systems (facilities, equipment, services) supported by one or more Facilities and Equipment (F&E) NAS Plan projects.
TMS (1-06) ▬▬▬▬	Solid bar, denotes a NAS Plan project with commonly accepted project title or acronym and project number. Example: Traffic Management System, Project 1-06.
▲	Denotes a project or sub-system milestone, i.e., achievement of an operational readiness demonstration, or gaining an operational capability involving one or more projects (i.e. 12,500' surveillance coverage).
▲ c	Represents completion of a project or project phase milestone, i.e. Phase I of the TMS project, physical expansion of ARTCC buildings, full implementation of Enhanced DARC, etc.
▪▪▪▪▪▪▪▪▪▪▪▪▪▪▪▪	Shows an existing capability that will be affected by an F&E project. Example: Existing ARSR will be upgraded by the Long Range Radar Program.
▬▬▬ ▬ ▬ ▬	Broken bar extending beyond a solid bar indicates a project functional interface to another project with a later completion date. Also used to indicate a later equipment decommissioning as noted.

— — — — — — —	Broken bar by itself shows an existing capability that a system depends on, i.e. existing ATIS supports Air Traffic Control towers.
AWOS (Ref. 3-9) — — — — — — —	Broken bar with project title/acronym and ref. project number indicates that the project will support more than one specific system capability. Example: AWOS will support Air Traffic Control towers, but its implementation is shown as a major project under the Weather Data System.
●	Large dots show connectivity points where dependent projects aggregate, flow upward, and develop a system capability.
••••••••••••••••••	Small dots are "guidelines" to connect projects to vertical lines which collect associated projects into major milestone groups.
↑	The arrow symbol directs attention to specific points where dependent projects aggregate at the program or system level.
(25 sites)	Represents known number of buildings, facilities, or pieces of equipment. Examples: ARTCC plant modernization - 25 sites; ATCT/TRACON establishment, replacement, modernization - 29 facilities; ASR-9 - 101 radars.

National Airspace System Plan Programmatic Cap

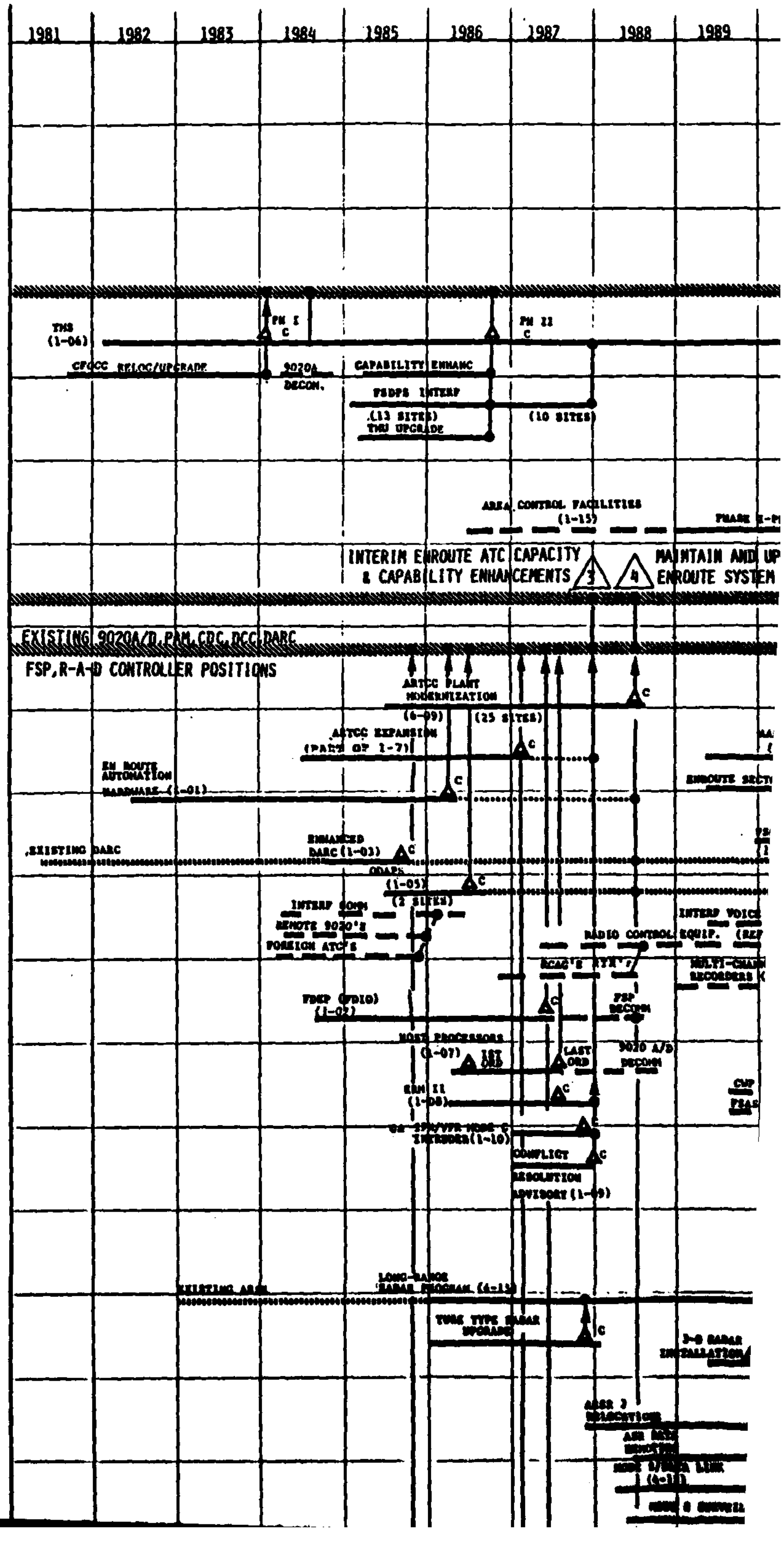
I. AIR TRAFFIC CONTROL SYSTEM

A. TRAFFIC MANAGEMENT SYSTEM

B. AREA CONTROL FACILITIES

C. ENROUTE AIR TRAFFIC CONTROL SYSTEMS

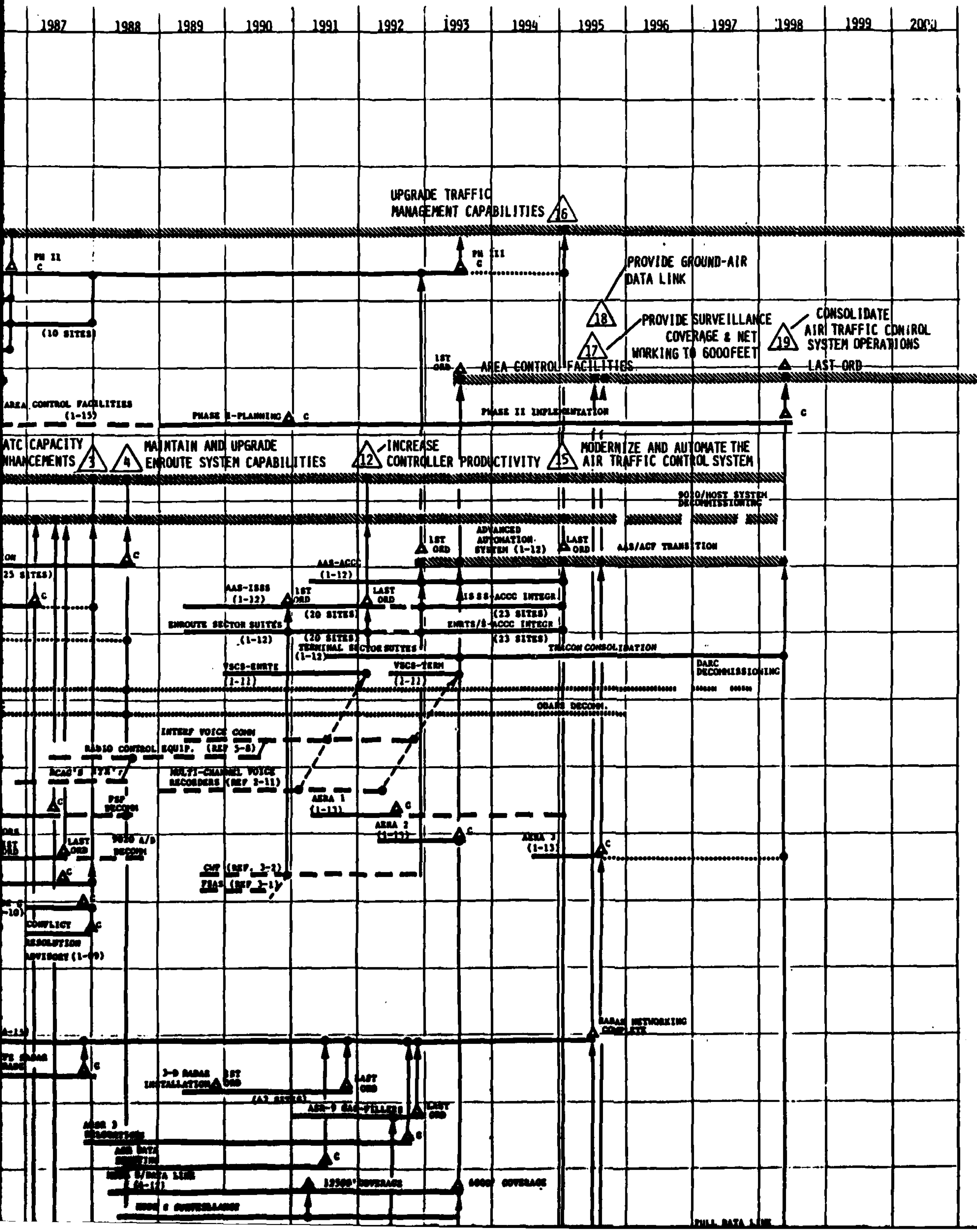
1. AIR ROUTE TRAFFIC CONTROL CENTERS (ARTCC'S) (20 CONUS LOCATIONS)



3

2

Programmatic Capabilities & Dependencies



4

3

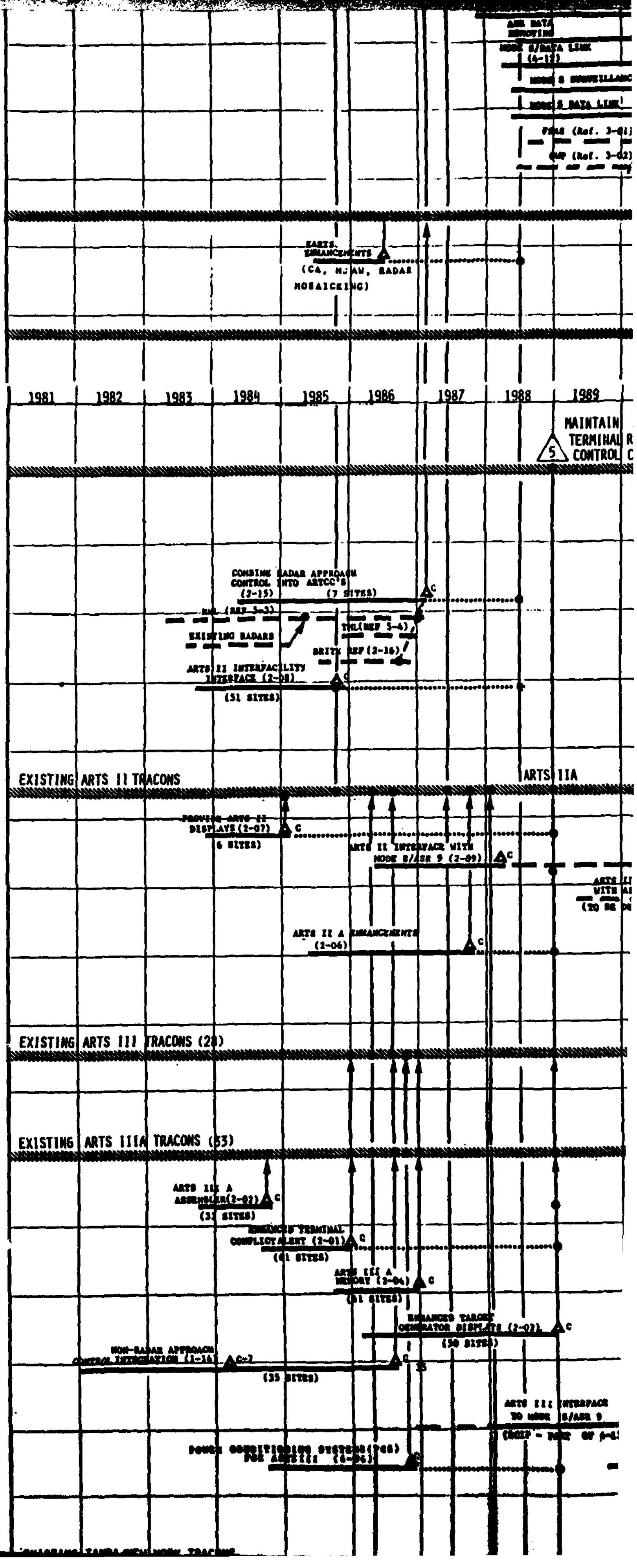
2. ENROUTE AUTOMATED RADAR TRACKING SYSTEM (EARTS) (ANCHORAGE, HONOLULU, SAN JUAN, NELLIS AFB)

3. ENROUTE AUTOMATED RADAR APPROACH (CERAP) (SAN JUAN, GUAM,)

D. TERMINAL AIR TRAFFIC CONTROL SYSTEMS

1. AUTOMATED RADAR TERMINAL SYSTEM II (ARTS II)

2. AUTOMATED RADAR TERMINAL SYSTEM III (ARTS III)



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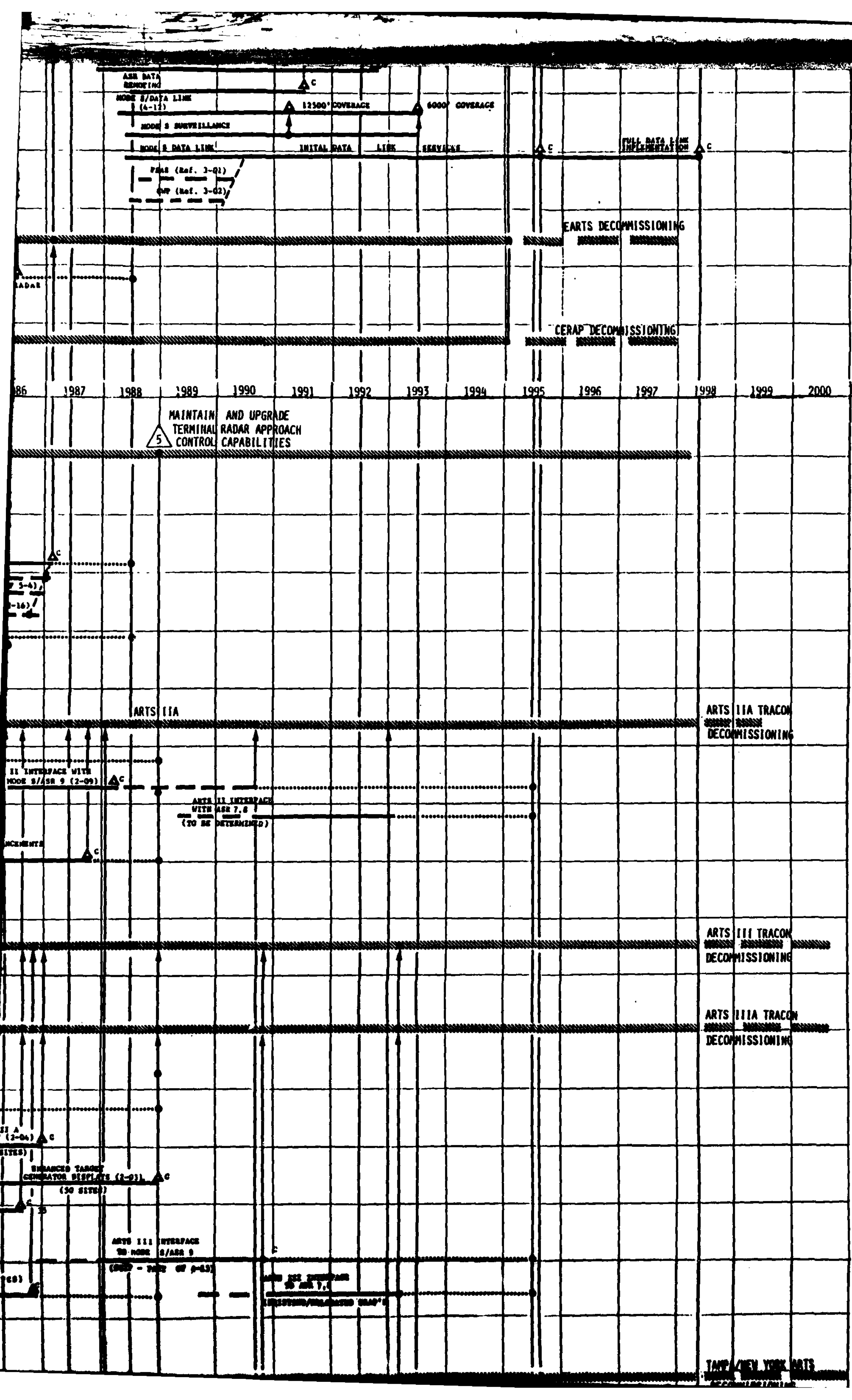


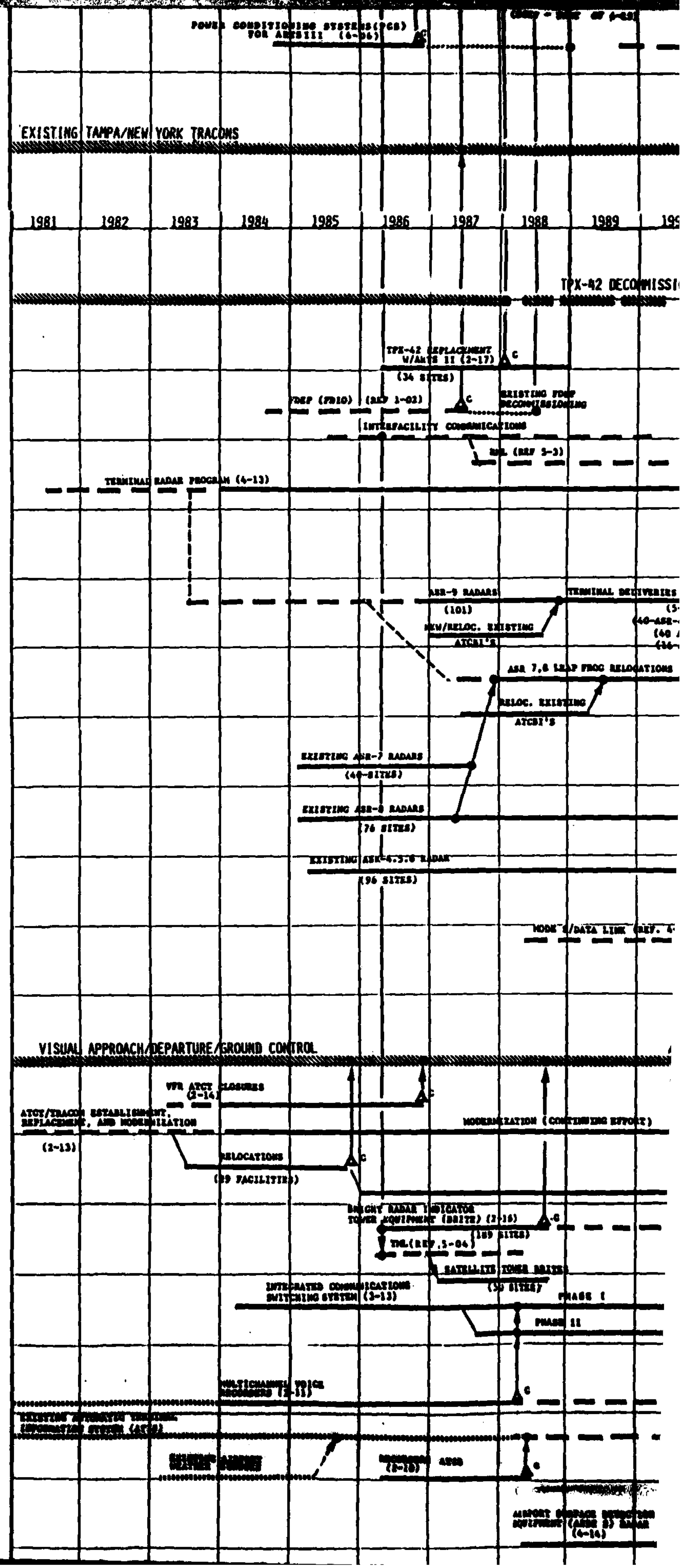
ASR DATA
RENDERING
MODE S/DATA LINK
(4-12)
12500' COVERAGE
6000' COVERAGE
MODE S SURVEILLANCE
MODE S DATA LINK
INITAL DATA
LINK
SERVICES
FULL DATA LINK
IMPLEMENTATION
EARTS DECOMMISSIONING
CERAP DECOMMISSIONING
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
MAINTAIN AND UPGRADE
TERMINAL RADAR APPROACH
CONTROL CAPABILITIES
ARTS IIA
ARTS IIA TRACON
DECOMMISSIONING
ARTS II INTERFACE
WITH ASR 7,8
(TO BE DETERMINED)
ARTS III TRACON
DECOMMISSIONING
ARTS IIIA TRACON
DECOMMISSIONING
ENHANCED TARGET
GENERATOR DISPLAYS (2-01)
(50 SITES)
ARTS III INTERFACE
TO MODE S/ASR 9
TAMPA/NEW YORK ARTS

5

3. TAMPA/NEW YORK AUTOMATED RADAR TERMINAL SYSTEMS(ARTS)

4. TPX-42 SYSTEM

E. AIR TRAFFIC CONTROL TOWERS (ATCT)



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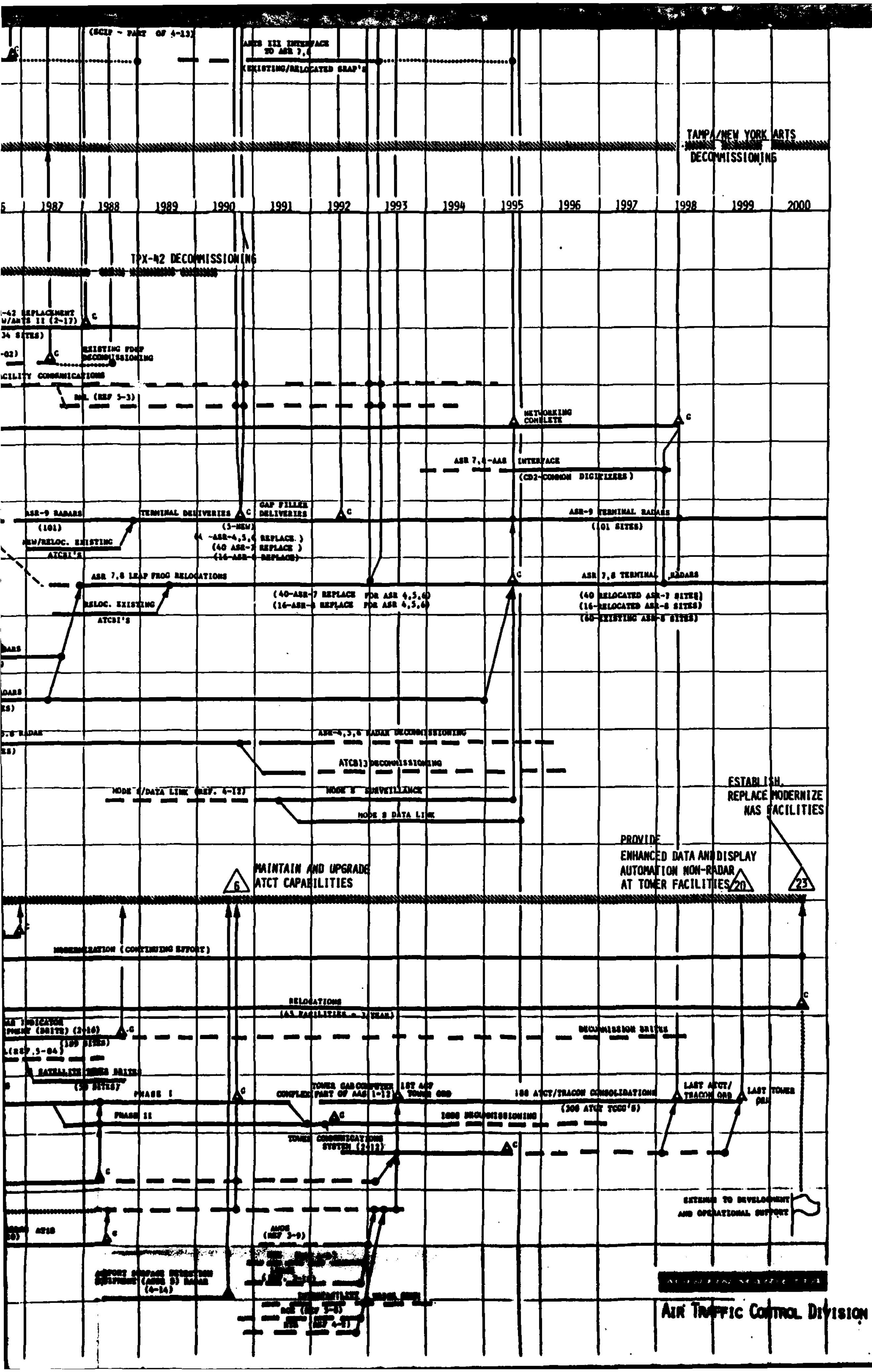
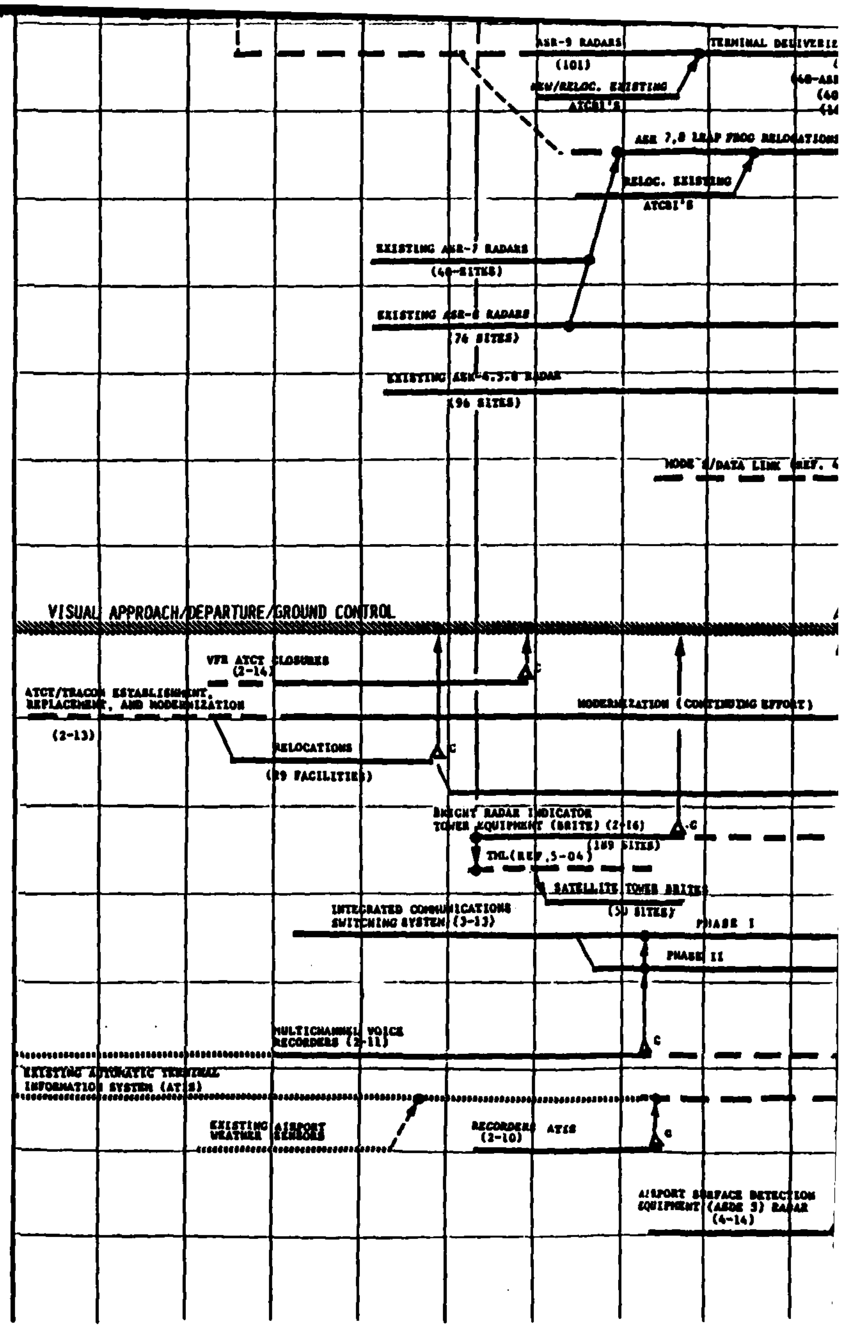
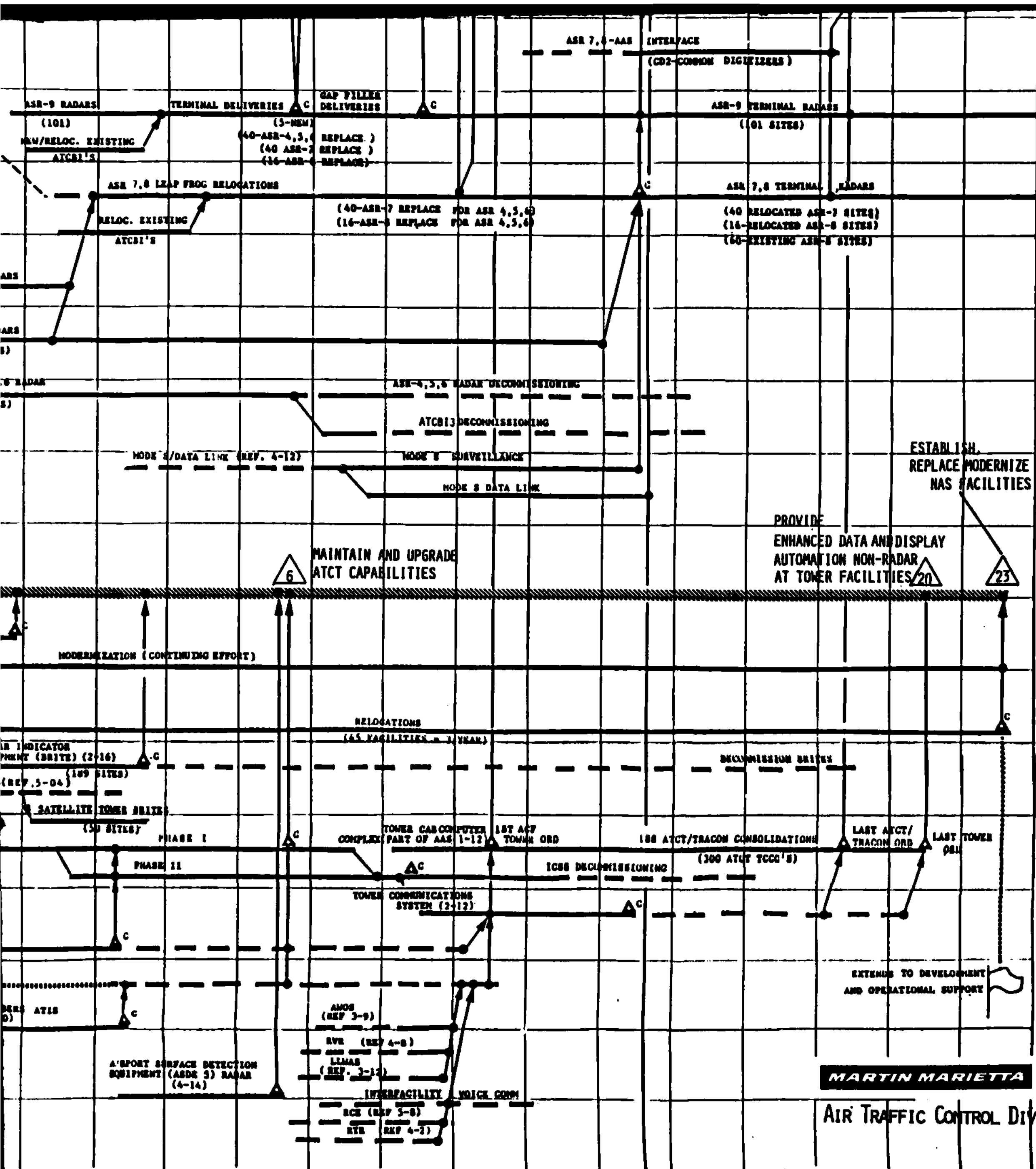

(SCIP - PART OF 4-13)
ARTS III INTERFACE TO ASR 7,8
(EXISTING/RELOCATED SRAP'S)
TAMPA/NEW YORK ARTS DECOMMISSIONING
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
TPX-42 DECOMMISSIONING
EXISTING FDEP DECOMMISSIONING
NETWORKING COMPLETE
ASR 7,8-AAS INTERFACE
(CD2-COMMON DIGITIZERS)
ASR-9 RADARS
(101)
TERMINAL DELIVERIES
GAP FILLER DELIVERIES
ASR-9 TERMINAL RADARS
(101 SITES)
NEW/RELOC. EXISTING ATCBI'S
(5-NEW)
(40 ASR-7 REPLACE)
ASR 7,8 LEAP FROG RELOCATIONS
(40-ASR-7 REPLACE FOR ASR 4,5,6)
(16-ASR-8 REPLACE FOR ASR 4,5,6)
ASR 7,8 TERMINAL RADARS
(40 RELOCATED ASR-7 SITES)
(16-RELOCATED ASR-8 SITES)
(60-EXISTING ASR-8 SITES)
RELOC. EXISTING ATCBI'S
ASR-4,5,6 RADAR DECOMMISSIONING
ATCBI3 DECOMMISSIONING
MODE S/DATA LINK (REF. 4-12)
MODE S SURVEILLANCE
MODE S DATA LINK
ESTABLISH, REPLACE MODERNIZE NAS FACILITIES
PROVIDE ENHANCED DATA AND DISPLAY AUTOMATION NON-RADAR AT TOWER FACILITIES
20
23
MAINTAIN AND UPGRADE ATCT CAPABILITIES
6
MODERNIZATION (CONTINUING EFFORT)
RELOCATIONS
DECOMMISSION BRITES
PHASE I
PHASE II
TOWER CAB COMPUTER COMPLEX PART OF AAS 1-12
1ST ACF TOWER ORD
188 ATCT/TRACON CONSOLIDATIONS
(300 ATCT TCCC'S)
LAST ATCT/ TRACON ORD
LAST TOWER
TOWER COMMUNICATIONS SYSTEM (2-12)
EXTEND TO DEVELOPMENT AND OPERATIONAL SUPPORT
AIRPORT SURFACE DETECTION EQUIPMENT (ASDE 3) RADAR (4-14)
AIR TRAFFIC CONTROL DIVISION

E. AIR TRAFFIC CONTROL TOWERS (ATCT)



ISSUE DATE: 7/2/84
SHEET 1 OF 3



MARTIN MARIETTA

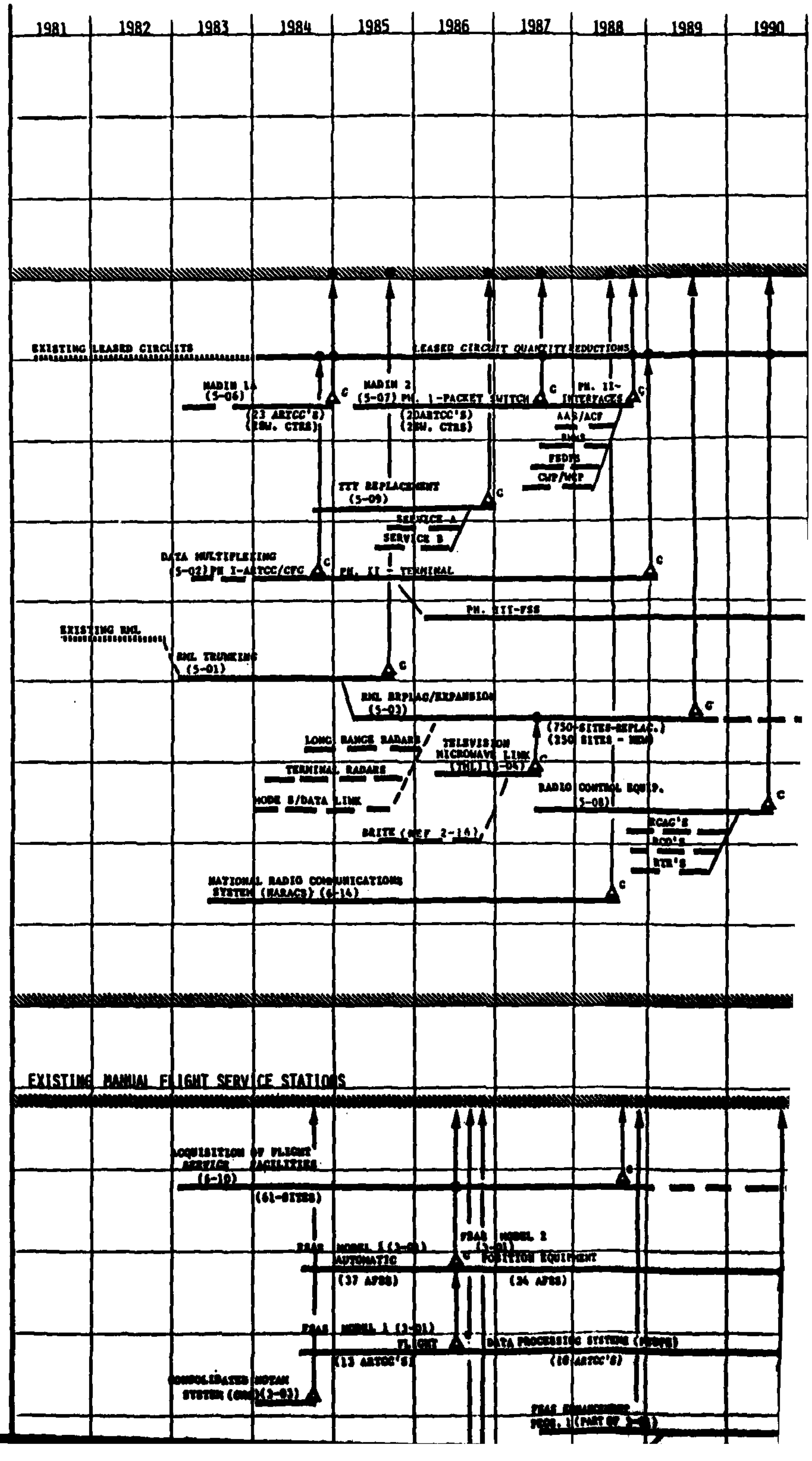
AIR TRAFFIC CONTROL DIVISION

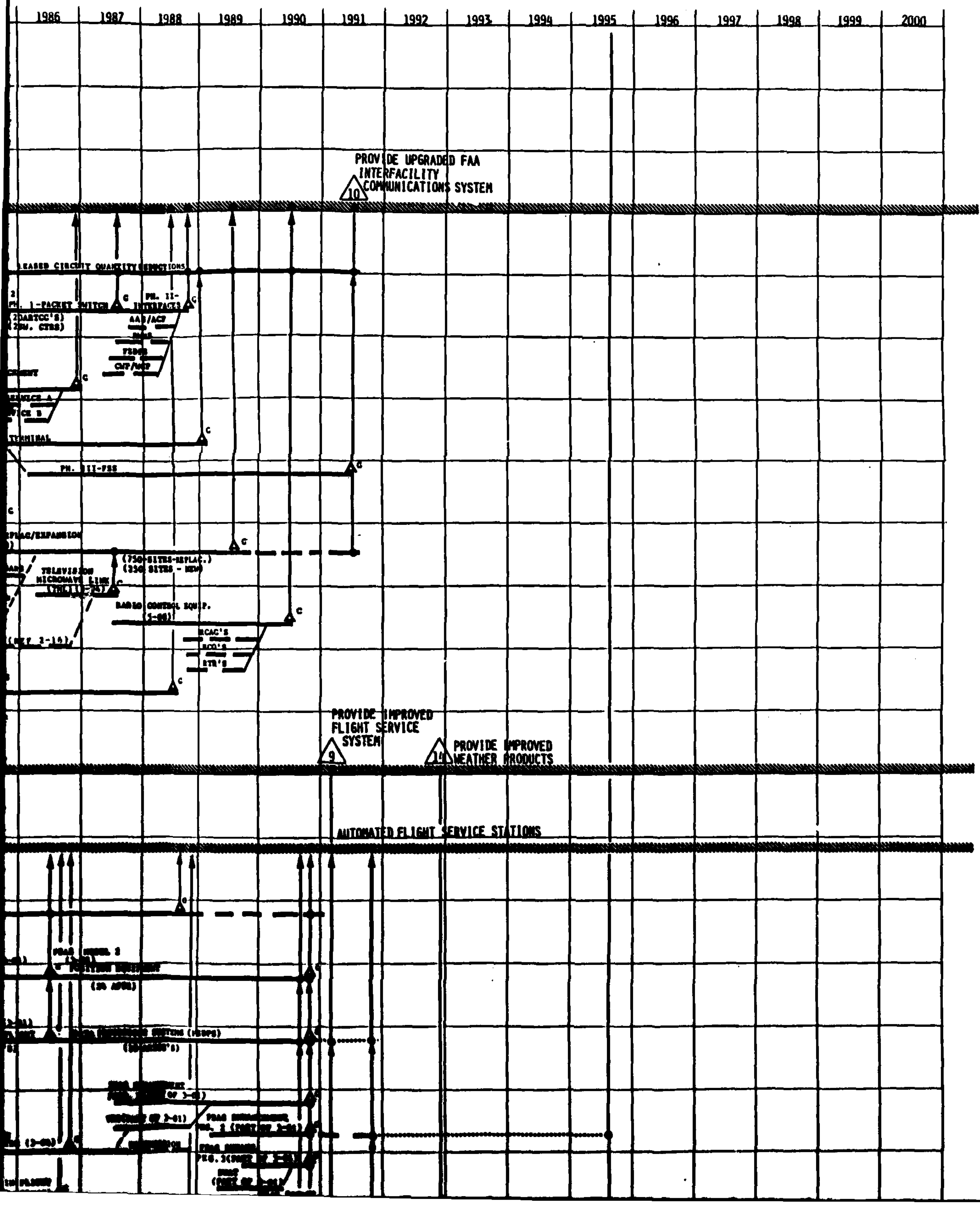
8

II. INTERFACILITY COMMUNICATIONS SYSTEM

III. FLIGHT SERVICE SYSTEMS

A. FLIGHT SERVICE STATIONS

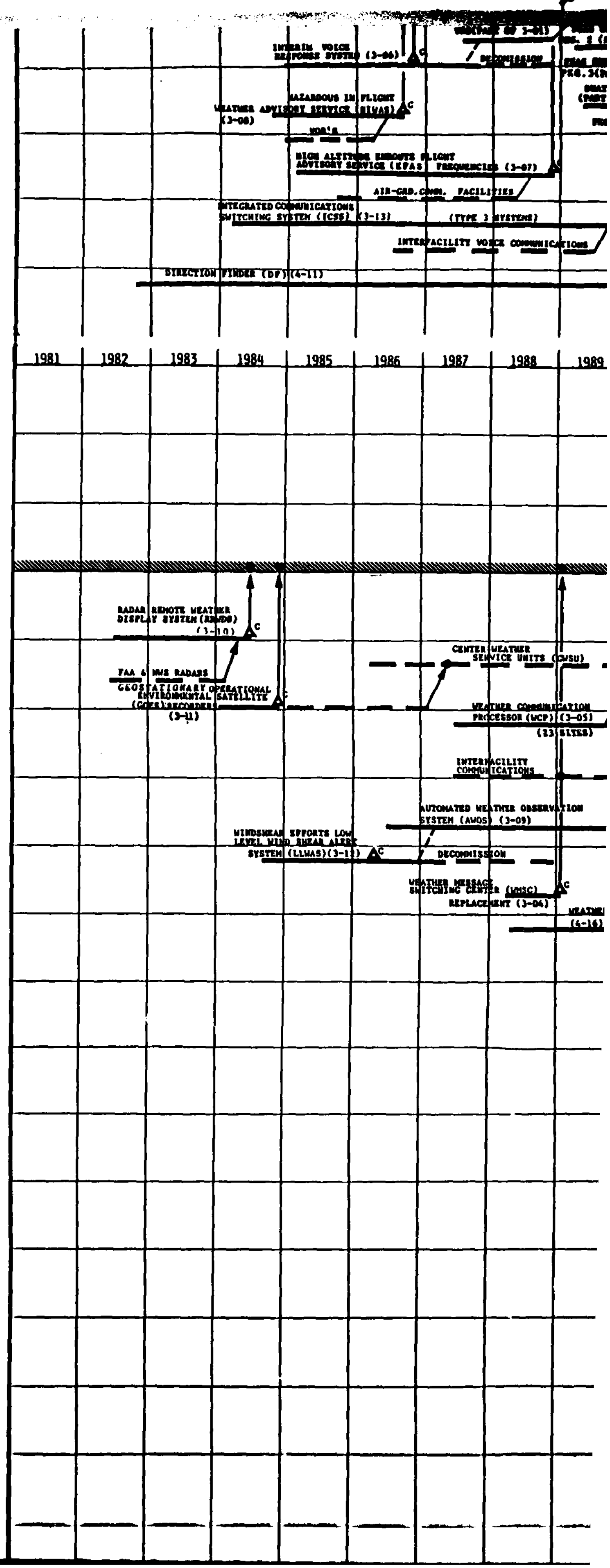




1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
PROVIDE UPGRADED FAA INTERFACILITY COMMUNICATIONS SYSTEM
10
LEASED CIRCUIT QUANTITY REDUCTIONS
PH. III-FSS
TELEVISION MICROWAVE LINK
RADIO CONTROL EQUIP.
PROVIDE IMPROVED FLIGHT SERVICE SYSTEM
9
PROVIDE IMPROVED WEATHER PRODUCTS
14
AUTOMATED FLIGHT SERVICE STATIONS

3

B. WEATHER DATA SYSTEM



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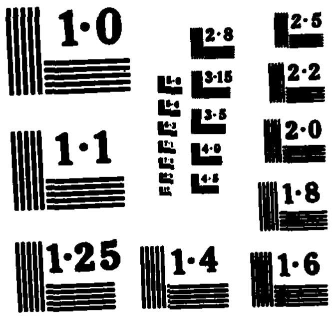
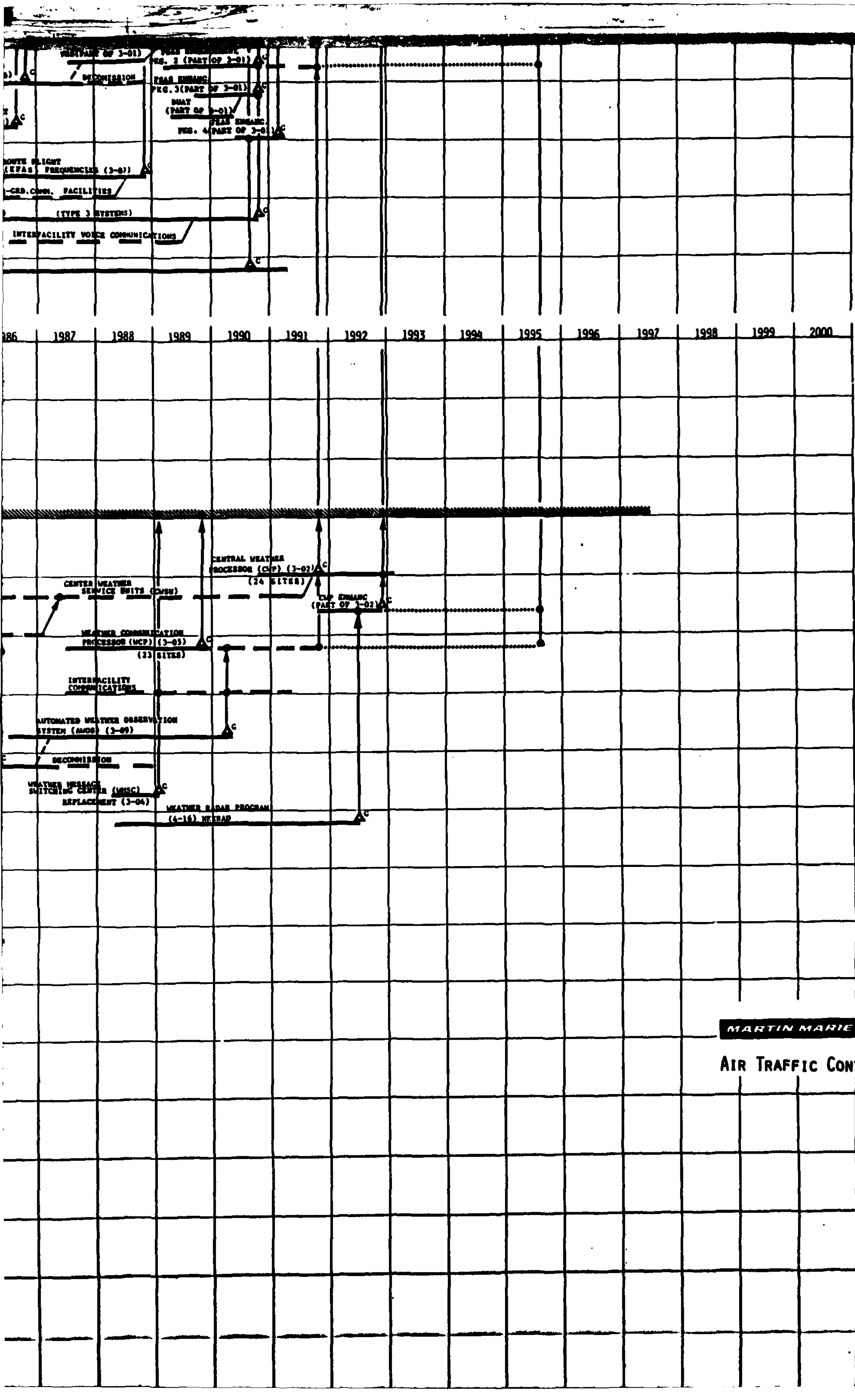

1·0
2·8
2·5
3·15
2·2
3·5
2·0
1·1
4·0
4·5
1·8
1·25
1·4
1·6



4

MARTIN MARIETTA

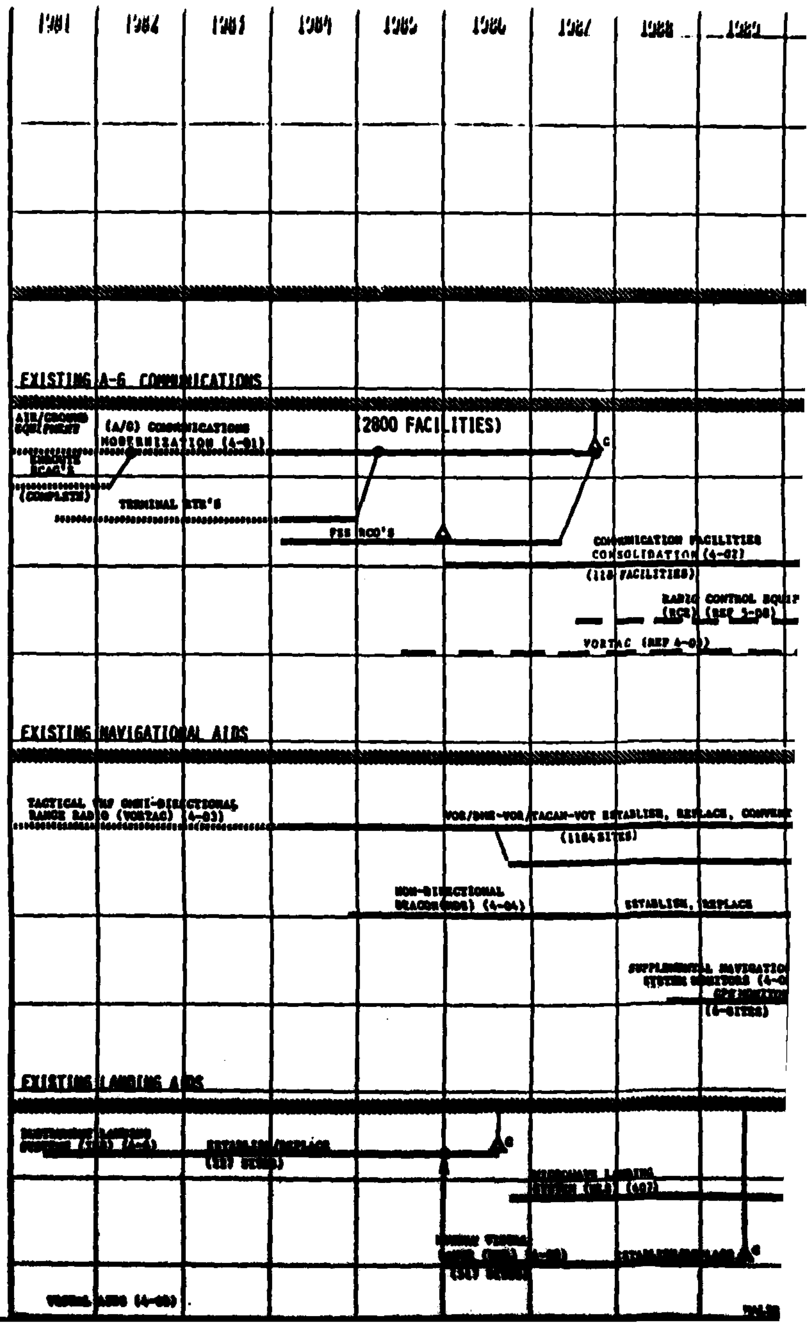
AIR TRAFFIC CONTROL DIVISION

IV GROUND-AIR SYSTEMS

A. AIR-GROUND COMMUNICATION SYSTEM

B. NAVIGATION SUPPORT SYSTEM

C. LANDING SUPPORT SYSTEM



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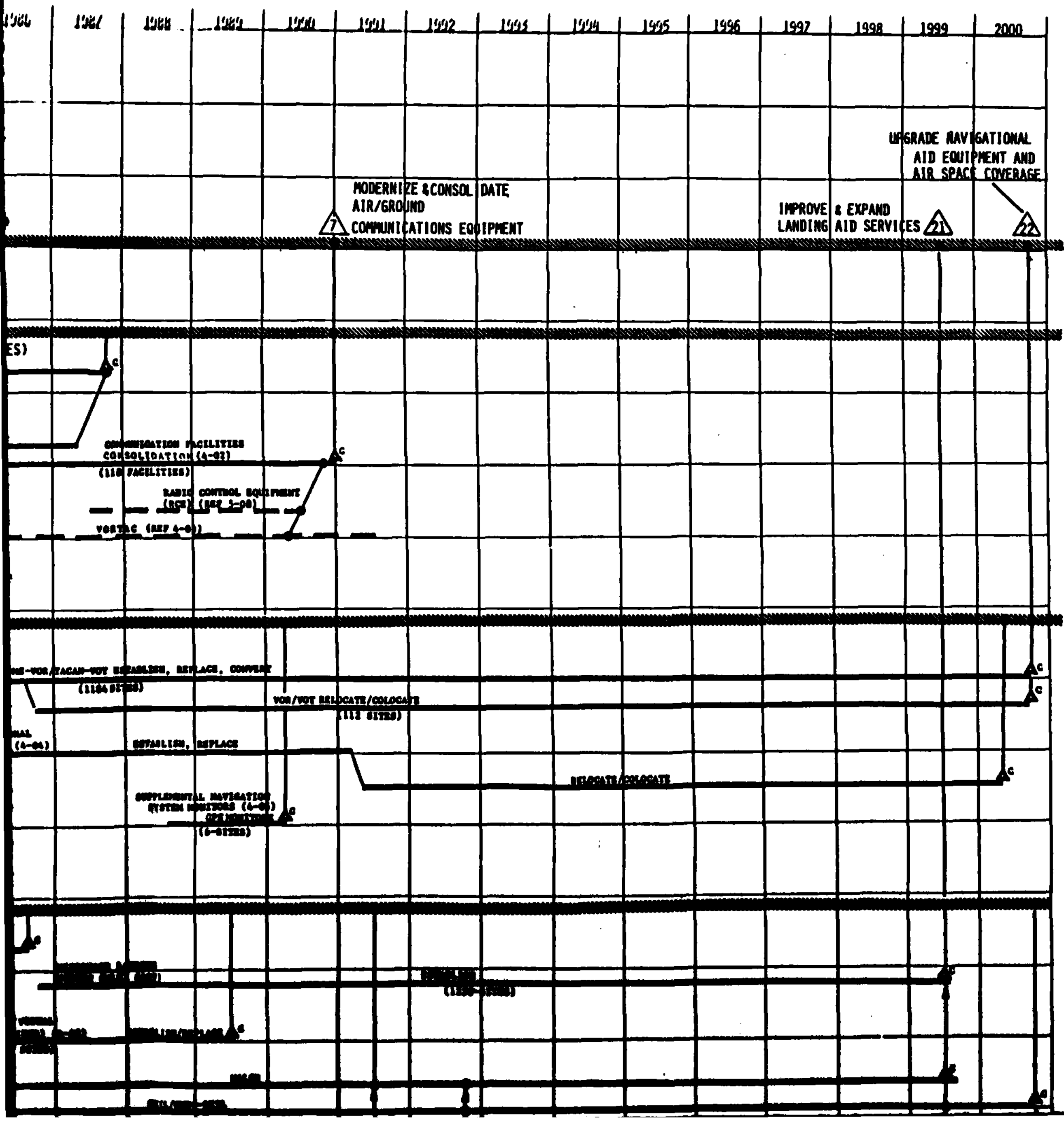
2



1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
UPGRADE NAVIGATIONAL AID EQUIPMENT AND AIR SPACE COVERAGE
MODERNIZE &CONSOLIDATE AIR/GROUND COMMUNICATIONS EQUIPMENT
7
IMPROVE & EXPAND LANDING AID SERVICES
21
22
ES)
COMMUNICATION FACILITIES CONSOLIDATION (4-07)
(118 FACILITIES)
RADIO CONTROL EQUIPMENT
VORTAC
VOR/VOT RELOCATE/COLOCATE
(112 SITES)
ESTABLISH, REPLACE
RELOCATE/COLOCATE
SUPPLEMENTAL NAVIGATION SYSTEM MONITORS
(6-SITES)

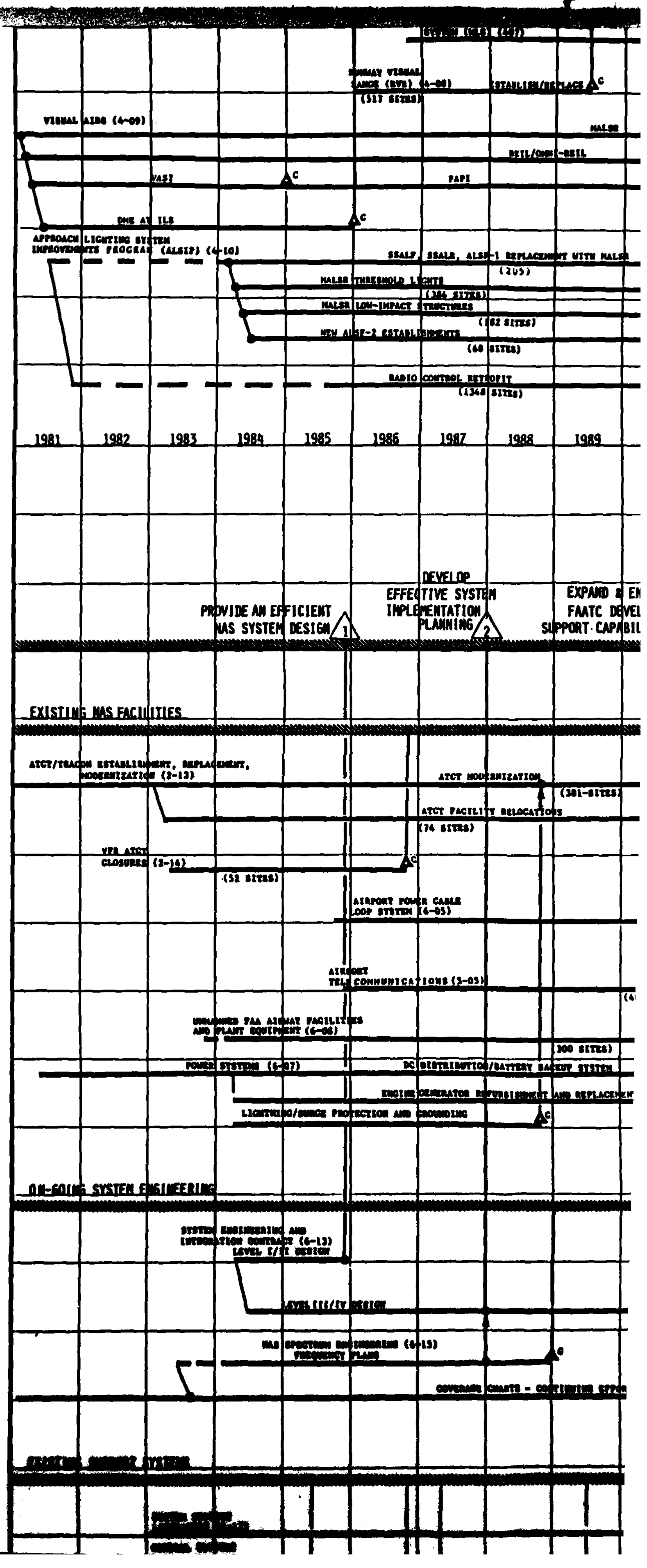
4

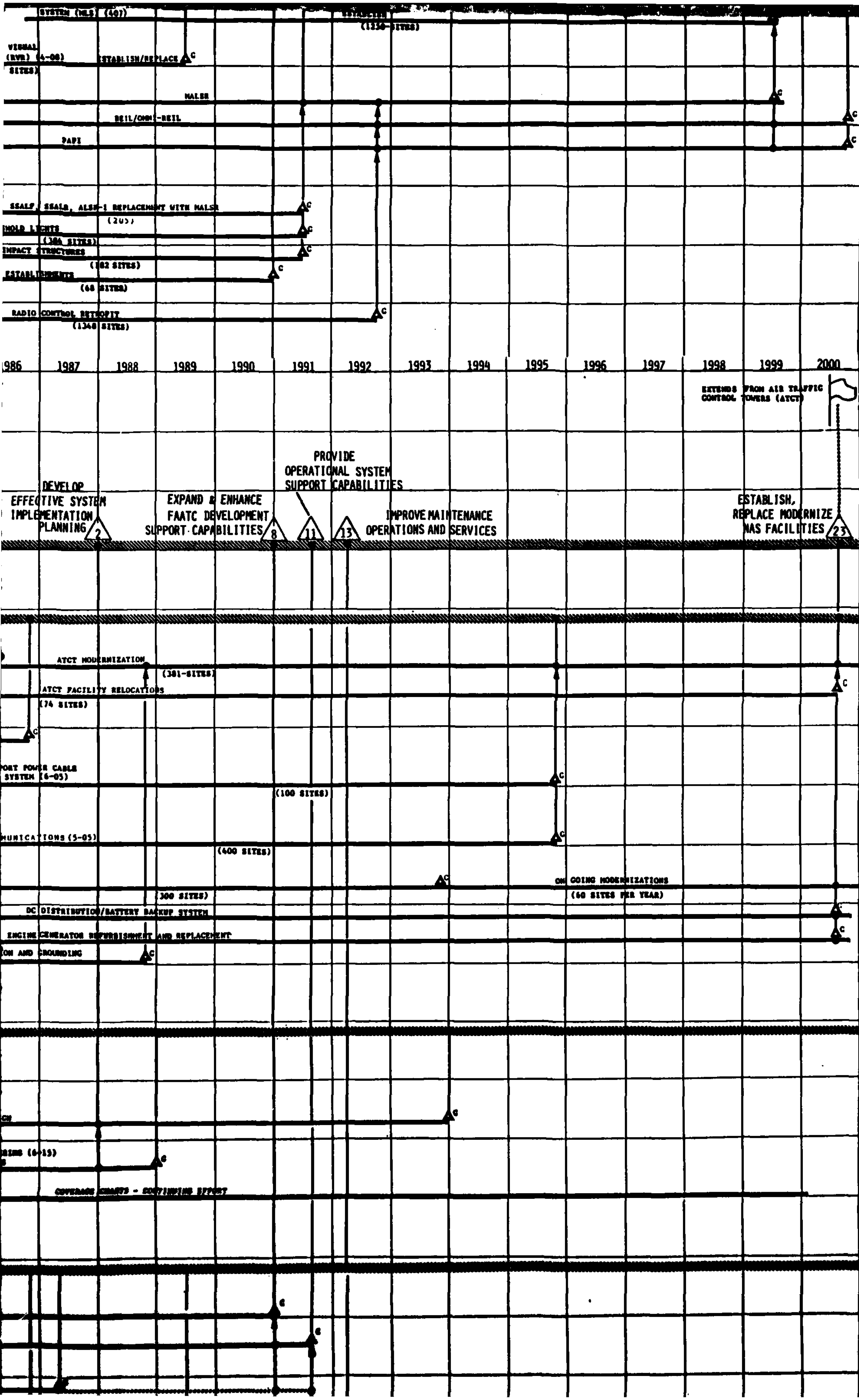
V. DEVELOPMENT AND OPERATIONS SUPPORT SYSTEM

A. NAS OPERATIONAL FACILITIES

B. SYSTEM ENGINEERING

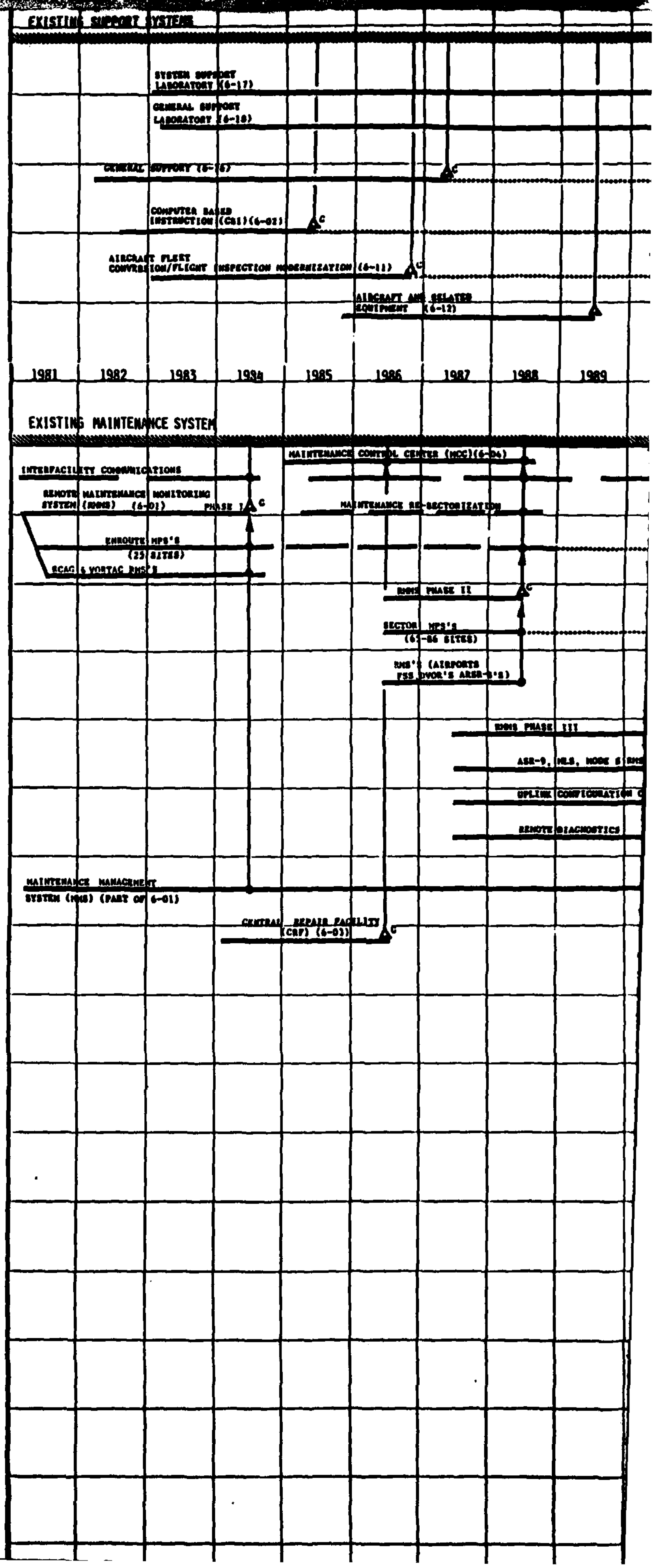
C. SUPPORT SYSTEMS




SYSTEM (MLS) (607)
(1230 SITES)
VISUAL (RVR) (4-08) SITES)
ESTABLISH/REPLACE
MALSR
REIL/OMNI-REIL
PAPI
SSALF, SSALS, ALSF-1 REPLACEMENT WITH MALSR
(205)
HOLD LIGHTS
(386 SITES)
IMPACT STRUCTURES
(182 SITES)
ESTABLISHMENTS
(68 SITES)
RADIO CONTROL RETROFIT
(1348 SITES)
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
EXTENDS FROM AIR TRAFFIC CONTROL TOWERS (ATCT)
DEVELOP EFFECTIVE SYSTEM IMPLEMENTATION PLANNING
2
EXPAND & ENHANCE FAATC DEVELOPMENT SUPPORT CAPABILITIES
8
PROVIDE OPERATIONAL SYSTEM SUPPORT CAPABILITIES
11
13
IMPROVE MAINTENANCE OPERATIONS AND SERVICES
ESTABLISH, REPLACE MODERNIZE NAS FACILITIES
23
ATCT MODERNIZATION
(381-SITES)
ATCT FACILITY RELOCATIONS
(74 SITES)
PORT POWER CABLE SYSTEM (6-05)
(100 SITES)
MUNICATIONS (5-05)
(400 SITES)
ON GOING MODERNIZATIONS
(60 SITES PER YEAR)
(300 SITES)
DC DISTRIBUTION/BATTERY BACKUP SYSTEM
ENGINE GENERATOR REFURBISHMENT AND REPLACEMENT
ION AND GROUNDING
INGS (6-15)
COVERAGE CHARTS - CONTINUING EFFORT

C. SUPPORT SYSTEMS

D. MAINTENANCE SUPPORT SYSTEM



ISSUE DATE: 7/2/84
SHEET 3 OF 3

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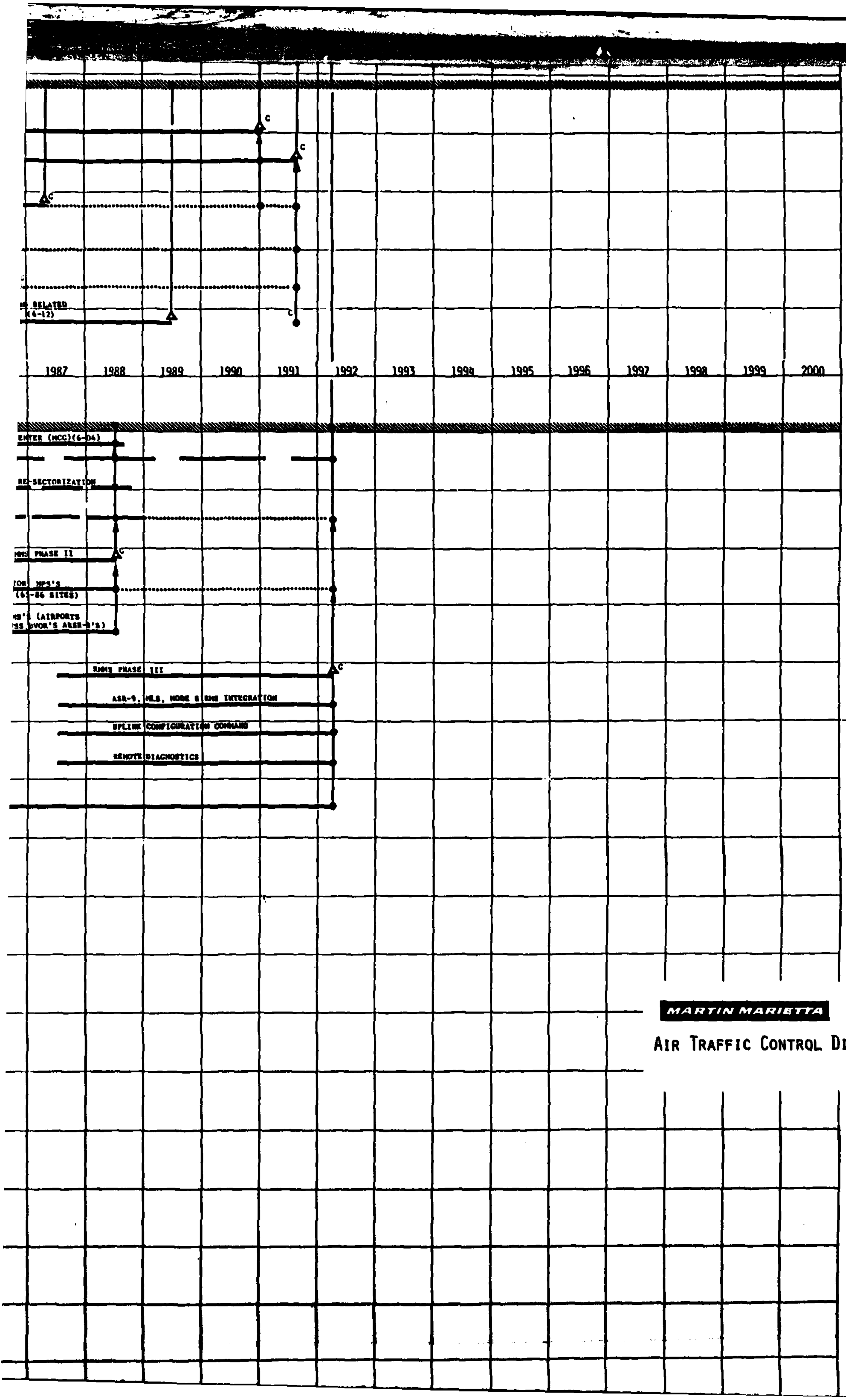

MARTIN MARIETTA

AIR TRAFFIC CONTROL DIVISION

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