NASA Independent Verification and Validation Program

Five Year Implementation Plan

2007-2012

Our Guiding Values

Guiding values are the behaviors or characteristics that are essential to maintaining and supporting the NASA Independent Verification and Validation (IV&V) Program, and reflect in greater detail NASA's values of safety, teamwork, and mission success.

The guiding values of the NASA IV&V Program are:

Safety Being safe and ensuring personal safety for employees and the public; providing security for everyone and protection of our resources and assets; being good stewards.

Respect Noticing individual worth; being open-minded; accepting diversity; seeking first to understand and then to be understood; having credibility; empowering oneself and others; welcoming every idea; listening; being civil.

Teamwork Working together; supporting each other; collaborating effectively; sharing accomplishments and successes; providing collective wisdom; being responsible; helping others; leveraging synergy; exhibiting open communication.

Balance Being well rounded with work, family, and self; balancing professional and personal time; giving to the community; practicing wellness of living; having a balanced involvement that enhances all; being there; coaching others.

Excellence Producing quality goods and services; doing the right thing; performing second to none; practicing continuous improvement; being distinctive, creative, and committed; leading in best practices; being efficient.

Innovation Seeking better ways or new methods to do things; being imaginative to enhance processes; staying on the leading edge; being original, agile, adaptive, and responsive to change.

Integrity Doing what was said would be done; having trust; being honest, fair, and accountable, both personally and organizationally; having steadfast ethical conduct; living by high standards of individual behavior.

Table of Contents

Our Guiding Values **2**
Our Vision **4**
Our Mission **4**
Our Role in the Agency **4**
Our Plan **5**
Return on Investment and Software Rework Risk Reduction **7**
Desired End-State for FY07/FY08 ..... **10**
Objectives and Tactics **11**
Objective # 1 11
Objective # 2 11
Objective # 3A 12
Objective # 3B 12
Objective # 4 12
Objective # 5 13
Objective # 6 13
Objective # 7 14
Objective # 8 14
Objective # 9 15
Appendix A: Detailed Plan for Each Objective and Tactic **16**
Appendix B: Desired End State 2009-2010 and 2011-2012 ..... **29**
Appendix C: Definitions **30**

List of Figures

Figure 1 - Boehm's Software Relative Cost to Repair Model 7
Figure 2 - Severity Definitions 8
Figure 3 - 2006 Software Rework Risk Reduction 9

Our Vision

The NASA IV&V Program is valued for its superior performance in independent software validation and verification, its ability to provide high confidence safety and mission assurance of NASA software, its positive impact on the development of high quality software, and its expertise in software engineering.

Our Mission

The NASA IV&V Program provides assurance to our stakeholders and customers that NASA's mission-critical software will operate dependably and safely.

The NASA IV&V Program performs leading-edge research that improves IV&V and software assurance methods, practices, and tools.

The NASA IV&V Program participates in the vitality of the community, as well as engages the public in the experience and benefits of exploration and discovery.

Our Role in the Agency

The NASA IV&V Program performs independent software validation and verification (V&V) to ensure NASA's mission-critical software will operate dependably and safely. The NASA IV&V Program performs research and provides engineering services to improve IV&V software assurance methods, practices and tools. The NASA IV&V Program engages the public in the experience and benefits of exploration and discovery. The NASA IV&V Program supports the mission of the Office of Safety and Mission Assurance (OSMA) to ensure the safety and success of all NASA activities for Agency-wide safety, reliability, maintainability, and quality assurance in support of the six Agency strategic goals (as documented in the NASA Strategic Plan), as well as NASA's goal to achieve managerial and institutional excellence comparable to the Agency's technical excellence.

The NASA IV&V Program exists to provide an additional level of assurance for NASA missions that involve human safety or other core Agency objectives. Mission objectives are assigned to NASA Centers based on their expertise. The details of the technical analyses provided by the NASA IV&V Program's IV&V Services Functional Organization vary from project to project, and are tailored to the specifics that make each NASA project unique. What does not vary is our commitment to the safety and success of the projects we support.

The IV&V Services Functional Organization strives to improve software safety, reliability, and quality of NASA programs and missions through effective applications of systems and software IV&V methods, practices, and techniques. The IV&V Services Functional Organization includes all aspects of delivering the highest quality, state-of-the-art, IV&V services to its customers.

For each IV&V project, our goal is to objectively answer the following questions:

1. Does the software exhibit behaviors exactly as intended?
2. Does the software not exhibit behaviors that were not intended?
3. Does the software exhibit expected behaviors under adverse conditions?

During our analysis efforts, we provide information to NASA Project Managers to assist them in gauging their progress towards achieving their goals and objectives. At various critical points during the project's development, the NASA IV&V Program provides assessments of software readiness for use to both the project's management and to our management in the OSMA.

Thirty years of software industry experience, research, and reports indicate that the cost of software rework can approach fifty percent for large software projects. Additionally, finding and fixing requirement errors can consume seventy to eighty-five percent of total project rework costs. Defect phase containment is an extremely important aspect of software and systems engineering. Defect phase containment helps ensure that correct and reliable systems are delivered on time and within the costs allocated to the software efforts. Some of the results of our recent analysis efforts can be seen in the *Return on Investment and Software Rework Risk Reduction* section of this document. We are excited about the prospect of not only continuing this good work, but also presenting even greater results that benefit our Agency throughout and beyond the next five years.

Our Plan

This is a time of great excitement and evolution as the NASA IV&V Program revolutionizes the Agency's approach to software IV&V. The NASA IV&V Program has made great strides in the past ten years, and has evolved from primarily focusing IV&V on human missions to focusing on all critical and safety-related Agency software for high priority missions. The purpose of this Five Year Implementation Plan is to create a well defined and well communicated path for the next five years of NASA IV&V Program growth. This plan is intended to be a living document that is continually updated to reflect the NASA IV&V Program's progress in creating an environment in which champions can thrive in the pursuit of success.

> *Champions win wars, business share, campaigns, and titles – they carry the ball for the long haul. Heroes win battles or avert disaster – they carry the ball for a short while. Heroes will succumb to either adversarial champions or forces that have the odds against the heroics. A dependency on heroics is a dependency on continued miracles to achieve the long-haul success. A dependency on developing champions and the environment for champions to thrive will greatly increase the chances of success.*
>
> *- Dr. Butch Caffall, Director, NASA IV&V Facility*

The Management Challenge:

> *If you cannot measure, then you cannot manage.*
> *If you cannot manage, then you cannot improve.*
> *If you cannot improve, then you cannot change.*
> *If you cannot change, then you cannot remain relevant.*
> *If you cannot remain relevant, then you cannot be useful.*
> *If you cannot be useful, then you cannot retain your customer base.*
> *If you cannot retain your customer base, then you cannot obtain resources.*
> *If you cannot obtain resources, then you cannot exist as an organization.*
>
> *- Dr. Butch Caffall, Director, NASA IV&V Facility*

The next five years are intended to generate as much or more progress than the previous ten years. The NASA IV&V Program's focus for the next five years will be based on nine primary objectives that focus on **Satisfying Customer/Stakeholder Requirements**, **Measuring Goodness**, **Optimizing Program Services**, and **Increasing Technical Proficiency**. The strategic management theme for the first two years is "*Analyze, Plan, Affect, and Stabilize the Desired Changes*", and the theme for the three years beyond that will be to "*Sustain and Perfect the Implemented Changes*."

The NASA IV&V Program's primary focus will be employing effective V&V techniques on large, complex software systems to increase the probability that the software being delivered will:

- Exhibit behaviors exactly as intended
- Not exhibit behaviors that were not intended
- Exhibit expected behaviors under adverse conditions

Initially, we must work to clearly identify our customers and stakeholders, and to plan and transition the NASA IV&V Program to the newly established system reference model-based validation and verification approach. The NASA IV&V Program has already begun several initiatives to shift the pre-2007 IV&V philosophy to this new approach. Our customers will quickly see a heavy focus on early life cycle validation. This creates a system reference model that clearly represents the system's intentions (e.g., requirements) and the associated activity diagrams. These products will help NASA IV&V Program project management ensure that the NASA IV&V Program will apply a risk-based focus to the most critical and challenging aspects of the software.

Fiscal years 2008 and 2009 will be the most defining in this transition from all aspects of the NASA IV&V Program. The NASA IV&V Plans and Programs Functional Organization will lead with an initiative to review and clearly establish the NASA IV&V Program's customers and stakeholders, and clearly state their requirements. Once the review is complete, we will work together to identify the characteristics of NASA IV&V Program success from the customer/stakeholder perspective and the periodic measures that will highlight those characteristics and lend confidence in the NASA IV&V Program.

Return on Investment and Software Rework Risk Reduction

In Figure 1, *Boehm's Software Relative Cost to Repair Model*, we present Barry Boehm's software Relative Cost to Repair model[1]. Boehm has proven that it is two hundred times more cost efficient to find and fix an error in the requirements phase (stage) than it is to find and fix the same error in the operations phase. To fully understand the model, containing errors in the other phases yielded the following cost savings: Design – 40x; Code – 20x; Unit Test – 10x; System Test – 4x; and, Operations and Maintenance – 1x. During the past year, software issues found by the NASA IV&V Program on the various NASA missions supported to date were analyzed. These missions included Human Space Flight missions (e.g., Space Shuttle, International Space Station). Additionally, full IV&V support for most Space and Earth Science missions began between 2000 and 2003. Our analysis, to date, yielded more than 18,700 IV&V issues on both Human Space Flight and Science missions.

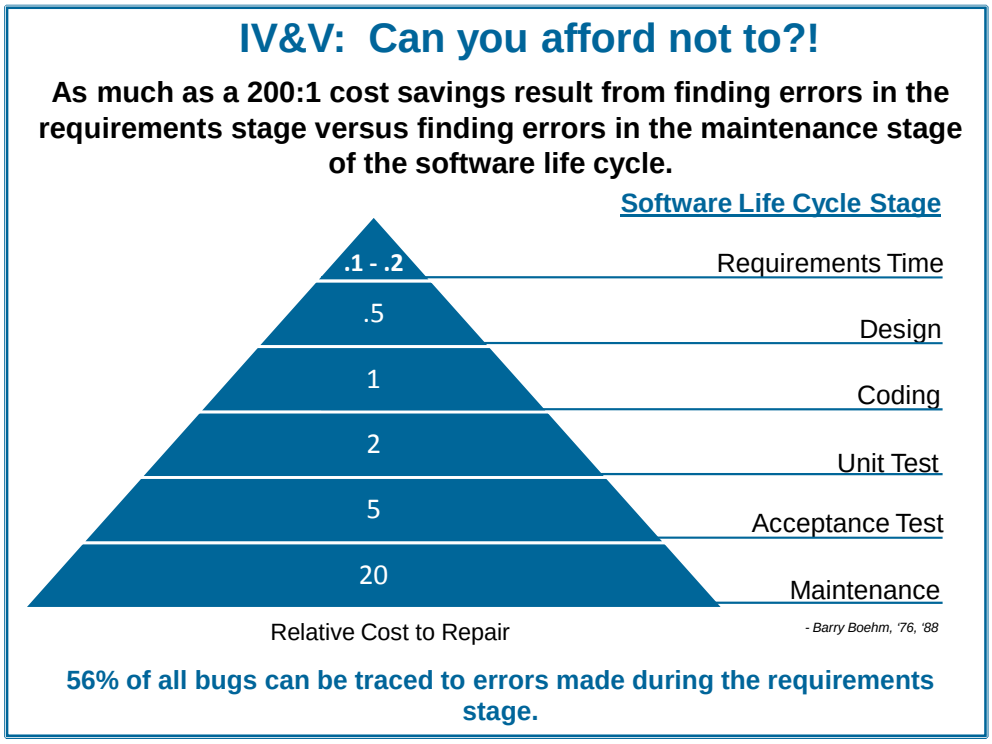


Figure 1 - Boehm's Software Relative Cost to Repair Model

For our Return on Investment and Software Rework Risk Reduction (referred to as risk reduction) analysis, we restricted the data to our most significant (Severity 1 and 2) issues (see Figure 2, *Severity Definitions*, for additional details). We present the data and our notes/assumptions in Figure 3, *2006 Software Rework Risk Reduction*, for our risk reduction calculation. Since we do not have actual data at this time to determine true NASA phase containment effectiveness, we assume that the development project

[1] Relative Cost to Repair -- B.W. Boehm, "*Verifying and Validating Software Requirements and Design Specifications*," IEEE Software, 1984.

would catch one hundred percent of the defects during the test phase. Therefore, the relative cost to repair a requirement error discovered in the system test phase would be fifty times more expensive.

Severity	Definition
1	a) Prevent accomplishment of an essential capability b) Jeopardize safety, security, or other requirement designated critical
2	a) Adversely affect the accomplishment of an essential capability and no work-around solution is known b) Adversely affect technical, cost, or schedule risks to the project or life cycle support of the system, and no work-around solution is known
3	a) Adversely affect the accomplishment of an essential capability but a work-around solution is known b) Adversely affect technical, cost, or schedule risks to the project or life cycle support of the system, but a work-around solution is known
4	a) Result in user/operator inconvenience but does not affect a required operational or mission essential capability b) Result in inconvenience for development or maintenance personnel, but does not affect the accomplishment of these responsibilities
5	a) Any other effect

Figure 2 - Severity Definitions

Based on this analysis, our 2006 risk reduction yield is 21:1, as depicted in Figure 3, *2006 Software Rework Risk Reduction*. For every dollar spent on IV&V, NASA gains a benefit potential of $21 in risk reduction. In 2006, NASA allocated $29 million to the NASA IV&V Program budget. Of that, $20 million went directly to the IV&V Services Functional Organization. If every IV&V dollar yields maximum potential, the 2006 risk reduction benefit to the Agency would be $500 million. Even if we consider the minimum potential, seventy-five percent of IV&V dollars yield 1:1 and only twenty-five percent yield maximum potential. Minimally, the benefit to the Agency is still an impressive $140 million in risk reduction.

2006 Software Rework Risk Reduction (with IV&V)

Severity 1 and 2 Issues by Software Life Cycle Phase

	Require-ments	Design	Coding	Unit Test	System Test	O&M	Total
Savings Ratio†	**50:1**	**10:1**	**5:1**	**2.5:1**	**1:1**	**1:1**	
Missions							
Space Shuttle and ISS (pre 2004/7)	**36%**	**6%**	**49%**	**8%**	**0%**	**0%**	**100%**
Science (2004-2007)	**35%**	**8%**	**23%**	**33%**	**0%**	**1%**	**100%**
Weighted Subtotal	**18**	**1**	**2**	**1**	**0**	**0**	**21**
Software Rework Risk Reduction Return on Investment	**21:1**						

Software Rework Cost Reduction Ratio: 21:1

†IVV ROI:

- Is based on severity 1 and 2 issues
- Does not include the 16,500 severity 3, 4, and 5 issues found on the same IV&V Projects
- Does not factor any additional savings for preventing total loss of mission due to software

Figure 3 - 2006 Software Rework Risk Reduction

Based on our current analysis, NASA realized a potential software rework risk reduction benefit of at least $140 million in Fiscal Year 2006 alone by applying IV&V.

Desired End-State for FY07/FY08

OBJECTIVE	FY07	FY08	CRITERIA
1. Customer Requirements	Complete	Repeat	Shared Understanding
2. Stakeholder Requirements	Complete	Repeat	Shared Understanding
3. Measure Goodness	Prototype	Complete	Assessment of Goodness
4. Measure Research	Prototype	Complete	TRLs For All Projects (FY07); Apply Criteria Renewal/Retirement (FY08)
5. Measure Outreach	Prototype	Complete	Develop Metrics (FY07) ; Apply Metrics (FY08)
6. Optimize Government Staff	Prototype	Complete	100% Projects Led by Trained Government Staff
7. Optimize Resources	Prototype	Complete	Carry-Over < 5% (FY07); Carry-Over < 1% (FY08)
8. Optimize Contracts	Prototype	Complete	Project Estimates < 5 Days (FY07); Project Cost/Schedule/Performance within 5% of Actuals
9. Increase Tech Proficiency	Prototype	Complete	1 Government Project (FY07); 2 Government Projects (FY08)

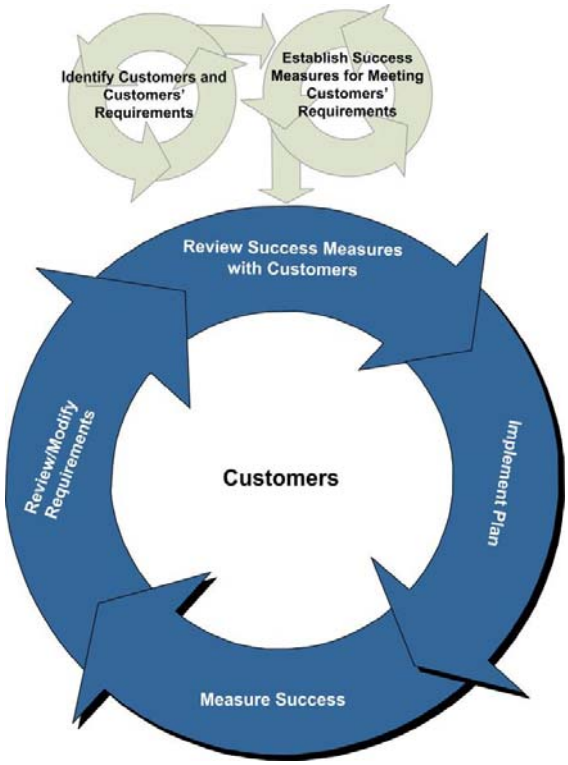
Objectives and Tactics

Objective # 1

MEET CUSTOMER REQUIREMENTS

TACTICS

- Identify customers and their requirements
- Develop measures of success for meeting requirements
- Review measures of success with customers
- Assign responsibilities for meeting requirements
- Monitor progress through metrics
- Review progress with customers



Objective # 2

MEET STAKEHOLDER REQUIREMENTS

TACTICS

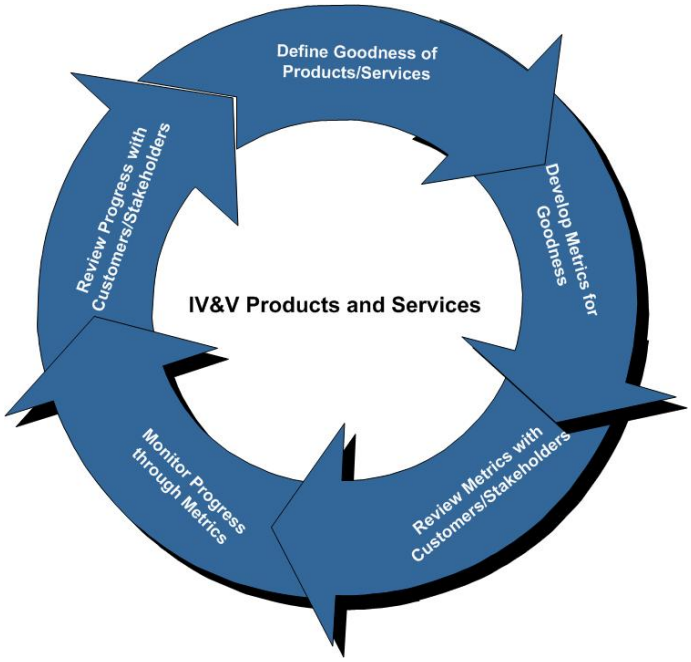
- Identify stakeholders and their requirements
- Develop measures of success for meeting requirements
- Review measures of success with stakeholders
- Assign responsibilities for meeting requirements
- Monitor progress through metrics
- Review progress with stakeholders

Objective # 3A

MEASURE GOODNESS OF IV&V PRODUCTS

TACTICS

- Define goodness for our products
- Develop metrics for goodness
- Review metrics with customers and stakeholders
- Monitor progress through metrics
- Review progress with customers and stakeholders



Objective # 3B

MEASURE GOODNESS OF IV&V SERVICES

TACTICS

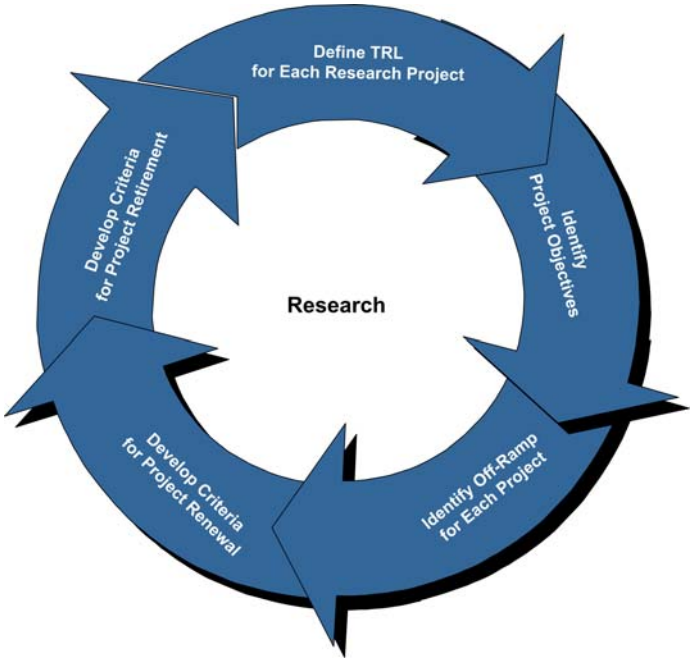
- Define goodness for our services
- Develop metrics for goodness
- Review metrics with customers and stakeholders
- Monitor progress through metrics
- Review progress with customers and stakeholders

Objective # 4

MEASURE GOODNESS OF OUR RESEARCH

TACTICS

- Identify TRL for each research project
- Identify project objectives
- Identify off-ramp for each project
- Develop criteria for project renewal
- Develop criteria for project retirement

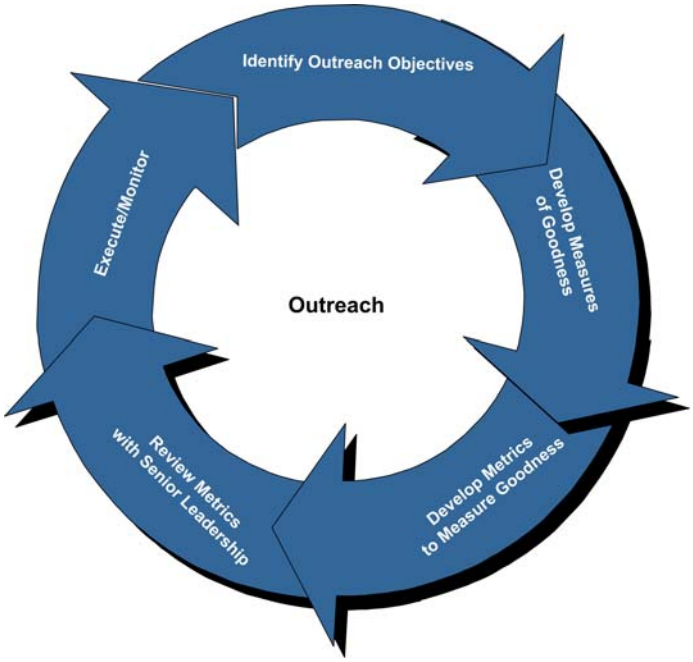


Objective # 5

MEASURE GOODNESS OF OUR OUTREACH

TACTICS

- Identify outreach objectives
- Develop measures of goodness
- Develop metrics to measure goodness
- Review metrics with Senior Leadership
- Execute
- Monitor



Objective # 6

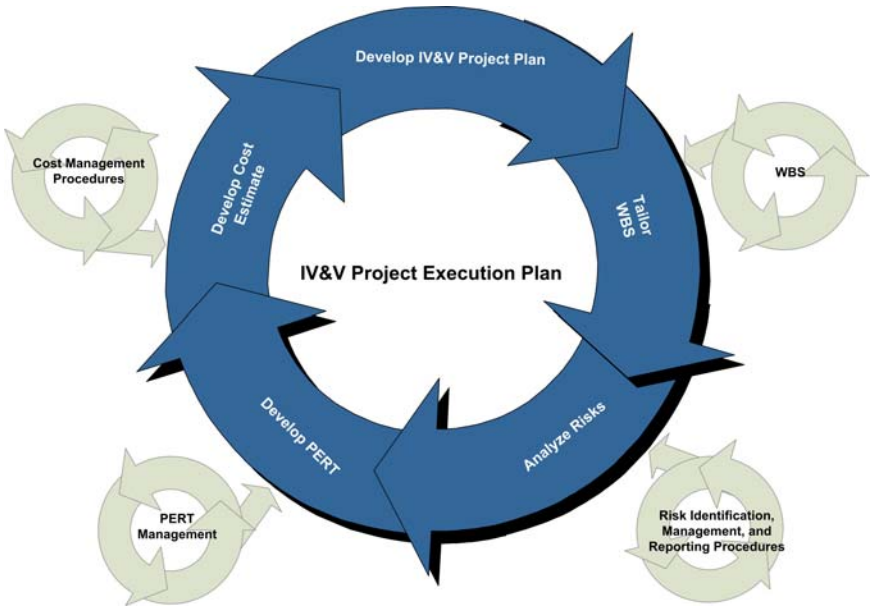
OPTIMIZE GOVERNMENT STAFF FOR PROJECTS

TACTICS

- Optimize Government staff for projects
- Define notional IV&V project in terms of WBS
- Define Government roles and responsibilities in leading IV&V project
- Identify required skills and knowledge to lead IV&V project
- Develop metrics to measure goodness
- Review metrics with Government staff
- Assign staff to project

Objective # 7

OPTIMIZE RESOURCES FOR PROJECTS

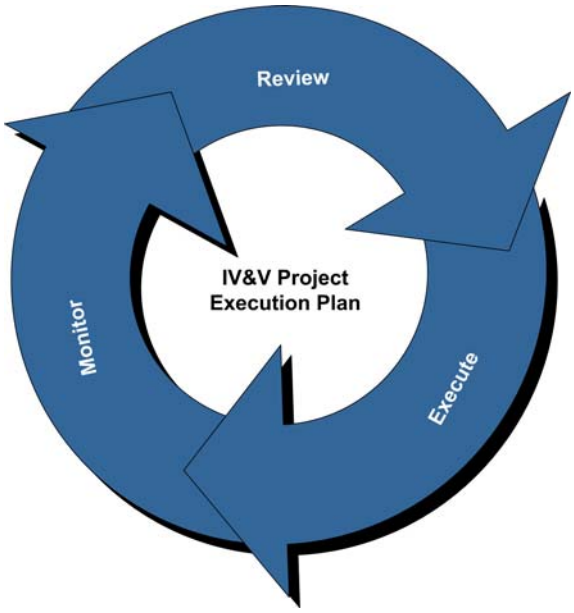


TACTICS

- Define notional IV&V project in terms of WBS
- Identify risks
- Tailor notional WBS to project
- Develop risk handling procedures
- Develop notional PERT with Start/Stop, tasks, milestones, dependencies
- Develop cost estimate
- Refine WBS, PERT, cost estimate
- Review with IV&V project plan with Senior Leadership
- Execute plan
- Monitor progress through PERT
- Monitor actual versus estimated resource expenditures

Objective # 8

OPTIMIZE IMPLEMENTATION OF PROJECTS



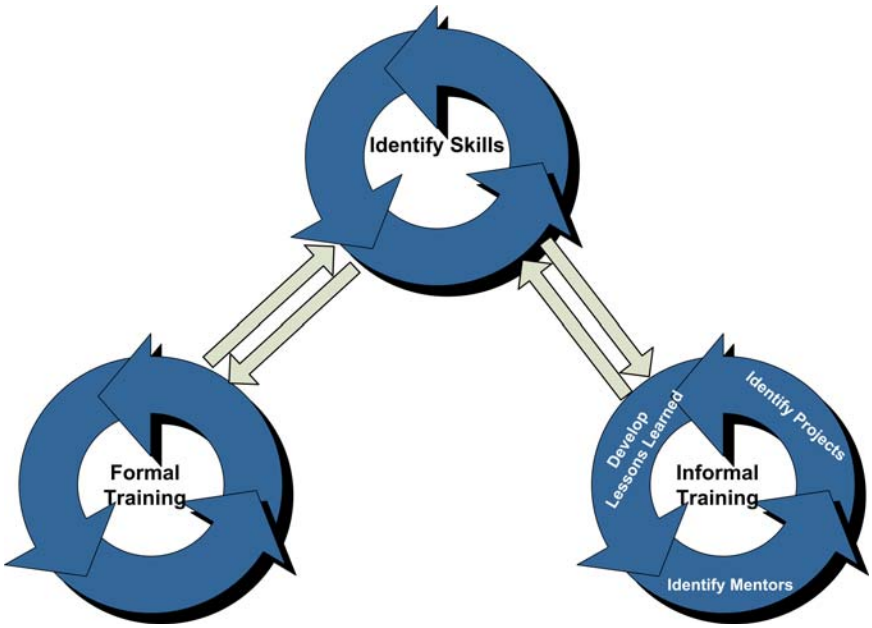
TACTICS

- Define notional IV&V project in terms of refined WBS
- Define notional task plan in terms of IV&V project work summary of goals, tailored WBS, risks and associated handling procedures, PERT, and cost estimate
- Review notional task plan with Government staff and industry partners
- Execute
- Monitor effectiveness in terms of shared understanding of project and tasks, useful level of documentation, project estimation development

Objective # 9

INCREASE STAFF TECHNICAL PROFICIENCY

<u>TACTICS</u>



- Identify required skills and knowledge to lead IV&V projects
- Identify required skills and knowledge for Engineering Services Group
- Identify two or more small projects for Government-only work
- Identify Government mentor to review products and progress
- Develop lessons learned for future Government staff assignment
- Identify formal training requirements

Appendix A: Detailed Plan for Each Objective and Tactic

Objective #1: Meet Customer Requirements
Program Lead: Program & Plans

Tactics	Actions	FY 07	FY08	Criteria
Identify customer and their requirements	Establish team – (P&P Lead with reps from each pillar) review and update current list	4th Quarter	1st Quarter (semi annual review) 3rd Quarter (semi annual review)	List of Program POCs established. Review conducted and list updated. Capture and maintain all customer requirements in a central document.
Develop measures of success for meeting requirements	Meet and draft measures	4th Quarter	As Required	Measures drafted and plan established to incorporate in IMS
Review measures of success with customers	Schedule meetings conduct 50% of meetings conduct 100% of meetings	N/A	1st Quarter	Meetings scheduled 50% conducted 100%cConducted
Assign responsibilities for meeting requirements	Detailed responsibilities to be drafted and assigned after meetings with customers	N/A	1st Quarter Review at Monthly Program Planning Meeting	Document drafted and finalized
Monitor progress through metrics	Quarterly Program Metrics Review (Senior Staff)	N/A	Quarterly—begin 2nd quarter FY08	Reviews conducted
Review progress with customers	Semi-Annual Review with Customers (Pillar Leadership)	N/A	Semi-annually—begin 3rd quarter FY08	

Objective #2: Meet Stakeholder Requirements
Program Lead: Program & Plans

Tactics	Actions	FY 07	FY08	Criteria
Identify stakeholders and their requirements	Establish team – (P&P Lead with reps from each pillar) review and update current list	4th Quarter	1st Quarter (semi annual review) 3rd Quarter (semi annual review)	List of Program POCs established. Review conducted and list updated. Capture and maintain all customer requirements in a central document.
Develop measures of success for meeting requirements	Meet and draft measures	4th Quarter	As Required	Measures drafted and plan established to incorporate in IMS
Review measures of success with stakeholders	Schedule meetings conduct 50% of meetings conduct 100% of meetings	N/A	1st Quarter	Meetings scheduled 50% conducted 100% conducted
Assign responsibilities for meeting requirements	Detailed responsibilities to be drafted and assigned after meetings with stakeholders	N/A	1st Quarter Review at Monthly Program Planning Meeting	Document drafted and finalized
Monitor progress through metrics	Quarterly Program Metrics Review (Senior Staff)	N/A	Quarterly—begin 2nd quarter FY08	Reviews conducted
Review progress with stakeholders	Semi-Annual Review with Stakeholders (Pillar Leadership)	N/A	Semi-annually—begin 3rd quarter FY08	

Objective #3A: Measure Goodness of IV&V Products
Program Lead: IV&V Services Lead

Tactics	Actions	FY 07	FY08	Criteria
I) Define goodness for validation and verification	Definition complete and defined in WBS: Unambiguous, Correct, Complete, Consistent, Verifiable Disseminate standards to Project Leads	4th Quarter	Sustaining	Excellent quality issues and risks as determined by: % accepted & corrected by projects; Internal Review Process; Customer Survey Comments; PMRs; SRM Research regarding post launch anomalies do not reveal issues "missed" by IV&V
II) Develop metrics for goodness	Engineering Services to develop NASA IV&V Program metrics	Review current Metrics Plan- - 4th Qtr Begin Annual Metrics Report prep - - 4th Qtr	Complete Annual Metrics Report and enhance relevant Metrics collection – 1st Qtr	Metrics accurately measure quality and impact of the NASA IV&V Program
III) Review metrics with stakeholders	P&P Lead to meet with HQ stakeholders to discuss metrics	Semi-annually	Brief Annual Metrics Report and associated efforts to stakeholders Sustain	Stakeholders understand and agree with metrics used to track NASA IV&V Program.
IV) Monitor progress through metrics	Metrics are reviewed semi-annually to ensure Program and projects are progressing adequately	Semi-annually	End of 2nd & 4th Qtrs Sustain	Metrics progress as expected, deviations are detected early and addressed
V) Review progress with stakeholders	P&P Lead to meet with HQ stakeholders to review progress	Semi-annually	Sustaining	Stakeholders understand and agree with metrics used to track NASA IV&V Program and their progress

Objective #3B: Measure Goodness of IV&V Services
Program Lead: IV&V Services Lead

Tactics	Actions	FY 07	FY08	Criteria
I) Define goodness for validation and verification	Definition complete and defined in WBS: Unambiguous, Correct, Complete, Consistent, Verifiable Disseminate standards to Project Leads	4th Quarter	Sustaining	Excellent quality issues and risks as determined by: % accepted & corrected by projects; Internal Review Process; Customer Survey Comments; PMRs; SRM Research regarding post launch anomalies do not reveal issues "missed" by IV&V
II) Develop metrics for goodness	Engineering Services to develop NASA IV&V Program metrics	Review current Metrics Plan- - 4th Qtr Begin Annual Metrics Report prep - - 4th Qtr	Complete Annual Metrics Report and enhance relevant Metrics collection – 1st Qtr	Metrics accurately measure quality and impact of the NASA IV&V Program
III) Review metrics with stakeholders	P&P Lead to meet with HQ stakeholders to discuss metrics	Semi-annually	Brief Annual Metrics Report and associated efforts to stakeholders Sustain	Stakeholders understand and agree with metrics used to track NASA IV&V Program.
IV) Monitor progress through metrics	Metrics are reviewed semi-annually to ensure Program and projects are progressing adequately	Semi-annually	End of 2nd & 4th Qtrs Sustain	Metrics progress as expected, deviations are detected early and addressed
V) Review progress with stakeholders	P&P Lead to meet with HQ stakeholders to review progress	Semi-annually	Sustaining	Stakeholders understand and agree with metrics used to track NASA IV&V Program and their progress

Objective #4: Measure Goodness of Research (relative to both SARP and internal research)
Program Lead: Research Lead

Tactics	Actions	FY 07	FY08	Criteria
I) Identify TRL for each research project	Assign preliminary TRL to each initiative; Discuss with PI; Refine TRL (explore the use of the NASA TRL calculator – may need multiple assessments of the same initiative.) Begin with FIs and then move to SARP Adjust documentation Map out TRL progression plan for each initiative Assess TRL profile for both SARP and IV&V Research portfolios	4th Quarter Where appropriate, update SLPs Begin with June 07 review cycle, initiate discussion.	Begin FY08 Update the SARP and Program Research proposal templates to include a TRL plan. (Annual ISO updates as appropriate) Refine during Quarterly Reviews Draft post-SAS. Refine during Quarterly Reviews. (Assess what is an appropriate mix.)	Action complete when all initiatives have been assigned a preliminary TRL. At least one TRL evaluation for each initiative. Documentation adjusted as new initiatives are begun, TRLs will be assessed per procedures Plan in place (Goal: at least N% initiatives demonstrate an increase in TRL level over the course of a year) Begin benchmarking this measure in FY 08 to be able to set a reasonable goal to strive for in FY 09/10 Profile created (Profiles are balanced between new and foundational efforts and more mature or more application based efforts)
II) Identify project objectives (deliverables)	Review the way initiative objectives and deliverables are defined and chosen Review documentation and update to support greater focus Assess, and, if necessary, refine during quarterly reviews	4th Quarter	Update the SARP and Program Research proposal templates. (Annual ISO updates as appropriate) Quarterly Reviews (March, June, SAS, December)	Review complete with sufficient information to support next steps (updates to documents and consistent realignment of initiative deliverables.) Documents (proposal and review templates, etc.) are updated. Initiatives have a more focused list of deliverables

Tactics	Actions	FY 07	FY08	Criteria
III) Identify Technology Transfer Plan for each project	Review current practice Define set of standard actions/practices Update proposal templates Develop individual plans Evaluate whether a confidence measure (NPR 7009) is appropriate	4th Quarter Begin evaluation	End of FY 08 Before the next solicitations, update the proposal templates to include a more detailed tech transfer plan Begin June 08 Begin pilot assessments	Review complete sufficient to support the next step Templates updated Each initiative has a tech transfer plan Evaluation complete and determination made about the appropriateness and utility of the measure
IV) Develop criteria for project renewal	Review current practice (update documentation as appropriate) Draft updated criteria Assess initiatives with new criteria Assess utility of the criteria and refine as appropriate	4th Quarter	Oct 07- June 08 Begin June 08	Review Complete New criteria complete Initiatives assessed Criteria are assessed as they help move the work forward
V) Develop criteria for project retirement	Review current practice (update documentation as appropriate) Draft updated criteria Begin applying Assess utility of the criteria and refine as appropriate	4th Quarter	Oct 07- June 08 Begin June 08	Review Complete New criteria complete Initiatives assessed Criteria are assessed as they help move the work forward

Objective #5: Measure Goodness of Outreach
Program Lead: Outreach Lead

Tactics	Actions	FY 07	FY08	Criteria
I) Identify Outreach Objectives		Sustain Effort Tactics/Actions (1-5)	Sustain Effort Tactics/Actions(1-5)	
1) Public Affairs Response	response to television newspaper information and interview request; press releases			As requested
2) Presentations to Stakeholders	presentations to stakeholders;			As requested
3) Publications	Annual Report; Newsletter; Website Updates			Publication schedules met
4) Student Outreach - To provide expertise and facilities to excite and encourage students to pursue careers in science, mathematics, geography, engineering and technology.	Demonstrate and facilitate the use of NASA curriculum materials to local students to facilitate increasing the participation of elementary and secondary students. Coordinate the Science and Engineering Apprentice Program (SEAP). Increase visibility of NASA within schools to promote awareness of science, technology, engineering and math (STEM) related fields of endeavor. Partner with a higher education institution which has a strong student program in which STEM programs will be offered to further expansion of the pool of human capitol.			As requested; increased beyond effort of 2005-06 Increased impact beyond effort of 2005-06, i.e. increased # of workshops; increased # of teachers; increased # of students 4/5.a Accept WV State program or successfully identify new site 4/5.b One successful initiative
5) Educator Resource Center - To provide expertise and facilities to help educators access and utilize science, mathematics, geography, engineering and technology instruction products which are aligned with national standards and appropriate state	Demonstrate and facilitate the use of educational technologies. Provide in service, preservice and informal educators training utilizing NASA curriculum support products. Partner with local, state and regional educational organizations to become part of the systemic initiatives in West Virginia.			

Tactics	Actions	FY 07	FY08	Criteria
frameworks. The products are also based on NASA's unique mission and results.				
II) Develop Measures of Goodness (SLP-19)	Continue to apply current evaluation tools and surveys; Assess SEAP graduation rates, # of participants and # of programs	Complete 1st Quarter	Sustain Effort	Sustained to improved results depending on evaluations and surveys; sustained SEAP undergraduate degrees received; increased # of participants and programs overall.
III) Develop Metrics	Develop Prototype for Tactic/Actions 1-5 Develop Prototype for Tactics/Actions 5-08 Develop Prototype for Tactic/Actions 4&5-08	Complete 1st Quarter Complete 3rd Quarter Begin 3rd Quarter	Complete 1st Quarter	Metrics development complete for all actions
IV) Review Metrics with Senior Leadership	Present and respond to review of Prototype for Tactics/Actions 1-5 Present and respond to review of Prototype for Tactics/Actions 5-08 Present and respond to review of Prototype for Tactics/Actions 4&5-08	Complete 2nd Quarter Complete 3rd Quarter Complete 4th Quarter	Sustain Effort Sustain Effort Begin 1st Quarter and Sustain Effort	Metrics approved for all actions
V) Execute	Schedule events/Assign resources; Apply metrics	Monthly and Quarterly Review	Monthly and Quarterly Review	Metrics in use
VI) Monitor	Review of Surveys; Evaluations; Budget Meetings with Outreach Team Program Performance Reviews Outreach Vision/Value Retreat	Monthly Monthly Annually Annually	Monthly Monthly Annually Annually	Report to Outreach Director/IV&V Director

Objective #6: Optimize Government Staff for Projects
Program Lead: IV&V Services Lead

Tactics	Actions	FY 07	FY08	Criteria
I) Define notional IV&V project in terms of WBS	Complete and disseminate new WBS Update SLP 9-1	Complete	Sustaining	SLP 9-1 incorporate new WBS IPEPs define work in terms of new WBS
II) Define government roles and responsibilities in leading IV&V project	Update SLP 9-4 annually Update IPEPs at least semi-annually Refine/reinforce during Projects Workshop, PMRs, IPRs	Sustaining	Sustaining IPEPs – End of 2nd & 4th Qtrs	PM responsibilities are understood and match those described in SLP 9-4
III) Identify required skills and knowledge to lead IV&V project	Perform PM training analysis Develop graduated PM tiers and associated training requirements Provide training opportunities	4th Quarter	Sustaining	Available PM IDPs reflect training requirements PMs completing training as planned and progressing through tiers
IV) Develop metrics to measure goodness	Engineering Services to develop IV&V Program metrics Disseminate and collect data from Customer Surveys Evaluate PMR for completeness and accuracy Produce process to evaluate Risks and Issues (coordinated with Objectives 3A & 3B)	Initiate	Customer Surveys & Risks – 1st Qtr Program Metrics – 2nd Qtr Move to Sustaining	Customer Surveys are positive and show IV&V work is understood and appreciated by supported projects PMR presentations show progress with a focus on SRM development/use IV&V risks and issues are clear, concise, accurate and severity levels are defendable
V) Review metrics with government staff	Engineering Services will review IV&V Program metrics with gov't. staff Provide feedback regarding PMRs Provide feedback regarding IPRs Provide feedback regarding Customer Survey	Sustaining	Sustaining	PMs receive and understand PMR, IPR and Customer Survey feedback
VI) Assign staff to project	IV&V Services Management will continually evaluate PM work load and adjust as necessary	Sustaining	Sustaining	PMs are assigned missions in accordance with their availability and capability, Most PMs typically will have 2 active missions

Objective #7: Optimize Resources for Projects
Program Lead: IV&V Services Lead

Tactics	Actions	FY 07	FY08	Criteria
I) Define notional IV&V project in terms of WBS	Complete and disseminate new WBS Update SLP 9-1	3rd Quarter New WBS complete	1st Quarter Update SLP 9-1	New WBS incorporated in 9-1 IPEPs define work in terms of new WBS
II) Identify risks	Task FAB-5 to investigate and propose method for Program risk management	Initiate	Complete initial effort – 1st Qtr Move to Sustaining	Project Risks are accurate, defendable and consistent IV&V efforts are determined based on risk reduction
III) Tailor notional WBS to project	Each Project Lead to prepare IPEP defining IV&V requirements	4th Quarter	Sustaining	Project IPEPs approved through Program management
IV) Develop risk handling procedures	Task FAB-5 to investigate and propose method for managing and reporting IV&V Risk	4th Quarter	Sustaining	Project Risks are accurate, defendable and consistent From a programmatic perspective, project risks are consistent IV&V efforts are determined based on risk reduction
V) Develop PERT with Start/Stop, tasks, milestones, dependencies	Provide PERT training Each Project Lead will develop resource loaded project schedules and capture them in their IPEPs	4th Quarter	Sustaining	Project IPEPs approved through Program management
VI) Develop Cost Estimate	Task FAB-5 to develop cost estimate procedures	Study (w/ recommendations) -- Completed	Revisit recommendations and develop implementa-tion plan by 2nd Qtr Move to Sustaining	Program Cost Estimate process defined and followed
VI.) Refine WBS, PERT, Cost Estimate	Each Project Lead will document their WBS, PERT, and Cost Estimates in their IPEPs. Project IPEPs will be reviewed and modified at least annually	4th Quarter	Annually	Project IPEPs approved through Program management
VII) Review IPEP with Corporate Board and Peers	Project IPEPs will be provided to Stakeholders OSMA representatives will be	4th Quarter	Annually	Stakeholders understand and are agreeable with Project IV&V plans

Tactics	Actions	FY 07	FY08	Criteria
	invited to PMRs			
VIII) Execute Plan	Project Leads will execute as documented in IPEPs	Sustaining	Sustaining	Project IV&V is completed as described in the IPEPs
IX) Monitor Progress through PERT	Each Project Lead will document their PERT schedules in their IPEPs. Each Project Lead will evaluate progress and report deviations during PMRs and IPRs.	4th Quarter	Sustaining	Project IV&V is completed on schedule as described in the IPEPs
X) Monitor Resource Expenditures: Actual to Estimate	Project expenditures will be reviewed monthly during RAC	Sustaining	Sustaining	Project IV&V expenditures are consumed as described in the IPEPs

Objective # 8: Optimize Implementation of Projects
Program Lead: IV&V Services Lead

Tactics	Actions	FY 07	FY08	Criteria
I) Define notional IV&V project in terms of WBS	Complete and disseminate new WBS Update SLP 9-1	3rd Quarter New WBS complete	1st Quarter Update SLP 9-1	New WBS incorporated in 9-1 IPEPs define work in terms of new WBS
II) Define notional task plan in terms of IV&V project work summary of goals, tailored WBS, risks and associated handling procedures, PERT and cost estimate	Project Leads create and maintain IPEPs for each project managed	4th Quarter	Sustaining	Project IPEPs approved through Program management
III) Review notional task plan with government staff and industry partners	Project Leads work with industry partners in creation of IPEPs	4th Quarter	Sustaining	Project IPEPs approved through Program management
IV) Execute	Project Lead accomplish IV&V execution as defined in the IPEPs	4th Quarter	Sustaining	Project execution correlates with approved IPEPs
V) Monitor effectiveness in terms of shared understanding of project and tasks, useful level of documentation, project estimation development	Services Management monitors execution of IV&V through routine IPEP Review, PMRs, IPRs, SRMs, and the RAC	4th Quarter	Sustaining	Project execution correlates with approved IPEPs

Objective #9: Increase Technical Proficiency
Program Lead: Outreach Lead

Tactics	Actions	FY 07	FY08	Criteria
I) Identify required skills and knowledge to lead IV&V projects	Develop approved PM training curriculum developed and approved Use PM Workshops to provide recurring training	2nd Quarter	Sustaining	IDPs reflect training requirements PMs completing training as planned
II) Identify two or more small programs for government-only work	HST (Engineering Services) GPM Startup (FY08)	3rd Quarter	Sustaining	Government only work underway
III) Identify government mentor to review products and progress	PM/ DPM Senior PMs Deputy Services Lead / Services Lead PM Meeting	N/A	4th Quarter	Mentor program established with mentoring skills identified Monitoring plan documented and implemented
IV) Develop lessons learned for future government staff assignment	Develop and publish Lessons Learned Work Instruction (Engineering Services)	Complete	Sustaining	New Lessons Learned is incorporated into database and being disseminated to Project Leads
V) Identify formal training requirements	Develop and present training plan	4th Qtr -- Begin effort	Complete and Sustain	Training program in place All Facility employees actively pursuing training opportunities as outlined in plan

Appendix B: Desired End State 2009-2010 and 2011-2012

To Be Determined

Appendix C: Definitions

Customer – anyone who directly receives and uses NASA IV&V Program products and services (e.g. Mission Project Managers & supported project teams, Center Management, Outreach participants, SAS Participants, etc.)

Stakeholder – any individual or organization who has direct interest, or can be affected by, the NASA IV&V Program's actions (e.g. OSMA, OCE, Mission Directorates, Local Community, etc.)

Product – a single item or unit produced by the NASA IV&V Program for a customer (e.g. Report, Presentation Package, Issue paper, Risk Summary, etc.)

Service – non-material equivalent of a product performed by the NASA IV&V Program (e.g. Analysis, Testing, Traceability, etc.)