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Power Systems Sustained Support (PS^3)

Investment Analysis Report

Revalidated CIP F-11: Power Systems Sustained Support Program

May 23, 2000

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DCN: R90384

Executive Summary

This Investment Analysis Report (IAR) documents activities conducted by the FAA PS^3 Investment Analysis Team (IAT). As specified in the Acquisition Management System (AMS) and Investment Analysis Process Guidelines, the report summarizes the mission need, requirements, assumptions, funding alternatives analysis, costs, benefits, and risks. The report also documents the affordability assessment conducted by the System Engineering Operational Analysis Team (SEOAT). Finally, it summarizes the IAT's Investment Decision recommendation to the Joint Resources Council (JRC). This investment analysis (IA) was part of a pilot program to streamline the IA process and was conducted over a 45-day period.

The PS^3 program is responsible for acquiring backup power systems and power conditioning systems to support services across the National Airspace System (NAS). The purpose of this investment analysis is to determine the near-term funding needs of the PS^3 program and recommend the appropriate funding levels for fiscal years 2002-2004.

Findings

?? The PS^3 Program has been significantly underfunded in recent years. The IAT's analysis shows that steady state replacement of the existing power infrastructure (based on service life) would cost approximately $100 million annually. In contrast, the program has received a total of $75 million over the past five years, and no more than $19 million in any one year.

?? Based on FAA data, commercial and standby power outages are increasing in number and duration.

?? Certain systems can operate safely beyond their service lives, but the proportion of systems beyond their estimated service life (ESL) is becoming overwhelming (more than 90% of engine generators, batteries, power cables, and lightning protection, grounding, bonding, and shielding).

?? Current funding does not allow for any systematic reduction in the average age of the power infrastructure; nor does it allow for disciplined program planning or execution.

?? Given the size and age of the inventory, as well as its role in supporting systems across the NAS, failure to significantly increase funding to this program is likely to result in a compounding degradation of existing NAS services.

?? Modern, reliable power is required to obtain the user benefits envisioned for programs such as Next Generation Air-to-Ground Communications (NEXCOM), Free Flight and Safe Flight 21.

?? Replacing aging power systems is economically viable: the cost/benefit ratios for all funding alternatives range from 2.3 to 2.9.

Recommendations

?? Given the magnitude of near-term needs identified, the team continues to support Alternative 5 ($260 million over three years) as the preferred alternative. Recognizing an affordability problem, however, the team strongly recommends that the JRC fund this program at a level no lower than the Air Traffic Services (ATS) proposal ($53.8 million in

FY02; $60 million in FY03; and $70 million in FY04). While less than the team's preferred alternative, the ATS proposal constitutes a significant increase over historical funding levels. It will (1) allow the PS^3 program to address its critical near-term sustainment needs in about five years, (2) begin to reduce the average age of equipment, and (3) reduce the risk of significant pop-up expenditures, thereby increasing the integrity of the planning process.

?? The IAT further recommends a 5% annual funding increase (on top of inflation) from FY05 through FY10. This would bring the funding to the level (approximately $100 million annually) that would allow steady state, service life replacement of the power infrastructure.

?? Given the undefined and unfunded power requirements identified for Standard Terminal Automation Replacement System (STARS), NEXCOM, and Air Traffic Control Beacon Interrogator (ATCBI-6), the IAT recommends that the NAS Infrastructure Power Systems (NIPS) Product Team (PT) and the product teams responsible for the three new systems (1) reach consensus on their power requirements, and (2) ensure appropriate funding is included in program baselines. The product teams should be assisted by the Automation and CNS Integrated Management Teams to reach consensus.

?? The IAT further recommends that the NIPS PT take the lead in ensuring consistency across the FAA's power systems engineering guidance.

?? Finally, the IAT recommends that the NIPS PT complete a technical alternatives analysis to investigate power systems requirements for FY05 and beyond. The analysis should be completed by FY02.

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1.0 INTRODUCTION

The Power Systems Sustained Support (PS^3) program is responsible for acquiring backup power systems and power conditioning systems to support services across the National Airspace System (NAS). This Investment Analysis Report (IAR) documents activities conducted by the FAA PS^3 Investment Analysis Team (IAT). As specified in the Acquisition Management System (AMS) and Investment Analysis Process Guidelines, the report summarizes the mission need, requirements, assumptions, funding alternatives analysis, costs, benefits, and risks. The report also documents the affordability assessment conducted by the System Engineering Operational Analysis Team (SEOAT). Finally, it summarizes the IAT's Investment Decision recommendation to the Joint Resources Council (JRC).

1.1 Scope/Objectives

The purpose of this investment analysis is to evaluate the near-term needs of the PS^3 program and to recommend the appropriate funding level for the three-year period covering fiscal years 2002 through 2004. To determine the near-term needs of the program, the team was instructed to consider the replacement needs of the existing power infrastructure as well as the power requirements of new NAS systems scheduled for deployment over the analysis period.

1.2 Major Assumptions, Constraints, and Conditions

Following are the major assumptions, constraints, and conditions that guided the analysis:

?? The team was instructed to undertake a funding alternatives analysis in lieu of a technical alternatives analysis, given the near-term nature of the analysis and the focus on sustainment.

?? Management provided three budget scenarios to guide the team's analysis, but allowed the team discretion to add more scenarios if warranted. The original funding scenarios totaled $100 million, $130 million, and $160 million over three years.

?? The team was instructed to assume existing power requirements would be maintained throughout the analysis period.

?? The team was expected to complete its analysis in approximately 30 days, thereby serving as a test case for a streamlined investment analysis process.

?? Data on historical failure rates for individual power systems were not available to the team. (The FAA started collecting system-specific outage data at about the same time this IAT was convened; therefore, while such data may be useful for future analyses, it was not available in time to contribute to this analysis.)

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2.0 MISSION NEED AND REQUIREMENTS

2.1 Mission Need

As stated in the Revalidation of CIP F-11, Power Systems Sustained Support (PS^3) Program, dated November 12, 1998, quality power is a fundamental component of the NAS infrastructure, and the PS^3 program is the key element in ensuring that current and future power requirements of the NAS are met. The FAA cannot rely solely on commercial power sources to support NAS facilities. In recent years, the number and duration of commercial power outages have increased steadily, and the trend is expected to continue into the future (see Benefits Analysis, Section 5.2). Reliable standby power systems must be in place to maintain the integrity of the NAS during commercial power outages.

Much of the FAA's power infrastructure is operating beyond its service life. As the average age of the infrastructure has increased, its availability has decreased. The infrastructure has also become difficult to maintain because parts are difficult to obtain.

In addition to reliable standby power, the increasingly microprocessor-based NAS requires cleaner and more stable power than it has in the past. New equipment is sensitive to voltage and frequency fluctuations. To provide clean and stable power, NAS power systems must be continually updated to comply with equipment manufacturers' power requirements, standards of tolerance, *the National Electric Code* (NEC), the *National Lightning Code* (NLC), and *Occupational Safety and Health Administration* (OSHA) regulations.

2.2 Requirements

PS^3 requirements were established based on the mission need documented in Revalidation of CIP F-11. Requirements are based in several considerations, including:

?? Lightning and transient noise voltage resistant power in accordance with Institute of Electrical and Electronic Engineering (IEEE), NEC, and OSHA standards.

?? Appropriate OSHA, Lightning Protection Council (LPC), and National Fire Protection Association (NFPA) standards in grounding, bonding, and lighting protection, and electrical wiring systems for FAA facilities.

?? A secure data transmission path for Remote Maintenance Monitoring (RMM) and security measures in place at all power sites.

?? Adherence with Federal and State environmental regulations.

?? Adherence with installation methods to mitigate the potential of seismic events.

?? NAS operational availability of quality power at all times.

A summary of some of the key, high-level system requirements is provided below. For a detailed requirements description refer to the *Initial Requirements Document for Power System Sustainment and Support Programs (PS^3)*. Power system service is classified as defined in NAS SR-1000, *FAA NAS System Requirements Document*.

The PS^3 systems shall be able to:

?? Provide critical power systems to mission critical priority services that, if lost, would prevent the NAS from exercising safe separation and control over aircraft. Critical power distribution systems operate for the uninterrupted control of air traffic by providing highly reliable conditioned power. Critical power has a reliability, maintainability, and availability (RMA) of .999998.

?? Provide essential power systems to services that, if lost, would reduce the capability of the NAS to exercise safe separation and control over aircraft. Essential power distribution systems supply power to environmental and operational services that are required to sustain NAS critical systems/equipment. Essential power has a RMA of .9998.

?? Provide routine power systems to services that, if lost, would not significantly degrade the capability of the NAS to exercise safe separation and control over aircraft. Building services power systems supply power to NAS systems/equipment that can be shed without major or immediate impact on air traffic operations. Routine power has a RMA of .998.

3.0 PS^3 IN PERSPECTIVE

The IAT found that an appreciation for the near-term needs of this program can only be gained in the context of the program's total requirements. This section describes the size and characteristics of the FAA's total power systems inventory, which should serve as a reference point as one reads the remainder of the analysis.

3.1 Total Inventory and Age of Systems

Based on data provided by the NIPS PT, Table 3-1 shows the approximate number of power systems currently in the NAS and the proportion of each category that is estimated to have exceeded its ESL. It shows that most of the batteries, engine generators, power cables, and lightning protection infrastructure have exceeded their service lives.

Table 3-1. Total Power Systems Inventory

PROGRAM	Number of Systems in NAS	Proportion Exceeding ESL
Batteries	8680	0.97
Engine Generators	2960	0.97
Lightning Protection, Grounding, Bonding, and Shielding	2470	1.00
Power Cables	2860	0.71
Uninterruptible Power Supplies	620	0.05

3.2 Replacement Timeframes: Steady State Versus Recent Funding

Based on a bottoms-up analysis of each system's inventory and service life, steady state replacement based on service life would cost approximately $100 million annually. At a $100 million annual funding level, the entire inventory would be replenished every 15-20 years (see Figure 8-1).

Recent funding for the PS^3 program has not approached such levels. In fact, over the past five years (FY 1996-FY 2000), the program has received a total of $75 million and no more than $19 million in any one year. At this average annual funding level of $15 million, it would take more than 100 years to replenish the existing inventory one time.

3.3 Historical Emergency Expenditures

The low funding levels in recent years has not allowed for disciplined program planning or execution. "Management by emergency" has become the norm within the PS^3 program. As priorities are developed into an annual work plan, they are disrupted by "pop-ups" or emergencies that must be addressed. Emergencies are due to facility outages or the expectation of an imminent facility outage.

Table 3-2 shows examples of unplanned expenditures due to emergency failures in recent years. These examples total more than $5,000,000, which was absorbed within the program and displaced other projects.

Table 3-2. Examples of Unplanned/Emergency Replacements

Project	City	State	FAC Type	Project	City	State	FAC Type
UPS	FAIRBANKS	AL		UPS	LAS VEGAS	NV	ATCT/TR
TRAINING	OKLAHOMA CITY	OK	Academy	UPS/ELEC UPG	BOSTON	MA	ATCT -stars
E/G & ELEC UPG	MACON	GA	AFSS	battery rep	ANCHORAGE	AK	ICSS
UPS	LOS ANGELES	CA	ALSF	E/G	SAN JOSE	CA	LOC
E/G	WASHINGTON	DC	ALSF	POWER CABLE	BARROW	AK	MALSR
battery rep	FALLON	NV	ARSR	POWER CABLE	NASHUA	NH	MALSR
battery rep	BEALE	CA	ASR	E/G	GUAM		MOBILE E/G
battery rep	MEMPHIS	TN	ASR	POWER CABLE	HAINES	AK	NDB
battery rep	WINDSOR LOCKS	CT	ASR	E/G	BALDWIN HILLS	CA	RCAG
UPS	ST LOUIS	MO	ASR	battery rep	MONTGOMERY	AL	RCLR
UPS	DEADHORSE	AK	ATCBI	POWER CABLE	DUTCH HARBOR	AK	REIL
battery rep	ALBUQUERQUE	NM	ATCT	LPGBS	MOUNTAIN VIEW		RTR
UPS	CHANTILLY	VA	ATCT	battery rep	OFFUTT AFB	NE	TRACO
battery rep	CHARLOTTE	NC	ATCT	battery rep	WESTBURY	NY	TRACO
battery rep	DENVER	CO	ATCT	UPS /LPGBS	OAKLAND	CA	TRACON
LPGBS E	ELMIRA	NY	ATCT	E/G	FORT YUKON	AK	VOR
EG	LIHUE	HI	ATCT	battery rep	GREENSBORO	NC	VOR
battery rep	MEMPHIS	TN	ATCT	POWER CABLE	LEVEL ISLAND	AK	VOR
battery rep	ORLANDO	FL	ATCT	POWER CABLE	SISTER ISLAND	AK	VOR
ELEC UPG	SEATTLE	WA	ATCT	E/G	BUCKLEY	AZ	VORTAC
E/G	W PALM BEACH	FL	ATCT	E/G	LAWRENCEVILE	VA	VORTAC
battery rep	WILLMINGTON	NC	ATCT				
BATTERIES	Windsor Locks	CT	ATCT				

3.4 Commercial Power: Deregulation and Restructuring

The Federal Energy Regulatory Commission's Order No. 888 of 1996 began the process of converting power systems in the United States into a network in which electricity could be bought and sold freely. Instead of one utility owning the generator, transmission lines, substations and distribution lines, deregulation is expected to result in separate ownership of various segments of the grid. Electric utilities bid for electricity from various generators in two auctions, one that occurs the day before the power is scheduled to be used and another that occurs an hour before. Critics of deregulation say that the complexity of the grid, compounded by a proliferation of auction data, will lead to an increase in the number of blackouts.

In July and August of 1999, limited brownouts and blackouts occurred in New York, New Jersey, Chicago, the mid-Atlantic region, and the south-central states when peak demand for power overwhelmed system capacity. More extensive power system failures occurred in the West in 1998.

A reliability assessment report titled, *"The Reliability of Bulk Electric Systems in North America for the Period 1998-2007"* and conducted by the North American Electric Systems Reliability Council, documented rapidly declining capacity margins in the face of increasing demand for electric power. Reports from many areas afflicted by failures indicated that local utilities have been reluctant to invest in replacement equipment due to uncertainty as to how these investments would be recouped. Additionally, little new transmission infrastructure has been built, even as the wholesale exchanges of power has grown.

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4.0 ANALYSIS METHODOLOGY

4.1 General Overview

A primary purpose of this IA is to show the types and amount of work that can be performed under each funding scenario. The IAT, therefore, spent considerable time developing a method to collect and prioritize the near-term needs of the program. Based on the lists of project priorities, the team estimated the costs and benefits associated with each funding scenario. The following sections describe the team's methodology in detail.

4.2 Funding Scenarios

Based on information available early in the IA, management provided three funding scenarios to bound the analysis: $100, $130, and $160 million over the three years. Management also allowed the team discretion to add more scenarios if warranted, which the team did after prioritizing and totaling the near-term needs of the program. The team elected to add a scenario (Alternative 6) that would capture the total near-term needs, as well as two others to fill in between the total needs and the original scenarios. In total, therefore, the IAT analyzed six funding scenarios, as follows (dollars are approximate and represent totals over the three-year period):

?? Alternative 1: $100 million

?? Alternative 2: $130 million

?? Alternative 3: $160 million

?? Alternative 4: $210 million

?? Alternative 5: $260 million

?? Alternative 6: $310 million

4.3 Data Collection and Prioritization

4.3.1 Sources of Data

The IAT obtained information on program needs from the Regional Tracking Program (RTP) and from program managers within ANS-600. The IAT compiled the data into a master list and edited it to remove duplicates and other projects that the team believed inappropriate to address in the near-term (e.g., systems that had not exceeded the service life, systems at facilities due for decommissioning or major renovations in the near future).

4.3.2 Prioritization Methodology

The IAT adopted the following methodology for prioritizing the sustainment projects:

?? First, the IAT divided projects into two broad categories—One-Time Activities and Ongoing Sustainment Activities—and into individual program lists as follows:

- ?? One-Time Activities: ARTCC Critical and Essential Power System (ACEPS, including busway replacements, EG maintenance, monitoring and diagnostics, fuel system upgrade, and training materials update); battery monitoring, training facility, and Critical Power Distribution System (CPDS) installations
- ?? Ongoing Sustainment Activities: battery replacements; replacement of certain engine generators with direct current (DC) systems; engine generator replacements; LPGBS replacement and installation; power cable replacement; and uninterruptible power supply (UPS) replacement and installation

?? The IAT then assigned relative priorities to the one-time activities, as follows:

- ?? Based on the Health of ACEPS Study (July 1999), the IAT decided that two ACEPS activities could be deferred beyond fiscal year 2004: the fuel system upgrade and the training materials upgrade. The remaining ACEPS activities (busway replacements, EG maintenance, and monitoring and diagnostics) were determined to be priorities, and IAT members agreed that they should be funded within the 2002-2004 timeframe.
- ?? Based on information provided by ANS-600, the IAT concluded that the installation of battering monitoring equipment was also a priority and should be completed in the 2002-2004 timeframe. The monitoring equipment will help to determine how to address problems with sealed batteries, which are expiring well in advance of their estimated service lives.
- ?? Of the potential CPDS projects, the IAT concluded that the New York TRACON and the Philadelphia Tower were the top priorities. This decision was based on the age and supportability of those facilities.
- ?? The IAT also concluded that the training facility should remain among the top priorities within the one-time activities. The need for a new facility is driven by the CPDS program. Currently, CPDS training takes place in new facilities before they are deployed, but there is no permanent training facility that provides the opportunity to train on each of the three CPDS designs.

?? The IAT then developed objective criteria for ranking ongoing sustainment activities:

- ?? For engine generators, battery replacements, DC systems, uninterruptible power supplies, and power cable, the following equation was used to calculate the priority rank: (age divided by the service life of the system to be replaced) X (ATC facility level) X (criticality of the service provided)[1]
- ?? For lightning protection, grounding, bonding, and shielding, the following equation was used: (risk of lightning strike in given geographic area) X (ATC facility level) X (criticality of the service provided)
- ?? And for battery monitoring, the equation was as follows: (ATC facility level) X (criticality of the service provided)

[1] ATC facility level refers to an ordinal rank of 1-12 that specifies the activity level at that facility, 12 being the highest. Criticality refers to the service's RMA and is assigned a 2, 3, or 5, according to the number of "9s" required.

?? Next, the IAT applied the ranking criteria and sorted the project lists according to the priority ranks.

?? The IAT then developed per-project costs for each program and project type and employed them to estimate total costs for each program list and for F-11 as a whole.

?? Finally, the IAT estimated individual program needs as a percentage of the total and applied the proportions consistently across all funding scenarios.

The results of the prioritization process fed into the cost and benefits analyses, as described in the following section.

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5.0 ECONOMIC ANALYSIS

5.1 Life Cycle Costs

Life cycle costs for the PS^3 program include site surveys/engineering, acquisition, installation, logistics, construction (when applicable), operations and maintenance, and disposal. The cost estimates in Table 5.1 show the Facilities and Equipment (F&E) cost estimates for the team's six alternatives. Table 5.2 shows the Operations and Maintenance (O&M) costs for the preferred alternative, Alternative 5. Costs are presented in escalated dollars.

5.1.1 Acquisition (F&E) Costs

The F&E cost estimates are based on *most likely* costs and, on a per-unit basis, remain the same throughout each alternative. High and low estimates for the sensitivity analysis were prepared based on estimating judgment. Little uncertainty was estimated because (1) contracts are in place for many of the systems, (2) systems are available through General Services Administration (GSA) contracts, and (3) other systems are commercially available. Only when quantities vary do F&E costs change from one alternative to the next.

A sensitivity analysis was run using the *Crystal Ball* software package. Utilizing Monte Carlo simulation, Crystal Ball ran 1,000 iterations using the *most likely*, *high*, and *low* per-unit costs the team developed to calculate high-confidence cost estimates.

The following sections include general assumptions and methods used to compile the cost estimates. A more detailed basis of estimate is provided in Attachment 2.

5.1.1.1 Assumptions and Constraints

The F&E cost estimates are based on the following assumptions and constraints:

1. Costs were estimated in constant 2000 dollars and escalated to current (then-year) dollars according to the Office of Management and Budget (OMB) inflation rate guidelines (February 2000).
2. F&E costs were estimated for a three-year period, FY 2002 through FY 2004.[2]
3. The list of power projects to be accomplished over the three-year period was collected from the ANS-600 program managers and the nine FAA regions (via the RTP). Projects were segmented into the individual alternatives based on the prioritization methodology discussed in Section 4.3.
4. The FAA has been acquiring these systems for several years; therefore, a wide range of historical data was available for use in developing F&E costs.
   - ?? Cost data are available via current contracts or the GSA schedule.
   - ?? Historical data aided in developing installation costs for each element.

[2] The Power Systems IAT was directed to examine this three-year period. This does not represent the optimal number of years for total F&E requirements.

?? Engineering judgment was applied when necessary.

?? Regional personnel provided funding requests for new programs based on costs of implementing similar programs.

5. Per-unit costs were developed for each program element (batteries, engine generators, UPS, etc.).

?? The number of available sizes for each element determined the number of "per unit" cost estimates for each per system. For example, Engine Generators were divided into three categories: small, medium, and large, for estimating purposes.

?? Certain engineering-related costs can vary widely between the nine FAA regions. Per unit costs were developed on a national level using an average historical cost for each applicable element. Potential low and high estimates were captured with three-point estimates, and variances were considered as part of the cost sensitivity analysis.

5.1.1.2 F&E Funding Alternatives

Below is the summary table of the six alternatives developed. FY05 is included due to LPGBS requirements. The alternatives as presented here include inflation and reflect an 80% confidence level.

Table 5-1. PS^3 Alternatives (Millions of Then-Year Dollars)

	FY02	FY03	FY04	FY05	TOTAL
Alternative 1	$26.6	$48.9	$23.8	$3.3	$102.7
Alternative 2	$38.7	$52.3	$41.8	0.0	$132.8
Alternative 3	$48.7	$59.1	$51.4	$4.4	$163.5
Alternative 4	$58.3	$72.2	$74.3	$12.3	$217.1
Alternative 5	$70.1	$91.0	$88.6	$10.9	$260.6
Alternative 6	$101.9	$134.6	$76.3	$0.5	$313.4

*Attachment 2 provides greater detail on the costs for each alternative.

Table 5-2 presents, by alternative, the three-year cost totals for the various PS^3 program elements. The totals reflect the priorities established by the IAT and described in Section 4.0.

Table 5-2. Summary of Cost Alternatives

	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6
One-time Costs						
ACEPS Busway Replacements	$4.1	$4.1	$4.1	$4.1	$4.1	$4.1
ACEPS EG Maintenance	$2.4	$2.4	$2.4	$2.4	$2.4	$2.4
ACEPS Monitoring & Diagnostics	$2.9	$2.9	$2.9	$2.9	$2.9	$2.9
ACEPS Fuel System Upgrade	$0.0	$0.0	$0.0	$0.0	$0.0	$10.0
ACEPS Training	$0.0	$0.0	$0.0	$0.0	$0.0	$6.4
Battery Monitoring	$3.2	$3.2	$3.2	$3.2	$3.2	$3.2
Training Facility	$14.0	$14.0	$14.0	$14.0	$14.0	$14.0
CPDS	$18.1	$18.1	$18.1	$18.1	$18.1	$18.1
Subtotal	***$44.8***	***$44.8***	***$44.8***	***$44.8***	***$44.8***	***$61.1***
Ongoing Infrastructure Costs						
Battery Replacements	$5.5	$9.0	$12.4	$18.5	$23.3	$27.2
DC Systems	$3.0	$5.3	$6.9	$10.4	$12.9	$15.3
EG	$22.3	$36.9	$50.9	$75.4	$95.6	$113.2
LPGBS	$10.2	$15.1	$21.6	$33.7	$44.2	$51.0
Power Cable	$1.8	$3.3	$4.2	$6.0	$7.3	$8.7
UPS	$5.5	$8.9	$13.1	$18.7	$22.9	$27.4
Contract Support	$9.6	$9.6	$9.6	$9.6	$9.6	$9.6
Subtotal	***$57.9***	***$88.0***	***$118.7***	***$172.3***	***$215.8***	***$252.2***
TOTAL (High Confidence)	**$102.7**	**$132.8**	**$163.5**	**$217.1**	**$260.6**	**$313.4**

Table 5-3 presents the number of sites addressed under each funding alternative. The numbers presented are totals over the three-year analysis period.

Table 5-3. Number of New Projects Funded per Alternative

	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6
One-time Costs						
ACEPS Busway Replacements	23	23	23	23	23	23
ACEPS EG Maintenance	25	25	25	25	25	25
ACEPS Monitoring & Diagnostics	24	24	24	24	24	24
ACEPS Fuel System Upgrade	0	0	0	0	0	25
ACEPS Training	0	0	0	0	0	1
Battery Monitoring	48	48	48	48	48	48
Training Facility	1	1	1	1	1	1
CPDS	2	2	2	2	2	2
Subtotal	***123***	***123***	***123***	***123***	***123***	***149***
Ongoing Infrastructure Costs						
Battery Replacements	9	19	28	61	329	727
DC Systems	36	68	90	140	175	208
EG	70	120	166	255	334	398
LPGBS	6	9	12	18	25	103
Power Cable	2	11	21	24	39	59
UPS	12	19	28	40	52	65
Contract Support	3	3	3	3	3	3
Subtotal	***138***	***249***	***348***	***541***	***957***	***1563***
GRAND TOTAL	**261**	**372**	**471**	**664**	**1080**	**1712**

5.1.2 Operations & Maintenance (O&M) Costs

5.1.2.1 Ground Rules and Assumptions

O&M cost estimate assumptions are summarized below:

1. Costs are calculated in constant FY00 and then-year dollars.
2. Then-year costs are based on OMB inflation indices for FY00, dated January 2000.
3. Life cycle costs for nineteen years were estimated, from FY02 through FY20.
4. Base year costs are assumed to remain constant in the out years.
5. Preventive maintenance costs are included under the corrective maintenance cost element.
6. The General Schedule Salary Tables for the year 2000 are used to estimate government salaries.
7. The equipment and schedule for the preferred alternative were provided by the IAT.

5.1.2.2 Methodology

This estimate was constructed using Automated Cost Estimating Integrated Tools (ACEIT) software. Data sources include actual contract costs, the Workload Information System (WIS), the Department of Energy's Energy Information Administration databases, equipment specifications, ANS-700's SmartSheets, and interviews (in person or by phone) with the appropriate FAA and support contractor personnel. Estimating methodologies with their corresponding data sources are provided in Attachment 2. Estimates were prepared for two alternatives: a reference or baseline case and Alternative 5, the IAT's preferred alternative. O&M estimates (for the other alternatives) were linearly interpolated between these two points. Table 5-4 shows Alternative 5 O&M estimates that should be considered a preliminary estimate.

5.1.2.3 O&M Costs

Table 5-4. PS^3 Preferred Alternative - O&M Costs (Then-Year $M)

Cost	FY02	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11
In-Service Management	$72.0	$73.2	$74.8	$76.4	$78.0	$79.5	$81.1	$82.8	$84.4	$86.1
Corrective Maintenance	$51.1	$51.8	$52.7	$53.7	$54.8	$55.9	$57.0	$58.2	$59.3	$60.5
Shift Augmentation	$1.9	$1.9	$2.0	$2.1	$2.1	$2.1	$2.2	$2.2	$2.3	$2.3
Program Support	$1.8	$1.8	$1.9	$1.9	$1.9	$2.0	$2.0	$2.1	$2.1	$2.1
Logistics	$10.9	$11.1	$11.6	$11.9	$12.2	$12.5	$12.7	$13.0	$13.2	$13.5
In-Service Training	$1.0	$1.0	$1.0	$1.1	$1.1	$1.1	$1.1	$1.2	$1.2	$1.2
Second Level Engineering	$2.9	$3.0	$3.0	$3.1	$3.2	$3.2	$3.3	$3.4	$3.4	$3.5
Infrastructure Support	$2.5	$2.5	$2.5	$2.6	$2.6	$2.7	$2.7	$2.8	$2.9	$2.9
Cost	**FY12**	**FY13**	**FY14**	**FY15**	**FY16**	**FY17**	**FY18**	**FY19**	**Total**	
In-Service Management	$87.8	$89.6	$91.4	$93.2	$95.1	$97.0	$98.9	$100.9	$1,542.2	
Corrective Maintenance	$61.8	$63.0	$64.2	$65.5	$66.8	$68.2	$69.5	$70.9	$1,084.9	
Shift Augmentation	$2.4	$2.4	$2.5	$2.5	$2.6	$2.6	$2.7	$2.7	$41.5	
Program Support	$2.2	$2.2	$2.3	$2.3	$2.4	$2.4	$2.5	$2.5	$38.4	
Logistics	$13.8	$14.0	$14.3	$14.6	$14.9	$15.2	$15.5	$15.8	$240.7	
In-Service Training	$1.2	$1.3	$1.3	$1.3	$1.3	$1.4	$1.4	$1.4	$21.6	
Second Level Engineering	$3.6	$3.6	$3.7	$3.8	$3.8	$3.9	$4.0	$4.1	$62.5	
Infrastructure Support	$3.0	$3.0	$3.1	$3.2	$3.2	$3.3	$3.3	$3.4	$52.2	

5.2 Benefits

5.2.1 Methodology

Two approaches were used to determine benefits for power systems. The System Outage Disruption Model (SODM) was used to estimate NAS delays caused by power system outages. Future outage trends were estimated using the National Airspace Reporting System (NAPRS). These trends corroborated input from subject matter experts on power system obsolescence rates.

5.2.2 Future Outage Trends

Future outage trends were forecast using historical data from the NAPRS database. Occurrence and duration values were analyzed for unscheduled primary and standby electric power caused facility outages. Data were analyzed from FY 1985 through FY 1998. Regression analyses were performed using the historical data to derive 10-year trends. Polynomial, exponential,

logarithmic, power, and linear regression techniques were applied to the data sets. The polynomial regression showed the best fit, however the IAT believed the linear regressions were the most realistic.

?? Figures 5-1 and 5-2 show significant increases in power outage occurrences and durations, respectively, for primary and standby power.

?? Figure 5-3 shows increasing average mean time to repair (MTTR) for both primary and standby power failures.

?? Figure 5-4 presents a 10-year trend showing an increase in both outage occurrences and durations of approximately 100% based on FY93-98 data.

Figure 5-1. Outage Occurrences for Primary and Standby Power

Figure 5-2. Duration of Outages for Primary and Standby Power

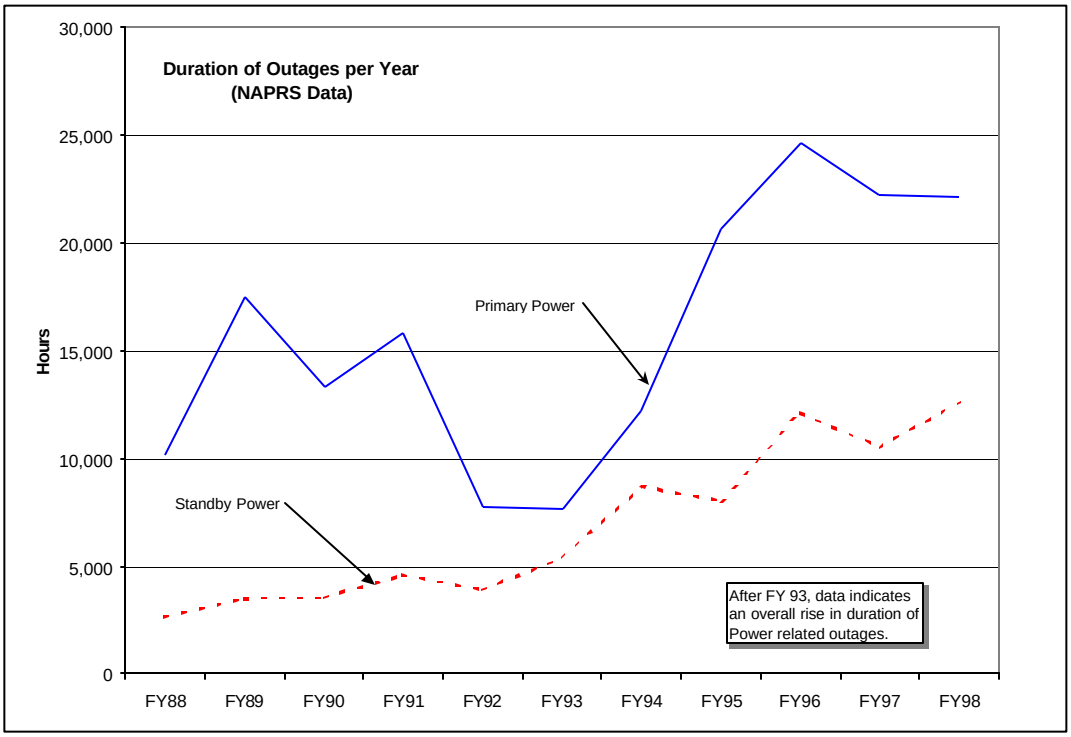


Figure 5-3. Average Mean Time to Repair for Primary and Standby Power Outages

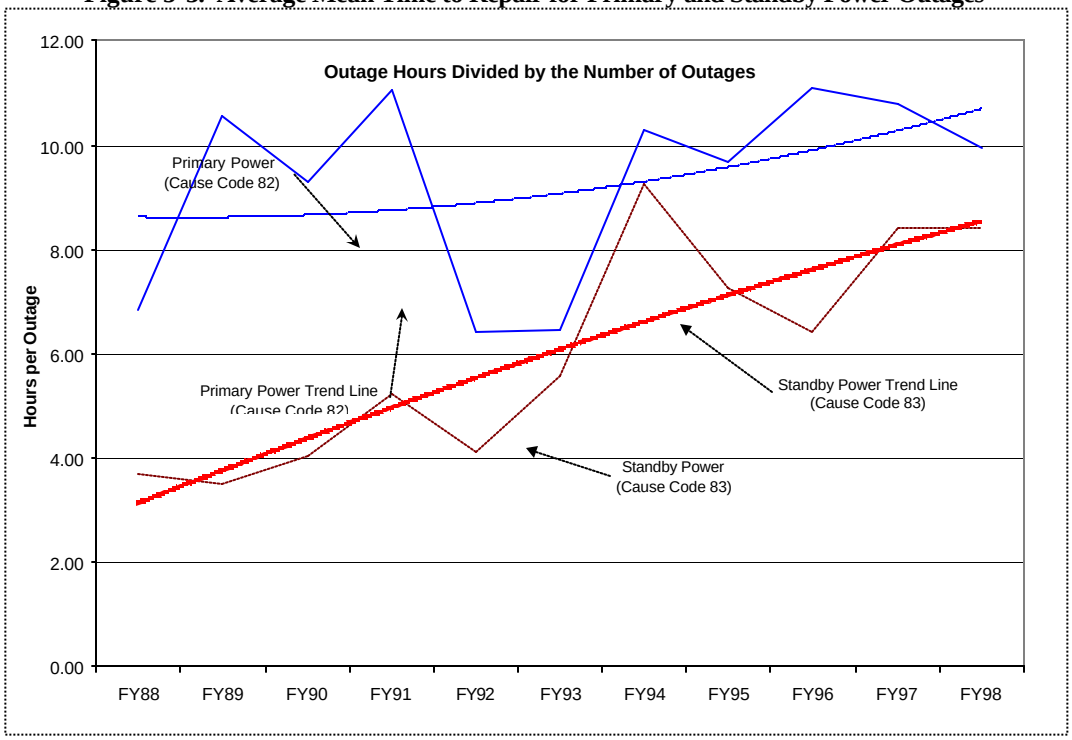
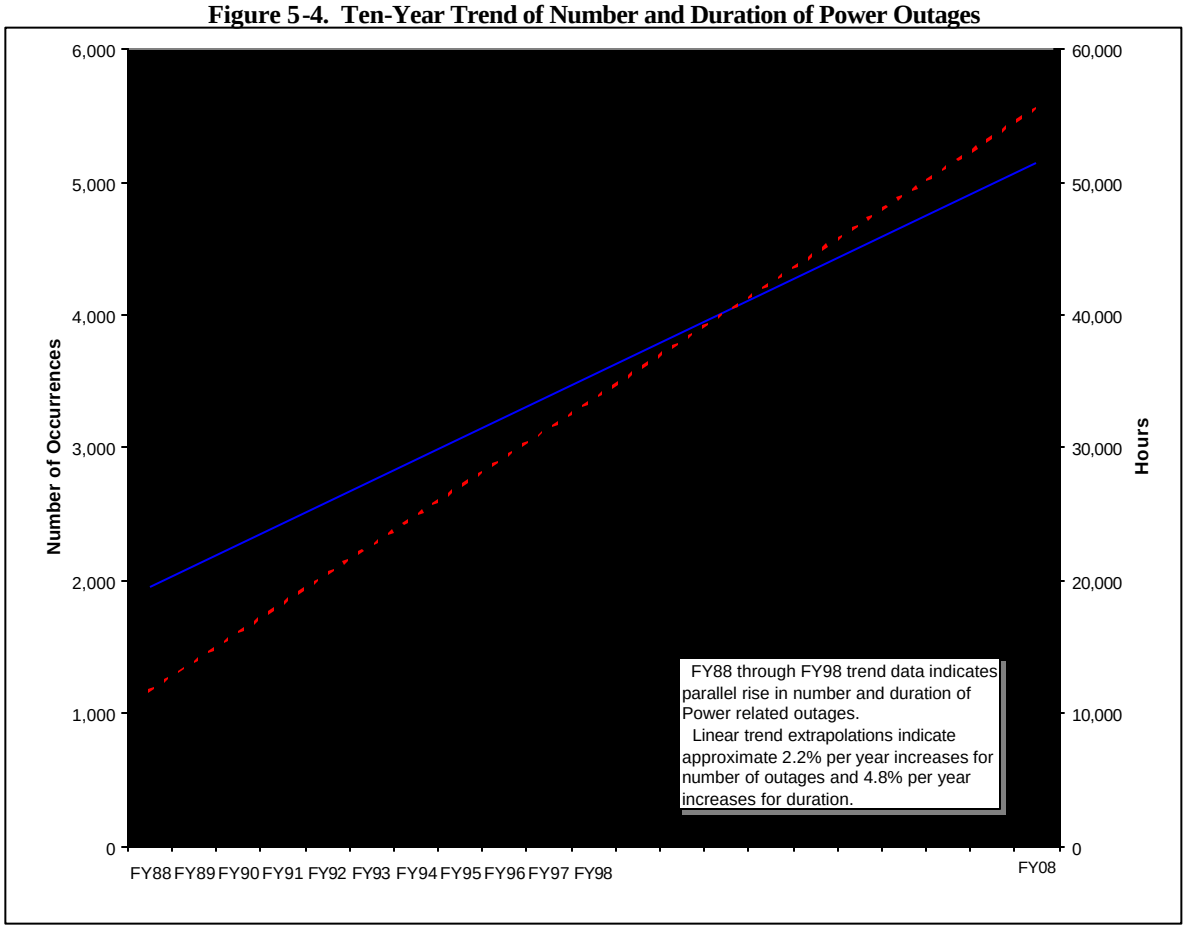


Figure 5-4. Ten-Year Trend of Number and Duration of Power Outages



5.2.3 System Outage Disruption Model

The Power Systems Benefits Team quantified user benefits using the SODM to project the future NAS disruption changes in mean time between failure (MTBF) and MTTR of power systems. SODM uses inputs for MTBF, MTTR, probability of delay, and reduced capacity parameters to generate the annual number of outages causing disruption and the duration of each outage caused by power systems at 39 major terminals and 20 centers. This is extended to the entire NAS by a factor of 1.45, which is the ratio between the modeled terminals' air carrier operations to total NAS air carrier operations. Using the demand during system outages, SODM generates median annual delay in minutes from 1,000 iterations using terminal hourly demand and terminal area forecasts (TAFs) of future operations.

Hourly demands were taken from 1998 Official Airline Guide (OAG) data sources adjusted for air taxis and general aviation. TAFs were derived from the December 1999 TAF from APO-200.

The Power Systems Benefits Team used system performance parameters for four scenarios (see Table 5-5). These scenarios were developed in consultation with subject matter experts who based their advice on industry data and the Health of ACEPS Study (see bibliography).

?? Current (FY 2000) system availability sustained (no future degradation)

?? 2% annual degradation in availability (MTBF and MTTR degrade by 2% per year over the analysis period)

?? 3% annual degradation in availability (MTBF and MTTR degrade by 3% per year over the analysis period)

?? 20% improvement in availability (Based on new power equipment, MTBF and MTTR improve 20% over current levels. This improvement takes effect in 2005 and remains constant through the analysis period.)

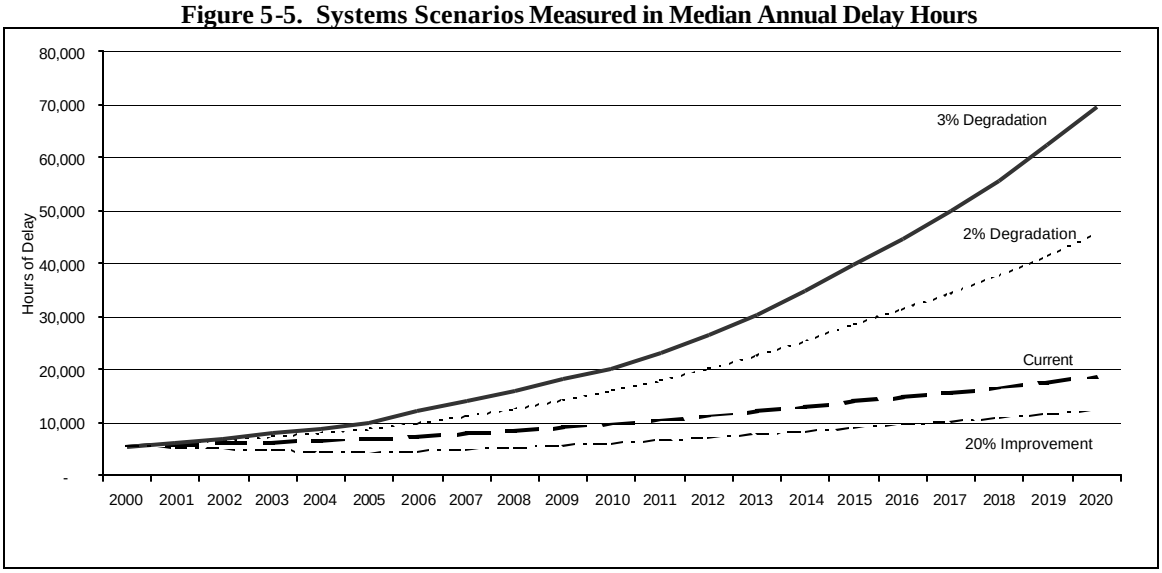
Table 5-5. Systems Scenarios MTBF and MTTR (Years)

	2% Degradation				3% Degradation				20% Improvement			
	Center		Terminal		Center		Terminal		Center		Terminal	
Year	MTBF	MTTR	MTBF	MTTR	MTBF	MTTR	MTBF	MTTR	MTBF	MTTR	MTBF	MTTR
2000	3.99	0.00029	0.68	0.00029	3.99	0.00029	0.68	0.00029	3.99	0.00029	0.68	0.00029
2005	3.61	0.00032	0.62	0.00032	3.44	0.00033	0.59	0.00033	4.79	0.00024	0.82	0.00024
2010	3.27	0.00035	0.56	0.00035	2.97	0.00038	0.51	0.00038	4.79	0.00024	0.82	0.00024
2015	2.97	0.00038	0.51	0.00038	2.56	0.00044	0.44	0.00044	4.79	0.00024	0.82	0.00024
2020	2.69	0.00042	0.46	0.00042	2.21	0.00052	0.38	0.00052	4.79	0.00024	0.82	0.00024

NAS disruption is calculated from the reduction in capacity during each outage and the total excess demand during the outage. Aircraft not able to land within their scheduled block "spill" into the next block causing a delay. The delay minutes generated by SODM are attributable to capacity constraints caused by power outages. Future delay increases are based on the TAFs of future air carrier operations.

The Power Systems Benefits Team simulated the median annual disruption for years 2000, 2005, 2010, 2015, and 2020 for each system scenario. Inclusive years were interpolated using a spreadsheet algorithm and the results plotted as hourly delay (median annual delay minutes/60) by scenario and year. Figure 5-5 shows the annual median hours of delay by improvement or degradation scenario.

Figure 5-5. Systems Scenarios Measured in Median Annual Delay Hours



To determine the benefits given a future demand and degradation or improvement scenario, the Power Systems Benefits team developed three benefits scenarios showing the differences in median annual delay hours between each scenario by year (see Figure 5-6).

1. Best Case (3% Degradation – 20% Improvement)
2. Most Likely Case (3% Degradation – Current parameters maintained)
3. Worst Case (3% Degradation – 2% Degradation)

Figure 5-6. Benefits Scenarios Median Annual Hours Difference

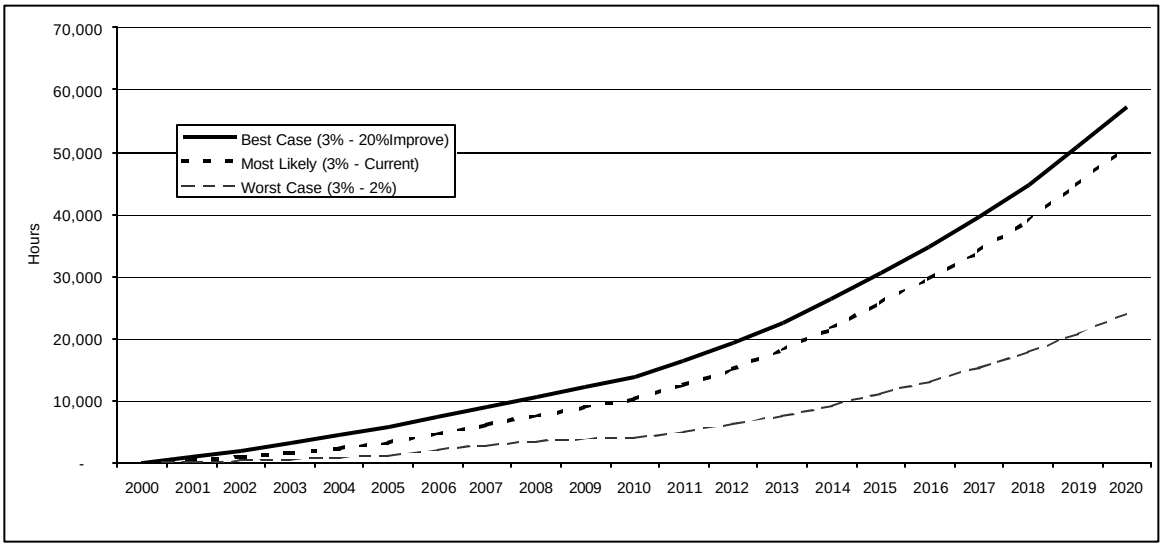


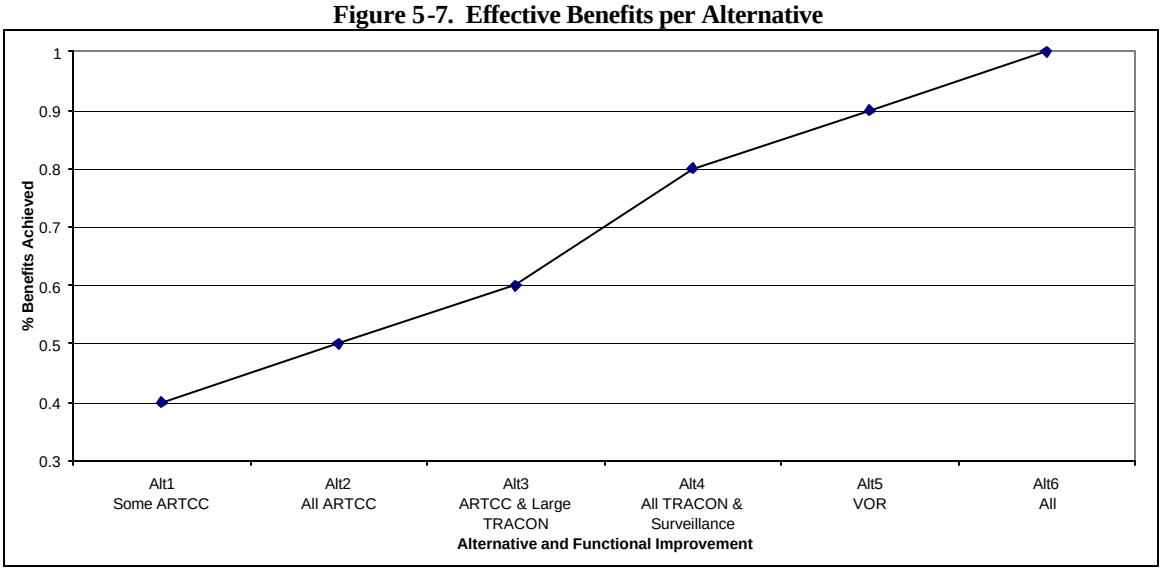
Table 5-6 monetizes the differences in median annual delay hours for the three benefit scenarios using Airline Direct Operating Costs (ADOC) block hour costs ($2104/hour) and Passenger Value of Time (PVT) ($26.7/hour; 90 passengers/plane).

Table 5-6. Avoided Arrival Delay Costs by Benefits Scenario

Scenario	Best Case	Most Likely	Worst Case
Arrival Delay Hours	352,000	286,000	126,000
ADOC (BY $)	$741.6M	$602.5M	$264.7M
PVT (BY$)	$855.6M	$694.9M	$305.4M
Arrival Delay Total (BY$)	$1,597.2M	$1,297.3M	$570.1M
Extension to NAS Total (BY)	$2,315.9M	$1,881.0M	$826.7M
Total NAS ($ PV)	$917.5M	$722.1M	$314.6M

The IAT then developed an "effectiveness factor" based on the quantity and functionality of equipment replaced for each funding alternative. This factor was applied to the estimated benefits (Figure 5-7).

Figure 5-7. Effective Benefits per Alternative



Lastly, Table 5-7 shows the present value of the benefits achieved by alternative.

Table 5-7. Discounted Benefits (FY 2003 – 2019)

Scenario	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6
Best Case	$359.6M	$449.7M	$539.0M	$716.7M	$807.0M	$901.4M
Most Likely	$285.0M	$356.3M	$427.3M	$568.6M	$640.1M	$713.7M
Worst Case	$124.4M	$155.5M	$186.5M	$248.3M	$279.4M	$311.4M

5.3 Economic Analysis Summary

The economic analysis considered the FAA life cycle costs, FAA life cycle benefits (cost savings to the FAA), net present value (NPV), and benefit/cost (B/C) ratio to evaluate the six alternatives.

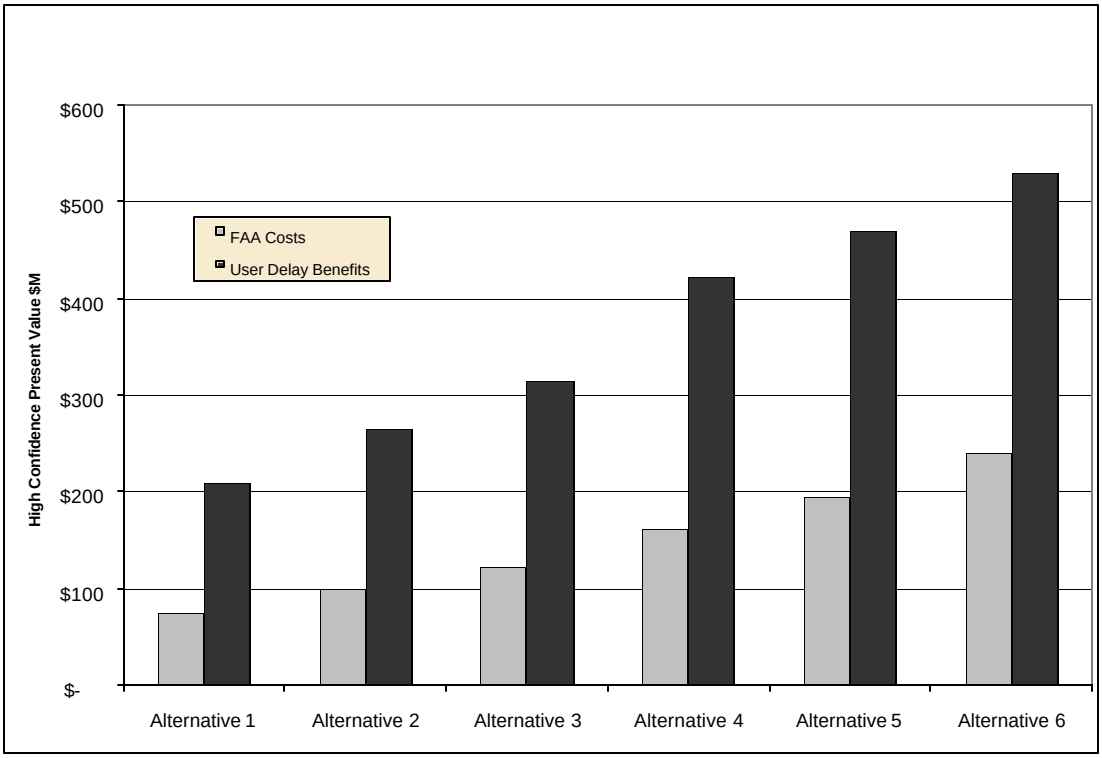
The cost analysis was based on conservative point estimates, or most likely values, provided by the NIPS PT. This analysis has identified the major cost drivers and cost uncertainty areas. Each of the benefits scenarios was applied to the six funding alternatives analyzed by the IAT. Using Crystal Ball, high confidence benefits, costs, NPV, and B/C ratios were calculated for each funding alternative.

Table 5-8 summarizes the economic analysis of the alternatives. It represents the 80% confidence level for the NPV and B/C ratios; that is, based on the sensitivity analysis results, there is an 80% certainty that the B/C and NPV will be at least that amount. Figure 5-8 shows the benefits and costs of power systems funding alternatives.

Table 5-8. Economic Analysis Summary[1] (Millions (M)

Alternative	Net Present Value	Benefit/Cost Ratio
Alternative 1	$138.0M	2.9
Alternative 2	$167.3M	2.7
Alternative 3	$189.5M	2.6
Alternative 4	$265.0M	2.7
Alternative 5	$279.9M	2.5
Alternative 6	$296.4M	2.3

Figure 5-8. Benefits and Costs of Power Systems Funding Alternatives



For the cost estimates, a cost sensitivity analysis using the Monte Carlo Simulation of the cost element was prepared for the all alternatives. Uncertainty was embedded within the cost estimates through the use of ranges on specific parameters. The 80th percentile values were recorded and are shown in Table 5-9 as the projected estimate.

Table 5-9. Funding Profiles (80% confidence)

	FY 02	FY 03	FY 04	FY 05	Total
Alternative 1	$26.6M	$48.9M	$23.8M	$3.3M	$102.7M
Alternative 2	$38.7M	$52.3M	$41.8M	$0.0M	$132.8M
Alternative 3	$48.7M	$59.1M	$51.4M	$4.4M	$163.5M
Alternative 4	$58.3M	$72.2M	$74.3M	$12.3M	$217.1M
Alternative 5	$70.1M	$91.0M	$88.6M	$10.9M	$260.6M
Alternative 6	$101.9M	$134.6M	$76.3M	$0.5M	$313.4M

5.4 Cost Ranges

The sensitivity analysis tool highlights those cost areas that have the most effect on the total cost over the range of their elements from low to high. The major F&E cost drivers for power systems are UPS, Training Facility, Battery Replacements, Engine Generators, and LPGBS. For example when the elements that make up the UPS costs[3] are varied over their ranges, the UPS costs cause the overall cost estimate to vary from $249.5M to $268.9M.

5.5 New System Needs

In addition to the sustainment needs identified previously in Section 5.0, the IAT identified three new programs with potential unfunded power requirements in the FY02-04 period. They include STARS, NEXCOM, and ATCBI-6. Based on information obtained from those product teams, the IAT estimates that the power infrastructure will have to be upgraded at numerous sites to support these programs. To date, the total estimated cost of such upgrades has not been included in either F-11 or the baselines for the three programs.

Table 5-10 shows the IAT's estimates of the number of systems that will be required to meet the needs of the three programs. Table 5-11 translates the requirements into costs. These estimates should be viewed as preliminary, as the program schedules on which they are based are not firm. In addition, the requirements are subject to discussion in certain cases and, once issues are resolved, these cost estimates will require refinement.
Given the preliminary nature of these estimates, the IAT has elected not to include these costs in the F-11 baseline at this time. They are identified to highlight the fact that they exist and that coordination between the NIPS PT and STARS, NEXCOM, and ATCBI-6 product teams is necessary to properly baseline the costs.

Table 5-10. Potential Unfunded Requirements for New Systems

New ATC System	Power Element	Number Required
STARS	Engine Generator	56
STARS	Uninterruptible Power Source	56
STARS	LPGBS—medium	37
STARS	LPGBS—small	37
NEXCOM	LPGBS—RCAG	216
ATCBI-6	Engine Generator	55

Table 5-11. Estimated Costs of Unfunded Requirements

Per Year Cost	No. Req'd	FY02	FY03	FY04	Total
Engine Generators	111	$11.7M	$11.9M	$12.2M	$35.8M
UPS	56	$7.3M	$7.5M	$7.2M	$22.0M
LPGBS	290	$9.3M	$9.5M	$9.5M	$28.3M
Total	**457**	**$28.3M**	**$28.9M**	**$28.9M**	**$86.1M**

[3] Site survey, design, equipment, construction, integration and implementation

~~4.5 Total Power Systems Needs~~

~~Below is a summary of all FAA power systems requirements in constant 2000 dollars.~~

~~Sustainment Power Requirements~~

~~Program~~	~~Number of Sites~~	~~Cost~~
~~Battery Replacement~~	~~8681~~	~~$69.2M~~
~~Engine Generators~~	~~2956~~	~~$850.9M~~
~~LPGBS~~	~~2466~~	~~$219.5M~~
~~Power Cable~~	~~2864~~	~~$98.6M~~
~~Uninterruptible Power Supplies~~	~~615~~	~~$250.5M~~
~~Total~~		**~~$1,488.7M~~**

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6.0 RISK ASSESSMENT

The risk assessment process provides an overall measure of the likelihood that the recommended investment decision will ultimately result in a successful outcome. It is intended to identify the possibility that the alternative solutions under consideration may not deliver projected benefits, either in whole or in part, and the consequences of such failures. The assessment examines the entire expected life cycle of candidate alternatives, and the programmatic risks that can result from uncertainties in the concept of an alternative, or from problems encountered during its design, development, implementation, or operation. The risk assessment addresses the perceived accuracy of benefit and cost estimates, whether or not the causal relationships between an alternative and its projected benefits are clearly understood, and whether or not the alternatives are sufficiently defined to enable costs and benefits to be estimated. The assessment addresses risks in achieving technical performance, operational effectiveness, supportability, and other factors. Further, the risk assessment considers linkages and dependencies on the performance of projects or activities outside the scope of the immediate investment decision that are necessary for program success.

A determination has been made for each risk facet of the relative probability that an adverse event will occur (low, medium, or high), and a similar judgment has been made of the impact severity of such an event (minor, moderate, or substantial). These determinations have been based upon discussions during working sessions of the investment analysis team, follow-up questions to team members with specific expertise, and review of the risk assessment by the entire team. Activities outside the scope of the alternatives or control of the IPT, but that are necessary to mitigate risk have also been recognized.[4] Specific risk facet definitions for the power systems investment analysis are presented in Appendix 4.A, and the detailed assessment by risk facet is presented in Appendix 4.B.

The most critical risk factors for the power systems program are funding and management risk. Any other significant risk factors are the consequence of funding and management issues. Unlike many other F&E programs, the power systems program does not (with some minor exceptions) involve the development of new technology or the fielding of new systems. Rather, it involves the sustainment and replacement of existing power-related components and equipment. This equipment is part of the basic, core infrastructure necessary to support the NAS; it simply is part of the physical plant that the FAA must maintain to operate the air traffic control system.

Historic funding levels have not been sufficient to replace much of this equipment as it has reached the end of its service life, and the facilities and systems included in the scope of this investment decision represent those components most overdue for replacement or refurbishment. Unlike most investment decisions, however, the alternatives being considered do not represent different conceptual or technological solutions. Rather, they represent different funding levels that correspond to different levels of effort in reducing this backlog of overdue replacement projects.

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[4] This risk assessment follows the basic principles and criteria outlined in **Risk Assessment Guidelines for the Investment Analysis Process**, July 1999 update, prepared for the FAA by the Volpe National Transportation Systems Center.

The IAT's recommended investment decision addresses a significant portion of near-term requirements, provides support beyond the largest facilities, decreases the risk of significant emergency replacements, and, relative to the total power systems inventory, do not represent an overly aggressive replacement schedule. However, funding for power systems infrastructure still must compete against other agency F&E programs and priorities. Many of these programs have more readily understood benefits. They function at the user end in the delivery of air traffic services, and consequently take on a greater sense of immediacy. In some cases, these competing programs have strong political support.

Although this IA may document the deterioration of the NAS power infrastructure and its consequences in greater detail than previous efforts, it does not change the fundamental business processes that are used to manage infrastructure planning and budgeting. Basic infrastructure costs remain largely hidden and external to NAS planning activities. This results in a high probability that the recommended decision will not be sufficiently funded. As a result, implementation schedules will be delayed, projects will be deferred, and the desired benefits will not be achieved. Anticipated increases in outage rates, based on empirical evidence, will not be adequately controlled, and delay costs will grow. Further, because sustainment of infrastructure is a continuous responsibility, the consequences of deferring projects recommended in the three year timeframe of this investment decision will be compounded by replacement requirements that become current after FY04, as well as by power system investments necessitated by the introduction of new air traffic control (ATC) technologies. As outage rates increase, stakeholder pressure from the aviation user community and Congress can also be expected to grow.

Success of the power systems program is therefore dependent on activities that are outside the scope of the IPT. In the absence of business processes that fully capture these true costs of doing business, and that more systematically plan, manage, and budget for basic infrastructure needs, the deterioration of the power systems infrastructure will continue, most likely at an increasing rate. These processes need to be examined to determine how they can best be improved. At the very least, improvements in tracking the status of power system components, capturing age with respect to expected service life, and other relevant parameters, need to continue. This will enable the FAA to more methodically monitor the overall condition of the NAS power infrastructure, determine if it is gaining or losing ground on the cumulative problem, and remain continuously aware of the total magnitude of the situation.

Other more conventional risk facets, such as technical problems, supportability, or producibility, do not present any serious issues for this investment decision and are discussed in Appendix 4.B.

7.0 AFFORDABILITY ASSESSMENT

The Capital Investment Plan (CIP) currently contains the following funding profile (see Table 7-1) for PS^3. All figures are in millions of then-year dollars.

Table 7-1. CIP F-11 Funding Profile

	2002	2003	2004	EAC
CIP profile	$33.8	$47.5	$48.5	$129.8

Table 7-2 shows the F&E funding profiles associated with the IAT's recommended Alternative 5. All figures are in millions of then-year dollars. The FY 2005 funding represents funds needed to complete projects begun in FY 2004.

Table 7-2. Alternative 5

	2002	2003	2004	2005	EAC
IA profile	$70.1	$91.0	$88.6	$10.9	$260.6

When briefed to the SEOAT at the Affordability Assessment, Alternative 5 was determined to be unaffordable. The SEOAT then proposed two additional funding alternatives which the IAT calls the ASD-300 Alternative and the ATS Alternative. These are shown in Tables 7-3 and 7-4.

Table 7-3. ASD-300 Proposed Alternative (In Millions of Escalated Dollars)

	2002	2003	2004	2005	TOTAL
One-time Costs					
ACEPS Busway Replacements	$1.4	$1.4	$1.3		$4.1
ACEPS EG Maintenance	$0.8	$0.8	$0.8		$2.4
ACEPS Monitoring & Diagnostics	$1.0	$1.0	$1.0		$2.9
ACEPS Fuel System Upgrade					
ACEPS Training					
Battery Monitoring	$1.2	$1.0	$1.1		$3.2
Training Facility	$1.2	$9.6	$3.1		$14.0
CPDS	$3.1	$13.2	$1.8		$18.1
Subtotal	**$8.7**	**$27.0**	**$9.1**		**$44.8**
Ongoing Infrastructure Costs					
Battery Replacements	$3.7	$2.5	$4.2		$10.4
DC Systems	$1.9	$1.5	$2.5		$5.9
EG	$13.6	$8.9	$20.0		$42.6
LPGBS	$0.6	$7.3	$9.0	$2.3	$19.2
Power Cable	$1.9	$0.6	$0.7		$3.2
UPS	$5.4	$2.2	$2.5		$10.2
Contract Support	$3.1	$3.2	$3.3		$9.6
Subtotal	**$30.3**	**$26.2**	**$42.2**	**$2.3**	**$101.0**
GRAND TOTAL	**$39.0**	**$53.2**	**$51.3**	**$2.3**	**$145.8**

Table 7-4. ATS Proposed Alternative (In Millions of Escalated Dollars)

	2002	2003	2004	2005	TOTAL
One-time Costs					
ACEPS Busway Replacements	$1.4	$1.4	$1.3		$4.1
ACEPS EG Maintenance	$0.8	$0.8	$0.8		$2.4
ACEPS Monitoring & Diagnostics	$1.0	$1.0	$1.0		$2.9
ACEPS Fuel System Upgrade					
ACEPS Training					
Battery Monitoring	$1.2	$1.0	$1.1		$3.2
Training Facility	$1.2	$9.6	$3.1		$14.0
CPDS	$3.1	$13.2	$1.8		$18.1
Subtotal	**$8.7**	**$27.0**	**$9.1**		**$44.8**
Ongoing Infrastructure Costs					
Battery Replacements	$8.5	$2.6	$3.4		$14.5
DC Systems	$3.0	$2.2	$3.1		$8.3
EG	$21.8	$13.1	$25.7		$60.7
LPGBS	$0.7	$8.6	$7.8	$10.1	$27.1
Power Cable	$1.9	$1.2	$1.6		$4.7
UPS	$6.3	$2.8	$6.0		$15.2
Contract Support	$3.1	$3.1	$3.2		$9.4
Subtotal	**$45.3**	**$33.6**	**$50.8**	**$10.1**	**$139.9**
GRAND TOTAL	**$54.0**	**$60.6**	**$59.9**	**$10.1**	**$184.8**

To date, the SEOAT has not made a final funding decision. As shown in Table 7-5, The economic analysis reveals that both SEOAT alternatives have similar B/C ratios but that the ATS Alternative has the higher NPV.

Table 7-5. Economic Analysis

	ASD-300 A1t.	ATS Alt.
F&E (TY $)	$ 145.8	$ 184.8
O&M (TY $)	$1,534.1	$1,533.2
Total (TY $)	$1,678.8	$1,717.9
NPV (in PV $)	$ 185.5	$ 229.0
B/C Ratio	2.7	2.7

8.0 DECISION CRITERIA

The team based its recommendation on several criteria, as follows:

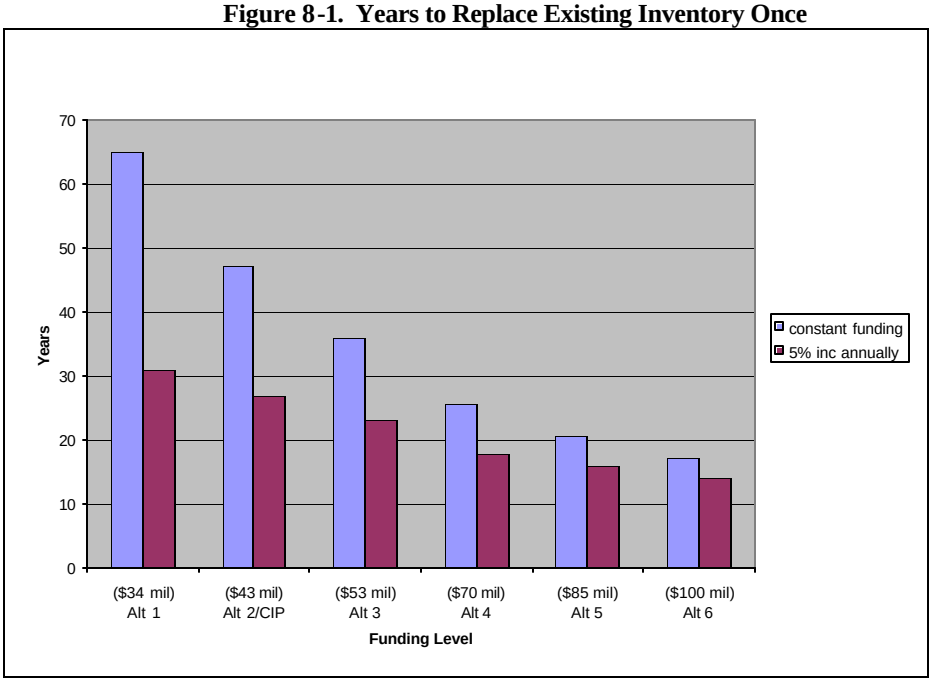
?? Magnitude of short-term needs identified
- The IAT identified total near-term sustainment needs exceeding $300 million.

?? Magnitude of long-term needs identified
- The IAT estimates the replacement value of the existing power infrastructure at approximately $1.5 billion. It further estimates that steady state replacement of the existing infrastructure would cost about $100 million per year.

?? Facility coverage
- This refers to the number and types of facilities that would be addressed under each alternative. In general, the greater the funding, the broader range of NAS services supported.

?? Length of time to replace existing inventory
- This criterion is a reminder that the near-term needs are part of a larger whole. If the FY02-04 funding level is carried into the future, it will take more or less time to ultimately replace the entire inventory, depending on the alternative. As shown in Figure 8-1, constant funding at the Alternative 5/preferred level would replenish the existing infrastructure in approximately 20 years. A consistent annual funding increase of 5% would reduce the timeframe to about 17 years. The ASD-300 alternative would fall between Alternatives 2 and 3, while the ATS alternative would fall between Alternatives 3 and 4 on this chart.

Figure 8-1. Years to Replace Existing Inventory Once

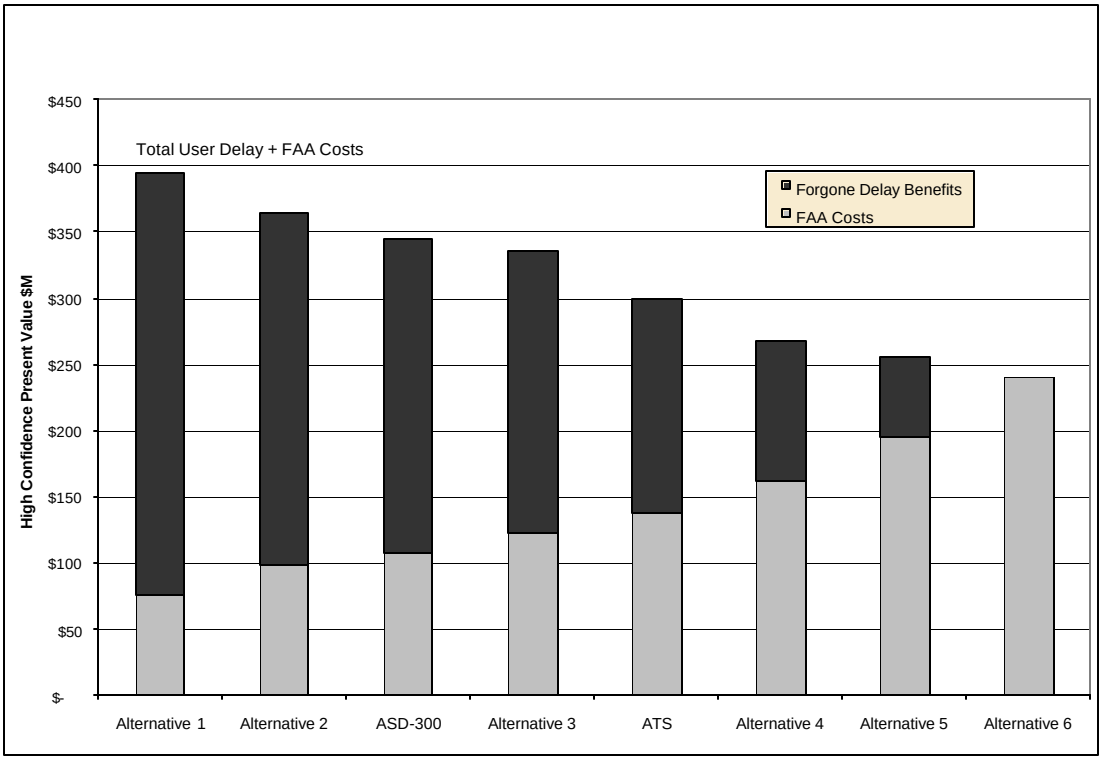


?? Extent to which pop-up expenditures will be reduced
- In general, the greater the funding, the greater the reduction in pop-up expenditures and the greater the integrity of the planning process.

?? Support for new systems, most of which need clean, reliable power
- This refers to the extent to which the integrity of the existing infrastructure will be maintained/strengthened by the various alternatives.

?? Reduction in costs to the aviation community
- Figure 8-2 shows the total power-related costs borne by users and the FAA. The lightly shaded areas are the FAA costs of replacing the power infrastructure. The darker-shaded areas show the costs borne by users in the form of delays. As FAA investment in infrastructure increases, the cost of delays decreases. The sum of the FAA and user costs is minimized under Alternative 6.

Figure 8-2. Total FAA Costs and User Delay Costs



?? Affordability
- While not a factor during the analysis period, the team recognizes that several scenarios represent affordability problems for the Agency, and this has been factored into our recommendation.

9.0 NEXT STEPS

The IAT recommends the following activities be initiated:

- ?? Final Requirements Document
- ?? Submit for approval AMS required documentation as appropriate:
  - ?? IPT Plan
  - ?? Acquisition Strategy Paper
  - ?? Integrated Program Plan

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10.0 RECOMMENDATIONS

?? Given the magnitude of near-term needs identified, the team continues to support Alternative 5 ($260 million over three years) as the preferred alternative. Recognizing the affordability problem, however, the team strongly recommends that the JRC fund this program at a level no lower than the ATS proposal ($53.8 million in FY02; $60 million in FY03; and $70 million in FY04). While less than the team's preferred alternative, the ATS proposal constitutes a significant increase over historical funding levels. It will (1) allow the PS^3 program to address its critical near-term sustainment needs in about five years, (2) begin to reduce the average age of equipment, and (3) reduce the risk of significant pop-up expenditures, thereby increasing the integrity of the planning process.

?? The IAT further recommends a 5% annual funding increase (on top of inflation) from FY05 through FY10. This would bring the funding to the level (approximately $100 million annually) that would allow steady state, service life replacement of the power infrastructure.

?? Given the undefined and unfunded power requirements identified for Standard Terminal Automation Replacement System (STARS), NEXCOM, and Air Traffic Control Beacon Interrogator (ATCBI-6), the IAT recommends that the NIPS PT and the product teams responsible for the three new systems (1) reach consensus on their power requirements, and (2) ensure appropriate funding is included in program baselines. The product teams should be assisted by the Automation and CNS Integrated Management Teams to reach consensus.

?? The IAT further recommends that the NIPS PT take the lead in ensuring consistency across the FAA's power systems engineering guidance.

?? Finally, the IAT recommends that the NIPS PT complete a technical alternatives analysis to investigate power systems requirements for FY05 and beyond. The analysis should be completed by FY02.

~~The PS^3 IAT recommends the following to the JRC:~~

~~? Affirm the need for the PS^3 program initiative.~~

~~? Affirm the recommendation for Alternative # as the Preferred Alternative for PS^3.~~

~~? Approve the Investment Decision for the Preferred Alternative.~~

~~? Approve the proposed PS^3 APB for the Preferred Alternative.~~

~~10.0 PROGRAM RECOMMENDATIONS~~

~~The following recommendations are based on the IATs experiences over the course of the analysis. It is the team's belief that future analysis of this program could be simpified and expedited if these recommendations are implemented.~~

~~Inventory Management~~

~~? Develop and maintain a centralized database on all power systems, including manufacturer, date of deployment and maintenance history.~~

~~Outage data~~

~~? Establish one definitive database to track outages rather than the current multiple databases (NAPRS, TTS+, MMS)~~

~~? Establish one set of definitions for outages~~

~~FAA engineering guidance~~

~~? FAA system level specifications and program implementation orders need to be synchronized in terms of requirements, definitions, update cycles, etc~~

~~Planning process~~

~~? Need to clarify IPT responsibilities vis-a-vis ANS on who pays for new system power requirements?~~

~~? Earlier and more coordination is required between the IPTs and the NIPS PT on new systems power requirements.~~

~~? IAs should include assessment of power system infrastructure support requirements~~

~~Budgetary planning~~

~~? Budgetary responsibilities, between the IPTs and ANS, for infrastructure investments need to be clarified~~

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11.0 GLOSSARY

Term/ Acronym	Definition
A	
AAF	Airway Facilities
AC	Alternating Current
ACF	Area Control Facility
AFSS	Automated Flight Service Station
ALS	Approach Lighting System
AMS	Acquisition Management System
ANSI	American National Standards Institute
APB	Acquisition Program Baseline
ARR	Requirements Development and Investment Analysis Division
ARS	Air Traffic Systems Requirements Service
ARSR	Air Route Surveillance Radar
ARTCC	Air Route Traffic Control Center
ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASOS	Airport Surface Observation System
ASR	Airport Surveillance Radar
ASTM	American Society for Testing and Materials
AT	Air Traffic
ATC	Air Traffic Control
ATCT	Air Traffic Control Tower
ATM	Air Traffic Management
ATS	Air Traffic Services
B	
B/C	Benefit/Cost
BUEC	Back Up Emergency Communication
C	
CBA	Cost Benefit Analysis
CERAP	Center Radar Approach
CFR	Code of Federal Regulations
CIP	Capital Investment Plan
CM	Configuration Management
CNS	Communications, Navigation, and Surveillance
COI	Critical Operational Issue
COTS	Commercial-Off-The-Shelf
CPDS	Critical Power Distribution System

D

DC	Direct Current
DoD	Department of Defense
DOT	Department of Transportation

E

EDDA	Environmental Due Diligence Audit
EG	Engine Generator
EGSA	Electrical Generating Systems Association
EMI	Electromagnetic Interference
EPA	Environmental Protection Agency
ESL	Economic Service Life

F

F&E	Facilities & Equipment
FAA	Federal Aviation Administration
FAALC	Federal Aviation Administration Logistics Center
FAC	Facility
FIS	Flight Information Service
FMS	Flight Management System
FOC	Final Operational Capability
FRD	Final Requirements Document
FY	Fiscal Year

G

GFE	Government Furnished Equipment
GNAS	General national Airspace System
GSA	General Services Administration

H

HAZMAT	Hazardous Materials

I

IA	Investment Analysis
IAR	Investment Analysis Report
IAT	Investment Analysis Team
IPT	Integrated Product Team
ICD	Interface Control Document
IEEE	The Institute of Electrical & Electronics Engineers
ILS	Instrument Landing System

INFOSEC	Information Security
IOT&E	Independent Operational Testing and Evaluation
IRD	Initial Requirements Document
IRT	Integrated Requirements Team
ISO	International Standards Organization
IV&V	Independent Verification & Validation

J

JRC	Joint Resources Council

L

LCC	Life Cycle Cost
LCCE	Life cycle Cost Estimate
LOC	Localizer
LPGBS	Lightning Protection, Grounding, Bonding and Shielding

M

MCC	Maintenance Control Center
MIL	Military
MMS	Maintenance Management System
MNS	Mission Need Statement
MTBF	Mean Time Between Failures
MTTR	Mean Time to Repair

N

NAILS	National Airspace Integrated Logistics Support
NAPRS	National Airspace Performance Reporting System
NAS	National Airspace System
NATCA	National Air Traffic Controllers Association
NDI	Non-Development Item
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NEPA	National Environmental Protection Act
NESC	National Electrical Safety Code
NFPA	National Fire Protection Association
NIMS	NAS Infrastructure Management System
NIPS	NAS Infrastructure Power Systems
NLC	National Lightning Code
NPV	Net Present Value

O

O&M	Operations & Maintenance
OMB	Office of Management and Budget
OPS	Operations
OT&E	Operational Test and Evaluation
OTS	Off-The-Shelf

P

PASS	Professional Airways Systems Specialists
PBO	Performance Based Organization
PDU	Power Distribution Unit
PRB	Priority Resource Board
PS^3	Power Systems Sustained Support
PT	Product Team
PV	Present Value

Q

Q&Q	Quantitative and Qualitative
QA	Quality Assurance
QoS	Quality of Service

R

RCAG	Remote Communications Air/Ground Facilities
RCE	Radio Control Equipment
RCL	Radio Communications Link
RFI	Request for Information
RMA	Reliability, Maintainability, and Availability
RMM	Remote Maintenance Monitoring
RTP	Resource Tracking Program

S

SAMS	Service Operations Support Automated Management System
SDP	Service Delivery Point
SEOAT	Systems Engineering/Operational Analysis Team
SL	Service Level
SODM	System Outage Disruption Model
SR	System Requirement
SS	System Specification
STARS	Standard Terminal Automation Replacement System
STD	Standard

T

T&E	Test and Evaluation
TIR	Transition and Implementation Report
TRACON	Terminal Radar Approach Control Facility
TTS+	Trouble Tracking System plus

U

UBC	Uniform Building Code
UL	Underwriters Laboratory
UPS	Uninterruptible Power Systems

V

W

WAAS	Wide Area Augmentation System
WBS	Work Breakdown Structure

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12.0 BIBLIOGRAPHY

The following list of documents and reports were reviewed and provided background data in the development of the PS^3 IAR listed in chronological order (date of publication).

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List of Attachments

Attachment 1 - PS^3 Program Prioritization Lists

Attachment 2 - Economic Analysis
(Addendum A – Basis-of-Estimate (BOE) – Official Use Only)

Attachment 3 - Acquisition Program Baseline (APB)

Attachment 4 - Risk Assessment Report

Attachment 5 - Revalidation of CIP, F-11: Power Systems Sustained Support Program

Attachment 6 - Power Systems Sustained Support Program Final Requirements Document Waiver

Power Systems Sustained Support (PS^3)

Investment Analysis Report