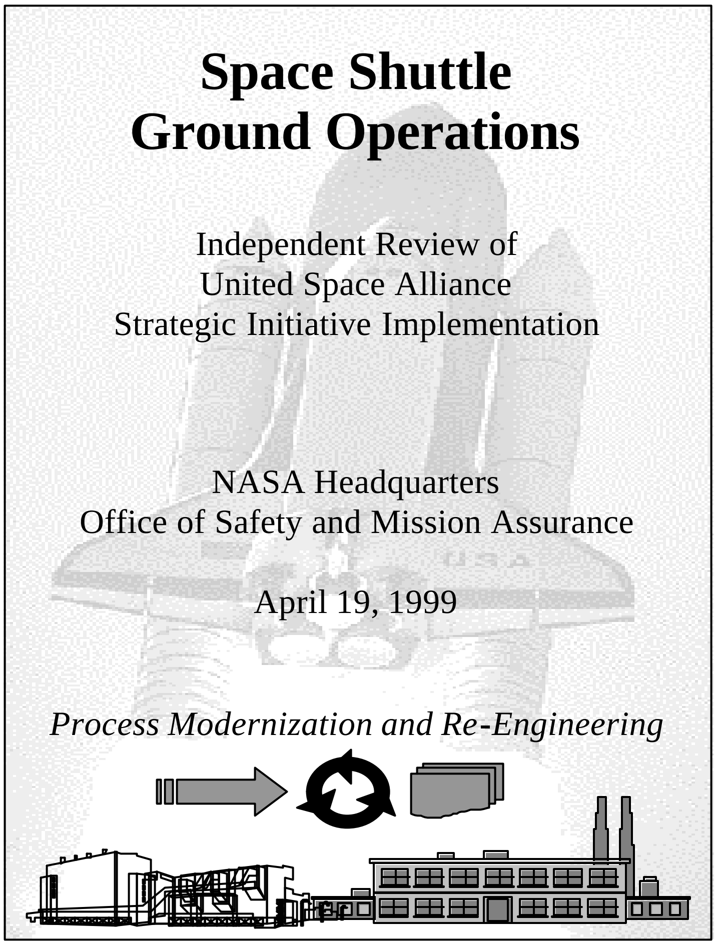
This document contains excerpts from the United Space Alliance (USA) Ground Operations Strategic Initiative Implementation Independent Assessment Report (title page shown below). Only those sections which relate to the PBMA element **Pre-Operations Integration and Test** are displayed.

The complete report is available through the PBMA web site, Program Profile tab.



Space Shuttle
Ground Operations

Independent Review of
United Space Alliance
Strategic Initiative Implementation

NASA Headquarters
Office of Safety and Mission Assurance

April 19, 1999

Process Modernization and Re-Engineering

2.0 Advanced System Technician (Skill-Based Workforce) 41 FTE Total

2.1 Initiative Content Overview

The Advanced System Technician (AST) strategic initiative is based on the notion of incorporating safety, quality, and engineering know-how into the skill/knowledge-base of selected experienced senior technicians who have been recognized for their excellence. The key to the success of the AST strategic initiative is training, certification, and demonstration of competency through hands-on performance and qualification.

The AST initiative was put in motion in May of 1998. USA/GO processing responsibilities encompass 500 separate "critical skills." The AST candidates will be trained, certified, and qualified using the Advanced Systems Technician Training (ASST) program. The AST will perform his/her current duties as well as many of the functions previously performed by engineers, inspectors, and safety personnel.

Total Task Ownership Concept

A fundamental principal in the Skill Based Workforce initiative is the concept of "Total Task Ownership." This includes the enabling philosophies of:

- First Time Safety and
- First Time Quality

The individual doing the work assumes greater personal responsibility to assure that the work is done safely and done correctly the first time.

<u>Processes which Support the Total Task Ownership Concept</u>

- Dupont Safety Observations Program
- Operational Area Safety Improvement System (OASIS)
- Process Product Integrity Continual Improvement (PPICI)
- Incident Review Board (IRB)
- Human Factors Team

<u>Qualification Approach</u>

Qualification includes on-the-job training (OJT) and Computer-Based Training (CBT). The CBT incorporates standard teaching modules as well as off-nominal problem resolution.

<u>Training Curriculum/Knowledge Content</u>

All OJT packages contain measurable learning success criteria called "key success factors" in which an individual must demonstrate competency.

Training content and changes are maintained through the NASA Program Review Change Board (PRCB) and incorporated into the USA training curriculum by way of the USA Training Board and the USA/GO Certification Board.

Training Elements

OJT

USA/GO is using the American Society for Quality Control (ASQC) training course for certified quality inspectors to develop and validate the inspection skills of AST candidates. AST candidates study under a designated engineer to acquire an OJT perspective of the engineering function. Note that all AST candidates were previously "A-Techs," the highest and most qualified technician job classification. The safety training involving activities such as establishment of a Safety Command Post, safety clear, and hazard monitoring activities will be acquired through OJT. In interviews with technicians it was pointed out that OJT provides a more realistic and better qualification of the worker in realistic work situations (e.g., lying on your back holding a flashlight and crimping a wire connection you can only see with a mirror).

CBT

CBT will be used along with OJT to enhance the knowledge level of the AST candidates.

Stand Board

The Stand Board is a peer review process, akin to an "oral exam," practical exam, or defense of a graduate thesis. All systems engineers must pass a similar Stand Board examination. Members ask questions designed to verify the readiness of the candidate for certification. Objectives of the Stand Board process include verifying that the candidate:

a. Understands the technical aspects of the system to which the position applies.

b. Knows and understands the operational and administrative aspects and interfaces of the proposed position and system.

c. Possesses sufficient ability in communicating information adequately to perform the task.

d. Knows and understands the safety hazards associated with the position and operating location and is thoroughly familiar with the applicable emergency procedures.

Stand Board Membership

a. Test Operations (Chairperson)
b. Test Project Engineering
c. Safety and Reliability Engineering
d. Candidate's Management
e. Move Directors (as required from applicable areas)
    1. Horizontal Processing
    2. Vertical Processing
    3. SSME Operations (Rocketdyne subcontract)
    4. Shuttle Engineering

Conservative Implementation Approach

The implementation of the AST program will begin with tasks which are "low criticality/high frequency of occurrence" in order to develop both management and workforce confidence in the overall AST approach. In addition, the training and qualification process will be indexed to task criticality and frequency of occurrence.

2.2 USA/GO FTE Savings Logic

Change in the Recertification Process

Planned changes in the training and recertification process will yield approximately 75 percent of the projected 41 FTE savings. It is projected that re-certification time will fall from the current level of 6,700 hours to 2,500 hours.

- Current skill recertification training (for technicians in vertical and horizontal processing) requires approximately 6,700 hours each month.
- A typical technician has 15 to 18 certified skills.
- At least half of any individual's recertification training currently requires repeating the entire course.
- 85 percent of recertifications can be done "on-the-floor."
- Estimated savings accrued through on-the-floor recertification = 4,200 hours/month.
- 4,200 hours savings divided by 150 labor hours/month = 28 FTE savings.

USA/GO personnel believe they are getting a better "training product" using the on-the floor approach.

Inspection Workforce Savings - 5 FTE

Inspection workforce savings are based on the following logic:

- 40,000 Work Authorization Documents (WADs) are processed each year for seven flows.
- 150,000 inspections occur on each flow.
- Inspections/year = approximately 1 million.

The AST will perform approximately 10 percent of the inspections previously performed by SMA. The inspection workforce currently includes 224 inspectors. Assuming that the inspection workforce is working at capacity one can assume that the AST-inspection activity represents a savings of approximately 22.4 FTE.

The first year of implementation is expected to yield a 5 FTE savings. By the fifth year of implementation this initiative is expected to yield a 20 FTE savings.

Engineering Savings - 8 FTE

- 40,000 WADs/yr (seven launches/year flow rate)
- 20 percent of WADs are "Problem Reporting and Corrective Action (PRACA) paper," also referred to as "real-time paper," such as Problem Reports (PRs), Discrepancy Reports (DRs) or Interim Problem Reports (IPRs).
- 8,000 WADs are in the PRACA arena.

- 80 percent of PRACA reports are non-Material Review Board (MRB) items or approximately 6,400 WADs are non-MRB PRACA items.
- Assume 2 hours per document which includes developing the work-around paper, coordinating signatures, and approvals, etc.
- Savings = 12,800 hours/year.

Deviation Savings

- 680 deviations/month
- 20 percent are temporary deviations
- 1,632 temporary deviations per year
- 30 minutes per deviation
- 816 hours per year saved

Pen and Ink (P&I) Change Savings

- 25 percent of WADs have P&I changes, in accordance with Test Assembly Instruction Record (TAIR) station managers
- Approximately 100,000 P&I
- 5 minutes/P&I for logging data and implementing Operations Maintenance Instruction (OMI) change, typically editorial in nature
- 8,333 hours saved per year

Total Savings

- Approximately 22,000 hours saved
- Divide by 2,000 hours/FTE year
- FTE savings = 11
- Of the projected 11 FTE savings USA/GO is conservatively claiming only 8 FTE savings the first year.

Summary of Savings

On-Floor Training/Recertification - 28

On-floor training to be implemented by May-June 1999

Advanced Systems Technician – 13

The AST first class of candidates (30 to 50 individuals) will graduate in August 1999. Savings will be realized as hardware processing occurs.

- Inspection = 5
- Engineering Paperwork = 8

Total Savings - 41

2.3 Objective Evidence of Implementation

The review team conducted a telecon with Mr. Terry Risley on February 26, 1999, to obtain background information and details of the logic and analytical basis of the FTE savings estimates for the initiative.

On-site interviews and discussions with USA technicians and management were held on March 19, 1999. The review team conducted an hour-long discussion with nine AST candidates, a bottoms-up team of technicians participating along with engineers, safety and quality professions to develop the curriculum and certification process. To a person, the technicians expressed a very positive view of the initiative and indicated that the expanded capabilities of the workforce represented a "win-win" situation for all parties concerned, i.e., technicians, engineering, surveillance, management, etc.

Presentation:	Terry Risley, Steve Pincka, John Seaman, James Comer
Tour:	Terry Risley, Steve Pincka + 9 team members

2.4 Discussion and Assessment

Key Assumptions

- Percent of Recertifications that can be performed "on the floor."
- Hours saved per document.
- Percentage of SMA inspections which will be performed by ASTs.

Discussion

The review team considers this an excellent initiative. The review team was impressed with the unanimous enthusiasm for this initiative and the floor-level belief that this is a good idea and would make the work move faster, better, and safer. The move away from time-intensive recurrent classroom training (which requires travel to the Air Force side of KSC) to OJT training and recertification is seen as a definite improvement in the quality of the training experience.

Confidence in Projected Savings Estimate

The review team assigns a <u>medium</u> level of confidence to the projected FTE savings based on the complexity of this initiative and the potential for increased stress in the AST workforce as flow-rate increases.

Independent Review Team Estimate

The review team applied a 70 percent (0.7) multiplier to the USA/GO estimate of 41, arriving at a (rounded) estimate of 29 FTE.

Recommendations

This initiative warrants review team follow-up during the training and certification of the first AST candidate class through the summer/fall of 1999. The AST program implementation must be monitored carefully, especially as Space Shuttle processing flow-rate increases.

3.0 OPF Enhanced Processing Concepts 60 FTE Total

3.1 Initiative Content Overview

The overall objective of this strategic initiative is to reduce Orbiter Processing Facility (OPF) or horizontal processing cycle time by improving planning and scheduling stability and execution consistency. This is to be accomplished through two initiatives, Readiness Process and Phased Shifting.

Readiness Process

The current processing environment involves work scheduling and resource coordination that is less than complete and rigorous. Because of this, changes are not effectively accomplished and requested support is not efficiently provided. The Readiness Process initiative - representing a more rigorous and structured approach to work task planning, scheduling, and execution - more effectively integrates all the elements needed to support the work schedule by verifying that paper, parts, people, and access are ready at least 24 hours prior to starting the work task or planned event. The criteria for this new concept are summarized below:

- Process shall verify that people, parts, paper, and access are ready to support.
- The verification shall be physical - not just a paper/system verification.
- No task shall be scheduled for work if all resource demands are not satisfied within 24 hours of planned event.
- No weekend task shall be scheduled unless resources are confirmed by close of business on Thursday.
- In cases where readiness is not verified, an "assessment of impact" sub-process shall resolve this issue.

Essentially, this initiative represents an excellent example of a *process* failure mode and effects analysis.

Figure 3-1 indicates how the Readiness Process initiative is intended to interface with the current Work Plan and Task Execution phases.

Basic Work Process (Simplified)

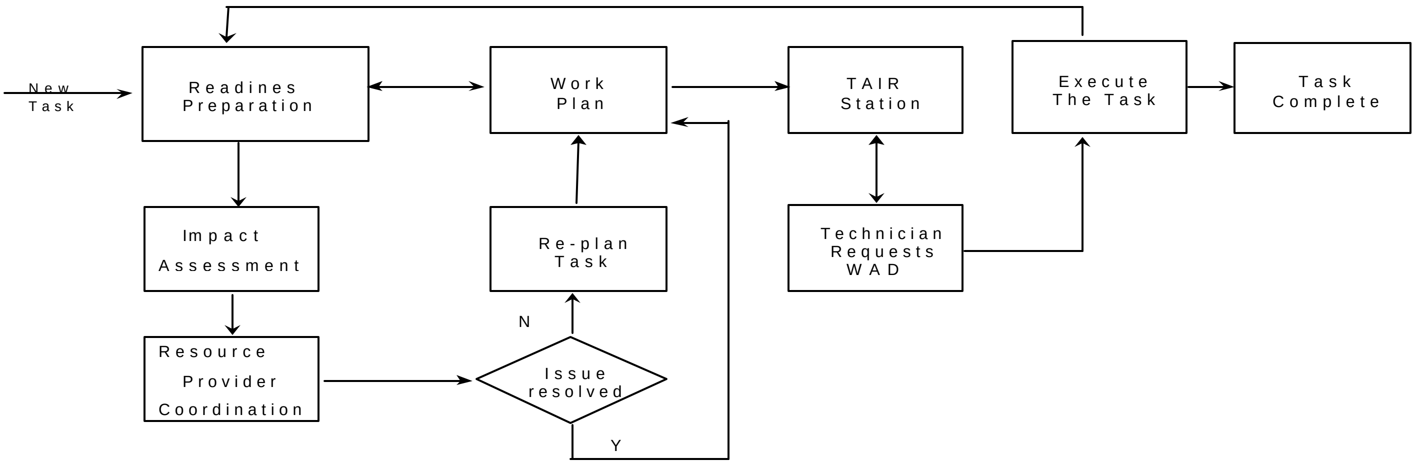


Figure 3-1

Figure 3-2 provides details of the Readiness Process initiative. As much as 11 days prior to the planned work task or event, each task/event is assessed for readiness on a daily basis.

Readiness Process - Overview

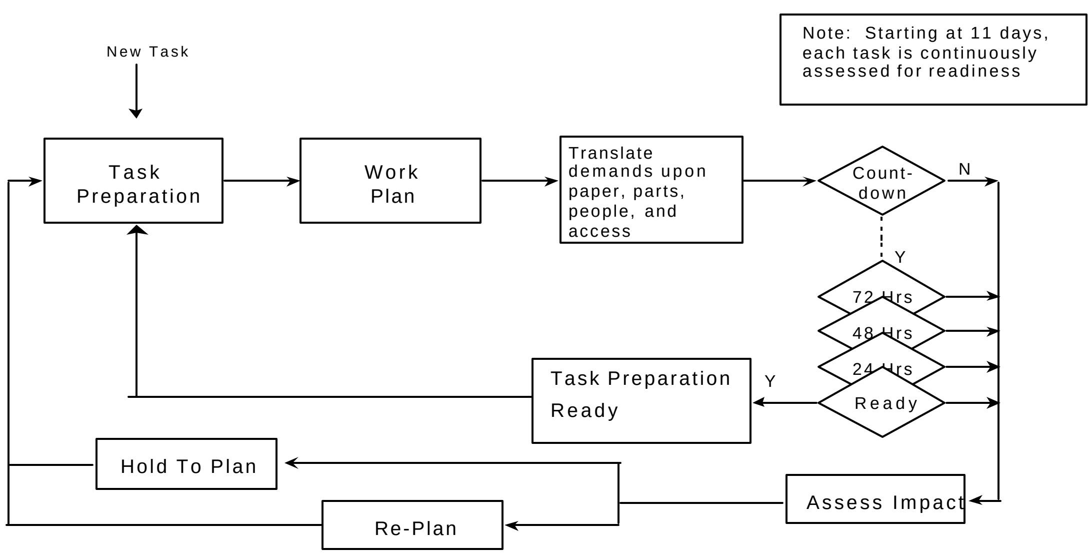


Figure 3-2

To date the Readiness Process initiative has been implemented in OPF Bays 1, 2, and 3. The expected completion date for implementation in the Hazardous Materials Facility (HMF) is fall of 1999.

A series of metrics have been developed to measure the effectiveness of the implementation.

- Number of times a WAD drops into the 11-day window (other than at the start).
- Number of times a WAD drops out of the 11-day window (after having started at the 11-day point).
- Number of times a job is statused as ready but did not start.
- Number of times an impact assessment was performed (at 3 days or less).

In effect, the number of WADs that enter and/or exit during the 11-day window represents a measure of process stability – low numbers are good, zero is best.

A test case for Readiness Process was undertaken during a pilot phase on OV-103. Based on 4,663 observations, 98 percent of the jobs were ready to work on the day planned and 95 percent of the tasks were ready 3 days in advance of schedule, which also allowed for work to be brought forward in the cue. A rate of 92 percent on-time starts was achieved as compared with a 50 percent rate prior to the pilot implementation of the Readiness Process initiative.

Phased Shifting

Phased Shifting represents the second of the Enhanced Processing Concept initiatives. The purpose of this initiative is to assess the benefits to be gained by adjusting the starting times of the first shift operation. This involves delaying the arrival of a portion of the first shift, allowing the earlier arrivals to better prepare for the day's work. The idea is that the delayed workers will be ready to immediately begin hands-on task execution (wrench time) upon arrival. This initiative also involves planning work in a way to achieve greater compatibility with natural events and rhythm in the workday (lunch and morning and afternoon break times) and to minimize task spillover into the next shift. Task spillover obviously introduces the additional risk associated with shift-to-shift hand-off and reduces worker job satisfaction (going home with an incomplete task). Phased Shifting is intended to stabilize or "smooth out" the work schedule so that workforce can be deployed more effectively, efficiently align the workforce with the work opportunities, and reduce the vehicle power-on time for testing by providing a better distribution of the test opportunities. This is illustrated in figure 3-3.

Phased Shifting

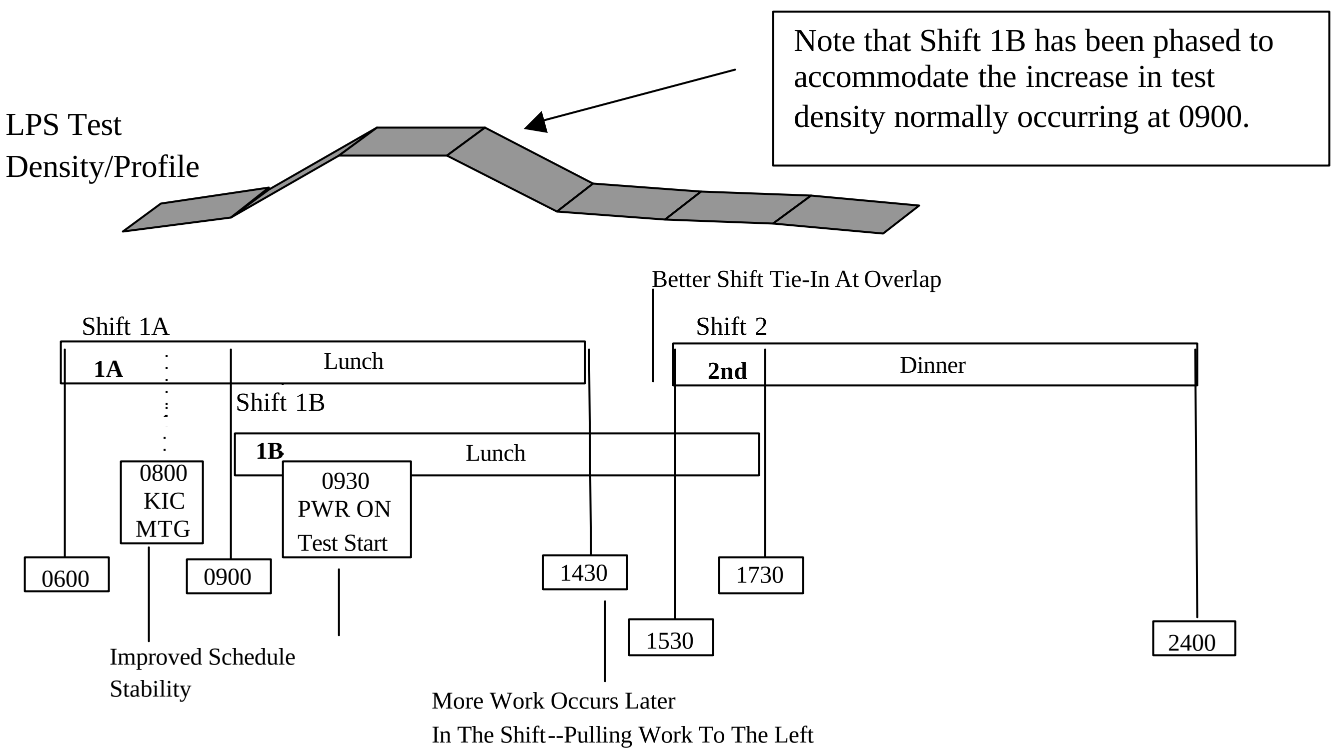


Figure 3-3

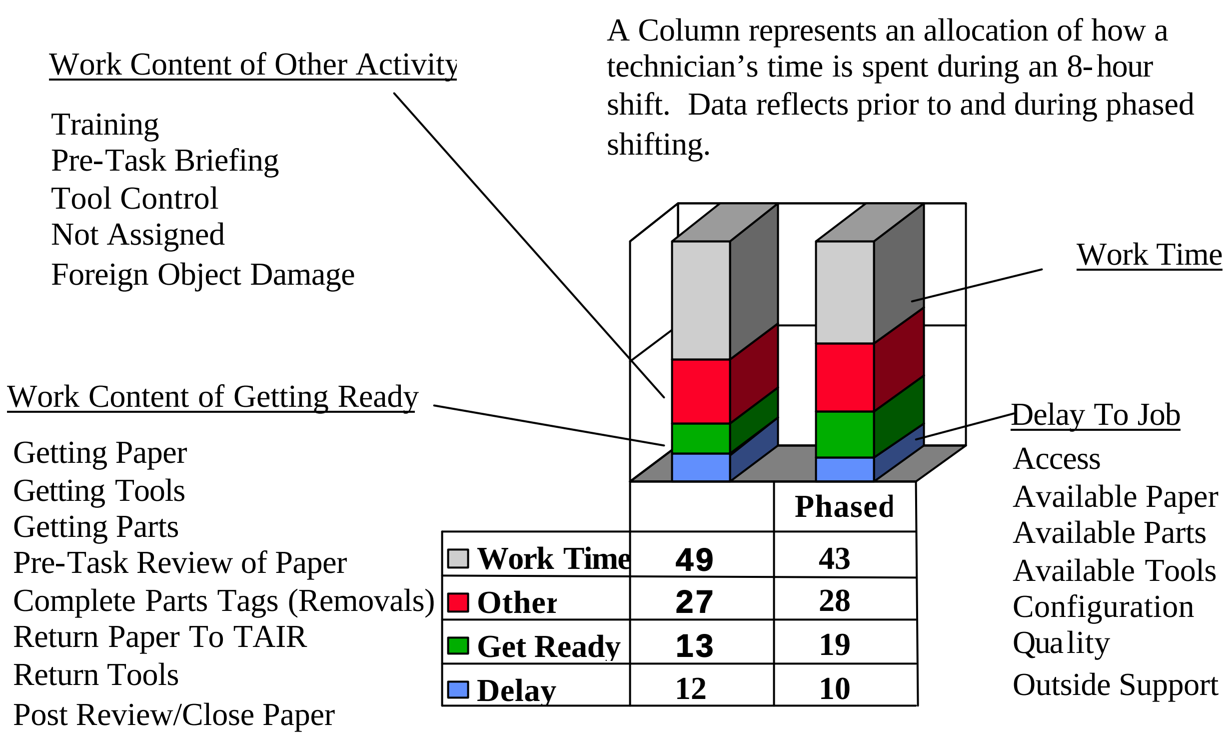
3.2 USA/GO FTE Savings Logic

The total projected savings of 60 FTE for this strategic initiative is apportioned as follows:

- Horizontal Processing/Shops and Labs — 49 FTE
  - -- Readiness Process — 38 FTE
  - -- Phased Shifting — 11 FTE
- Surveillance/SMA — 7 FTE
  - -- Readiness Process — 7 FTE
- Work Instruction Generation/Engineering — 4 FTE
  - -- Readiness Process — 4 FTE

A statistically defined data set (see figure 3-4) of 18,000 work samples of a technician's 8-hour day was established during the STS 85 and STS 87 flows in 1997/98.

Work Sampling Data



		Phased
Work Time	49	43
Other	27	28
Get Ready	13	19
Delay	12	10

Note: Totals do not add up to 100 percent due to rounding

Figure 3-4

The following sections represent the detailed calculations and logic for FTE savings associated with both the Readiness Process and Phased Shifting parts of the initiative.

Readiness Process

Horizontal Processing/Shops and Labs

- 350 technicians x 150 labor hours/month = 52,500 work hours available

Assuming 100 percent recovery of the 12 percent Delay Time (as indicated in the first column above):

- 52,500 hours x .12 = 6,300 work hours recovered

Converting back to FTEs:

- 6,300 hours divided by 150 labor hours/month = 42 FTE

This was arbitrarily de-rated by USA management to a total of 38 FTE for this area.

Surveillance/SMA

- 224 inspectors x 150 labor hours/month = 33,600 inspection hours available

Based on the assumption (no actual work sample data available) of a 4 percent standby of SMA personnel (as provided by SMA) associated with the 12 percent Delay Time:

- 33,600 hours. x .04 = 1,344 inspection hours recovered

Converting to FTEs:

- 1,344 hours divided by 150 labor hours/month = 9 FTE

As previously, this was de-rated by USA management to 7 FTE

Engineering (4 percent standby rate, as assumed above, was used)

- 500 engineers at 150 labor hours/month = 75,000 engineering hours x .04 = 3,000 hours divided by 150 labor hours/month = 20 FTE

However, Engineering was only willing to commit to a savings of 4 FTE.

Phased Shifting

The difference in Work Time (wrench time) between the baseline and the phased shifting approach (49 percent vs. 43 percent respectively) is explained as a “productivity increase” on the reasoning that the total amount of work accomplished would be the same. Based on this “wrench time” productivity improvement:

- 52,500 hours x .06 = 3,150 hours divided by 150 labor hours/month = 21 FTE

As was done previously, this computed FTE savings was de-rated by USA management to 11 FTE.

It should be noted that the reduction in Work Time (49 percent to 43 percent) was exactly matched by a 6 percent increase (13 percent to 19 percent) in Get Ready time.

3.3 Objective Evidence of Implementation

The review team conducted a telecon with Mr. Terry Risley and his staff on March 4, 1999.

Presentation:	Terry Risley, Tim Chastian,
Demo/Meeting:	Terry Risley, Tim Chastian + eight Senior team members

On-site interviews were conducted with Team Leads in OPF-2 on March 19, 1999. These discussions indicated that the on-time start rate has only been 90 percent. However, the Readiness Preparation Team is aggressively working to identify the root cause of delays, through use of Process Failure Modes and Effects Analysis (FMEA) and other methods. All parties interviewed considered this to be an excellent initiative.

3.4 Discussion and Assessment

Key Assumptions

Readiness Process

- 100 percent recovery of delay time
- 4 percent standby rate assumed for Engineering and SMA

Discussion

Readiness Process

A principle assumption in the Readiness Process initiative is that the 12 percent Delay Time is 100 percent recoverable. Clearly 100 percent recovery is not practically achievable. In addition, the assumption of a 4 percent standby time for both the SMA and Engineering is unsupported by work sample data. Consequently, it would seem appropriate to establish a database to validate this assumption.

However, the variability introduced by these two assumptions is offset to a large extent by the fact that USA management has chosen to accept a considerably lower value for FTE savings than the raw numerical calculations provide.

While the basic assumptions noted above do introduce a certain variability to the FTE savings estimates, USA/GO management has chosen to accept a very conservative estimate of the FTE savings claimed.

Phased Shifting

Although the Phased Shifting strategic initiative makes sense as a better way of working, it is difficult to construct an argument that shows a net cycle-time reduction. The data provided at this point in time suggests a zero net gain wherein reduced wrench time is offset by increases in preparation time. Until further pilot program activities and analyses demonstrate a real potential savings (possibly late CY99, based on pilot initiation in June of 1999), the projected FTE savings should be held in a TBD status.

Finally, the coupled effects of Readiness Process and Phased Shifting has not been considered or pursued. For example, given the assumption that the Phased Shifting initiative reduces delay times from 12 percent (baseline) to 10 percent (phased shifting), the extent to which this affects the calculation of FTE gains based on recovering a 12 percent delay time would certainly need to be assessed. Conversely, there may exist synergistic effects between these two initiatives that would provide an increased FTE savings. Since the Phased Shifting approach needs time to develop and mature, as noted above, the projected 11 FTE savings cannot be considered achievable at this point in time. Thus the total savings for the OPF Enhanced Processing Concept strategic initiative is the 49 FTE associated with the Readiness Process concept.

Confidence in Projected Savings Estimate

Readiness Process

The review team assigns a medium to high confidence to the projected FTE savings considering the limited foundation upon which the key assumptions are based.

Independent Review Team Estimate

Readiness Process

The review team applied a 0.8 multiplier to the USA/GO estimate of 49, arriving at a (rounded) estimate of 39 FTE.

Phased Shifting

The review team considers this initiative too immature to assign any projected FTE savings at this time.

Recommendations

Potential savings do exist in the Phase Shifting area and should be pursued.

4.0 MAXIMO (Commercial Off-the-Shelf Computerized Maintenance Management System) — 52 FTE Total

4.1 Initiative Content Overview

The MAXIMO system implements, to the greatest extent possible, a commercial off-the-shelf (COTS) process for the management and maintenance of all ground support equipment (GSE) and ground support systems (GSS) which do not directly interface with flight hardware.

The MAXIMO software application architecture is structured, in large measure, from a facility or factory maintenance management perspective, a point of distinction, or differentiation from the PeopleSoft architecture. PeopleSoft is the general-purpose industrial engineering COTS product being deployed for work planning and management in the flight hardware environment. Both MAXIMO and PeopleSoft derive savings through retirement of stand-alone legacy hardware and software systems along with their attendant "army" of support personnel. These legacy systems were previously not integrated electronically and required the generation of paper, which was carried from one site to another and maintained by administrative and clerical staffs. Most of that infrastructure is unnecessary with the MAXIMO/PeopleSoft implementation.

It is significant to note that MAXIMO provides a mechanism to perform both review and approval of work authorization documents. The parallel WAD Authorization and Validation Environment (WAVE) system in the flight hardware world provides an electronic means to develop (author) and review work authorization documents but retains a paper signature approval process.

GSS includes equipment that supports but does not physically come into contact with flight hardware. This includes all equipment "which is maintained." GSE is very often identical or similar (e.g., a pump, a fan, an actuator, a crane) but has the distinction that it "comes into physical contact with flight hardware."

The old system, as shown in figure 4-1a, was very "hands-on." Maintenance people were collocated in every facility and shop. Repair and maintenance activity required "issuance of paper," acquisition of work control numbers, use of couriers to transfer approved paperwork to schedulers, and additional paperwork to closeout and document repair maintenance activity. Many independent databases were developed and maintained by organizations participating in this complex process.

The new system, also portrayed in figure 4-1b, involves all elements in the process using a single COTS product called MAXIMO (see http://www.maximo.com). USA/GO selected MAXIMO through a competitive procurement process. MAXIMO is considered an "industry best practice" management system and is used by a wide range of industry leaders.

MAXIMO Training

Extensive training has been implemented and is continuing in the form of Town Hall meetings that address various features of the MAXIMO system. MAXIMO is a windows-based application program.

Other MAXIMO Interfaces

MAXIMO is linked to the PRACA database and automatically updates PRACA whenever a PR is issued and dispositioned (resolved). MAXIMO provides a built-in maintenance tracking database which enables/assists the implementation of reliability-centered maintenance in USA/GO.

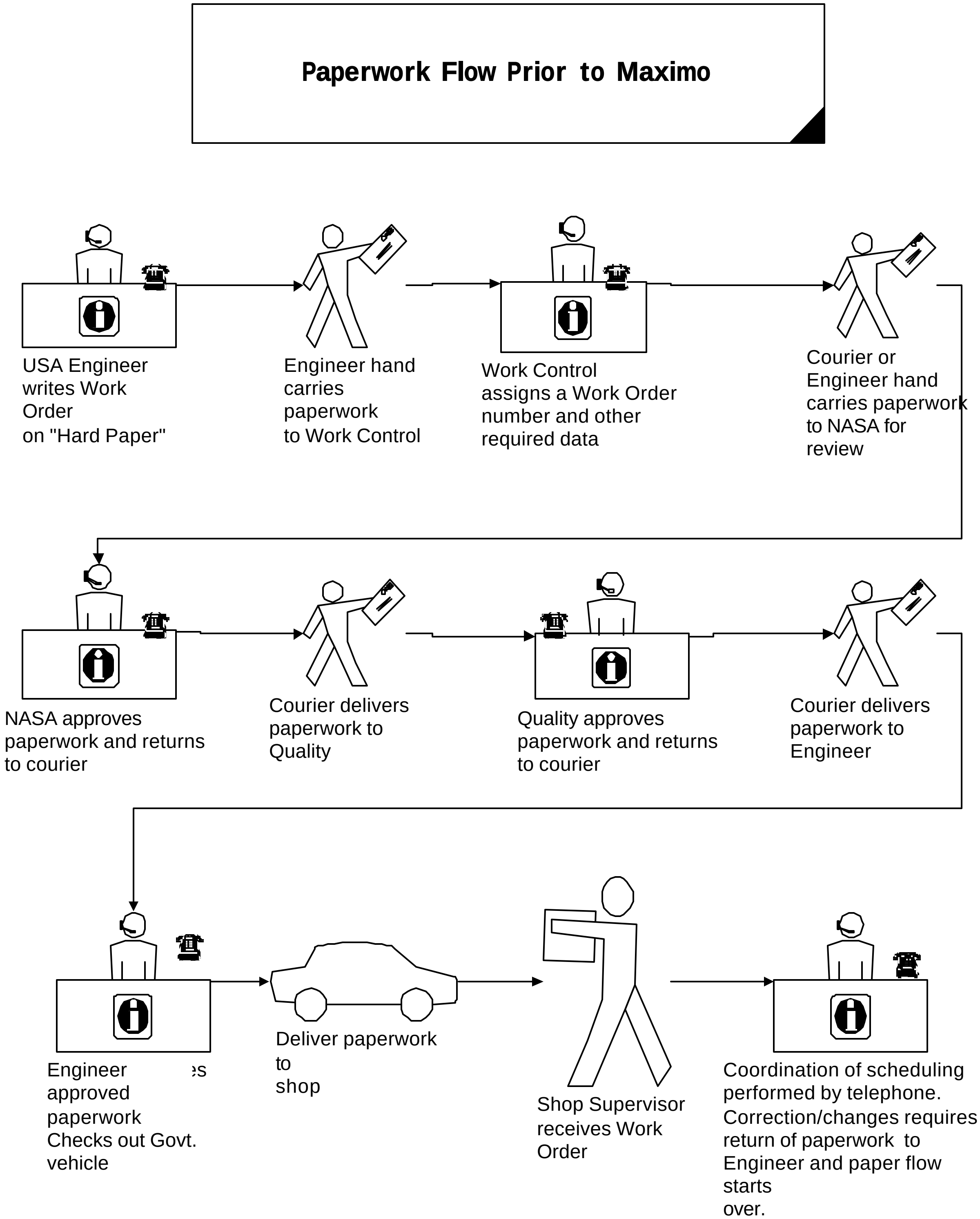


Figure 4-1 (part a)

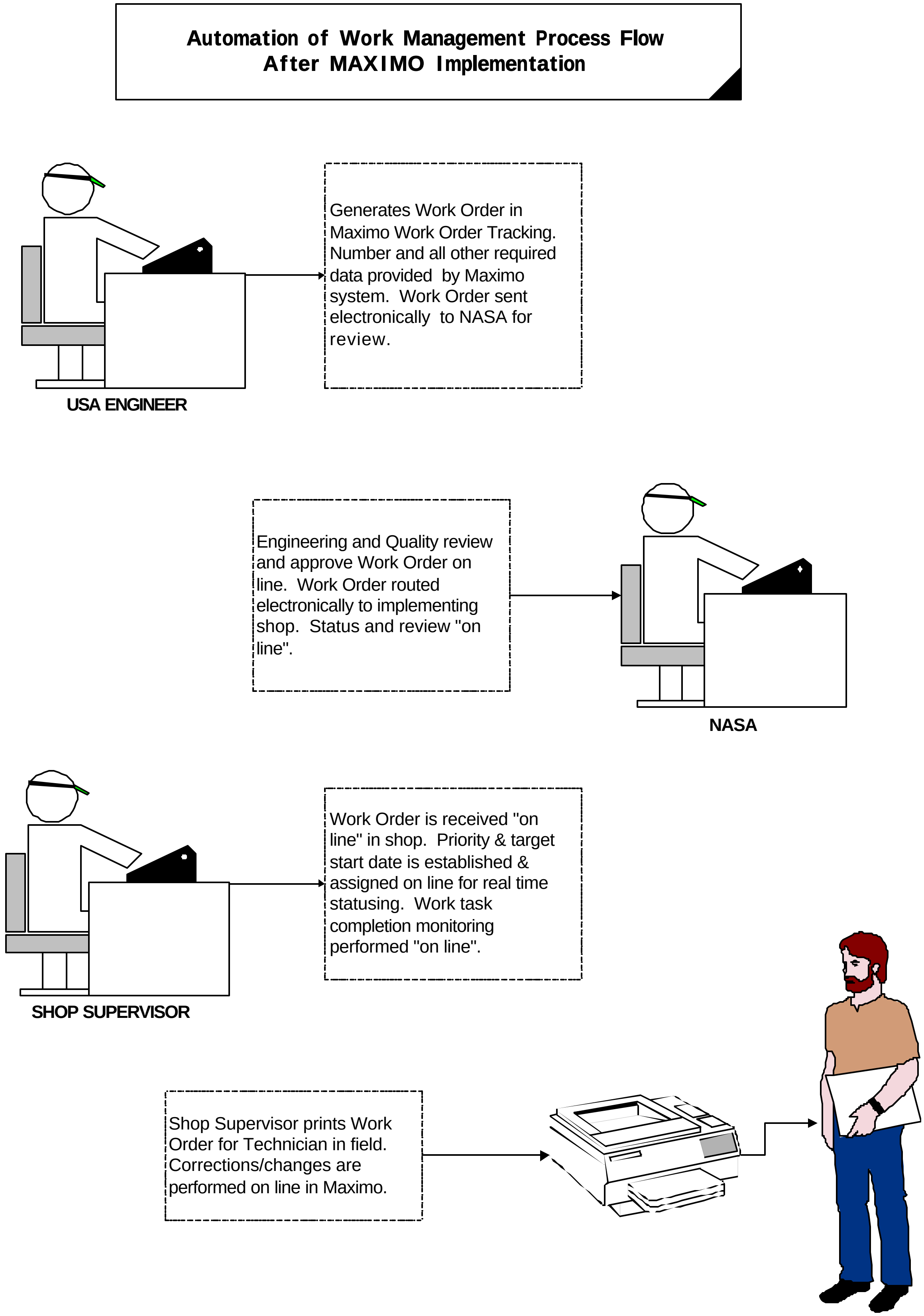


Figure 4-1 (part b)

4.2 USA/GO FTE Savings Logic

The MAXIMO savings are divided into savings associated with management and maintenance of GSS and GSE.

GSS: MAXIMO-Centered Process Savings in Ground Support Systems - 23 FTE

Twenty-three individuals were laid-off in anticipation of MAXIMO implementation. Job categories included planning, scheduling, paper-preparation, and software. Implementation has been completed in the facility electrical-predictive maintenance group.

<u>GSS Savings: Software Support Elimination - 8 FTE</u>

An immediate savings of 8 FTE will occur with the elimination of software development and support staff for stand alone systems. Thirteen separate legacy hardware systems have been consolidated under the MAXIMO umbrella.

<u>GSS: Collocated Work-Control Staff - 8 FTE</u>

Personnel involved in review and processing of "work-paper," typically collocated in facilities and shops, have been eliminated. The paper flow automated by MAXIMO consists of 80,000 separate new records generated each year.

<u>GSS: Centrally-Located Administrative Work-Control Personnel - 7 FTE</u>

Administrative/clerical personnel involved in the old paper-intensive process have been eliminated. The existing paper records include: 37,000 equipment records, 6,000 preventative maintenance plans and 5,000 test plans.

GSE: Horizontal and Vertical Processing (Vehicle Assembly Building (VAB) - Orbiter Processing Facility (OPF)) Maximo Savings - 29 FTE

The GSE FTE savings are estimated from an assessment of time saved in the processing of paper, including Problem Reports (PRs), Discrepancy Reports (DRs), and Interim Problem Reports (IPRs). The USA/GO FTE Savings Logic follows:

- the average time to process a "piece of paper" is approximately 40 hours
- the average cost of processing paper is $1,500/unit
- the estimated savings per piece of paper is $300/unit (20 percent)
- 9,500 PRs, DRs and IPRs are processed each year
- 9,500 x 40 hours x 0.20 = 76,000 hours
- 76,000 hours divided by 2,000 hours per work-year = 38 FTE
- USA de-rated the 38 FTE estimate (approximately 23 percent) to arrive at a savings of 29 FTE

4.3 Objective Evidence of Implementation

The review team conducted a telecon with Mr. Dale Nash and Mr. Terry Hayden on March 5, 1999. The team examined USA/GO Power Point presentations and other supporting documents available on the USA/GO web site. The team also reviewed information available at www.maximo.com to gain additional insight into the commercial applications of this product. The review team received a demonstration of the MAXIMO system on March 19, 1999, during the on-site visit.

Presentation: Dale Nash, Terry Hayden
Demo: Dale Nash, Terry Hayden, Marjie Harrison, Jerry Richards

4.4 Discussion and Assessment

Key Assumptions

- Cost and time estimates for processing WADs
- Estimated savings per WAD
- Flows per year

Discussion

The proper maintenance and configuration control of non-flight hardware which supports the processing and launch of Space Shuttles has traditionally been managed using a network of stand alone databases with largely "paperwork and people" interfaces. MAXIMO provides a single centralized database management system and eliminates many of the legacy paper and people-intensive interfaces.

Confidence in Projected Savings Estimate

The review team assigns high confidence to the projected FTE savings.

Independent Review Team Estimate

The review team applied a 1.0 multiplier to the USA/GO estimate of 52 FTE.

Recommendations

None

5.0 VAB Launch Flow Enhancements (Vertical Processing) 12 FTE Total

5.1 Initiative Content Overview

The central theme of the Launch Flow Enhancement (LFE) initiative is process cycle-time reduction, which will translate into FTE savings. The LFE process in many ways parallels the Integrated Process Team (IPT) concept where all participants or stakeholders in the process (suppliers, customers, people in the process, etc.) work together to identify ways to re-engineer existing processes to make them more efficient.

The LFE team meets three-to-four times per year. It consists of representatives of all communities and disciplines involved in External Tank (ET)/Solid Rocket Booster (SRB) Processing including USA, NASA at KSC and Marshall Space Flight Center (MSFC), element contractors, Engineering, Operations, Quality, Safety, and Logistics. The LFE team focuses and prioritizes efforts so that the community addresses the most “highly valued” changes from the list of potential changes.

The LFE team is an ongoing project. Over 118 items have been identified, and 85 are still in work. Review Teams identified ways of improving the flows to support an increased launch rate. Each LFE item has its own independent schedule. The LFE team tracks each item through closure.

Five Consolidated LFE Initiative Teams

The LFE activity has consolidated the various process initiatives into the following five areas of focus:

- ET Stand-alone
- Rotational Processing and Surge Facility (RPSF)
- Stacking
- ET/SRB Integration
- Post Flight

Each team has worked (is working) to identify inefficient processes and/or “long poles” on the critical event/critical path time-line for processing flight hardware. The top five or six candidates from each team have been combined into the FTE savings tracking log shown in the following section of this report.

5.2 USA/GO FTE Savings Logic

The FTE savings contained in the following analysis (see table 5-1) assume a seven flight per year rate. The 11 FTE savings estimate is based only on those items that have been completed. The savings are imbedded in the processing of hardware and for the range, three to ten flights per year, will be approximately linear with flight rate. The analysis assumes that a workyear includes 2,080 hours. The analysis in each case has been a very intensive "bottoms-up" exercise involving judgements and estimates from the individuals closest to the process.

ET/SRB LFE Savings				
Year Impl	**Brief Description**	**Equiv. Head Count (FTE)**	**Work Hours**	**Savings Per Flow**
1998	Reorganized to reduce management levels	4.00	8,320.00	1,188.57
1998	Eliminated an RTV closeout on an ET Umbilical	0.04	83.20	11.89
1998	Deleted an ET feedline borescope inspection	0.08	166.40	23.77
1998	Close out the ET Intertank at MAF	2.79	5,803.2	829.0
1998	Modified aft ET Closeout to eliminate rework	0.09	187.20	26.74
1998	Electronic version of RSRM controlled drawings available	0.37	769.60	109.94
1998	Reduced pre-use validation of segment joint leak check sys.	0.51	1,060.8	151.5
1998	Changed segment shaping tolerances (opened up specs)	0.70	1,456.0	208.0
1999	Eliminate the hydraset from SRB Stacking ops.	1.19	2,475.20	353.60
1999	Reduced the number of segment metal part inspections	0.23	478.40	68.34
1999	Changed schedule of segment lifting from the slip	0.03	62.40	8.91
1999	Provided contingency operations for sling misalignment	0.03	62.40	8.91
1999	Rescheduled wash-bay cleanups during disassembly	0.13	270.40	38.63
1999	Modified handling procedures for aft skirt breakover	0.03	62.40	8.91
1999	Nozzle disassembly inspection procedures were streamlined	0.03	62.40	8.91
1999	Changed handling method for ET hoisting adapters	0.09	187.20	26.74
1999	Replaced use of PR1422 with RTV133	0.01	20.80	2.97
1999	Revised ET primer touchup requirements for Al-Li	0.01	20.80	2.97
1999	Simplified ET weighing using scales	0.09	187.20	26.74
	Totals (rounded up to 11 FTE)	10.45	21,736.0	3,105.1

Table 5-1

Sample Calculations of FTE Savings

The following four examples provide a detailed look at selected line items from table 5-1 shown above.

ET/SRB LFE Savings Summary

Reduced Pre-Use Validation of Segment Joint Leak Check Hardware

Before the change, the Segment Joint Leak Check Hardware was validated before each use, a total of eight times per flow. As the equipment was used, reliability and operations were established. As people became more proficient with the hardware validation was not needed for each use. Validation of the hardware is now done once per flow, eliminating seven operations for each flow.

Summary of Savings:

Hours per set-up	7
Number of people needed for operation	x 3
Total hours per operation	21
Number of operations eliminated	x 7
Workhours saved per flow	147
Number of flows per year	x 7
Workhours saved per year	1,029
Available workhours per FTE	÷2,000
FTE savings per year	.51

Eliminate Hydraset from SRB Stacking Operations

Before the change, the hydraset was used during each segment mate. Now that the new 325-ton cranes are on-line, the hydraset is a redundant and less reliable system for controlling segment rate of engagement during the mate. Removing the hydraset has a minor affect on the critical path of the segment stacking flow. However, the effect on maintenance and readiness is substantial.

Summary of Savings:

Workhours per flow	45
Number of flows per year	x 7
Workhours saved per year (flight ops)	315
Workhours saved per year (maintenance)	+ 1,280
Workhours saved per year (total)	1,595
Other $$ spent per year	$30,000

Average hourly rate (estimated)	÷38
Equivalent workhour savings per year	790
Total equivalent workhours saved per year	2,385
Available workhours per FTE	÷2,000
FTE savings per year	1.19

Changed Segment Shaping Tolerances

Before the change, the segment shaping tolerances were very restrictive. Based on a history of successful operations, design analysis, and familiarity with the hardware, tolerances were changed (opened up) to allow a faster turnaround on shaping. The design center and the vendor agreed with the change in tolerances. Historical data has shown a significant savings in ongoing operations. The change has also reduced critical path stacking operations by about one shift per flow.

Summary of Savings:

Hours delayed per flow	20
Personnel involved in delay	x 10
Workhours saved per flow	200
Number of flows per year	x 7
Workhours saved per year (total)	1,400
Available workhours per FTE	÷2,000
FTE savings per year	.70

ET Intertank to be Closed Out at Michoud Assembly Facility (MAF)

Before the change, intertank operations included installation and removal of a substantial amount of GSE as well as a number of flight hardware setups. The program has approved closeout of the ET Intertank areas at MAF beginning with ET-106. This eliminates the flight work and the GSE work associated with those flight jobs. This also reduces the ET critical path by five shifts.

Summary of Savings:

ET Shifts reduced per flow	5
Workhours saved per shift	x 104
Workhours saved per flow	520
Integration workhours saved per flow	+ 52
Pad workhours saved per flow	+ 112
Workhours saved per flow (total)	684
Number of flows per year	x 7
Workhours saved per year (flight operations)	4,788
Workhours saved per year (maintenance)	+ 640
Workhours saved per year (Total)	5,428

Other $$ spent per year	$5,600
Average hourly rate per equivalent head (estimated)	÷ $38
Equivalent workhour savings per year	147
Total equivalent workhours saved per year	5,575
Available workhours per FTE	÷ 2,000
FTE savings per year	2.79

5.3 Objective Evidence of Implementation

The review team conducted a telecon with Mr. Greg Henry on March 5, 1999.
Presentation: Greg Henry, Mark Greby.

No on-site assessments or interviews were conducted.

5.4 Discussion and Assessment

Key Assumptions (partial listing based on evaluation of four sub-initiatives)

- Labor-hours per operation
- Labor-hours saved per operation
- Number of flows per year
- Number of operations eliminated

Discussion

This strategic initiative is comprised of 19 small initiatives of which four were addressed as examples for this report. Given the relatively large number of computations and associated estimates and assumptions, a correspondingly large variation attaches to the computed FTE savings.

Confidence in Projected Savings Estimate

The review team assigns a medium to low confidence for the projected FTE savings.

Independent Review Team Estimate

The review team applied a 0.6 multiplier to the USA/GO estimate of 12 FTE, arriving at a (rounded) estimate of 7 FTE.

Recommendations

None

6.0 Discrepancy Report (DR) Management Initiatives — 35 FTE Total

Fair Wear and Tear (18 FTE) and Intranet Provided Procedures (17 FTE)

6.1 Initiative Content Overview

Fair Wear and Tear (FWT)

This initiative provides a compendium (hardcopy only at this point) of "OK As Is" guidelines for minor defects which traditionally have been dispositioned with a paper-work intensive DR or PR. A DR can be written and approved at the technician level but typically requires extensive documentation review to produce the disposition. The FWT specification is projected to eliminate the creation of 10 percent of the items (PRs and DRs) tracked using the PRACA system for a typical processing flow.

This initiative calls for development of a specification that permits minor defects such as "cosmetic appearance" to be repaired with minimal disposition or to be "OK As Is" with no discrepancy paper being written. Current drawing requirements mandate a "new" condition.

Presently, there are 38 sections to the FWT document (MF0004-092), nine of these sections have been added since October 1997. The specification is constantly being revised and updated to include new hardware and inspection criteria. Usage rate is currently low, but usage rate will increase with training.

On-Line Maintenance and Repair Manual/Internet Provided Procedures (IPP)

The On-Line Maintenance and Repair Manual/IPP initiative is essentially a program to avoid recreation of typically recurring DR dispositions or "dispos" through the development and use of an intranet-based, on-line DR disposition recall system.

This initiative provides a library of pre-approved "Intranet Provided Procedures" directly to the technicians, reducing the need for engineering involvement during routine tasks. Using a Microsoft Word template, technicians can easily write procedures. Once written and approved by engineering, the procedures are configuration controlled, released, and ready to use within minutes using the Documentum document management system. Thus, this pre-approved disposition approach will eliminate the need for creating new dispositions and the repetitive involvement of safety, quality, and engineering personnel.

To date, the team has implemented 255 new procedures (of planned 569) available to technicians without engineering involvement. An estimated 60 percent of procedures identified are in-work or complete.

6.2 USA/GO FTE Savings Logic

Fair Wear and Tear

Applying the same ground rules as were used in the MAXIMO analysis:

- the average time to process a "piece of paper" is approximately 40 hours
- the average cost of processing paper is $1,500/unit
- 9,500 PRs, DRs, and IPRs are processed each year (based on historical data from calendar year 1996)

And assuming a cost avoidance of between 9 percent and 10 percent (Steering Team "best" estimate):

- 9,500 WADs/year x .095 = 902 "OK As Is" WADs x $1,500/WAD = $1,353,750 saved
- $1,353,750 divided by an estimated $38/hr divided by 2,000 hours/FTE = 17.8 FTE

This has been rounded-up to provide a claim of 18 FTE savings for this initiative.

On-Line Maintenance/IPP

Cost avoidance occurs in three areas:

- Engineering (Work Instruction Generation)
- Processing Shops and Laboratories
- SMA (Surveillance Support Process)

All of the following calculations are based on the plan of eventually building an IPP library of 300 DR-type WADs (currently at 255 and to go to 300 by Summer of 1999). Additional assumptions of using each of these 300 PRs/DRs twice during a typical flow and rate of 8 flows/year equates to a usage rate of 4,800 PRs/DRs per year.

<u>Engineering</u>

- 4,800 IPP/year x 3 hours/IPP = 14,400 hours/year divided by 2,000 hours/FTE = 7.2 FTE

Shop

Coordination and Waiting Time

- 4,800 IPP/year x 1.5 hours/IPP = 7,200 hours/year divided by 2,000 hours/FTE = 3.6 FTE

Planning and Scheduling

- 4,800 IPP/year x 1.5 hours/IPP = 7,200 hours/year divided by 2,000 hours/FTE = 3.6 FTE

DR Preparation (no longer required)

- 60 DRs/flow x 8 flows/year x 3 hours/DR = 1,440 hours/year divided by 2,000 hours/FTE = .72 FTE

SMA Surveillance

Floor Inspector to Log PRs/DRs

- 4,800 IPP/year x 0.5 hours/IPP = 2,400 hours/year divided by 2,000 hours/FTE = 1.2 FTE

Quality Data Center (QDC) to archive PRs/DRs

- 4,800 IPP/year x 0.5 hours/IPP = 2,400 hours/year divided by 2,000 hours/FTE = 1.2 FTE

The above calculations sum to 17.52 FTE and, thus, provide approximately a 17 FTE savings for this initiative.

6.3 Objective Evidence of Implementation

The review team examined the Fair Wear and Tear document provided by USA and conducted a telecon with Mr. Jeff Eberts on March 3, 1999.

Presentation: Rick Davignon, Jeff Eberts, Rick Corsillo, Greg Crews
Demo: Rick Davignon, Jeff Eberts, Rick Corsillo, Bob Osborne

During the team's on-site visit, USA provided a detailed description of the Fair Wear and Tear specification as well as a demonstration of how it is used during floor processing. A demonstration of how an IPP is accessed and released was also provided.

6.4 Discussion and Assessment

Key Assumptions

Fair Wear and Tear

- Estimate of 9 to 10 percent fewer wads
- Estimated savings per WAD

- Flows per year

On-Line Maintenance/IPP

- Utilization
- Number of WADs used per flow
- Hours saved per WAD for shop, engineering, and SMA

Discussion

Fair Wear and Tear

The FTE savings for Fair Wear and Tear are very clearly dependent on the cost avoidance assumption of 9 percent to 10 percent which the process owners agree represents a very aggressive, non-conservative assumption. Thus, the overall FTE savings estimate is probably overstated.

On-Line Maintenance/IPP

The assumption that 300 PR/DR WADs are used twice per flow or 600 accesses would appear to be somewhat high. This assumption obviously drives the expected FTE savings. A further refinement of this estimate or assumption is clearly warranted. Additional variability is associated with the estimated hours required in engineering, shop, and SMA to disposition or process PRs and DRs. While these represent best estimates or engineering judgements, they still represent average or mean values and necessarily have some degree of dispersion or variability associated with them.

Confidence in Projected Savings Estimate

Fair Wear and Tear

The review team assigns a medium confidence to the projected FTE savings.

On-Line Maintenance/IPP

The review team assigns a medium to low confidence to the projected FTE savings.

Independent Review Team Estimate

Fair Wear and Tear

The review team applied a 70 percent multiplier to the USA/GO estimate of 18 FTE, arriving at a (rounded) estimate of 13 FTE.

On-Line Maintenance/IPP

The review team applied a 60 percent multiplier to the USA/GO estimate of 17 FTE, arriving at a (rounded) estimate of 10 FTE.

Recommendations

None

7.0 Structured Surveillance Phase II — 17 FTE Total

7.1 Initiative Content Overview

The second phase of the structured surveillance program is conceptually excellent; incorporating statistical sampling design principles and use of state-of-the-art hand-held computer technology. The data availability, formatting, and graphical displays provided to Intranet users (usually) within 24 hours of the observations is truly a best practice.

This initiative involves the consolidation of the existing surveillance activities into a single, well-focused function that provides an overall assessment of the quality and safety of work performed by USA personnel. Included in this consolidation effort are programs such as Structured Surveillance, Safety Structured Surveillance, First-Time Quality, Surveillance Inspection Check Lists, Log/List Surveillance, Integrity Control Surveillance, Quality Planning Requirements Document (QPRD) Coding Surveillance, and Quality Paper Review.

Space Flight Operations Contract (SFOC)/USA Structured Surveillance Phase II

In order to accomplish the same successful quality assurance program with fewer people, USA has initiated a structured surveillance approach involving six highly qualified and experienced inspectors who conduct daily surveillance of work and inspection activity using a "Design of Experiments" approach. This approach assures a statistically valid sampling of activities in various facilities. Surveillance is automated to a great extent, utilizing Palm Pilot hand-held computers, to identify the surveillance tasks and to record the observations.

Data is downloaded at the end of the day and running statistics and trends are available on the USA Intranet by the following morning. Surveillance activities are distributed with 80 percent in process work and 20 percent in ground area surveillance such as work paper quality and integrity control. Inspections are randomly assigned within each category. This approach provides insight into the overall health of the quality inspection and task execution activities across the full range of critical USA/GO processes.

Example of Structure Surveillance Provided Data for a Typical Facility

OPF-1 Performance Measures include:

- Overall Performance Index
- Factory Performance Ratings
- Process Surveillance Component Ratings
- Monthly Component Rating Matrix
- Monthly Quality Pareto Analysis
- Monthly Safety Pareto Analysis

- Performance Index by Month
- Performance Index by Week
- Weekly Component Rating Matrix
- Weekly Quality Pareto Analysis
- Weekly Safety Pareto Analysis

A draft Standard Process Instruction (SPI) and supporting procedures that detail responsibilities and procedures have been developed. Reporting structures and formats have been designed and data collection software is complete. The surveillance team has been selected and trained, the pilot program has been completed, and the actual program has been initiated. Surveillance data can be obtained through the Process Surveillance Web Page (http://usago1.ksc.nasa.gov/apps/usago/orgs/sma001/surveillance/).

7.2 USA/GO FTE Savings Logic

The following logic was applied to developing the FTE savings estimate for the Structured Surveillance initiative:

- 4,000 observation/month x .75 hours/observation = 3,000 hours/month savings
- 3,000 hours/month x 12 months = 36,000 hours/year divided by 2,000 hours/FTE = 18 FTE

It is significant to note that 6 people now complete what previously took 23 people to accomplish. In addition to the "booked" FTE savings, it is projected that additional savings will result in elimination of:

- Structured surveillance observations and daily inspection data sheet
- The need for the inspection workforce to enter information by hand
- One data input position
- One Quality Engineer review position
- Three Quality Paper review positions

7.3 Objective Evidence of Implementation

The review team conducted a telecon with Mr. Mark Nappi and his staff on March 5, 1999. During the on-site visit, members of the review team were assigned to several of the surveillance inspectors and observed selected operations in the VAB and OPF-1.

Presentation: Mark Nappi, Richard Harvey, Jennifer Stenger
Tour: Richard Harvey + 5 Surveillance Inspectors

7.4 Discussion and Assessment

Key Assumptions

- Number of observations per month
- Labor hours saved per observation

Discussion

Potential Safety Concern

While conceptually excellent, it is unfortunate that significant problems appear to exist in the implementation. The technicians interviewed during the on-site review unanimously showed their mistrust and misunderstanding of the structured surveillance program. The program is viewed as punitive on the personal level and something to be feared and avoided if at all possible (e.g., shutting down the work in process or taking a lunch or coffee break). The technicians indicated that they are usually "written up" without even any discussion or feedback. On the other hand, individuals in the structured surveillance workforce indicate they have been verbally assaulted (in one case) and almost always referred to in pejorative terms by the technician workforce. The interpersonal dynamic of "I am here to surveill (sic) you" clearly could be construed as confrontational and/or threatening. It is essential that USA management move quickly to address this issue. Inspection and "work review" processes must be understood and recognized as important elements in assuring worker safety, flight safety, and mission success.

Confidence in Projected Savings Estimate

The review team assigns a medium confidence to the projected FTE savings.

Independent Review Team Estimate

The review team applied a 70 percent multiplier to the USA/GO estimate of 17 FTE, arriving at a (rounded) estimate of 12 FTE.

Recommendations

USA management must become involved in defining unequivocally the purpose and need for inspection as part of the work process. The value-added benefits with respect to worker safety must be emphasized. USA/GO may also wish to consider integrating the structured surveillance program with the role of Advanced System Technicians (ASTs), thereby eliminating the “we-they” conflict and mistrust. Rotating the best technicians through this position would underline the notion of inspection as a necessary element in the work process and a critical flight-safety assurance mechanism. The workers must achieve a level of understanding and trust of the inspectors before this process can be considered fully implemented.

8.0 WAVE — 13 FTE Total

8.1 Initiative Content Overview

WAD (Work Authorization Document) Authoring and Validation Environment (WAVE)

WAVE is a good example of how USA is streamlining a paper process that has evolved through a succession of changes intended to incorporate up-to-date technology and consolidate previously existing systems. This replaces the previous system known as the Paperless Work Environment (PWE) 1.2 and 2.1 which replaced the Operations and Maintenance Instruction Document (OMID) development system. WAVE currently resides as a section or cabinet within the higher level Documentum application.

In response to the numerous changes initiated in the ground operations arena during any given flow, it is necessary to identify the appropriate and applicable technical operating procedure (TOP) and develop a WAD to be released as the governing document for the work to be performed. WAVE is essentially the automation of this process, providing the engineer with the necessary library of documents (OMIs/WADs/PRs/DRs/Test Preparation Sheets (TPSs)/IPRs/job cards/graphics/etc.), the change request documentation, and a communications "shell" to provide for all proper and necessary coordination and concurrence, maximizing use of intranet/e-mail capabilities.

The system is expected to yield a savings of 13 equivalent FTE per year.

8.2 USA/GO FTE Savings Logic

The analysis of the estimated or expected FTE savings for this initiative applies only to Engineering and does not include any savings estimates for shop technicians or SMA surveillance support. The savings associated with Integrated Data Systems (IDS) is a straight forward head count (staffing level) reduction of 5 FTE.

Regarding the Engineering area, the analysis covers three principle areas:

- Electronic Review and Approval
- Electronic Parts and Materials Request (PMR)
- Reduced Wait Time

Electronic Review and Approval

This segment of the initiative enables a smoother and more efficient review and signature approval process. To date, only the Electronic Review part of the process is in place.

Electronic Approval (signatures) has not yet been implemented but is expected to be a future enhanceent.

Observations conducted during the November 1, 1995, to October 31, 1996, time period provided the following baseline data:

- PRs	17,791
- TPSs	4,740
- OMIs (updates)	1,263
- OMIs (new)	113
	23, 907 documents

Based on engineering judgement and sample data, the estimates for reduced processing times are 1 hour for PRs; and TPSs; 1/2 hour for OMI updates; and 1-1/2 hours for new OMIs. This represents an approximate reduction of 80 percent in processing or cycle time as compared to the systems replaced. Thus, the total hours saved on a per document basis is:

- PRs	17,791
- TPSs	4,740
- OMIs (updates)	632
- OMIs (new)	170
	23,333 hours

This cycle time savings was cut in half due to the fact that, as noted above, the Approval part of the process is not yet fully implemented. This yields:

- 23,333 hours divided by 2 = 11,667 hours divided by 2,000 hours/FTE = 5.8 FTE

Electronic Parts and Materials Request

Assuming that 1 hour of Engineering time is required to manually process paper PMRs and based on the previously used estimate (Section 6.0 - Fair Wear and Tear) of approximately 9,500 WADs processed per year (an eight flow/year rate), the FTE computations are as follows:

- 9,500 hours/year divided by 2 (no on-line error resolution capability) = 4,750 hours saved divided by 2,000 hours/FTE = 2.4 FTE

Reduced Wait Time

Based on the use of improved state-of-the-art software, wait times will be reduced. Assuming 10 minutes savings per document (a very conservative estimate), the FTE computations are as follows:

- 23,907 documents x 1/6 hours = 3,985 hours/year divided by 2,000 hours/FTE = 2.0 FTE

Thus, the total savings as computed for this initiative is 15 FTE (10 FTE Engineering and 5 FTE head count reduction in IDS). USA/GO management has chosen to de-rate this to 13 FTE.

8.3 Objective Evidence of Implementation

The review team conducted a telecon with Mr. Rick Davignon and his staff on March 4, 1999. Direct observation, during the review team's on-site visit, consisted of a description and demonstration of the Documentum system and the use of the WAVE cabinet within this application. As an example of the system capability, a simulated WAD was electronically created and manipulated to demonstrate the potential processing and cycle time savings available.

Presentation: Rick Davignon, James (Jamie) Griggs, Jeff Eberts
Demo: Rick Davignon, James (Jamie) Griggs, Bob Osborne, Jeff Eberts, Rick Corsillo

8.4 Discussion and Assessment

Key Assumptions

- Engineering hours saved per WAD
- 50 percent de-rating due to partial implementation (electronic review only - no electronic approval)

Discussion

This initiative would seem to be substantially under-committing to the potential FTE savings available. The incorporation of electronic approval would, theoretically, gain an additional 5.8 FTE. Currently USA management is only willing to commit to an additional 2.0 FTE when this capability comes on line.

Confidence in Projected Savings Estimate

The review team assigns a <u>medium to high</u> confidence to the projected FTE savings.

Independent Review Team Estimate

The review team applied a 80 percent (0.8) multiplier to the USA/GO estimate of 13 FTE, arriving at a (rounded) estimate of 10 FTE.

Recommendations

None

9.0 Deviation Reduction — 12 FTE Total

9.1 Initiative Content Overview

The initiative incorporates a series of activities to reduce the incidence of deviations being created for reasons other than "making the book work" (providing essential procedural changes in work instructions) or late requirement changes to support the specific task at hand. The past use of deviations to clarify a minor point of interpretation will be eliminated through increasing technician workforce skill level and building a task-team review process wherein the task team leader will discuss and clarify minor points. Deviations will continue to exist and be used as necessary to keep the work flowing forward in safe manner.

Underlying Concepts

- Too many deviations are created unnecessarily.

  The time spent in creating and approving unnecessary deviations can translate into FTE savings. All of the FTE savings included for this initiative are based on the assumption that fewer deviations will be generated.

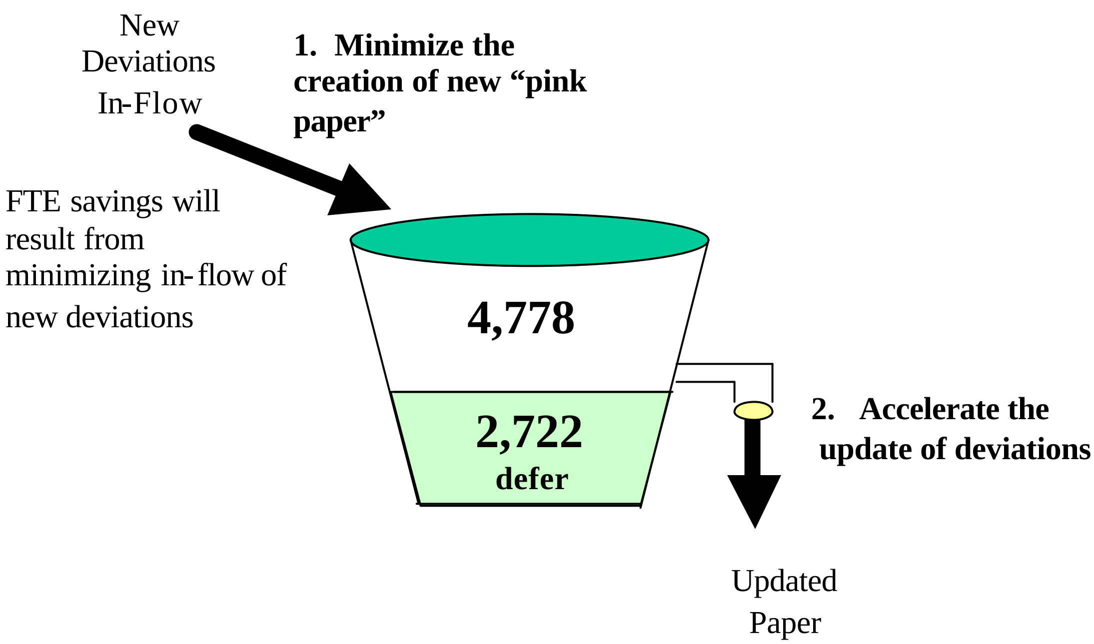
- The process for formally incorporating deviations into the body of the work document is unnecessarily cumbersome.

  The time required to convert a WAD or OMI with numerous deviations into a "clean" book can be reduced. No savings has yet been projected for streamlining the deviation incorporation process.

At the time of this report, there exist approximately 7,500 deviations in the system. This represents a 1,200 reduction from a total of 8,700 in April 1998. The current goal is to reduce this to 5,700 by October 1999. Approximately 50 percent of the deviations are "one signature" approvals and 50 percent require multiple signatures. Some of the latter are considered "out of family" which require NASA approval.

Figure 9-1 identifies the elements at work in the overall strategy to reduce the deviation backlog currently existing in the system. There are 7,500 deviations in the system today. Efforts are underway to accelerate proper incorporation of the 4,778 deviations considered most important to address. All of the current projected FTE savings will occur in stemming the flow of new deviations "into the bucket."

Figure 9-1 Two-Part Strategy for Deviation Reduction



Strategies to Reduce Creation of Unnecessary Deviations

Several Ground Operations initiatives are now in use or are being developed to provide more accurate OMIs, reduce the backlog of deviations not incorporated, and minimize the number of new deviations being written. In addition, several other initiatives are being considered. The following provides details about these initiatives.

Deviation Cause Code

Each deviation has an alpha-numeric cause code included by the deviation author. This cause code indicates what organization requested or caused the deviation and the reason for the deviation. These cause codes are used to develop metrics about the deviations. These metrics are used by management to provide feedback to OMI authors and approvers to use as a "first time quality" process to ensure accurate OMIs are released. These metrics can also be used by management to allow organizations to see the effects of using deviations to make a change when requirement changes come forward too late to allow an OMI revision before use. Further details about the cause codes are available in SPI SP-511(2)K Appendix C at URL http://kscgrndexc8.ksc.nasa.gov/spi/pdf/SPISP511.PDF.

Process-Product Integrity Continuous Improvement (PPICI)

This is a process where a team review of an OMI by knowledgeable representatives from each organizations that authors, works, or inspects is conducted to ensure all requirements are satisfied and that the OMI will be accomplished in the most effective and efficient way. After the review is completed and any resulting changes have been made, future changes to the OMI are tightly controlled by the PPICI team to minimize any process creep to the OMI and to ensure these changes are mandatory.

Suggested WAD Enhancements (SWE)

This is an on-line system that provides a method for anyone to request an enhancement change to an OMI. These requests are evaluated by the owner of the OMI and, if agreed to, are incorporated during the next redline ICR to the OMI. Management continues to emphasize the need to use this system instead of allowing a work stoppage to process an enhancement deviation. Further details about the SWE system are available at URL http://usago1.ksc.nasa.gov/apps/usago/orgs/engapp01/sweap/.

Task Team Leader (TTL)

This is an individual that has overall responsibility for working an OMI. The TTL can, through coordination with the affected organizations, determine if a change to an OMI is mandatory and needs a deviation or if the change is an enhancement and should be requested through the SWE system. Management continues to emphasize to the TTLs the need to only process deviations for mandatory changes (late requirement/design changes or work stoppage resolutions). Further details about the TTL are available in SPI SP-006(2)K at URL http://kscgrndexc8.ksc.nasa.gov/spi/pdf/SPISP006.PDF.

Redline Instruction Change Request (ICR)

This is the process where mandatory changes are incorporated in an OMI when the changes are identified far enough in advance of working the OMI to allow for changing and publishing a new revision of the OMI. Any known enhancement changes, including those listed in the SWE system, will be incorporated during this process. Management continues to emphasize to the OMI owners the need to plan ahead and incorporate OMI changes by this process. Further details about the redline ICR process are available in SPI SP-514(2)K at URL http://kscgrndexc8.ksc.nasa.gov/spi/pdf/SPISP514.PDF.

Direct Deviation Incorporation for a Non-Critical and Non-PPICI OMI

When an OMI is closed out after work is completed, the deviations are collected with an ICR cover to be processed as a Deviation Only ICR (DOI). If the OMI is both non-critical and non-PPICI, the deviations are incorporated in the OMI without any further approvals. This process eliminates the review and approval time normally required for an

ICR and allows a quicker more efficient revision to the OMI. Further details about the DOI process are available in SPI SP-514(2)K at URL http://kscgrndexc8.ksc.nasa.gov/spi/pdf/SPISP514.PDF.

Advanced System Technician (AST)

These technicians will receive specialized system-level training beyond the training currently received by technicians. Once the ASTs are in place, the level of detail in an OMI can be decreased since the ASTs are skill based and will not need as much detail to work the OMI. Having fewer details in the OMI will result in less needed changes to the OMI by ICR or deviations. Further details about the AST are available from the Ground Operations Strategic Initiative 2.a.1 at URL http://usago1.ksc.nasa.gov/usago/orgs/prog015/bhag/.

Strategies to Streamline the Deviation Incorporation Process

Direct Deviation Incorporation for All OMIs
Expand the direct incorporation of deviations to all DOIs.

Electronic Review and Approval of ICRs

This process will shorten the overall time for revising an OMI since the review and approval could be done on-line and in parallel by the required approvers instead of in series, when the paper ICR is passed from approver to approver. With the shorter cycle time, a formal revision to an OMI could be made closer to the work start time resulting in less need to create a deviation document at the last minute.

Prioritizing and Selecting OMIs for Incorporation of Deviations

The following plot (figure 9-2) shows the number of work authorization documents plotted versus the number of existing deviations per document.

The strategy is to live with the many documents containing only one, two, or three deviations for the time being, given the "overhead" associated with changing a single document. For example, there are 940 documents containing one deviation, there are 462 documents containing two deviations and one document containing 60 deviations.

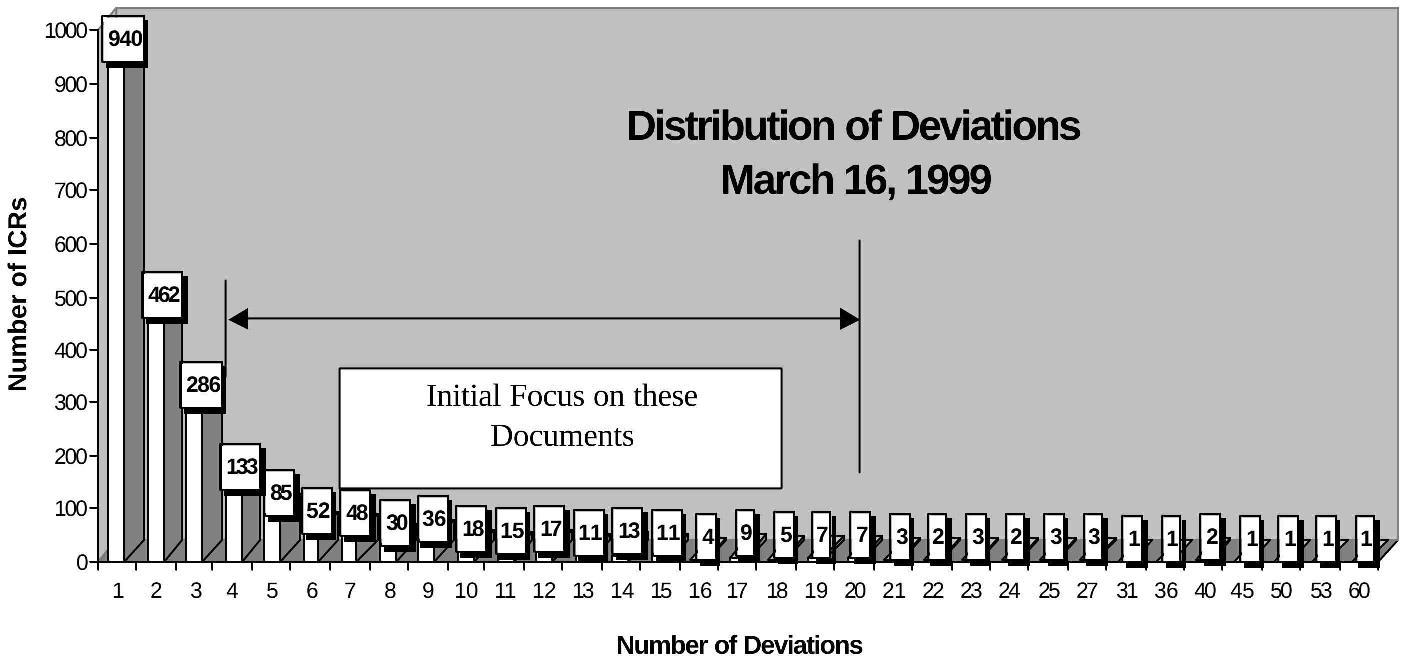


Figure 9-2

<u>(Note:</u> The vertical axis label “Number of ICRs” can be interpreted as “Number of Documents.”)

As indicated in the above chart, the USA/GO rationale for the document conversion activity focuses on documents containing four or more deviations, noting that some of the documents which contain more than twenty deviations are infrequently used.

Implementation Status and Milestones

The current implementation status:

- Deviation count = 7,043
- October 1, 1999, goal is 5,700 deviations
- Long range goal to maintain no more than 3,000 deviations in the system

9.2 USA/GO FTE Savings Logic

The proposed FTE savings are calculated for three areas: Engineering; Shops and Laboratories; and SMA.

Engineering

Using a database of 10,440 deviations written in 1997 (or 870 deviations/month) and based on achieving a goal of 7,080 deviations (or 590 deviations/month), this represents a 280 deviation/month reduction or a yearly reduction of 3,360 deviations. Assuming it requires 3 hours of an engineer's time to process a deviation, this equates to 10,080 hours saved or approximately 5 FTE. Based on this direct 5 FTE savings, an additional offline savings of 2 FTE was assumed. Total: 7 FTE

Shops and Laboratories

The assumed reduction in deviations for the Shop and Labs was 680 deviations/month. On this basis, and with an assumed 10 minutes per deviation processing time, a .68 FTE (680 deviations/month times12 months times 1/6 hour/deviation divided by 2,000 hour/FTE) savings is realized. This has been rounded-up to 1 FTE and is assumed to apply equally to Horizontal and Vertical processing activities. An additional 1 FTE savings is assumed for Offline support. Total: 3 FTE

SMA/Surveillance

The above analysis was conducted for estimating the FTE savings for surveillance support. It was assumed that 1 FTE savings would be realized for on-line Horizontal and Vertical processing and an additional 1 FTE savings would accrue to reduced work control requirements in the firing room or LCC. Total: 2 FTE.

9.3 Objective Evidence of Implementation

The review team conducted a telecon with Mr. Rick Davignon and his staff (Jeff Eberts and Larry Irminger) on March 8, 1999. Extensive discussions were held during the on-site visit. The process was described and data was presented and reviewed relative to reducing the number deviations being created as well as those activities underway to process the number of deviations that currently reside in the system.

Presentation: Rick Davignon, Jeff Eberts, Larry Irminger
Demo: Rick Davignon, Larry Irminger, Jim Sullivan, Jeff Eberts, Rick Corsillo

9.4 Discussion and Assessment

Key Assumptions

- Engineering/Shop/SMA hours saved per deviation
- Estimated deviation reduction per month

Discussion

The deviation reduction initiative appears to be well conceived and moving forward in a logical and safe manner. However, several factors contribute to assigning this FTE savings estimate to the medium to low level of confidence category.

First is the very large discrepancy in the estimated deviations per month reduction between Engineering (280 deviations/month reduction) and the Shop (680 deviations/month reduction). Whether one or both of these numbers is wrong, additional effort is clearly required to reconcile these per month savings estimates. Secondly, the basis for the Engineering goal of reducing deviations to 7,080/year (590/month) does not appear to be supported by fact or work sample data. This estimate or goal needs further assessment and validation. Finally, no accounting for the costs (manpower, time, training, etc.) associated with achieving this strategic initiative has been factored into the estimated FTE savings.

Confidence in Projected Savings Estimate

The review team assigns a medium to low confidence to the projected FTE savings.

Independent Review Team Estimate

The review team applied a 60 percent (0.6) multiplier to the USA/GO estimate of 12 FTE, arriving at a (rounded) estimate of 7 FTE.

Recommendations

None

10.0 Safety Clear (11 FTE) and Toxic Vapor (8 FTE) 19 FTE Total

10.1 Initiative Content Overview

Safety Clear

Currently, verification of clears, controls, personnel protective equipment (PPE), and emergency support is performed by safety personnel. Prior to, and during hazardous operations, safety personnel ensure that non-essential personnel are clear of the hazard control area, that PPE is being utilized, and that the required support is on-site. This initiative transfers, as a basic duty of the task team leader, the responsibility for verification of certain clears, controls, and PPE/support to the shop and or the work team.

Safety Operations has formed two teams to work on this initiative. The first team identifies tasks that can be transferred. The second team, working with Shop management, verifies that the task to be transferred is accepted by the affected group and that all required training is complete. Safety Engineering is responsible to ensure the paperwork is changed to reflect the task transfer. As of November 30, 1998, 847 of 1,645 OMIs have been completed.

<u>Safety Clear In-Place Safeguards</u>

- Pre-Task Briefings
- Pre-Task Walkdowns
- Notification to Firing Room Test Team
- Hazardous Control Clear Established
- Verification of Proper Protective Clothing
- Operational Intercommunication System
- Hand-Held Portable Radio (backup communication)
- Operational Television (recorded available at selected locations

Toxic Vapor

Currently, toxic vapor checks (TVCs) performed during the operation ensure that permissible exposure levels are not exceeded in the technicians breathing zone, a Self Contained Atmospheric Protective Ensemble (SCAPE) environment has not developed, and hypergolic vapors have not migrated beyond the established control area. This initiative transfers the responsibility for atmospheric monitoring for Class C and Modified Class C operations to the shop and/or the work team, as a collateral duty.

The updated technical training course is available to the identified technician organizations. To date, 142 technicians have received this training. Site safety has conducted hands-on OJT for approximately 24 technicians in the work areas. To expedite the OJT work, three additional safety representatives have been selected to help with this activity.

Toxic Vapor In-Place Safeguards

- Pre-Task Briefings
- Pre-Task Walkdowns
- Firing Room Test Team Involvement
- Hazardous Control Clear Established
- Verification of Proper Protective Clothing
- Operational Intercommunication System
- Hand-Held Portable Radio (backup communication)
- Operational Television (recorded and available at selected locations)
- Final TVC check performed by Safety

Safety Clear and Toxic Vapor Monitoring Will Continue in Major Processes

USA/GO safety personnel will continue to perform safety clears and toxic vapor monitoring for the following activities:

- Orbiter Launch and Landing (SOOO7, SOO28)
- Major Hypergolic Operations (SCAPE Orbiter Hypergolic Load)
- Major Ordnance Operations
- Major Clears
- Final TVC's Hypergolic operations
- Emergency Responses

Compliance with Occupational Safety and Health Administration (OSHA) and NASA Safety Requirements

USA/GO safety officials have verified that all of the requirements identified in OSHA Regulation/29 CFR 1910.146, "Permit-Required Confined Spaces," NASA Health Standard/NHS/IH-1845.2, "Entry into and Work in Confined Spaces" will continue to be fulfilled after implementation of the USA/GO Safety Clear and Toxic Vapor strategic initiatives.

10.2 USA/GO FTE Savings Logic

Transition of Safety Clear Verification To Processing Operations

Based upon examination of safety logs maintained on actual operations and engineering judgement of un-logged items, an estimated 3 labor hours can be saved per WAD involving Safety Clears. Those estimated savings are distributed as shown in table 10-1. Table 10-2 presents savings logic for Toxic Vapor using percent of worktime estimates.

	WAD Class			Hr. Est.	Per Flow		9 Flts/yr
WADS / Flow:	472	OMI's	x	3	1,416	x	12,744
	285	PR/IPR's	**x**	3	855	x	7,695
	85	TPS	**x**	3	255	x	2,295
Total Per Flow	**842**		**x**	**3**	**2,526**		**22,734**

* 22,734 labor hours per year / 2,080 = 10.9 equivalent heads, rounded to 11 FTE.

Table 10-1

Transition of Safety's Toxic Vapor Checks To Processing Operations

Location		Jan 97 Headcount		% Time On Task		Equivalent Headcount On Task
PADs		12		25		3
OPFs		10		30		3
Landing		1		10		0.1
VAB		12		5		0.6
RPSF		2		0		0
Hanger AF		1		5		0.05
HMF		3		70		2.1
					***Total =**	**8.85**

* The 8.85 equivalent heads has been rounded down to 8 FTE.

Table 10-2

10.3 Objective Evidence of Implementation

The review team conducted a telecon with Mr. Mark Nappi and his staff on March 5, 1999. Several follow-up telecons were held concerning specific safety issues related to the March 1981 safety clear mishap that resulted in the death of two contractor technicians.

The team reviewed descriptive material available on the USA/GO Strategic Initiative web site. Prior to the on-site review the review team requested that USA address the following five questions related to worker safety:

- Describe how the proposed initiatives will assure compliance with OSHA 29 CFR Part 1910 confined space entry and hazardous breathing environment requirements.
- Describe how the lessons learned after the 1981 mishap have been incorporated into the Safety Clear and Toxic Vapor risk management strategies.
- Describe how the proposed initiatives would compare with industry best practices.
- Describe how the proposed initiatives would match-up with the Dupont safety approach.
- Describe the extent to which the initiatives have been coordinated with NASA KSC SMA.

During the on-site review, team members interviewed contractor and KSC safety personnel and were provided with an actual demonstration of how safety clears and toxic vapor checks are being conducted in the VAB and OPF.

<u>Safety Clear</u>

Presentation: Mark Nappi, Vic Rebello, Dan Clarkson
Tour: Mark Nappi, Vic Rebello, Dave Kotz

<u>Toxic Vapor</u>

Presentation: Mark Nappi, Vic Rebello, Dan Clarkson
Tour: Mark Nappi, Vic Rebello, Dave Kotz

10.4 Discussion and Assessment

Key Assumptions

Safety Clear

- 3.16 SMA hours/WAD
- Number of WADs per year
- Flow-rate

Toxic Vapor

- Percent of SMA work time associated with various tasks

Discussion

The Safety Clear and Toxic Vapor strategic initiatives were activities which the review team initially identified as potential safety concerns (in part based on a Safety Clear-related catastrophic accident that occurred at KSC in 1981). The on-site review helped the team better understand the initiatives within that context.

Safety Clear

The function of establishing perimeters, communicating to task team leaders, and assuring personal protective equipment is something that technicians can perform by themselves. This is particularly true in the case of an individual qualified as an AST. The "second set of eyes" function can be performed by the second and/or third technician involved in the task. The benefit from a safety perspective is freeing the safety inspector to perform surveillance over the entire facility rather than focusing full time on one particular task.

Toxic Vapor

The toxic vapor check, just as the safety clear function, can be performed by the individuals on the technician team performing the work. The safety inspector is free to perform a surveillance role.

Obviously, if safety moves out of the task-inspection role to the process surveillance role, one can argue that workers have been empowered to assume total job responsibility while overall safety is improved with roving surveillance inspectors. This makes sense if, indeed, there is in-place a robust and respected surveillance function. On-site observations suggest that this is not the case. The logic for implementing Safety Clear and Toxic Vapor is dependent upon the effective implementation of the structured surveillance function.

Confidence in Projected Savings Estimate

Safety Clear and Toxic Vapor were both assigned a high confidence for projected FTE savings.

Independent Review Team Estimate

The review team applied a 100 percent multiplier to the USA/GO estimates of 11 FTE for Safety Clear and 8 FTE for Toxic Vapor arriving at a combined estimate of 19 FTE.

Recommendations

None

11.0 Calibration 7 FTE Total

11.1 Initiative Content Overview

The objective of this strategic initiative is to reduce the number of instruments maintained in the calibration recall cycle and reduce the overall number of calibrations being performed. The initiative's overall goal is a 40 percent reduction.

This objective is being accomplished in the following three phases:

Phase 1 - Reduce "issued-on-demand" calibrated instruments controlled by the Material Service Centers (MSCs). As of March 1999, 1,645 instruments/items from a total of 6,767 have been removed – a 24 percent reduction.

Phase II - Reduce instruments calibrated "in-place." To date, 1,725 instruments from a total of 10,000 have been removed – a 17 percent reduction.

Phase III - Reduce instruments exclusively owned or maintained by organizations without MSC control and not calibrated in-place. To date 2,846 out of a total of 12,663 instruments have been removed – a 22 percent reduction.

11.2 USA/GO FTE Savings Logic

Based on outside and industry estimates of calibration costs of between $65 to $150 per tool, a mid-range value of $100 per instrument cost was assumed.

- Total instruments removed to date (from all three phases) 1,645 + 1,725 + 2,846 = 6,216 x $100/instrument = $ 621,600 savings
- $621,600 - $37,924 (implementation costs) = $583,676 divided by $38/hour = 15,360 hours divided by 2,000 hours/FTE = 7.6 FTE

This has been rounded-down to an estimated 7 FTE savings for this initiative.

11.3 Objective Evidence of Implementation

The review team conducted a telecon with Messrs. Mark Nappi, Richard Harvey, and Dave Sheriff on March 5, 1999. No direct observations were conducted by the review team during the on-site visit.

11.4 Discussion and Assessment

Key Assumptions

- Cost per calibration

Discussion

This FTE estimate is well-grounded and based on actual numbers of instruments removed from calibration. The only source of variability is the assumed $100/instrument calibration cost and this would appear to be a relatively conservative estimate. Therefore, this estimate should be placed in the high level of confidence category.

Confidence in Projected Savings Estimate

The review team assigned a high confidence for projected FTE savings.

Independent Review Team Estimate

The review team applied a 100 percent multiplier to the USA/GO estimates of 7 FTE.

Recommendations

None

12.0 GOFOIT (Ground Operations/Flight Operations Initiative Team) 18 FTE Total

12.1 Initiative Content Overview

GOFOIT evolved from 22 separate teams which began formulating process improvement ideas in May 1997 and represents a series of initiatives related to information processing and storage. The initiatives address hardware development and maintenance, software development and maintenance, user support, and other software administrative management activities. GOFOIT consists of seven principle elements.

1) Phase out analog (magnetic) tape data acquisition systems and replace with digital systems.
2) Establish common "HELP DESK" tools and automation systems.
3) Establish common tools for use in Kennedy Avionics Test Set (KATS) and Shuttle Avionics Integration Laboratory (SAIL).
4) Standardize JSC/KSC networks and data transmission systems.
5) Consolidate software licenses.
6) Consolidate maintenance agreements.
7) Consolidate networks, help desks, and 24 hour monitoring functions.

12.2 USA/GO FTE Savings Logic

Mainframe Consolidation - 7 FTE

Seven fewer people are required to perform Help Desk functions as a result of consolidation activities. Instead of multiple Help Desk management systems, the GOFOIT initiative implements a single system. This initiative will be implemented by April 1999. A savings of 2 FTE support contractors has also been achieved, however, this has not been included in the GOFOIT tally.

Data Recording and Media Center - 6 FTE

GOFOIT personnel estimate the following savings associated with the move from costly ($155/tape) analog recording to the more compact, reliable, and less expensive digital data ($5/tape) recording system:

- 1 technician
- 1 Quality Control inspector
- 2 tape operators

Transfer of SAIL Technical Support Function to JSC - 2 FTE

KSC USA/GO personnel supporting the SAIL facility at Johnson Space Center (JSC) have been eliminated. JSC-based USA personnel will assume the support function.

Consolidation of USA Software License Administrative Management to JSC – 1 FTE

The software license management activity has been consolidated at JSC, saving USA/GO a single FTE.

Work Control System Software Maintenance Savings - 4 FTE

Fourteen separate work control systems are being combined under the PeopleSoft initiative. PeopleSoft is a COTS product which supports scheduling, work control, and configuration control activities. The savings under this element will be associated with not having to implement custom software fixes, software modifications, and maintenance.

12.3 Objective Evidence of Implementation

The review team conducted a telecon with Mr. John Weaver on March 1, 1999.

The review team was taken on an extensive tour of the existing data processing and data storage facilities supporting the Launch Control Center (LCC). Having examined the existing system, the team was then shown the new facilities with new and upgraded capabilities. The team was also shown the consolidated computer network support command center.

Presentation: John Weaver, Anthony Delmonte, Thomas Brown (Presentation)
Demo/Tour: John Weaver, Anthony Delmonte, Larry Carr, and Mike Shacreaw

12.4 Discussion and Assessment

Key Assumptions

No calculations requiring assumptions were involved in determining the FTE savings.

Discussion

The review team was impressed with the scope and breadth of this initiative and felt confident that the projected FTE savings will be achieved. The integration of multiple stand-alone operational and data storage systems provides obvious efficiencies. The move to COTS hardware and software systems provides obvious savings. The move to commonly used "open architecture" software languages (C++) eliminates the need for single vendor and sole-source contracting. The review team places this savings estimate in the high confidence level category.

Confidence in Projected Savings Estimate

The review team assigns high confidence to the projected FTE savings.

Independent Review Team Estimate

The review team applied a 100 percent multiplier to the USA/GO estimates of 18 FTE.

Recommendations

None

13.0 Review of Non-Hazardous WADs — 1 FTE Total

13.1 Initiative Content Overview

Safety and Reliability Engineering will transition from an in-line 100 percent review of safety requirements written into Non-Hazardous OMIs (by engineering personnel) to a lot-sampling assurance approach. This transition will only occur for non-hazard WADs which means it will not effect hypergolic propellant handling or any "high energy" operation.

Since initiation in June 1998, data shows that the 6.5 percent error rate present with 100 percent review has not changed in a statistically significant way since implementation of the sampling-review approach.

13.2 USA/GO FTE Savings Logic

The FTE savings rationale involves the following calculation:

OMI's per year	800	
Multiply by pages per OMI	x 115	
Multiply by minutes per page	x 1.25	
Divide by minutes per hour	/ 60	
Labor hours to read the OMIs.	1,900	(Rounded down)

This results in approximately one FTE savings.

13.3 Objective Evidence of Implementation

The review team conducted a telecon with Mr. Mark Nappi and Mr. Alfred Stevens on March 5, 1999. No direct observations were conducted by the review team during the on-site visit.

13.4 Discussion and Assessment

Key Assumptions

- Estimated SMA hours saved per WAD
- Number of WADs reviewed per year
- Flow-rate

Discussion

This initiative requires that engineering personnel increase their knowledge and understanding of OSHA and NASA safety requirements.

Confidence in Projected Savings Estimate

The review team assigns a high confidence to the projected FTE savings.

Independent Review Team Estimate

The review team applied a 100 percent multiplier to the USA/GO estimates of 1 FTE.

Recommendations

None