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.

Definitions

Customer – Anyone who directly receives and uses NASA IV&V Program products and services (e.g., Mission Project Managers and supported project teams; Center Management; Outreach participants; Office of Safety and Mission Assurance [OSMA] Software Assurance Symposium [SAS] Participants)

Stakeholder – Any individual or organization who has direct interest in or can be affected by the NASA IV&V Program's actions (e.g., OSMA; Office of Chief Engineer; Mission Directorates; local community)

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)

Service – Non-material equivalent of a product performed by the NASA IV&V Program (e.g., analysis; testing; traceability)

Table of Contents

List of Figures

Our Vision

The NASA IV&V Program is valued for its superior performance in independent 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 its 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 to ensure that 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 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 well as NASA's goal to achieve managerial and institutional excellence comparable to the Agency's technical excellence (as documented in the NASA Strategic Plan).

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 vary from project to project and are tailored to the specifics that make each NASA project unique. What does not vary is the commitment to the safety and success of the projects the NASA IV&V Program supports.

The NASA IV&V Program strives to improve software safety, reliability, and quality of NASA programs and missions through effective application of systems and software IV&V methods, practices, and techniques. The IV&V Program includes all aspects of delivering the highest quality, state-of-the-art IV&V services to its customers. The goals and objectives captured in this plan are reasonable and reachable, based on the expectation that each IV&V functional area is constantly striving to improve capabilities and products.

For each IV&V project, the goal of the NASA IV&V Program 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 analysis efforts, the NASA IV&V Program provides information to the responsible Project Managers to assist them in gauging their progress toward 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 IV&V Program 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 recent analysis efforts by NASA IV&V can be seen in the *Return on Investment and Software Rework Risk Reduction* section of this document. The NASA IV&V Program is excited about the prospect of not only continuing this good work, but finding other ways to contribute to the Agency's success.

Our Plan

This is a time of great excitement as the NASA IV&V Program revolutionizes the Agency's approach to software IV&V (i.e., systems engineering affecting Agency software development processes). 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 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.

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 three years is "Analyze, Plan, Affect, and Stabilize the Desired Changes", and the theme for the following two years will be to "Sustain and Perfect the Implemented Changes*".*

The NASA IV&V Program's primary focus will be employing effective independent verification and validation 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

For the past two years, the NASA IV&V Program has been actively implementing several initiatives to shift the pre-2007 IV&V philosophy to the newly established system reference model-based validation and verification approach. Customers are seeing 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 project management ensure that a risk-based focus to the most critical aspects of the software is applied.

Fiscal years (FY) 2008 and 2009 will be essential to the success of this transition. The NASA IV&V Chief of Plans and Programs will lead with an initiative to clearly identify and document the requirements of NASA IV&V customers and stakeholders. As part of this requirement identification, the NASA IV&V Program will work with its customers and stakeholders to establish the characteristics of NASA IV&V success 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

Figure 1, *Boehm's Software Relative Cost to Repair Model*, features 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. NASA IV&V Program analysis, to date, yielded more than 18,700 IV&V issues on both Human Space Flight and Science missions.

---

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

IV&V: Can you afford not to?!

As much as a 200:1 cost savings result from finding errors in the requirements stage versus finding errors in the maintenance stage of the software life cycle.

Software Life Cycle Stage

Relative Cost	Stage
.1 - .2	Requirements Time
.5	Design
1	Coding
2	Unit Test
5	Acceptance Test
20	Maintenance

Relative Cost to Repair

- Barry Boehm, '76, '88

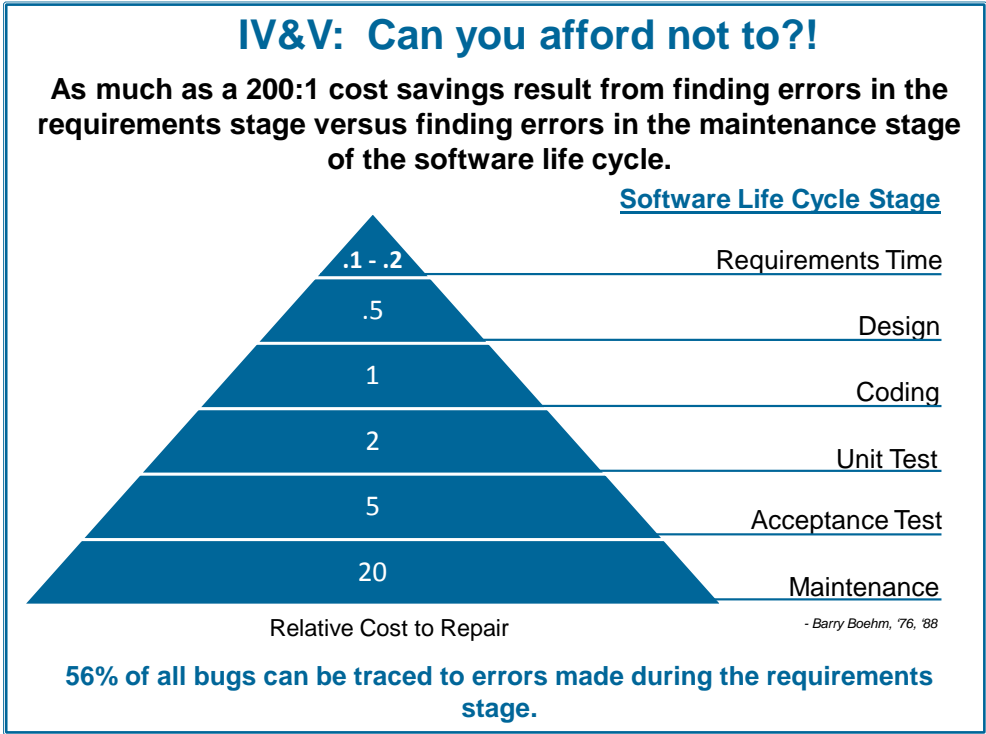**56% of all bugs can be traced to errors made during the requirements stage.**

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 for our risk reduction calculation in Figure 3, *2006 Software Rework Risk Reduction.* Since we do not have actual data at this time to determine true NASA phase containment effectiveness, we assume that the development project 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

Severity	Definition
	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 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							

†IV&V 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 in 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.

This document is organized to provide foundational information up front, followed by objectives for the subsequent two years. The actions associated with the objectives are captured in Appendix B. Appendix B looks ahead three and four years and defines desired status for each year, while Appendix C looks further out and captures ideas/plans further into the future. For recordkeeping, the end state (desired and actual) for 2007-08 is captured in Appendix D, while the detailed plans for 2007-08 can be found in Appendix E.

The following table reflects the desired end state for FY09 and FY10, as well as for the criteria used to assess completion. Actual end-of-year status will also be captured in this table as a formal record of progress against each objective within this plan.

Desired End-State for FY09/FY10

OBJECTIVE	FY09	FY10	CRITERIA	End of Fiscal Year (__) STATUS
1. Customer Requirements	Complete (with baseline requirements)	Sustain and Improve (with refined requirements)	Customer requirements have been established and documented, and a plan has been formalized to meet requirements (including actions, actionees, metrics, and schedules). Evidence of status and completion has been communicated (internally and with customers).	
2. Stakeholder Requirements	Complete (with baseline requirements)	Complete (with refined requirements)	Customer requirements have been established and documented, and a plan has been formalized to meet requirements (including actions, actionees, metrics, and schedules). Evidence of status and completion has been communicated (internally and with customers).	
3A. Measure Goodness of IV&V Products	Establish repeatable and actionable Project-oriented Goodness Metrics Program	Sustain and Improve (with refined requirements)	IV&V Goals, Questions, Metrics Plan has been developed and refined and is in full practice for IV&V Services.	
3B. Measure Goodness of IV&V Services	Complete	Complete	Measures for the goodness of IV&V Services are established. Procedures for collecting, understanding and improving IV&V Services are up and working. Feedback from customers	

| OBJECTIVE	FY09	FY10	CRITERIA	End of Fiscal Year (__) STATUS
			and stakeholders is included.	
4. Measure Research	In Progress	Refine	Research will continue to refine the connection and collaboration between Technology Readiness Level (TRL), deliverables, and transition plans. Additional effort will be applied to leverage NASA publication avenues and increase awareness of the research within the Agency.	
5. Measure Outreach	Apply and refine metrics as appropriate; actions are in accordance with results	Apply and refine metrics as appropriate; actions are in accordance with results	Effort is clearly targeted to ensure growing impact of program initiatives developed as a result of the surveys and evaluations—clearly ties to measurements of goodness.	
6. Optimize Government Staff for Projects	Partial -Attend APPL training as available - All L1 advancing to L2	Complete -All PLs L2 or L3	Projects and Product Lines are led by trained/competent Government staff.	
7/8. Optimize Resources/Implementation for Projects	Review/concur CE Metrics plan for performance, schedule, and cost. Establish monitoring and managing plan with Product Lines.	Complete	Project planning and execution correlates with approved IPEPs are aligned with the overall IV&V Program Execution Plan (PEP). Metrics are collected, reviewed, and assessed with criteria for success and Lessons Learned (LL).	
9. Increase Technical Proficiency	Prototype	Complete	For FY09 there is one IV&V project being performed by Government staff. In FY10 there are two IV&V projects being performed by Government staff.	

Objectives and Tactics

Each objective comprises multiple tactics, which are presented here. The actions associated with each tactic are captured in Appendix A, *Detailed Plan for Each Objective and Tactic FY09 and FY10*.

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
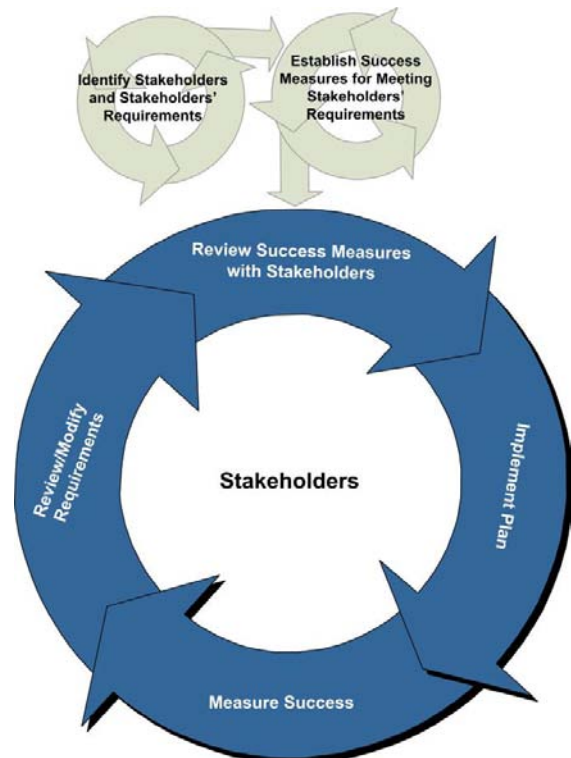- Review progress with customers
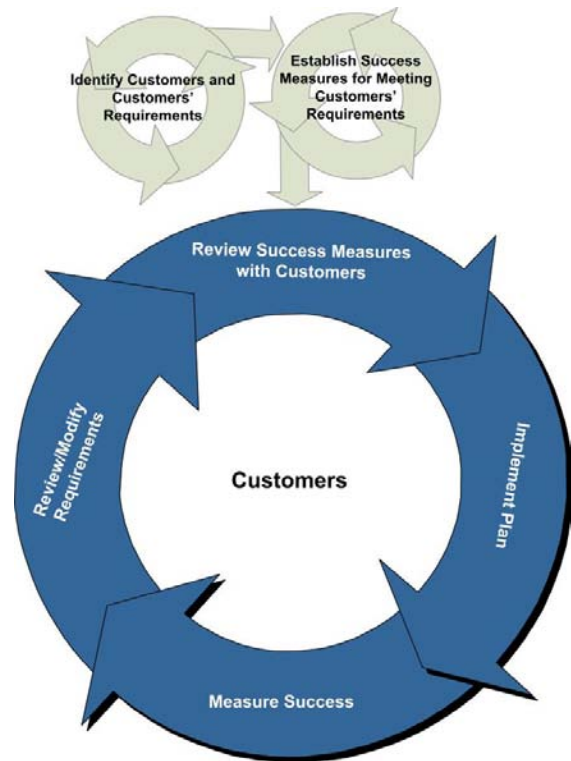
Objective # 2

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
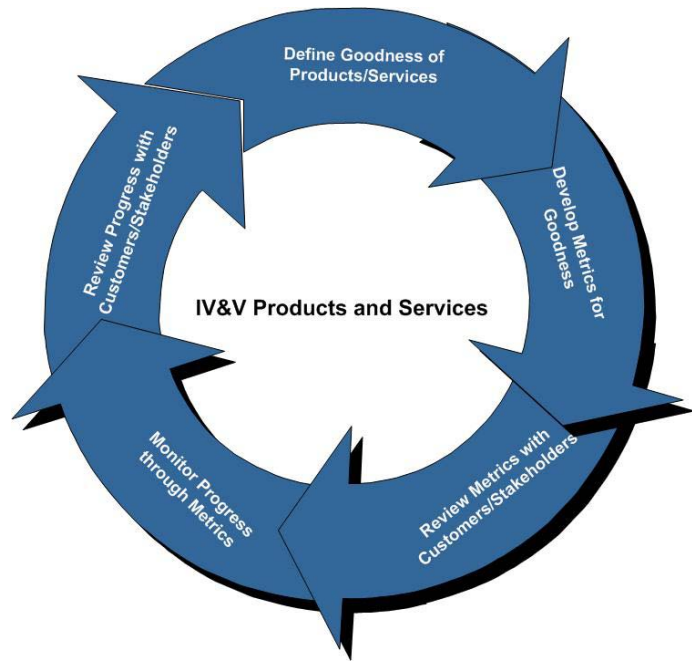
Objective # 3B

MEASURE GOODNESS OF IV&V SERVICES

TACTICS

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

Objective # 4

MEASURE GOODNESS OF OUR RESEARCH

TACTICS

- Apply TRL in the context of the Research Program
- Focus on deliverables to support TRL and transition
- Action the transition/ infusion plans for the initiatives
- Monitor Initiative progress
- Focus on retirement planning
- Increase NASA involvement in SARP
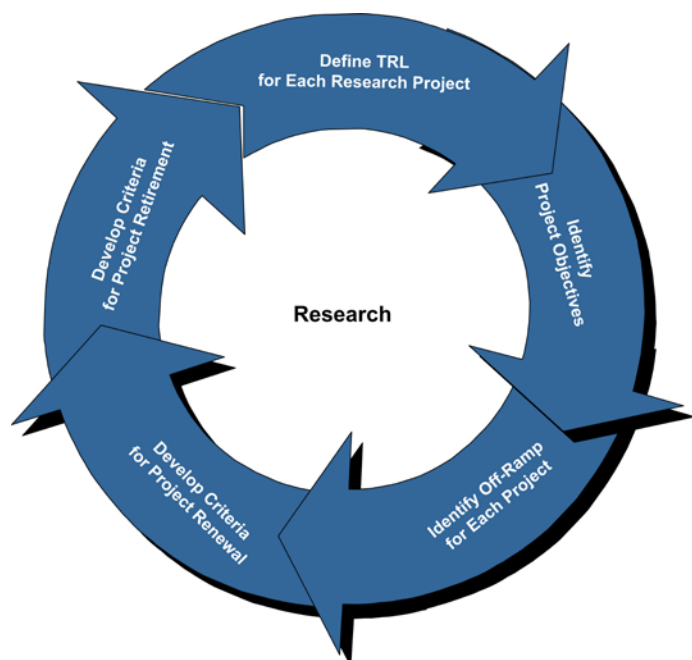
Objective # 5

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
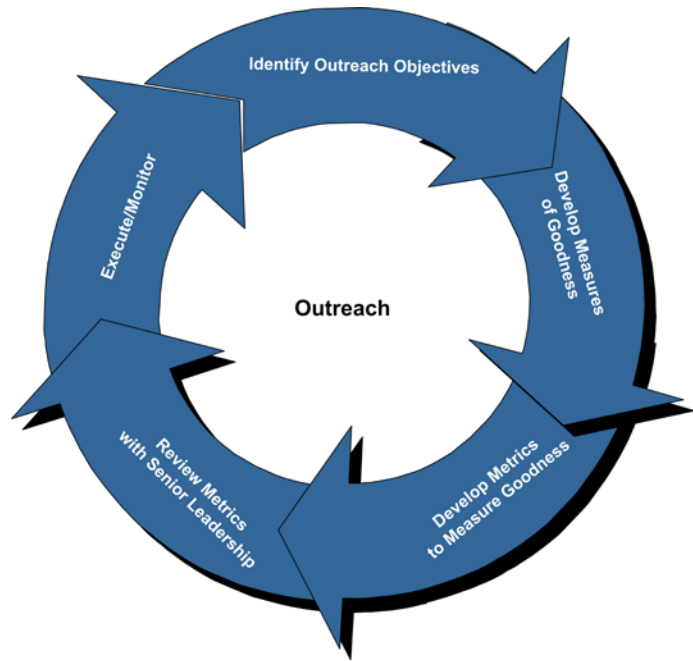
Objective # 6

OPTIMIZE GOVERNMENT STAFF FOR PROJECTS

TACTICS

- 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 and product line
- Develop metrics to measure goodness
- Review metrics with Government staff
- Assign staff to project

Objective # 7/8

OPTIMIZE RESOURCES/IMPLEMENTATION OF PROJECTS

TACTICS

- 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
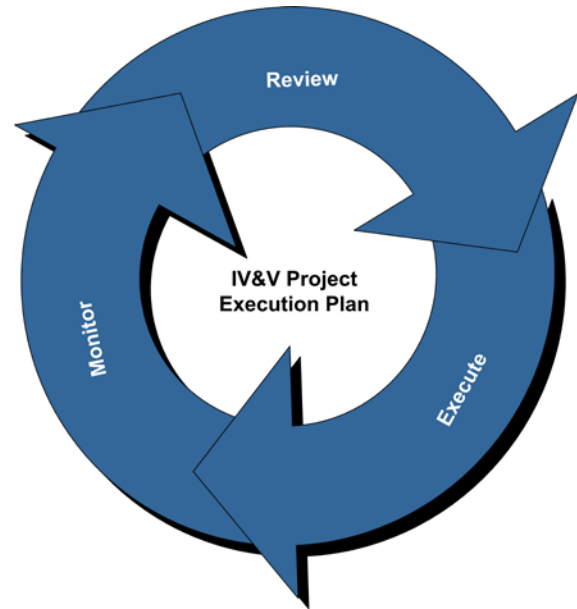
Objective # 9

**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 FY09/10

For each objective, the details and actions associated with accomplishing each tactic are provided. Completion dates and completion criteria are also provided.

Objective #1: Meet Customer Requirements
Program Lead: Chief of Plans and Programs (P&P)

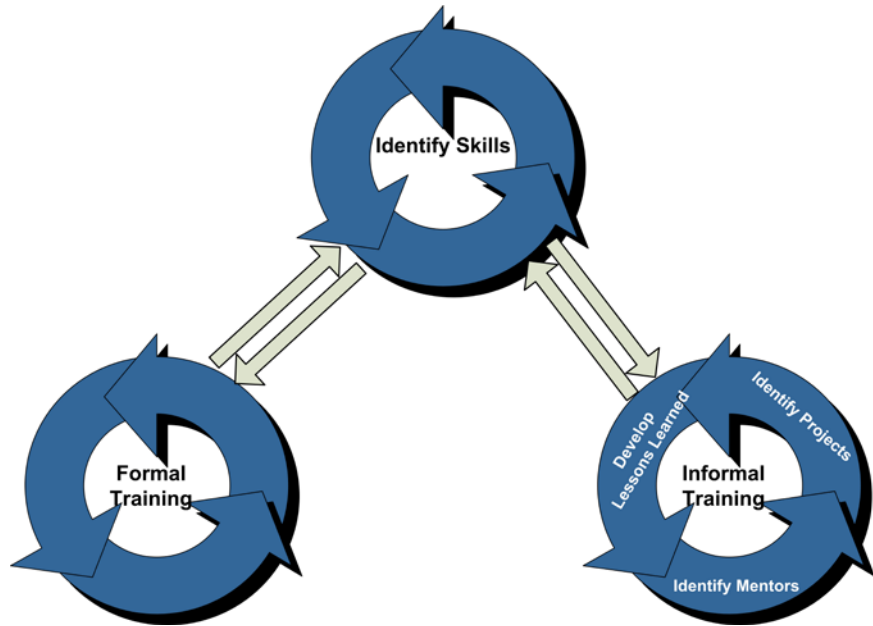| Tactics	Context	Actions	Actionee(s)	FY09	FY10	Criteria
I). Identify customers and their requirements	Ensure that we know who all of our customers are, not just those associated with IV&V Services. Understand what their expectations are, and ensure that we are in agreement on the expectations.	Establish team (P&P with representatives from each functional organization). Review and update current list of customers and their requirements (or expectations).	Chief of Plans and Programs (P&P); Chief of Integration (CI); Chief of Research (Research); Chief of Communications (Comm); Chief Engineer (CE); Chief of Operations (Operations)	3rd Quarter (perform in 3rd Quarter to ensure that all data is available during Five Year Plan review cycle) Data captured at the beginning of FY09, 1st Quarter	1st Quarter (semi-annual review) 3rd Quarter (semi-annual review)	Customer list is reviewed and updated semi-annually.
			Review by Senior Leadership (SL)	Data reviewed/ updated in 3rd Quarter.	1st Quarter (semi-annual review) 3rd Quarter (semi-annual review)	All customer requirements are captured and maintained in a central document.
II). Develop measures of success for meeting requirements	Make sure that the requirements we agree to are meaningful and push in the direction of growth (not bookkeeping).	Meet and draft measures.	P&P, CI, Research, Comm, CE, Operations	1st Quarter	As required	Measures are drafted, and a plan is established for incorporation into the IMS.
			Review and concurrence by SL			
III). Review measures of success with customers	Ensure that metrics show we are working toward meeting and/or exceeding the requirements.	Meet with customers semi-annually to review the plan, assess progress, and accomplish objectives. (Meetings may occur more frequently, but	P&P, CI, Research, Comm, CE, Operations	3rd Quarter	1st Quarter 3rd Quarter	Meetings with customers are held, and positive progress is demonstrated with respect to satisfying the agreed-to requirements.

Tactics	Context	Actions	Actionee(s)	FY09	FY10	Criteria
		at least two meetings per year should focus specifically on requirements and measures of success.)				
IV). Assign responsibilities for meeting requirements	Ensure that specific individuals are responsible for metrics and actions. Don't assume that things will take care of themselves. Real measures of progress require time and attention regularly, not just at reporting time.	Detailed responsibilities to be drafted and assigned after meetings with customers.	P&P, CI, Research, Comm, CE, Operations Individuals assigned actions	Status progress weekly at the Thursday SL meeting	Status and review monthly at the Five Year Planning Council meeting	A plan for meeting the requirements, with associated actionees and timelines, is drafted and finalized. This should be completed within 8 weeks after requirements are defined.
			Review and concurrence by SL	Status and review monthly at the Five Year Planning Council meeting		
V). Monitor progress through metrics	Ensure that specific individuals are responsible for metrics and actions. Don't assume that things will take care of themselves. Real measures of progress require time and attention regularly, not just at reporting time.	Monthly Five Year Plan Review at the Five Year Planning Council meeting.	P&P, CI, Research, Comm, CE, Operations Individuals assigned actions	Status progress weekly at the Thursday SL meeting	Status and review monthly at the Five Year Planning Council meeting	Reviews are conducted. Risks to success are identified. Mitigation plans are implemented as needed.
		Program Metrics Review as scheduled.	IMS	Status and review monthly at the Five Year Planning Council meeting Review status as part of the Metrics Program Review	Review status as part of the Metrics Program Review	
			Review and concurrence by SL			
VI). Review progress with customers	Close the loop with customers we made agreements with.	Covered by actions associated with "Review measures of success with customers" above.	Covered by actions associated with "Review measures of success with customers" above.	Covered by actions associated with "Review measures of success with customers" above.	Covered by actions associated with "Review measures of success with customers" above.	Covered by actions associated with "Review measures of success with customers" above.

Objective #2: Meet Stakeholder Requirements
Program Lead: Chief of Plans and Programs (P&P)

Tactics	Context	Actions	Actionee(s)	FY09	FY10	Criteria
I). Identify stakeholders and their requirements	Ensure that we know who all of our stakeholders are, not just those associated with IV&V Services. Understand what their expectations are, and ensure that we are in agreement on the expectations.	Establish team (P&P with representatives from each functional organization). Review and update current list of stakeholders and their requirements (or expectations).	P&P, CI, Research, Comm, CE, Operations	3rd Quarter (perform in 3rd Quarter to ensure that all data is available during Five Year Plan review cycle) Data captured at the beginning of FY09, 1st Quarter	1st Quarter (semi-annual review) 3rd Quarter (semi-annual review)	Stakeholder list is reviewed and updated semi-annually.
			Review by SL	Data reviewed/ updated in 3rd Quarter	1st Quarter (semi-annual review) 3rd Quarter (semi-annual review)	All stakeholder requirements are captured and maintained in a central document.
II). Develop measures of success for meeting requirements	Make sure that the requirements we agree to are meaningful and push in the direction of growth (not bookkeeping).	Meet and draft measures	P&P, CI, Research, Comm, CE, Operations	1st Quarter	As required	Measures are drafted and a plan is established for incorporation into the IMS.
			Review and concurrence by SL			
III). Review measures of success with stakeholders	Ensure that metrics show we are working toward meeting and/or exceeding the requirements.	Meet with stakeholders semi-annually to review the plan, assess progress, and accomplish objectives. (Meetings may occur more frequently, but at least two meetings per year should focus specifically on requirements and measures of success.)	P&P, CI, Research, Comm, CE, Operations	3rd Quarter	1st Quarter 3rd Quarter	Meetings with stakeholders are held, and positive progress is demonstrated with respect to satisfying the agreed-to requirements.

Tactics	Context	Actions	Actionee(s)	FY09	FY10	Criteria
IV). Assign responsibilities for meeting requirements	Ensure that specific individuals are responsible for metrics and actions. Don't assume that things will take care of themselves. Real measures of progress require time and attention regularly, not just at reporting time.	Detailed responsibilities to be drafted and assigned after meetings with customers.	P&P, CI, Research, Outreach, CE, Operations Individuals assigned actions	Status progress weekly at the Thursday SL meeting	Status and review monthly at the Five Year Planning Council meeting	A plan for meeting the requirements, with associated actionees and timelines, is drafted and finalized. This should be completed within 8 weeks after requirements are defined.
			Review and concurrence by SL	Also status and review monthly at the Five Year Planning Council meeting		
V). Monitor progress through metrics	Ensure that specific individuals are responsible for metrics and actions. Don't assume that things will take care of themselves. Real measures of progress require time and attention regularly, not just at reporting time.	Monthly Five Year Plan Review at the Five Year Planning Council meeting	P&P, CI, Research, Comm, CE, Operations Individuals assigned actions	Status progress weekly at the Thursday SL meeting	Status and review monthly at the Five Year Planning Council meeting	Reviews are conducted. Risks to success are identified. Mitigation plans are implemented as needed.
		Program Metrics Review, as scheduled	IMS	Status and review monthly at the Five Year Planning Council meeting Review status as part of the Metrics Program Review	Review status as part of the Metrics Program Review	
			Review and concurrence by SL			
VI). Review progress with stakeholders	Close the loop with stakeholders we made agreements with.	Covered by actions associated with "Review measures of success with stakeholders" above.	Covered by actions associated with "Review measures of success with stakeholders" above.	Covered by actions associated with "Review measures of success with stakeholders" above.	Covered by actions associated with "Review measures of success with stakeholders" above.	Covered by actions associated with "Review measures of success with stakeholders" above.

Objective #3A: Measure Goodness of IV&V Products
Program Lead: Chief Engineer (CE)

Tactics	Context	Actions	Actionee	FY09	FY10	Criteria
I). Define goodness for validation and verification	Goodness will be described in the form of system capabilities and associated validated and verified IV&V targets within a given system.	Definition complete and defined in WBS: Unambiguous, Correct, Complete, Consistent, Verifiable. Disseminate standards to Project Leads (PLs).	1. SRM Product Line Lead (SRM PLL) 2. Validation Product Line Lead (ValPLL) 3. Verification Product Line Lead (VerPLL) 4. CE 5. ValPLL and VerPLL	1. Draft clear and concise system capabilities and limitations from an IV&V perspective (SRM PLL) • Draft Definition (Jul 18) • Briefed to SL and refined (Aug 8) 2. Draft clear and concise definition of "validated IV&V target" (SRM PLL) • Draft Definition (Jul 18) • Briefed to SL and refined (Aug 8) 3. Draft clear and concise definition of "verified IV&V target" (VerPLL) • Draft Definition (Jul 18) • Briefed to SL and refined (Aug 8) 4. Associated briefing given at Program Staff meeting (CE – Aug 22) 5. Integrate definitions and overview in appropriate IV&V	Establish a Product Line Quarterly Review focused on planning and accomplishments • Tentative Dates: o Q1 – Jan 09 o Q2 – Mar 09 o Q3 – Jun 09 o Q4 – Oct 09 • Review all definitions and major WBS elements each quarter (refine as required) Define attributes for each method/ technique associated with each WBS element	Definitions are refined and approved by Program Leadership. Briefing is provided to Government and contractors at Program Staff meeting and distributed via email for those not in attendance. All information is documented and integrated into Program processes.

Tactics	Context	Actions	Actionee	FY09	FY10	Criteria
				Process Documentation (SRM PLL, ValPLL, and VerPLL – Aug 29)		
II). Develop metrics for goodness	Initiate Product-oriented Metrics Initiative (in process, CE).	Engineering Services to develop NASA IV&V Program Metrics.	Product-oriented Metrics Project Lead	1. Assemble the team (Government, contractor, and academia) 2. Include Naval Post Graduate School representatives on the team 3. Draft FY08 Product-oriented Metrics Plan: • Conduct two Industry Software Metrics Program benchmarking initiatives • Develop Goals, Questions, and Metrics associated with Goodness and Coverage • Review Benchmarking results and Goodness/ Coverage Goals, Questions and Metrics with Program Leadership	PLLs (assisted by the Product-oriented Metrics Team) will develop metrics associated with each WBS element • Development Objectives and Schedule due NLT Oct 31, 2008	Metrics accurately measure the quality and impact of the NASA IV&V Program.

Tactics	Context	Actions	Actionee	FY09	FY10	Criteria
				Team (NLT Sept 15) 4. Develop FY08 Annual Metrics Report Plan (Jul 30) 5. Draft FY09 Product-oriented Metrics Plan: • Conduct FY09 Focus Session and review with Program Leadership Team • Develop Goals, Questions and Metrics associated with IV&V effort associated with Modeling, Validation, and Verification activities		
III). Review metrics with stakeholders	Brief results to the CE and and other stakeholders.	P&P and CE to meet with HQ stakeholders to discuss metrics.	CE, Chief of Knowledge Management (KM), P&P	Brief FY07 Annual Metrics Report and associated efforts to NASA Deputy CE (mid-FY08 – CE/KM/P&P) Brief Annual Metrics Report summary to HQ stakeholders at first quarterly meeting after report is published (CE/KM/P&P) Conduct updated	Sustaining Brief Annual Metrics Report summary to HQ stakeholders at first quarterly meeting after the report is published (CE/KM/P&P)	Stakeholders understand and agree with metrics used to track the NASA IV&V Program.

Tactics	Context	Actions	Actionee	FY09	FY10	Criteria
				briefing on Benchmarking and Program Metrics Initiatives to NASA Deputy CE (end FY08 – CE/KM/P&P)		
IV). Monitor progress through metrics	Review IV&V Execution Metrics with stakeholders.	Metrics are reviewed semi-annually to ensure Program and projects are progressing adequately.	Product-oriented Metrics Project Lead	Compile Metrics summaries for review at the end of 2nd and 4th Quarters Execute a preliminary Annual Metrics Report data extraction at the end of Sept to conduct a preliminary assessment and begin analysis for the Annual Report process (Sept 30)	Sustaining Report quarterly IV&V Product Metrics Status and Initiatives at Program Management Review (CE)	Metrics progress as expected. Deviations are detected early and addressed.
V). Review progress with stakeholders	Communicate progress.	P&P and CE to meet with HQ stakeholders to review progress.	CE, P&P	Sustaining	Sustaining Brief quarterly IV&V Product Metrics Status and Initiatives to HQ stakeholders (CE)	Stakeholders understand and agree with metrics used to track the NASA IV&V Program and its progress.

Objective #3B: Measure Goodness of IV&V Services
Program Lead: Chief of Integration (CI)

Tactics	Context	Actions	Actionee(s)	FY09	FY10	Criteria
I). Define goodness of IV&V Services	Objective 3A addresses Engineering. aspects. This objective addresses Project Management Metrics aspects.	Define goodness criteria.	CI, Mission Directorate Leads (MDLs), PLs	2nd Quarter	1st Quarter - update	Excellent quality Sev. 1, 2, and 3 issues and external risks: > 90% defendable to customers. Use Customer Survey Comments, IPRs, and UC approach to determine goals for goodness
II). Develop metrics for goodness	UC analysis of IV&V Services business processes. Dashboard development.	1-Determine best metrics for IV&V Services. 2-Disseminate metrics to PL Engineers.	1-CI, MDLs, PLs 2-CI	2nd Quarter	1st Quarter - update	Metrics accurately measure quality and impact of the NASA IV&V Program. SLPs and other guidance documents are updated with metrics criteria.
III). Review metrics with customers and stakeholders	Starting new quarterly Project Reviews with stakeholders (Agency MDs). SLP 9-4 being updated.	1-Provide project metrics periodically to customers via tailored meetings and Dashboard. 2-Provide servicemetrics to stakeholders in quarterly MD Project Reviews and Dashboard. 3- Combine with Product metrics.	1-PLs, MDLs 2-MDLs, P&P 3-PLLs, PLs, MDLs	2nd Quarter and then at least quarterly	At least quarterly	Customers and stakeholders understand and provide feedback on metrics used to track NASA IV&V Program. SLPs and other guidance documents are updated with tailorable templates for customer and stakeholder interactions.

Tactics	Context	Actions	Actionee(s)	FY09	FY10	Criteria
IV). Monitor progress through metrics	To ensure that Internal progress is now being measured via IPRs periodically.	Review IV&V Services Metrics periodically in IPRs or as needed	SL	Periodically	Periodically	Metrics are measured periodically, deviations from established thresholds are detected within a quarter of occurrence, and plans to address are approved within the same quarter.

Objective #4: Measure Goodness of Research (SARP and Internal Research)
Program Lead: Chief of Research (Research)

Tactics	Context	Actions	Actionee(s)	FY09	FY10	Criteria
I). Apply Technology Readiness Level (TRL) in the context of the Research Program	Relevant questions to answer to enable better planning for the entire life cycle of research include: (1) How long does it take to move from one TRL to another? (2) What does the curve look like? (3) Where are the tar pits?	Gather data to answer the questions.	Research	The questions won't have absolute answers by the end of FY09. However, there should be enough illumination available to make smart adjustments to the plans for the work scheduled to begin in FY10 (incorporate updates 4th Quarter FY09)	Make improvements based on what we learn (4th Quarter FY10)	Data is gathered to inform next steps.
	Initiative deliverables, or research products, are the expression of TRL. Additionally, there is a continued challenge to provide structure without being uselessly rigid.	Continue to refine deliverable guidelines and templates to better support TRL.	Research	Refine the connection between TRLs and deliverables (ongoing during FY09 Quarterly Reviews)	Make improvements based on what we learn (ongoing during Quarterly Reviews)	Meaningful guidelines and templates are in use.
II). Focus on deliverables to support TRL and transition	Increase awareness (make it possible for people to have information) about the results of the research. We can have great research, but if the right person in the right position at the right time doesn't have the right information, we've lost an opportunity.	Assess current initiative deliverables to move through the NASA Technical Report Server NTRS	Research	Understand process; put necessary support in place; publish (4th Quarter FY09)	Publish more (4th Quarter FY10)	Assessment and publication processes are tested and in use.
		Assess past initiative deliverables to move through the NTRS	Research			

Tactics	Context	Actions	Actionee(s)	FY09	FY10	Criteria
	Initiatives have plans appropriate to the planned end goals. Now we action the plans.	Monitor progress.	Research	In progress; assessed during Quarterly Reviews	In progress; assessed during Quarterly Reviews	Research initiatives worthy/capable of being infused are ready and in progress.
III). As appropriate, action the transition/ infusion plans for the initiatives and assess additional actions to support transition	Transition and infusion are supported by sufficient information for potential users/adopters to make a good decision. Initiative deliverables, or research products, are the indication of TRL and the way we move toward readiness to transition into practice. As we see more research-developed technologies used in practice, we gain a greater understanding of what will really matter to support transition.	Draft guidelines and templates to support more consistency for certain types of deliverables.	Research	Assess the efficacy of guidelines and templates; assessment ongoing during Quarterly Reviews (any updates to templates or processes will be done 4th Quarter FY09)	Continue to refine during Quarterly Reviews (any updates to templates or processes will be done 4th Quarter FY10)	Guidelines and templates are in use and refined as necessary.
IV). Monitor Initiative Progress	The progression through deliverables and consequently TRL will also continue to be a check on our review and grading process. Additionally, the focus on getting better and more accurate research needs will support an awareness of whether ongoing research	Monitor progress in relation to TRL.	Research	Ongoing during Quarterly Reviews; continue to monitor and assess efficacy	Ongoing during Quarterly Reviews; continue to monitor and assess efficacy	Initiatives are assessed and renewed or culled as appropriate.

Tactics	Context	Actions	Actionee(s)	FY09	FY10	Criteria
	should continue to be ongoing.					
V). Focus on retirement planning	We're looking at retirement as not allocating more effort to a project. That may be because: (1) it was successful and has transitioned or is transitioning; (2) it has faltered (see initiative renewal), it isn't feasible, or we are not putting resources in that area going forward; (3) it has completed work, but it is currently ahead of the curve and it is not the time yet for an infusion effort; or (4) it has reached the natural end of its life and it is not appropriate for transition (going forward, this should not be common). What we need to do is consider how to keep the information active/accessible so that if anyone else wants to pursue that topic, the previous work is the starting point.	Plan for future retirement for current initiatives.	Research	Depending on planned end-state of current initiatives, assess whether deliverables support retirement (ongoing during Quarterly Reviews)	More of the same (ongoing during Quarterly Reviews)	Retirement plans flow from the goal(s) of the initiative.
		Assess initiatives that have ended to bring out of retirement.	Research	Maximize prior deliverables (4th Quarter FY09)	More of the same (4th Quarter FY10)	Maximize deliverables from closed initiatives.

Tactics	Context	Actions	Actionee(s)	FY09	FY10	Criteria
VI). Improve the goodness of the SARP by increasing the ability of NASA to shape the Research needs that drive the program	The SARP is only as good as the Research needs are valid. The challenge, then, is to increase the opportunity for more of the Agency with the right background, knowledge, and perspective to be engaged in a meaningful way, and to provide them the ability to provide input.	Expand the number of appropriate people (and perspectives) that provide input to the SARP Research Needs List and who evaluate proposals.	Research	Enable all Centers/Programs to have the opportunity to provide input to the SARP Research Needs List, and evaluate proposals as part of the solicitation for FY10 (1st Quarter FY09)	Enable all Centers/Programs to have the opportunity to provide input to the SARP Research Needs List as part of the solicitation for FY11 (likely 3rd or 4th Quarter FY09)	Involvement increased over previous year.
		Provide information to all levels of stakeholder to enable more informed input, particularly to enable a prioritized list.	Research	Provide feedback to OSMA and Center SMA leadership regarding Center participation (3rd or 4th Quarter FY09)	Provide feedback to OSMA and Center SMA leadership regarding Center participation (3rd or 4th Quarter FY10)	Information is provided.

Objective #5: Measure Goodness of Outreach
Program Lead: Chief of Communications (Comm)

Tactics	Context	Actions	Actionee(s)	FY09	FY10	Criteria
I). Identify Outreach objectives	Provide information to local, regional, and NASA Centers.	Respond to requests from television newspaper outlets. Develop press releases to inform of IV&V Services/ Research activities. Support internal/external publications.	Public Affairs Specialist	Sustaining	Sustaining	Constituency requirements are satisfied.
	Provide information to legislative stakeholders.	Develop presentations. Respond to requests for information.	Comm	Sustaining	Sustaining	Stakeholder requirements are satisfied.
	Student Outreach: To provide expertise and facilities to excite and encourage students to pursue careers in science, mathematics, geography, engineering, and technology	Increase visibility of NASA within schools to promote awareness of science, technology, engineering, and math (STEM) related fields of endeavor to attendees of high school and college career fairs. Demonstrate the use of NASA curriculum materials to local students. Partner with a higher education institution that has strong student studies in STEM programs. Coordinate the NASA IV&V Apprentice Program (NEAP). Coordinate Day in the Park.	Student Outreach Manager	Target effort per survey results	Target effort per survey results	Increase impact by diversifying customers/audience. Complete CASTEM initiative at West Virginia State. Complete initatives with Fairmont State University. SEAP successfully complete (i.e., students' presentations well-received by HQ review team). NEAP students pursue further STEM studies. Evaluated as improved experience each year by students and teachers.

Tactics	Context	Actions	Actionee(s)	FY09	FY10	Criteria
	Educator Resource Center: To provide expertise and facilities to help educators access and utilize science, mathematics, geography, engineering, and technology instruction products that are aligned with national standards and appropriate state frameworks. The products are also based on NASA's unique mission and results.	Demonstrate and facilitate the use of educational technologies. Provide in-service, pre-service 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.	Educator Resource Center	Target effort per survey results	Target effort per survey results	New and returning educators. Proof of use in classroom or informal educational settings. Positive survey results.
II). Develop measures of goodness (SLP 19)	Measures of goodness have been developed and applied in FY07/FY08. Those metrics will be applied and refined in FY09/FY10.	Continue to apply current evaluation tools and surveys. Assess SEAP graduation rates, number of participants and number of programs.	Comm	Complete 1st Quarter	Sustaining	Sustained to improved results depending on evaluations and surveys. Sustained SEAP undergraduate degrees are received.
III). Develop Metrics		Refine metrics as appropriate; i.e., ERC end-of-year survey; SEAP graduation rates and college placement statistics	Comm	Complete 1st Quarter	Sustaining	Metrics development is completed for all actions.
IV). Review Metrics with SL		Present and respond to review of metrics to ensure that a clear picture of the impact of Outreach effort unfolds.	Comm	Complete 1st Quarter	Sustaining	Metrics are approved for all actions.
V). Execute		Schedule events. Assign resources. Apply metrics.	Comm	Monthly and Quarterly Review	Monthly and Quarterly Review	Metrics are in use.

Tactics	Context	Actions	Actionee(s)	FY09	FY10	Criteria
VI). Monitor		Review of surveys, evaluations.	Comm	Monthly	Monthly	Report to Comm/IV&V Director.
		Budget meetings with Outreach Team.		Monthly	Monthly	
		Program Performance Reviews.		Annually	Annually	
		Outreach Vision/Value Retreat.		Annually	Annually	

Objective #6: Optimize Government Staff for Projects
Program Lead: Chief of Integration (CI)

Tactics	Context	Actions	Actionee(s)	FY09	FY10	Criteria
I). Define notional IV&V project in terms of WBS	Projects should be led by trained/competent Government staff to ensure Government staff understands expectations of what an IV&V project is.	1- Define notional types and purposes of IV&V projects. 2-Update appropriate documentation and disseminate.	1-CI, CE, KM, P&P, MDLs, PLs 2-CI and TBD	2nd Quarter	Sustaining	SLP 9-4, *Project Management*, guidelines are updated. SLP 9-1 incorporates new WBS and *Project Management* updates. IPEPs are updated.
II). Define Government roles and responsibilities in leading IV&V projects	To ensure Government staff understands Government roles and responsibilities with regard to the defined project types.	1-Update SLP 9-4 annually. 2-Update IPEPs at least semi-annually. 3-CI and CE update roles and responsibilities for matrixed organization. 4-Refine/reinforce during Projects Workshop, IPRs.	1-CI, MDLs, PLs 2-PLs, MDLs 3-CI, CE 4-CI, KM, MDLs	2nd Quarter update	Update and sustaining	PL and MDL responsibilities are understood (at least via mid-year and annual performance review) and match those described in updated SLP 9-4.
III). Identify required skills and knowledge to lead IV&V project and Product Lines	Have PL, PLL, and MDL tiered individual training plans defined. Actual training is established in other objectives.	1-Establish Individual Development Plans (IDPs) for all PLs, MDLs, and PLLs. 2-Schedule training. Attend APPL training and other as available.	1-PL, PLL, MDL, CI, CE 2-PL, MDL, PLL, Training Coordinator, CI	1st Quarter and sustaining	Sustaining	PL, PLL, MDL, IDPs reflect training requirements. PLs, MDLs, PLLs completing training as planned and progressing through tiers. FY09: All L1 advancing to L2. FY10: All PLs L2 or L3.

Tactics	Context	Actions	Actionee(s)	FY09	FY10	Criteria
IV). Develop metrics to measure goodness	Project effectiveness measures are captured in other objectives and should be considered when evaluating individual effectiveness (or goodness).	1-Complete/update developed VerPLL and ValPLL, MDL, PLL goodness metrics. 2-Collect data from customer and stakeholder surveys. 3-Evaluate IPRs for PL, PLL, MDL goodness metrics.	1-CI, CE, KM, MDL, PLs and PLLs 2-P&P, CI, CE 3-CI, MDL, KM, CE, and appropriate SL	2nd Quarter and at least annually	Sustaining	Customer and stakeholder surveys contain evaluation criteria to support both project and staff goodness evaluations. IPR presentations are scorable via written comments (or grades) for each. IV&V C&Ls, issues, and risks are clear, concise, and accurate, and severity levels are defendable.
V). Review metrics with IV&V staff	Again, this is for individual goodness evaluation; however, project goodness should count for a lot.	1-Gather goodness data from various sources and determine feedback to be provided to Government staff individuals. 2-Review IV&V Metrics results and goodness data with IV&V Government staff individuals.	1-CI, MDL, KM, CE; supported by P&P for survey data 2-CI, or CE, as appropriate	At least annually	At least annually Sustaining	PLs, MDLs, PLLs receive and acknowledge feedback.
VI). Assign staff to project	The results of Government staff performance feedback should inform assignments.	CI and CE will continually evaluate Government workload and adjust as necessary.	CI, CE	Sustaining	Sustaining	PLs, MDLs are assigned missions in accordance with their availability and capability. Most PLs typically will have two active missions.

Objective # 7/8: Optimize Resources/Implementation of Projects
Program Lead: Chief of Integration (CI)

Tactics	Context	Actions	Actionee(s)	FY09	FY10	Criteria
I). 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	New PEP and IPEP template updated. This objective addresses planning and execution of IV&V projects.	1-Review new project goals or review previous year's project accomplishments and identify risks. 2-Determine PBRA. 3-Determine summary of system goals. 4-Apply tailored WBS. 5-Determine PERT and effort estimates.	1-PL, MDL 2-PL, PLL support 3-PL & PLL 4-PL 5-PL (PL, MDL, consult with PLLs as needed at this stage)	1st Quarter	Prior to 1st Quarter	Project IPEPs are approved through MDLs.
II). Review notional task plan with Government staff and industry partners	Follow PEP to get initial project plans refined into detailed plans.	1-Negotiate with PLLs for agreement of effort and schedules. 2-Get MDL agreement. 3-Complete baseline documents and signatures.	1-PL, PLL, MDL 2-PL, MDL 3-PL, MDL, CI, CE, Director, customer	1st Quarter	Prior to 1st Quarter	Project IPEPs are approved through Contracts and Program Management.

Tactics	Context	Actions	Actionee(s)	FY09	FY10	Criteria
III). Execute	Conduct execution phase.	Accomplish IV&V execution as defined in the IPEPs.	PL, MDL, PLLs	1st Quarter	Sustaining	Project execution correlates with approved IPEPs.
IV). Monitor effectiveness in terms of shared understanding of projects and tasks, useful level of documentation, project estimation development	Measuring goodness is defined in Objectives 3A, 3B, and 6. This objective focuses on Planning and Execution of IV&V projects.	CI, CE, and SL monitor execution of IV&V through routine IPEP Review, IPRs, Project Reviews with stakeholders, RAC, and the collection and review of metrics.	CI, MDL, PLs, CE, KM	2nd Quarter	Sustaining	Project execution correlates with approved IPEPs. Metrics are collected, reviewed, and assessed with criteria for success and Lessons Learned.

Objective #9: Increase Technical Proficiency
Program Lead: Chief of Knowledge Management (KM)

Tactics	Context	Actions	Actionee(s)	FY09	FY10	Criteria
I). Identify required skills and knowledge to lead IV&V projects (CI, CE, Operations, RMO, Research)	Skills and knowledge for all types of projects are identified.	Develop approved PL training curriculum for leading Program projects.	SL	2nd Quarter	Sustaining	IDPs reflect training requirements. PMs complete training as planned.
		Establish expectations for all functional areas.	SL			
		Develop IDPs for all Program PLs.	PLs, Supervisors			
		Execute IDPs and monitor progress.	PLs, Supervisors			
		Use IV&V Workshops to provide recurring training.	KM			
II). Identify required skills and knowledge to work as team members on Program projects (CI, CE, Operations, RMO, Research)	Skills and knowledge for all types of projects are identified.	Develop specialized training modules for areas of interest (CI, CE, Operations, RMO, Research).	SL	3rd Quarter	Sustaining	Government-only work is underway.
		Prioritize training modules for deployment.	SL			
		Deploy training modules.	SL			
		Measure competencies of staff.	KM			
III). Identify Government-only work	Government work is identified	HST (Engineering, Services). GPM Startup (FY08). MMS Startup.	CI	N/A	Sustaining	Government-only work is underway.

Tactics	Context	Actions	Actionee(s)	FY09	FY10	Criteria
		Note: Each of the Program areas of interest (CI, CE, Operations, RMO, Research) will be represented on the teams and tasks will be assigned/ measured.	SL			
IV). Identify Government staff assignment	Resources are allocated to Government work.	CE and PLLs serve as mentors.	CE, PLL	Complete	Sustaining	New Lessons Learned is incorporated into database and is disseminated to PLs.
		IV&V Workshop present status.	CE, PLL			
V). Identify formal training requirements	Formal training requirements.	Develop and publish Lessons Learned Work Instruction.	CE	Sustaining	Sustaining	New Lessons Learned is incorporated into database and is disseminated to PLs.
		Integrate the use of Lessons Learned into Program processes.	CE			
		Measure/monitor that Lessons Learned are being shared and considered for applicability.	CE			
		Measure/monitor where Lessons Learned are being authored and used.	CE			

Appendix B: Desired End State for FY11/12

The table below captures the plans that are two to three years in the future to reinforce long-term and larger goals associated with each objective.

OBJECTIVE	FY11	FY12	CRITERIA	End of Year (__) STATUS
1. Customer Requirements	Sustain and Improve (with refined requirements)	Sustain and Improve (with refined requirements)	Customer requirements have been refined and documented, and a plan has been formalized to meet requirements (including actions, actionees, metrics, and schedules). Evidence of status and completion has been communicated (internally and with customers).	
2. Stakeholder Requirements	Complete (with refined requirements)	Complete (with refined requirements)	Customer requirements have been refined and documented, and a plan has been formalized to meet requirements (including actions, actionees, metrics, and schedules). Evidence of status and completion has been communicated (internally and with customers).	
3A. Measure Goodness of IV&V Products				
3B. Measure Goodness of IV&V Services	Complete	Complete	Measures for the goodness of IV&V Services are established; procedures for collecting, understanding and improving IV&V Services are up and working; feedback from customers and stakeholders is included.	3B. Measure goodness of IV&V Services
4. Measure Research	Sustain and improve	Sustain and improve	Publication, awareness, transition continue to be the focus. Other efforts are stable and steady-state.	
5. Measure Outreach	Continue work of FY09/FY10: Expand surveys to informal educators; apply new technologies to reach remote educators	Sustain	On-going work is evaluated as meaningful/impactful. Work initiated in FY11 is evaluated as well-targeted and impactful through FY12.	
6. Optimize Government staff for Projects	Maintain, continue to improve	Maintain, continue to improve	Projects and Product Lines are led by trained/competent Government staff.	

OBJECTIVE	FY11	FY12	CRITERIA	End of Year (__) STATUS
7/8. Optimize Resources Implementation for Projects	Maintain, continue to improve	Maintain, continue to improve	Project planning and execution correlates with approved IPEPs are aligned with the overall IV&V PEP. Metrics are collected, reviewed, and assessed with criteria for success and Lessons Learned.	
9. Increase Tech Proficiency	Sustain and improve (with refined requirements)	Sustain and improve (with refined requirements)	Core competencies are established. Domain-specific knowledge is established.	

Appendix C: Future Vision - Planning 2013-2018

We will look to 2012 as the end-date of this plan and approach future planning in this section. This future vision-planning will be revisited in FY09 during the annual review process, once the customer and stakeholder requirements are documented. This will allow a realistic consideration of long-term actions versus shorter-term initiatives. This section will be used to capture ideas and thoughts for conversation, consideration, and planning.

Appendix D: Actual End State for FY07/08

This section provides a historical record of progress made against each objective for FY07 and FY08. This information serves as a starting point for consideration when revising out-year efforts and future (greater than two years) plans.

OBJECTIVE	FY07	FY08	CRITERIA	End of Year (08) STATUS
1. Customer Requirements	Complete	Repeat	Shared Understanding	Definition and agreement on customer requirements were not completed in FY07 or in FY08. 50% of Tactic 1 completed (Customer List established/updated), but capturing requirements in a central document did not occurred. No progress was made on Tactics 2-6.
2. Stakeholder Requirements	Complete	Repeat	Shared Understanding	Definition and agreement on stakeholder requirements were not completed in FY07 or in FY08. 50% of Tactic 1 completed (Customer List established/updated), but capturing requirements in a central document did not occurred. No progress was made on Tactics 2-6.
3. Measure Goodness 3/A	Prototype	Complete	Assessment of Goodness	3A Tactics 1-2 and 4-5 complete. Tactic 3 Scheduled: 2007 Annual Report review planned for upcoming Mission Directorate Review/IBD Annual Meeting.
3b. Measure Goodness of IV&V Services	Prototype	Partial	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	Risk Review Board for IV&V Services established; currently reviewing adequacy of all identified risks for our projects, ultimately leading to better risks. Issue Review Board conceptualized, in the midst of being formed to review all Severity 1 and 2 issues, will ultimately lead to better issues. PMRs have been replaced by IPRs. CE role defined to "divide the tasking" on projects to allow increased focus on building a better confidence data story.
4. Measure Research	Prototype	Complete	TRLs For All Projects (FY07); Apply Criteria Renewal/Retirement (FY08)	TRL for all projects complete (researcher self-assessment – Jun 07; Delphi assessment – Dec 07; test of the full calculator – Feb 08; Research-focused

OBJECTIVE	FY07	FY08	CRITERIA	End of Year (08) STATUS
				TRL – Mar 08. There are updated criteria for evaluating initiatives, which have been tested and are currently in effect for regular quarterly reviews.
5. Measure Outreach	Prototype	Complete	Develop Metrics (FY07) ; Apply Metrics (FY08)	Metrics for FY07 were developed and refined in FY08, applied throughout ERC programs and Student Outreach programs, informed strategies and new initiatives for FY09/FY10.
6. Optimize Government Staff for Projects	Prototype	Partial	100% Projects Led by Trained Government Staff	Many IV&V projects defined work in terms of new WBS in FY08 IPEPs. Defined initial matrix organization with regard to Product Lines and IV&V Services. PM levels/capabilities identified; required PM training listing for these levels identified. All PMs performed self-evaluation; CI performed assessment as well.
7/8. Optimize Resources/Implementation for Projects	Prototype	Complete	Carry-Over < 5% (FY07); Carry-Over < 1% (FY08)	IPEP and Network Diagram templates defined and used to assess cost, schedule, and performance. FY08 rebaselining and organization transition will posture Services to achieve criteria by the end of FY08. IV&V project-related costs are tracked at IPR and RAC. Overall for FY08, IV&V Services are at 2% underrun. Programmatic risk-based portfolio process developed and is being used to facilitate our FY09 planning efforts. SMD projects complete 1st round of assessing Science-related projects. Space Operations and Exploration will perform similar exercise by end of Jul/early Aug. All FY08 IPEPs were approved except MSL, LRO, and Ares I. Ares I project baseline was approved in Jul 08; however, IPEP efforts will go to FY09 IPEP. Risk handling procedures were approved, and risk mitigations are in process. Procedures for Overall Risk Assessments

OBJECTIVE	FY07	FY08	CRITERIA	End of Year (08) STATUS
				across the IV&V Program are started.
9. Increase Tech Proficiency	Prototype	Complete	1 Government Project (FY07); 2 Government Projects (FY08)	1 PL assigned to 1 mission (FY07) and 2 PLs assigned to 2 missions. No other staff assigned, so work has not started.

Appendix E: Detailed Plan for Each Objective and Tactic FY 07/08

This section provides a historical record of initial plans against each objective for FY07 and FY08.

Objective #1:   Meet Customer Requirements
Program Lead: Chief of Plans and Programs

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: Chief of Plans and Programs

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: Chief of IV&V Services

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: Chief of IV&V Services

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: Chief of Research

Tactics	Actions	FY07	FY08	Criteria
I) Identify TRL for each initiative	Assign preliminary TRL to each initiative;	(researcher self-assessment - June 2007)		TRL initially assigned based on researcher self-assessment.
	Refine TRL		(Delphi - December 2007) (test of the full calculator - Feb 2008) (Research TRL - March 2008)	More than one TRL evaluation for each initiative.
	Map out TRL progression plan for each initiative		2nd Quarter 2008	The goal for FY09 is that at least 50% of the initiatives increase a TRL
	Assess TRL profile for both SARP and IV&V Research portfolios	2nd Quarter Draft post-SAS.		
II) Identify project objectives (deliverables)	Review objectives and deliverables and the way they are defined and chosen	4th quarter 07		Review complete with sufficient information to support next steps
	Review documentation and update	In line with ISO review schedules and SARP solicitations		Documents are reviewed and updated as necessary to support program schedules
	Assess, and, if necessary, refine during quarterly reviews	On Going	Refine as need indicates	
III) Identify Technology Transfer Plan for each project	Review Current Practice	End of FY07		Review complete with sufficient information to support next steps
	Define Set of Standard Actions and Practices		End of FY08	
	Update proposal templates		Refine as needed based on previous solicitation	Templates updated
	Develop Individual plans		Begin June 08	
	Evaluate Confidence criteria.		December 07	Decision made whether to continue exploring whether this was something to incorporate.

Tactics	Actions	FY07	FY08	Criteria
IV) Develop criteria for project renewal	Review Current Practice and update documentation	End of FY07		Review complete with sufficient information to support next steps
	Draft updated Criteria		June 08	New Criteria complete
	Assess initiatives with the criteria		Begin June 08	Initiatives assessed
	Assess the utility of the criteria	On Going	Refine as need indicates	
V) Develop criteria for project retirement	Review Current Practice and update documentation	FY07		Review Complete
	Draft updated Criteria		June 08	New Criteria complete
	Begin applying		Begin June 08	
	Assess the utility of the criteria	On Going	Refine as need indicates	

Objective #5: Measure Goodness of Outreach
Program Lead: Chief of Communications and Outreach

Tactics	Actions	FY 07	FY08	Criteria
I) Identify Outreach Objectives 1) Public Affairs Response	Response to television newspaper information and interview request; press releases	Sustain Effort Tactics/Actions (1-5)	Sustain Effort Tactics/Actions(1-5)	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 sustaining the participation of elementary and secondary students. Coordinate the Science and Engineering Apprentice Program (SEAP). Sustain 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. sustain current efforts and diversification of audience.
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 frameworks. The products are also based on	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.			4/5.a Continue supporting NASA Day at WVSU 4/5.b One successful initiative

Tactics	Actions	FY 07	FY08	Criteria
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.
III) Develop Metrics	Develop Prototype for Tactic/Actions 1-5	Complete 1st Quarter	Complete 1st Quarter	Metrics development complete for all actions
	Develop Prototype for Tactics/Actions 5-08	Complete 3rd Quarter		
	Develop Prototype for Tactic/Actions 4&5-08	Begin 3rd Quarter		
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	Complete 2nd Quarter	Sustain Effort	Metrics approved for all actions
	Present and respond to review of Prototype for Tactics/Actions 5-08	Complete 3rd Quarter	Sustain Effort	
	Present and respond to review of Prototype for Tactics/Actions 4&5-08	Complete 4th Quarter	Begin 1st Quarter and Sustain Effort	
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;	Monthly	Monthly	Report to Outreach Director/IV&V Director
	Budget Meetings with Outreach Team	Monthly	Monthly	

Tactics	Actions	FY 07	FY08	Criteria
	Program Performance Reviews	Annually	Annually	
	Outreach Vision/Value Retreat	Annually	Annually	

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

Tactics	Actions	FY 07	FY08	Criteria
I) Define notional IV&V project in terms of WBS	Complete and disseminate new WBS Chief Eng update SLP 9-1 with latest Validation and Verification WBS definitions	Complete	Sustaining 33% complete update	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 Services Lead & CE update roles and responsibilities for matrixed org. Refine/reinforce during Projects Workshop, PMRs, IPRs	Sustaining	Sustaining IPEPs – End of 2nd & 4th Qtrs R&R defined by end of 4th quarter, SLP 9-4 updated	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 08: Establish Individual Development Plans for all. Begin scheduling training for FY09	complete	By end of 4th quarter	Available PM IDPs reflect training requirements PMs completing training as planned and progressing through tiers
IV) Develop metrics to measure goodness	KM/CE to develop IV&V Program metrics Disseminate and collect data from Customer Surveys Evaluate reviews for completeness and accuracy FY08: Produce process to evaluate Risks and Issues (coordinated with Objectives 3A & 3B)	Initiate	Customer Surveys & Risks – 1st Qtr Program Metrics – 4th Qtr	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	KM/CE will review IV&V Program metrics with government. Staff FY08:Provide feedback regarding IPRs FY08:Provide feedback regarding Customer Survey	Sustaining	Initiate	PMs receive and understand IPR and Customer Survey feedback
VI). Assign staff to project	IV&V Services Management will continually evaluate PM work load	Sustaining	Sustaining	PMs are assigned missions in accordance with their availability

Tactics	Actions	FY 07	FY08	Criteria
	and adjust as necessary			and capability, Most PMs typically will have 2 active missions

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

Tactics	Actions	FY 07	FY08	Criteria
I) Define notional IV&V project in terms of WBS	Complete and disseminate new WBS Chief Eng update SLP 9-1 with latest Validation and Verification WBS definitions	3rd Quarter New WBS complete	1st Quarter Update SLP 9-1: 33% complete	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	Initiate	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 FY08: Senior Leadership special team: Develop full cost elements and FY program execution plan guide, FY08: RMO/P&P communicate full cost results	Study (w/ recommendations) -- Completed	Complete full cost and PEP Guide Revisit recommendations and develop implementation plan in FY09	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	4th Quarter	Initiate IPEP to customers in FY09 FY08: Quarterly stakeholder	Stakeholders understand and are agreeable with Project IV&V plans

Tactics	Actions	FY 07	FY08	Criteria
	FY08:Schedule Quarterly Reviews with stakeholders		reviews scheduled	
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: Chief of IV&V Services

Tactics	Actions	FY 07	FY08	Criteria
I) Define notional IV&V project in terms of WBS	Complete and disseminate new WBS Chief Eng update SLP 9-1 with latest Validation and Verification WBS definitions	3rd Quarter New WBS complete	1st Quarter Update SLP 9-1: 33% complete	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: Chief of Knowledge Management

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