DEFENSE STANDARDIZATION PROGRAM

CASE STUDY

Navy Integrated In-Service Reliability Program

This case study describes how the Navy addressed the challenge of standardizing processes and tools to improve the in-service reliability of its aircraft components. As a result of that effort, the Navy has increased fleet readiness and markedly reduced its flying-hour costs.

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Navy Integrated In-Service Reliability Program

Background and Problem

Component reliability is a "force multiplier" in sustaining warfighter readiness and reducing the cost of operations. Component in-service reliability is a function of a component's inherent (designed-in) reliability and many other logistics-related factors such as maintenance, packaging, preservation, and transportation.

In the early 2000s, a Naval Air Systems Command (NAVAIR) business process reengineering effort identified a reduction in the in-service reliability of its aviation components, measured as the average length of time between components' installation on and removal from aircraft (time-on-wing). Meanwhile, the Navy's expenditures for depot-level repair of aviation components were increasing at a rate of 6 to 8 percent per year. The drop in time-on-wing and the rise in aviation depot-level repair costs were due to several major factors:

- Aging aircraft
- Operations in harsh combat environments
- Funding cuts in weapons system support and the loss of corporate knowledge as trained personnel were rotated out and replaced with untrained personnel, which contributed to a rise in beyond capability of maintenance (BCM) rates
- The cumulative effect of numerous small and varied deficiencies in logistics processes, including errors in technical documentation, failure to comply with maintenance process standards, inadequate packaging and preservation, and lack of adequate support equipment or maintenance capabilities.

With time-on-wing going down, costs continuing to rise, aircraft getting older, and the need to keep aging aircraft flying, it was vitally important that the aircraft systems be made to operate as reliably and cost effectively as possible. One approach was to address component in-service reliability by identifying and mitigating the effects of age, combat operations, and logistics-related deficiencies.

Addressing component in-service reliability was a challenge, because the Navy did not have a centralized, standardized in-service reliability program, nor did it have any formal, documented processes, automated analysis tools, or overall corporate policy on issues related to component in-service reliability and maintenance. In addition, the Navy lacked essential data, such as data on operational-, intermediate-, and depot-level maintenance activities at the component serial-number level and failure mode data at the depot level. Those and other data deficiencies made it extremely difficult and time-consuming to analyze system performance, identify root causes of low component reliability, and monitor reliability metrics to determine the effectiveness of corrective actions—activities that are key to improving reliability.

In May 2002, NAVAIR took on the challenge of addressing component in-service reliability by establishing the Integrated In-Service Reliability Program (IISRP). The decision to establish the IISRP was one of the outcomes of a NAVAIR business process reengineering effort focused on improving core support processes and reducing life-cycle costs. That effort had demonstrated the potential for further improving reliability and reducing life-cycle costs through improved component reliability.

The goals of the IISRP are twofold:

- Improve component in-service reliability
- Lower fleet operational costs.

To achieve those goals, the IISRP identified two key objectives:

- Develop and document standard processes and tools to assist with identifying high-value aviation depot-level reparable (AVDLR) components exhibiting poor reliability, analyzing those components to identify the root causes of the low reliability, developing solutions to correct the problems, and measuring success
- Export those processes to other Navy and DoD support teams.

Approach

The IISRP is the collaborative effort of a NAVAIR management team at NAVAIR Patuxent River, MD, and three dedicated, integrated analysis teams—one at each of the Naval Aviation Depots (NADEPs): Cherry Point, NC, Jacksonville, FL, and North Island, CA. Today, the management team has three individuals, and the NADEP teams each have about 10 senior, experienced maintainers.

Working closely and cooperatively, the IISRP teams identified significant shortcomings in reliability and set about developing required strategies and processes to fully implement component in-service reliability improvements. The teams pursued a dual strategy of getting the most improvement in the system using *existing* processes and tools, while working to develop, advance, and mature *new* standardized processes and tools. To ensure the development of processes and tools based on best industry and DoD practices, as well as to ensure their consistent and effective application, the IISRP collaborated with DoD's Reliability Analysis Center.

The IISRP teams evaluated data compilation, formatting, and analysis techniques; application of tools; interactions between organizational, intermediate, and depot maintenance activities; management of logistics elements; and other support functions related to the in-service reliability of aviation components. The IISRP teams also identified the latest techniques and procedures needed to assess component in-service reliability and maintainability; employed root cause analysis methods; and benchmarked existing NAVAIR capabilities with other DoD components and industry, including commercial airlines. In each case, the teams worked collaboratively to mature processes for selecting and analyzing high-value aviation depot-level reparable components exhibiting poor reliability, determining the root causes of the low reliability, recommending solutions for addressing those root causes, and measuring the results of the implemented solutions.

Working closely with fleet operational- and intermediate-level maintainers, program managers, Fleet Support Teams (FSTs), depot managers and artisans, Naval Inventory Control Point (NAVICP) Philadelphia, PA, and the Defense Logistics Agency (DLA), the IISRP teams studied mission-critical components with significant reliability problems, applying—and fine-tuning—the processes and tools they had developed and identified as representing best practices.

For each mission-critical AVDLR component they studied, the teams focused on understanding the many factors that influence and degrade reliability. Identifying and understanding those factors entailed detailed examination of the documentation—standards, specifications, and technical guidance—related to the component and of the related flows, processes, actions, and results as the component travels from the depot as a new or fully refurbished part, to its installation on the aircraft, to its removal from the aircraft, and back to the depot for repair. This examination considered such factors as packaging, preservation, shipping, storage, tracking, handling, transportation, and maintenance. For each factor, the team compared the actual process to the process specified by the documentation. The primary difficulties faced by the teams were determining all the activities contributing to the support of each component and understanding other ongoing improvement efforts that could affect the component's reliability.

Engineers, maintainers, quality experts, and others walked through the selected support process—end-to-end—to identify weaknesses and faults. Every aspect of support was scrutinized. Findings were discussed with FSTs, NAVICP, maintainers, and others during consensus meetings, and improvements were identified. Most often, the solution was to address process effectiveness, either by adhering to or improving existing maintenance processes.

The IISRP teams measured reliability performance—both before and after implementation of the improvement solution—using relevant metrics, such as the number of BCM items returned to the depot for repair per thousand flying hours (kFH) and the time-on-wing.

The IISRP management team was responsible for developing policy, directing completion of the component studies in accordance with the standardized processes, training FST personnel in these processes, and reviewing IISRP-related documents and software tools. As a means to improve processes and techniques, quarterly IISRP management meetings included peer reviews of the studies to validate findings and cost projections. Frequent communication among the team leads enabled the teams to share ideas and techniques, to standardize approaches, and to incorporate best practices into the formal IISRP process documentation. This communication provided vital feedback for the IISRP management team and enabled the program manager to accurately assess the effectiveness and efficiency of the program.

In addition, the IISRP teams worked with FSTs, program offices, depot production management, NAVICP, and DLA counterparts to educate the community on available IISRP processes and tools. They cooperatively engaged these stakeholders in the performance of every reliability study and maximized the strengths of each support activity to complete the analyses. These synergistic efforts reduced process time, improved study effectiveness, and created a strong sense of teamwork and accomplishment. The efforts ensured that the in-service reliability process continued to mature toward the NAVAIR objective of having an automated, data-based, technically valid, and repeatable process in use by all support activities.

Outcome

By the end of the third quarter of FY05, the IISRP had completed 257 component reliability studies. The studies reveal a powerful story about how several different and relatively small factors in the documentation can combine to significantly degrade a component's in-service reliability, reduce its availability, and increase overall life-cycle costs. That story has several themes, which recur across every IISRP study. It is instructive to look at how those themes align across the life cycle of the documentation—standards, specifications, and technical guidance—that forms the baseline reference for the studies. Table 1 depicts the life cycle and summarizes the factors that are key to ensuring the reliability of a component. The key lesson for individuals involved in a document's life cycle is that high-quality performance is crucial at every stage.

Document Development

The life cycle begins with the development of a military standard, a specification, an instruction, a maintenance manual, or some other technical guidance document. The lesson from the IISRP studies about document development is this: the higher the quality of the document, the better will be the in-service reliability. This lesson is valid no matter the category of document being prepared. Several IISRP studies illustrate how document quality affects reliability and cost. In other words, the studies illustrate that achieving high reliability depends on having complete, accurate documentation.

The IISRP team at NADEP Cherry Point conducted a very successful study of the E-2/C-2 propeller assembly in which the poor quality of the technical documents played a role in degrading in-service reliability. Among those documents were NAVAIR 03-20CFA-2, *Depot Overhaul Manual*, and NAVAIR 15-01-500, *Preservation of Naval Aircraft*.

Rust accumulation in propeller assembly raceways required the raceways to be reworked, resulting in processing delays and increased cost. The rust was caused by the use of a preservative oil that was too light and began breaking down after several weeks. The guidance documentation failed to adequately specify the grade of oil required.

Even a typographical error in a specification can adversely impact in-service reliability. The uniform automatic data processing system for the propeller assembly hub erroneously referenced a Clean S process that calls for steam cleaning. The proper cleaning process is Clean 9, which requires saturation with Varsol P-D-680 and final preservation with MIL-C-81309, *Corrosive Preventative Compounds*. This error in the technical guidance documentation, if followed, would result in improper preservation, corrosion, and increased cost. Often, documents contain text that is ambiguous or difficult to comprehend.

NAVAIR 03-20CFA-2, technical guidance document, contained an instruction concerning a crack "closer to the spar than L inches"; the correct guidance would state the measurement as "¼ inch." Ambiguity, lack of clarity, and even small errors in specifications or guidance documents can result in field failures with significant reliability and cost consequences. In another instance, a testing and troubleshooting section was not written in the proper sequence. The technicians, recognizing the error, used a locally modified procedure. A problem arises when new personnel attempt to use the manual without knowledge of the alternate local procedure.

The same guidance document states, "Blades may be injection repaired in accordance with work

Table 1. Factors That Degrade Reliability and Increase Costs Across a Document's Life Cycle

Document Development	Implementation	Execution	Maintenance and Support	Document Cancellation
Accuracy Clarity Completeness Adequacy Achievability Consistency	Capability Training Sources	Compliance Quality Assurance Logistics Supports Feedback	Document Maintenance Retraining Communication	Document Relationships

Reliability Improvements: E-2/C-2 Propeller Assembly

The NADEP Cherry Point team selected the E-2/C-2 propeller assembly as a candidate for reliability analysis. The E-2/C-2 propeller blades are foam filled and have a steel spar and glass fiber shell. The propeller assembly is an electro-mechanical mechanism with reversible-pitch constant-speed operation.

The propeller assembly is a significant cost driver. Because the propeller assembly is out of production, limited avenues are available to fill shortages of critical replacement parts. Therefore, it is of utmost importance that efforts continue to enhance component reliability. Hub and blade repairs are performed at the depot, where the component is disassembled and parts are replaced or reworked as necessary. However, the depot's repair capability was limited; maintainers were unable to repair the foam-filled blades due to the lack of an automated foam pouring machine. The Navy would have been forced to ground the aircraft in 2004 if no solution could be found. The IISRP provided funds to purchase and install a foam pouring machine at NADEP Cherry Point. In addition, the FST developed a standardized repair and training process for the repair of blades by foam pouring, which did not exist previously.

The Cherry Point team—with the cooperation of depot production shops, engineering, and logistics—observed the processing of the component in all stages of disassembly, overhaul, reassembly, and test. Upon completion of the review, the team recommended process improvements, including the following:

- Improve component handling during processing
- Update the depot overhaul manual (NAVAIR 03-20CFA-2)
- Improve component preservation
- Improve the local process specification for plating the hub
- Establish the capability to perform the spar foam process.

Since the beginning of FY03, the E-2/C-2 propeller assembly BCM/kFH rate has decreased by 39 percent, generating a $5.4 million cost avoidance and cost savings of $30.7 million through the second quarter of FY05.

process 003." The correct reference should be to a different manual. Incorrect references within a specification can cause confusion, lost productivity, increased cost, and lower in-service reliability.

The Cherry Point E-2/C-2 propeller assembly study identified numerous discrepancies in many different technical guidance documents. Such discrepancies are a theme that runs through most IISRP studies. These discrepancies indicate that document-related issues are systemic. These errors can contribute significantly to lower in-service reliability. All those involved in developing standards, specifications, and other technical guidance documents must pay particular attention to ensuring that their product is accurate, clear, complete, consistent, and achievable.

Implementation

Several costly E-2/C-2 propeller hubs were scrapped due to excessive pitting and corrosion. These hubs had not been installed on aircraft since their last overhaul. The damage resulted from improper packaging and preservation. Those responsible had not been pressurizing the shipping containers since 1994, when the responsibility was transferred to them. The responsible personnel cited lack of necessary equipment and instructions. Proper implementation depends on providing the appropriate technical documentation and ensuring that the technical workforce is trained in its use.

Several issues were discovered concerning an essential technical guidance document on nickel electroplating. The document, issued in 1999, was never officially signed by laboratory personnel and was never issued through the technical library. The document contained vague, erroneous, and misleading guidance regarding key stages of the process. The failure to properly implement the document through a review, signature, and issuing process resulted in an inadequate electroplating process and subsequent pitting and corrosion problems on propeller assembly parts.

Having the capability to meet the requirements of a standard or specification is a key part of implementation. Lack of that capability was an issue identified in many IISRP studies. A plating shop lacked the means to maintain and test key processes within specified tolerance requirements. This lack of capability resulted in plating defects requiring unnecessary machining, stripping, replating, or scraping of scarce and costly components. In another instance, a specification required a sandblasting process at 40 pounds per square inch, but the facility had no pressure gauge available to verify compliance with the pressure requirement.

Implementation-related issues are a theme running through many IISRP studies. Such errors contribute to lower reliability and higher costs. All those involved in implementing standards, specifications, and other technical guidance documents must pay particular attention to ensuring that required capabilities are in place, including the necessary equipment and materials; appropriate training; review, approval, and issuing processes; and achievable logis-

tics requirements, including sources of supply and compliance with environmental requirements.

Execution

Several very expensive E-2/C-2 propeller blades were scrapped due to excessive corrosion. The cause of the corrosion was improper packaging and preservation somewhere along the logistics chain. The packaging and preservation did not comply with the guidance in NAVAIR 15-01-500. Proper execution depends on training and adequate quality control to ensure compliance with the specification or guidance.

During nondestructive testing of critical components, small quantities of epoxy-like residue were found in critical areas on propeller blade assemblies. The cause was the failure to comply with guidance requiring that these sensitive areas be masked during a sealing process. Lack of compliance may result from inadequate training, process control, or quality management—a consistent theme across IISRP studies. As a result of the studies, improved compliance is producing shorter cycle times, higher achieved reliability, and lower cost.

The IISRP team at NADEP Jacksonville conducted a successful study of the F/A-18 F404-400 low-pressure turbine rotor. The team found that a quarter of the rotors that had been inducted into the depot for repair had, in fact, no discrepancies upon disassembly and inspection. Maintainers lacked the precision measuring equipment at the organizational and intermediate levels, resulting in false rejections of rotor assemblies. Correct discrepancy identification will preclude a number of organizational-level engine removals and intermediate-level engine teardowns.

Maintenance and Support

All standards, specifications, and technical guidance documents require continuous maintenance and support to ensure that the documents remain accurate and complete. In one reliability study, a key technical document had 68 unincorporated material change requests, resulting in confusion for artisans having to continually reference back and forth between current instructions and the corresponding change request.

Another key technical guidance document required a particular test to ensure that propeller blade heaters showed no signs of local overheating. The machine used to perform the test had been removed from the depot approximately 5 years earlier, and the test has not been performed since then. Because the specification still contains the requirement, either the capability should not have been removed or the requirement for the test should have been removed from the specification. This issue creates confusion and increases potential risk. Effective document maintenance and support are essential to either retain the capability or to revise and update the requirement.

In a recent IISRP study conducted by NADEP North Island on F/A-18 A/B/C/D servovalves, research revealed that original equipment manufacturers were using an improved thermo-stabilization process that, compared with the previous process,

Reliability Improvements: F/A-18 F404-400 Low-Pressure Turbine Rotor

The NADEP Jacksonville team identified the low-pressure turbine rotor as a candidate for a reliability analysis review due to both the number of BCM rotors—220—and AVDLR expenditures totaling more than $7 million.

The team's reliability study revealed that many of the 220 rotors had no verifiable discrepancies. When a rotor is returned to the depot for repair, the depot must disassemble the rotor and inspect it to discover that no problem existed. When the rotor is disassembled, inspected, and reassembled, new nuts and bolts are installed and some components are installed in different positions, requiring the rotor to be rebalanced. The fact that units were unnecessarily returned to the depot resulted in depot maintenance actions with considerable cost even with no discrepancy. These costs could be avoided.

The study also revealed that many components are returned to the depot with incorrectly calculated operating hours. Twenty percent of the modules had an average of 590 hours operating time remaining. This amount of time was significant when the average flight time per aircraft was below 30 hours per month through 2005.

The IISRP team recommended several improvements:

- Establish a reporting and tracking procedure within the depot that identifies rotors inducted and found to have no discrepancies. These data can assist the FST with identifying possible fleet troubleshooting and training deficiencies.
- Develop and schedule training—for intermediate- and operational-level personnel—on improving troubleshooting, identifying rejection criteria, and determining special tools needed to preclude the needless return to the depot of good rotor assemblies.
- Reemphasize the importance of existing instructions to ensure that all parts packaged have the required paperwork attached, and, if needed, develop new directives and instructions.

The short-term impact was a near-immediate stop in the increasing BCM trend. Since mid-FY01, the BCM/kFH rate decreased 34 percent and time-on-wing increased 44 percent.

Reliability Improvements: F/A-18 A/B/C/D Servovalves

The IISRP teams at NADEPs North Island and Jacksonville conducted F/A-18 servovalve studies over 4 years. Those studies revealed a surprising number of common threads involving the maintenance philosophy and methods for servovalves. The North Island team conducted an overarching servovalve review that included in-depth discussion with the various original equipment manufacturers (OEMs). This review sought to standardize maintenance procedures and philosophies at North Island and Jacksonville with the best available practices from the OEMs for the various servovalves.

Discussions with the OEMs revealed that commercial facilities had made many advances in servovalve maintenance, but those advances were not reflected in the maintenance procedures and equipment employed in the depots. The information from the OEMs and from the work center artisans and supervisors at the depots led to several improvements, including the following:

- Use of appropriate thermo-stabilization of torque motors and servovalves
- Use of only nonmagnetic tools during servovalve buildup
- Complete degaussing and recharging of all torque motors when additional charge is required
- Inspection of all subcomponents within the housing subassembly for material degradation
- Inspection of 100 percent of the spools within spool and housing assemblies on specific servovalves
- Standardized maintenance procedures, reducing vagaries in respective maintenance manuals and technical data.

more realistically simulates actual environmental conditions. This improved procedure will be shared via a local engineering specification with NADEPs North Island and Jacksonville or changes to the technical manuals via manual change releases until the technical manual can be updated.

Often, document maintenance and support involves requirements found in other standards or technical guidance documents. For example, some IISRP studies revealed that critical documents are not controlled in accordance with ISO 9000 requirements. In other instances, the studies discovered that guidance contained in one document is inconsistent or contradicts guidance contained in another related document. A failure to properly maintain standards, specifications, and technical documents may result in execution errors, lost productivity, lower achieved reliability, and higher cost.

Document Cancellation

Like the early phases of a document's life cycle, cancellation can have ripple effects that degrade in-service reliability, cost, and even safety. For instance, one key technical document required the use of a scouring powder when cleaning a blade shank. However, the specification for the scouring powder had been cancelled. Lacking the required powder, the cleaning shop applied hot soapy water and rinsed with tap water. Scouring powder is quite different from hot soapy water.

The cancellation of a document can affect many other documents that reference the cancelled document. In each case, this forces field technicians to improvise solutions that may or may not be suitable. When a document is cancelled, it is important to understand the chain of references and the impact of the cancellation on other referenced or referencing documents.

Standardization Achievements

In addition to identifying key themes related to deficiencies in the supporting documentation for aviation components—deficiencies that must be addressed to improve in-service component reliability—the IISRP developed several standardized processes and tools for conducting reliability studies. To date, the IISRP has accomplished the following:

- Established a strategic partnership with DLA—the provider of consumable material used in the repair of aviation depot-level repair components—and NAVAIR's Aircraft Equipment Reliability and Maintainability Program—a research and development program to address reliability and maintainability deficiencies in Navy aircraft. The partnership is actively working to resolve reliability problems. As a result of this effort, DLA is now funding multiple redesign projects, and NAVAIR is tailoring its data-mining and research efforts to support IISRP analysis of components.
- Established a strategic partnership with NAVICP Philadelphia to work jointly in the resolution of reliability problems on critical, high-value AVDLR components. A close working relationship is now in place between the individual Integrated Weapons System Team

managers and the IISRP. Meetings are held at least twice a year to jointly choose new candidates for study and to evaluate the performance of components previously studied.

- Because normal regression tools were unusable (the assumptions underlying linear regression were not true for IISRP data sets), IISRP worked closely with other stakeholders and industry experts to develop and implement a standardized method for measuring return on investment. The IISRP teams worked with their counterparts to identify a valid statistical model to track reliability improvements in fielded components.
- Developed a standardized set of processes, for use across the NAVAIR enterprise, to investigate and resolve in-service reliability problems. As part of this effort, the IISRP team developed *IISRP Manual*, Appendix C, "Case Manager's Desktop Guide," which contains a flexible set of guidelines and procedures to be employed as needed to complete an IISRP study. The guide shows the progression of a study from introductory component reliability analysis, to identification of failures and failure modes and investigation of root causes, and to identification of remedial actions and presentation of cost-benefit analysis projections for the remedial actions.
- Developed and implemented a standard, statistically valid Cost Avoidance Projection Model. The model has been approved by NAVAIR, NAVICP Philadelphia, and the Naval Supply Systems Command.
- Developed a comprehensive online reliability database to track and monitor the results of all IISRP studies based on the IISRP Cost Avoidance Projection Model. This database is being shared with teams working on airspeed, program enterprise teams, and other aviation support groups.
- Developed a standardized, uniform, and automated benefits tracking database to measure the success of reliability improvements in aging systems with underlying negative trends. This database has nearly eliminated reporting errors and has significantly reduced the time and effort needed to monitor component performance and develop status reports.
- Incorporated the internationally recognized Crow-AMSAA reliability growth model into a user-friendly software application allowing for standardized analysis of components under investigation. This involved working with the Reliability Analysis Center and industry experts to develop software that is now available commercially to all organic and military users.

Benefits

Since its inception, the IISRP has achieved significant improvements in AVDLR component availability, resulting in improved fleet readiness and reduced operating costs. Completion of the 257 AVDLR component studies resulted in a cumulative cost avoidance of more than $210 million; that cost avoidance is due to reduced component demand and material usage. The application of stan-

dardized, systematic, and data-driven analysis processes has enabled the IISRP teams and FSTs to identify the root causes of major readiness degraders and, subsequently, to develop cost-effective solutions to the problems.

Results include

- generating more than 1,000 reliability improvement recommendations;
- achieving actual cost avoidance of $210 million (or a 4:1 return to date);
- developing standardized processes, analysis methods, and software analysis tools; and
- reversing negative trends in reliability and time-on-wing for high-value, mission-critical aviation components.

The standardized processes and tools for conducting reliability studies have been exported to other DoD and industry users for potential widespread application. Success stories and standardized IISRP processes and tools have been presented at several commercial and DoD symposiums since 2002.

Future Efforts

The IISRP continues to mature. Additional emphasis is being placed on sustaining achieved improvements, maturing data gathering and analysis, and creating and nurturing strategic partnerships. In addition, the IISRP teams continue to evolve and standardize their processes to select, analyze, fix, and measure the reliability of high-value components.

Today's analysis requires the manual selection of top mission degraders for analysis; a future system may provide automated triggers that highlight repair and maintenance problems. Likewise, today's analysis relies on manual process audits. Future analysis may leverage online models and tools.

Lessons Learned

The IISRP teams attribute their success in enabling the depots to improve reliability and cut costs to several factors:

- ***Clear road map***. A clear map of where the IISRP was headed enabled participants to work effectively with one another. Each team member contributed to the identification and prioritization of IISRP objectives for each year.
- ***Effective collaboration***. The IISRP teams learned early that collaboration is the key to success. Since inception, the teams have focused on playing to the strengths of each stakeholder in the support process. Team members have formed strong ties with their peers on the FSTs and

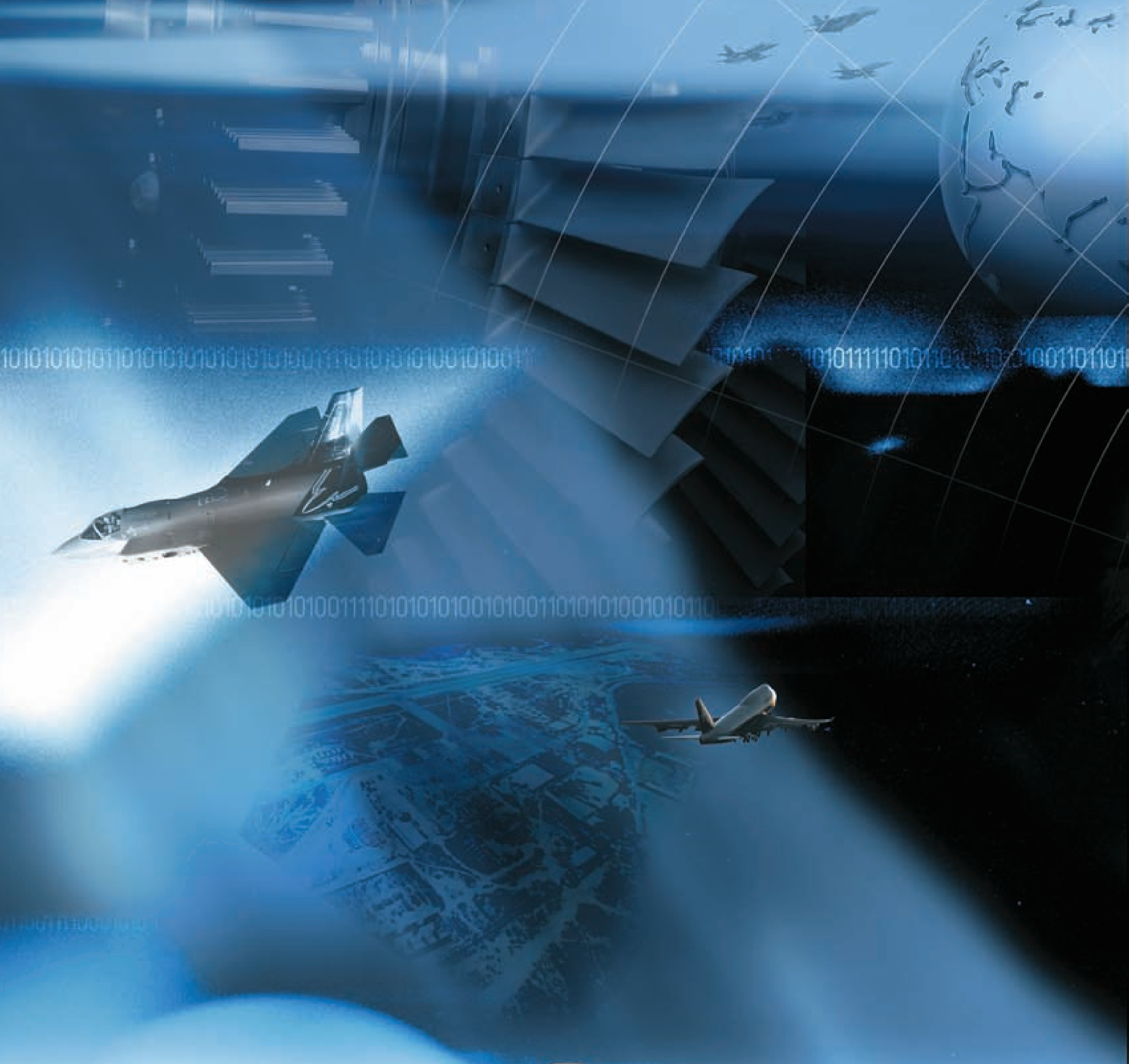
other support organizations to ensure that all elements of logistics and engineering are thoroughly reviewed during the study of selected components. Moreover, team members were senior, experienced maintainers who had worked in FSTs and were trusted and knowledgeable insiders.

- ***No-fault policy***. "Don't shoot the messenger" and "fix problems; don't fix blame" are essential themes. To understand causes and effects of reliability problems, it is necessary to create an environment of trust and integrity, where problems can be discussed openly and honestly. Strong leadership by depot commanders and others provided cover for individuals to provide honest answers.
- ***Team spirit***. Individuals and teams were recognized with standard rewards, but the real incentive was their belief in the IISRP goals and their recognition that their efforts were resulting in positive changes. The process included a large degree of interaction, keeping participants informed of progress and outcomes.
- ***Process, process, process***. A key to early success was the understanding that most reliability solutions do not involve part redesign, but do involve process improvements. In fact, 58 percent of the actions resulting from the studies called for adhering to existing processes or developing improved processes. Only a small percentage of the actions were related to inherent part reliability improvements related to part design. This insight was especially helpful because the team was pressed to demonstrate near-term results.
- ***Dedicated funding***. NAVICP Philadelphia provided funding for the program, which allowed dedicated teams at the three NADEPs and NAVAIR to focus their efforts exclusively on in-service reliability improvement.

The program also yielded many useful lessons for those who create, implement, use, and maintain standards, specifications, or technical guidance documents. The following are among those lessons:

- The greatest opportunities to improve reliability and reduce cost are in the processes involved in maintaining and supporting a component—not in changing the inherent reliability of the item.
- Those who create or develop standards, specifications, and similar technical documents that govern the related processes can support in-service reliability by ensuring the documents' accuracy, clarity, completeness, adequacy, achievability, and consistency.
- Those responsible for implementing standardization and technical documents in the field have significant responsibilities for ensuring that documents' requirements are satisfied. This requires ensuring that those who must execute the documents' guidance have the necessary training; the necessary capabilities, including facilities and equipment; and adequate supporting processes, including packaging, preservation, shipping, handling, and transportation. They also must comply with related requirements such as ISO 9000.

- Those responsible for execution have a major role in ensuring full compliance with standardization documentation requirements, providing adequate quality assurance to monitor compliance, providing necessary logistics support such as the necessary parts and materials, and finally, providing feedback throughout the system to address errors and problems contained in the guidance documents.
- Those responsible for maintaining and supporting standardization or technical documents throughout their life cycle can support in-service reliability through the quality of their efforts to keep the document current and relevant, as well as addressing retraining requirements when major changes are made in the documents and providing adequate communication to ensure that all those who need to know understand the changes.
- Those who decide to cancel a standard, specification, or other technical document must consider the ripple effect of the decision across the various related documents and the operations that use the document.



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