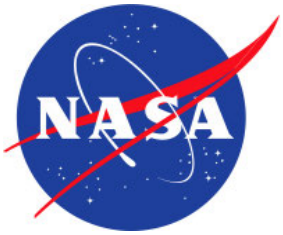
National Aeronautics and Space Administration



Independent Verification and Validation (IV&V)
Mars 2020 Technical Scope & Rigor FY16

IV&V Technical Scope and Rigor

M2020

FY2016 (TSR-78)

Updated Date: 8/7/2015

Status: v1.0

NASA Independent Verification and Validation Facility

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Contents

Purpose

The Mars 2020 (M2020) Independent Verification and Validation (IV&V) Technical Scope and Rigor (TS&R) document describes the overall IV&V approach to defining a set of Assurance Objectives that will drive the IV&V efforts. These efforts will be further defined as activities that will be applied on the M2020 IV&V Project.

Assessment of Technical Scope

Heritage

The M2020 Project is following a similar development process as the Mars Science Lab (MSL) Project utilized, including a core reuse of the MSL flight software (FSW); therefore, heritage considerations from both the MSL development process and IV&V perspectives of those processes and products, play a role in the selection of Assurance Objectives and IV&V analysis activities that will be selected to meet those objectives.

The M2020 IV&V team conducted a heritage review, the purpose of which was to survey prior NASA IV&V programs for applicability of their results to the M2020 program and to document references to applicable project results for use in M2020 IV&V work.

The Mars 2020 Heritage Review document, including applicable Lessons Learned, is located on the NASA IV&V's Enterprise Content Management (ECM) system in the following location: <Redacted>

M2020 Development Milestones

The mission will rely on prior technological innovations that were successfully demonstrated by MSL, especially for entry, descent, and landing. The spacecraft would use a guided entry, descent, and landing system, which includes a parachute, descent vehicle, and, during the final seconds prior to landing, an approach called a "sky crane maneuver" for lowering the rover, on a tether, to the surface. This is necessitated due to the size and weight of the rover being placed on Mars. The rover design will be similar to Curiosity and provide a long-range mobility system for traversing the Martian surface.

There will be a number of minor changes made to the FSW to increase efficiencies over the current MSL configuration, but the key differences from the MSL system architecture are:

- The technique for the guidance system for landing is being modified to increase the accuracy of the landing. This change would at minimum require modification to the EDL software and would likely require additional processing hardware.
- The rover will carry a new instrument suite, consisting of seven new instruments, which will be used to conduct geological assessments of the rover's landing site, determine the potential habitability of the environment, and directly search for signs of previous Martian life.

- The Sample Collection System (SCS) on the rover will be new for the M2020 mission and will support the mission requirement of collecting Martian soil and rock samples for availability of a follow on mission to return the samples back to Earth. The SCS will at a minimum require new software to control the subsystem and will likely require new hardware to adequately perform the collection and storage of the samples.
- In an effort to increase efficiency of overall Mars operations, as part of the overall NASA strategic goal to land humans on the Martian surface, the software controlling mobility on the surface will be enhanced to help increase the speed that the rover can autonomously and safely operate, without ground intervention.

The M2020 key development milestones are shown in Figure 1. The mission is currently in Phase B having completed Phase A in fourth quarter of Calendar Year (CY) 2014. The Preliminary Design Review, followed by Key Decision Point (KDP) C, is currently scheduled for September 2015, for Part 1, and December 2015, for Part 2. Successfully completing those milestones will allow for the mission to proceed into an extended Phase C. Phase C is highlighted by the Mission Critical Design Review (CDR) in late-CY2016 and the Systems Integration Review (SIR) and KDP-D at the end of 2017. CY 2018 involves preparations for the Pre-Ship Review (PSR) at the beginning of CY2019, whereas CY2019 and part of CY2020 will be the lead in for the final mission readiness reviews leading up to launch. Phase E begins after launch and extends throughout the life of the science portion of the M2020 mission, which has a primary end date of 12/31/2022.

<Redacted>

Figure 1 Mars 2020 Software Development Key Milestones

Throughout the course of the software development lifecycle, the M2020 IV&V Team will present IV&V status to various stakeholders as required and/or requested. The IV&V Team will communicate and coordinate the overall message/content of these presentations with the Project prior to the actual reviews. The planned mission milestones reviews that IV&V plans to support is detailed in the IV&V Project Execution Plan, which can be found within the NASA IV&V's ECM system at the following location: <Redacted>

Scope

PBRA/RBA Results

The M2020 IV&V Team uses the NASA IV&V Portfolio Based Risk Assessment (PBRA) and Risk Based Assessment (RBA) to prioritize the areas where IV&V analysis will be focused. The overall PBRA results for each of the capabilities defined in Table 1 and shown on the risk 5x5 in Figure 2. The supporting data/rationale is maintained by the IV&V PM and is available upon request. Capabilities that fall into the green category will not receive IV&V. Capabilities in the red category will typically receive IV&V, as

these represent the most critical capabilities of the system. Capabilities that are in the yellow category may receive IV&V pending funding availability and other factors.

<Redacted>

Figure 2 - Mars 2020 PBRA Results

Table 1 - Mars 2020 PBRA Results

<Redacted>

The complete PBRA is located on NASA IV&V's ECM system in the following location: <Redacted>

The overall RBA results for each of the system entities are listed in Table 2 and shown on the risk 5x5 in Figure 3. The supporting data/rationale is maintained by the IV&V PM and is available upon request. The RBA is used to communicate to the developer about the areas of IV&V focus within the software and to provide IV&V an understanding of the riskiest software entities that may require more focus.

<Redacted>

Figure 3 - Mars 2020 RBA Results

Table 2 - Mars 2020 RBA Results

<Redacted>

The complete RBA is located on NASA IV&V's ECM system in the following location: <Redacted>

Combined Perspective from the M2020 IV&V Init Documents

In order to understand the complete view of the risks that exists for the M2020 mission and the subsequent areas that IV&V should focus on, the M2020 IV&V team performed an overlay of the M2020 RBA onto the M2020 PBRA. In addition to this combined perspective, the results of the heritage review were added to the view. This included the understanding from the M2020 Project of what the expected FSW reuse from MSL is. It also included the perspective of what areas the MSL IV&V team focused on and applied various levels of technical rigor. This combined perspective provides a comprehensive evaluation of the M2020 mission, including areas where IV&V should be applying appropriate focus. See Figure 4 below for the combined perspective of the PBRA, RBA and the Heritage Review. For a more detailed look at this product, it can be found on ECM at this location: <Redacted>

The "XX" markings in the matrix represent the fact that the S/W entity across the top is a driving entity for the corresponding critical capability along the left side and an "X" represents that the entity is a supporting entity to the corresponding capability. This completed artifact provides a driver for how the IV&V team plans the technical rigor that is to be placed on each of the capabilities/entities. The intent on planning the technical rigor for IV&V analysis is to ensure that the higher risk capabilities and S/W entities get the most focus and attention, but if you add in the Heritage Review, the amount of planned reuse can help identify areas that should receive more or less scrutiny.

Additionally, if the MSL IV&V analysis understanding is added, the team can choose to increase or reduce analysis performed based on the analysis that was performed on those entities for MSL. See Table 3 below for an explanation on how the Combined Perspective is helping drive scope and rigor for M2020 IV&V.

If the rigor discriminators are applied to the M2020 Capability versus Entity (CvE) matrix, the resulting analysis rigor for each software entity is understood. Figure 5 below shows the planned rigor to be applied to each TF for each S/W entity. While the rigor applied to each TF / S/W entity combination is dependent on the capability that it is being applied to, as the rigor discriminators depend on the risk level of the capability, whether the entity is driving versus supporting, and what the planned MSL S/W reuse for that capability is. Given that, the rigor levels (1-5) shown in Figure 5 represent the highest level of rigor (rigor level 1 is the highest) that will be applied to that Capability/ S/W entity combination.

<Redacted>

Figure 4 - M2020 Capability vs. Entity Matrix, with Reuse and MSL IV&V Assessments

Table 3 - M2020 Scope and Rigor Levels

PBRA Rating	MSL Reuse Plan	MSL IV&V Coverage	Planned M2020 Scope and Rigor
Green	All	All	Rigor Level 5: - As needed analysis of the related S/W entities to support Concept Analysis, Interface Analysis, and Scenario Analysis
Yellow	Medium	High	
Yellow	High	All	
Yellow	Medium	Medium	Rigor Level 4: - Q2 and Q3 focused for validation and verification analysis activities, including Scenario and Independent Testing. - Focus on all driving S/W entities, with supporting S/W entities used for Scenario Analysis. -Change Impact on MSL analysis only
Yellow	Low	High	
Yellow	Medium	Low	Rigor Level 3: - Q2 and Q3 focused for validation and verification analysis activities, including Scenario and Independent Testing. - Focus on all driving S/W entities, with supporting S/W entities used for Scenario Analysis. - Change Impact on MSL analysis and augment where necessary.
Yellow	Low	Medium	
Red	Low	High	Rigor Level 2: - Q1, Q2, and Q3 focused for validation and verification analysis activities, including Scenario and Independent Testing. - Focus on all driving S/W entities, with supporting S/W entities used for Scenario Analysis. - Utilize MSL Analysis performed where appropriate and augment when necessary.
Red	Medium	High	
Red	High	Medium	
Red	High	High	
Red	Low	Low	Rigor Level 1: - Q1, Q2, and Q3 focused for validation and verification analysis activities, including Scenario and Independent Testing. - Cover all driving and supporting S/W entities. - Utilize MSL Analysis and work instructions where appropriate.
Red	Low	Medium	
Red	Medium	Low	
Red	Medium	Medium	
Red	High	Low	
Yellow	Low	Low	

<Redacted>

Figure 5 - M2020 Rigor Level per Software Entity, Full Project Lifecycle

Assurance Objectives

The major factor driving the development of goals/objectives for the M2020 IV&V effort in FY16 is the intent to provide assurance that the selected safety-critical and mission-critical M2020 software will operate reliably and safely under nominal and selected off-nominal conditions and that the software will not introduce unintended features. Based off the scope provided by the M2020 CvE matrix in Figure 4 and scope and rigor defined in Table 3, the M2020 IV&V team compiled the M2020 Assurance Objectives from areas covered under Rigor levels one through four.

These Assurance Objectives follow a common path through the M2020 IV&V Initialization products:

- Mission
    - Phase
        - Critical Capability (from PBRA)
            - Software Entity (from RBA)

At any level of the overall objective tree, an analysis level objective can be added. For instance, a mission concept-based objective on the software reuse would be added under the Mission level and a software requirements-based objective would be added under the Software Entity level. In addition to all of this, if the current M2020 Project Integrated Master Schedule (IMS) is added to the Assurance Objectives, the team can apply the knowledge of when analysis level objectives can be worked on and completed. This time-based element is obviously a point in time and would need to be revisited periodically throughout the project lifecycle.

To review the entire collection of M2020 IV&V Assurance Objectives, the document can be found on ECM at this location: <Redacted>

To view a summary of the expected objectives to be met for each FY of the M2020 IV&V efforts, refer to the M2020 IPEP (link provided on page 4.)

Technical Rigor

NOTE: The next three figures describe the full and partial coverage for Technical Framework (TF) planning from beginning to end.

Figure 5, shows the planned TF coverage throughout the planned IV&V analysis activities over the life of the Project.

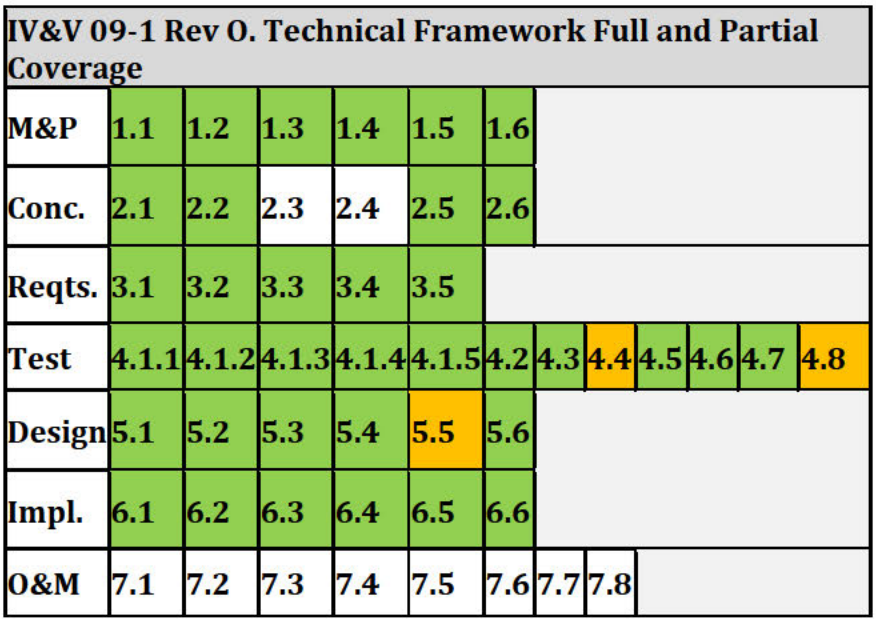

Figure 6 - IV&V 09-1 TF Full and Partial Coverage for IV&V Project per RBA/PBRA over the full Project Lifecycle

TF Coverage Key:

= Full Coverage of TF element

= Partial Coverage of TF element

= TF element not being performed on IV&V Project

Table 4 - TF Full and Partial Coverage Rationale

TF Objectives:	Rationale for non-applicability:
2.3	<Redacted>
2.4	MSL proved the feasibility of the mission.

Figure 6 below shows the completed TF coverage since the inception of the IV&V project.

IV&V 09-1 Rev O. TF Project-to-date Full and Partial Coverage												
M&P	1.1	1.2	1.3	1.4	1.5	1.6						
Conc.	2.1	2.2	2.3	2.4	2.5	2.6						
Reqts.	3.1	3.2	3.3	3.4	3.5							
Test	4.1.1	4.1.2	4.1.3	4.1.4	4.1.5	4.2	4.3	4.4	4.5	4.6	4.7	4.8
Design	5.1	5.2	5.3	5.4	5.5	5.6						
Impl.	6.1	6.2	6.3	6.4	6.5	6.6						
O&M	7.1	7.2	7.3	7.4	7.5	7.6	7.7	7.8				

Figure 7 - TF Coverage Achieved by IV&V Project-to-date

TF Coverage Key:

= Full coverage of TF element completed prior to this FY.

= Partial coverage of TF element completed prior to this FY.

= No work performed on this TF element prior to this FY.

Figure 7 shows the current plans for TF coverage to be achieved during FY16. The TF coverage goals for Implementation and Test are not covered as there is not expected to be any artifacts available for thos areas this fiscal year..

IVV 09-1 Rev O. Full and Partial Coverage for Current Fiscal Year												
M&P	1.1	1.2	1.3	1.4	1.5	1.6						
Conc.	2.1	2.2	2.3	2.4	2.5	2.6						
Reqts.	3.1	3.2	3.3	3.4	3.5							
Test	4.1.1	4.1.2	4.1.3	4.1.4	4.1.5	4.2	4.3	4.4	4.5	4.6	4.7	4.8
Design	5.1	5.2	5.3	5.4	5.5	5.6						
Impl.	6.1	6.2	6.3	6.4	6.5	6.6						
O&M	7.1	7.2	7.3	7.4	7.5	7.6	7.7	7.8				

Figure 8 - Technical Framework for Current Fiscal Year

TF Coverage Key:

= Full coverage of TF element for current FY.

= Partial coverage of TF element for current FY.

= No work to be performed on TF element for current FY.

Activity 1: FY16-01: Determine Applicability of Re-Use Software for Mars 2020

Method:	M-5, Version 1.0 (Current Status: Approved)
Method Title:	Determine Reuse Applicability by Manually Comparing Operational Environments
Method Synopsis	Method that uses manual inspection to determine differences between legacy and intended operational environments, establishes lines of inquiry to assess the impacts of those differences, and evaluates the reuse proposal on the basis of those impacts. When necessary, detailed inspection of the proposed reuse artifacts may also be performed, to address critical reuse suitability concerns.
Subsystem/Entity	Flight System
Required Method Revisions (if any)	There are no method revisions anticipated at this time.
Technical Goal:	2.1 Ensure that software planned for reuse meets the fit, form, and function as a component within the new application.
WBS Coverage:	IVV 9-1 IV&V Technical Framework, Rev N:
Scope:	This analysis will cover all the RBA entities listed under "Spacecraft & Mission Operations" and "Ground" systems. Each of the Spacecraft & Mission Operations has an MSL Functional Design Documents (FDD) associated with it.
Target Artifacts:	<Redacted>
Inputs (includes Technical Reference):	The technical Reference will include heritage documentation from the MSL program: FDDs, and Interface Control Documents (ICDs). Other inputs include: Mars 2020 SRR/MDR presentation package, JPL, Held October 30, 2014 Mars 2020 PDR1, Planned for 2015.09.15 NASA IV&V Mars 2020 Heritage Review Artifacts
Prerequisites:	To perform this analysis, IV&V will require the Project's assessment on planned reuse by module.
Success Criteria:	1. Confirmation that all software planned for reuse meets the requirements of being a component of the Mars 2020 program. 2. Confirmation that the reuse software interfaces correctly with the Mars 2020 software 3. Confirmation that the reuse software does not introduce any unwarranted or unneeded capabilities to

	the Mars 2020 software. 4. Confirmation that the reuse software does not propagate any errors from the heritage code to the Mars 2020 Flight software.
Activity Assumptions:	We are assuming that the RBA entities listed under "Scope" all have tried and tested MSL flight software associated with them.
Rationale for Approach:	This method is operational and has been utilized by several of our IV&V team members in the past. No other viable options for meeting this technical goal were identified, since method M-5 is the only method identified for performing this function.
Concerns:	All target artifacts have not yet been released to the IV&V program, so timing of release could be an issue.
Method Application Notes: Recommend using analysis templates that were developed for TF 2.0 by another IV&V program (SLS), but which are expected to be applicable to the Mars 2020 program as well.	
Required Tools:	MS Office (Excel, Word) RESOLVE
Empirical Evidence:	Answers to reuse questions for each module along with assessment and rationale for assessment For input/output analysis, evidence is lists of inputs and outputs or interface contracts with assessment of each item
Output (include updates to Project Technical Reference):	Completed analysis spreadsheet, documenting the determination that the "Reuse is valid", "Reuse is not valid", or that "Further Analysis is needed", along with associated rationales. Issues derived from analysis submitted as Technical Issue Memoranda (TIMs) An analysis report that will include metrics from the analysis, and will be uploaded to the TR
Basis of Estimate:	See Mars 2020 IV&V FY16 Schedule
Other:	Assurance Objective: 1.11, 2.8, 3.11

Activity 2: FY16-02: Analyze Software-Based Hazard Causes, Contributors and Controls for Mars 2020

Method:	M-109, Version 1.0 (Current Status: Approved)
Method Title:	Verify System Software Safety Documentation Identifies all known software based hazard causes and controls by inspection of Adverse Conditions/Failure Modes
Method Synopsis	This method provides a systematic approach to analyze (and document) the software safety of a system by identifying safety hazards where software is a cause or control of a safety hazard. This analysis can be done on the system as a whole, or on a targeted (focused) part of the system (as determined by risk/criticality assessment). Ensure all known hazards that threaten the safety of the system (as they relate to software) are properly understood and well-documented.
Subsystem/Entity	Project System; Flight System; Payload System
Required Method Revisions (if any)	No revisions are anticipated for this method.
Technical Goal:	2.5 Ensure that known software based hazard causes, contributors, and controls are identified and documented.
WBS Coverage:	IVV 09-1 IV&V Technical Framework, Rev O:
Scope:	The analysis will cover each entity given in the Mars 2020 RBA. This will include the “Instruments”, "Spacecraft & Mission Operations" and "Ground" software architecture.
Target Artifacts:	1. Failure Modes Effects Analysis (FMEA - produced by the project), 2. Other available Fault management documentation (i.e. SPF, FTA, FMECA, PHA)
Inputs (includes Technical Reference):	<Redacted> Mars 2020 SRR/MDR presentation package, JPL, Held October 30, 2014 Mars 2020 PDR1, Planned for 2015.09.15 Mars 2020 PDR2, Planned for 2015.12.01 References: - Flight Software Safety or Criticality Analysis (produced by the project), - NASA Software Safety Guidebook (NASA-GB-8719.13)

	- NASA Software Safety Standard (NASA-STD 8719.13C) - Project Software Management Plan - Project Systems Safety Plan (if available)
Prerequisites:	IV&V has performed a PBRA/RBA All Target and Input artifacts are available and mature (enough) for analysis at current phase in mission
Success Criteria:	1. Confirmation that all identified hazards have either been mitigated or that a mitigation plan is in place for that hazard. 2. Confirmation that all identified hazards have been documented and are well-understood by the community. 3. Confirmation that all identified MSL hazards have not been propagated to the Mars 2020 program, but if so, that a mitigation plan is in effect.
Activity Assumptions:	Since a great deal of the software being planned for this program is heritage software, we must assume that all hazard reports from MSL may still be relevant to the Mars 2020 program. This will provide us with a good starting point to our analysis. The exception to this may be related to any hazards the new instruments may cause.
Rationale for Approach:	This method is operational and has been utilized by several of our IV&V team members in the past. Other viable options for meeting this technical goal were identified, but M-109 was chosen because all other options relied on tools or documentation not currently available.
Concerns:	All target artifacts have not yet been released to the IV&V program, so timing of release could be an issue.

Method Application Notes:
Recommend using analysis templates that were developed for TF 2.5 by another IV&V program, but which are expected to be applicable to the Mars 2020 program as well. Additionally, the SSO team has developed templates for hazard analysis and they should be evaluated for this activity.

The IV&V Adverse Conditions and FMEA Failure Modes are used to ensure that all identified failures that correspond to safety hazards have associated hazard controls and that the hazard controls are in fact managed by the project design via verification. Some failures may only correspond to mission critical cases which occur beyond Spacecraft separation. These maybe considered out of scope for this task. Mission Critical Cases will be identified for M2020 using FMEA (triggers, responses), Hazard Reports, CONOPS; These cases will be assessed for TF 3.5.

Required Tools:	MS Office (Excel, Word) RESOLVE

Empirical Evidence:	1. Consistencies between Technical References and the target artifacts. 1a. List of evaluation criteria based on NASA Software Safety Guidebook that are compliant with project target artifacts 1b. List of IV&V expected software based causes, contributors, and controls that are identified in project target artifacts 1c. Identified Adverse Conditions that include safety critical triggers or responses that correlate to identified software causes and controls of a safety hazard (define all known software causes and controls) 2. Inconsistencies between Technical References and the target artifacts. 2a. List of evaluation criteria based on NASA Software Safety Guidebook that are not compliant with project target artifacts 2b. List of expected software based hazard causes, contributors and controls from the Technical Reference not identified and documented in the target artifacts. 2c. Identified Adverse Conditions that include safety critical triggers or responses that do not correlate to identified software causes and controls of a safety hazard (deficiencies of missing software causes, controls of a safety hazard)
Output (include updates to Project Technical Reference):	Completed analysis spreadsheet An M2020 Adverse Condition List Issues derived from analysis submitted as Technical Issue Memoranda (TIMs) An analysis report that will include metrics from the analysis, and will be uploaded to the TR
Basis of Estimate:	See Mars 2020 IV&V FY16 Schedule
Other:	Assurance Objective: 1.14, 2.11, 3.14

Activity 3: FY16-03: Perform Assessment of Security Threats, Risks and Preventative Measures for the M2020 Project

Method:	M-52, Version 1.0 (Current Status: Approved)
Method Title:	Validate System Security Categorization and Regulatory Security Requirements by Inspection using Security Risk Management Framework (NIST-SP-800-37, Step 1)
Method Synopsis	Verify system categorization is appropriate for selection of Security Controls and validate security requirements meet system needs
Subsystem/Entity	<Redacted>
Required Method Revisions (if any)	
Technical Goal:	2.6: Ensure that security threats and risks are known and documented and that relevant regulatory requirements are identified. <Redacted>
WBS Coverage:	IVV 9-1 IV&V Technical Framework, Rev O: WBS 2.6 is partially addressed with this method and wholly addressed when combined with the "Verify Security Controls" Method addressing NIST SP 800-37 RMF Step 2.
Scope:	In accordance with the PBRA definitions and resulting Project Assurance Objectives, this effort is in focus.
Target Artifacts:	<Redacted>
Inputs (includes Technical Reference):	Apply checklists provided in NIST SP 800-37 RMF Task 1-2 to verify completeness of the Information System description
Prerequisites:	Analyst should be familiar with: NIST SP 800-37, Risk Mgt Framework (RMF) Step 1, Categorize Information System FIPS Pub 199 , Standards for Security Categorization of Federal Information and information systems NIST SP 800-59, Guideline for Identifying an Information System as a National Security System NIST SP 800-60, Guide for mapping types of Information and Information Systems to Security Categories NASA ITS-HBK 2810.x series
Success Criteria:	Designation of possible external risks/threats and evidence collected showing the M2020 Project's plan to address them. A plan for IV&V assessment of the determined risks/threats through the life-cycle of the project.

Activity Assumptions:	<Redacted>
Rationale for Approach:	This approach has been and is used successfully by other projects.
Concerns:	Getting access to all necessary artifacts as the Project will likely be cautious with providing this data to IV&V.
Method Application Notes: None	
Required Tools:	MS Office (Excel, Word) RESOLVE Analyst should Apply the guidance described in the following sources to determine whether the system is correctly categorized: NIST SP 800-37, Risk Mgt Framework (RMF) Step 1, Categorize Information System FIPS Pub 199 , Standards for Security Categorization of Federal Information and information systems NIST SP 800-59, Guideline for Identifying an Information System as a National Security System NIST SP 800-60, Guide for mapping types of Information and Information Systems to Security Categories
Empirical Evidence:	The IV&V Team will generate independent assessments for the security categorization of the systems as supported by the system descriptions. The IV&V Team will demonstrate traceability of applicable federal and organizational regulatory security requirements to the system security plan.
Output (include updates to Project Technical Reference):	IV&V Findings, evidence collected and stored, assurance statement(s), risk assessments. Mars 2020 Project Security Analysis Report
Basis of Estimate:	See Mars 2020 IV&V FY16 Schedule
Other:	Assurance Objectives: 4.2

Activity 4: FY16-04: Validate Systems Level Requirements for Mars 2020

Method:	M-2, Version 1.3 (Current Status: Approved)
Method Title:	Validate Requirements by Inspecting Against Quality Criteria and System/Software Background Artifacts
Method Synopsis	Method for tool-supported manual inspection of a set of requirements to assess and document the degree to which they individually and collectively exhibit desired quality attributes (Unambiguous, Verifiable, Consistent, Correct, Complete, Design Independent, and Feasible). Use documents that inform the validation target to insure that the requirements are complete and correct.
Subsystem/Entity	Flight System; Payload System
Required Method Revisions (if any)	This activity will concentrate on providing assurance against TF goals 3.1 (Fully) and 3.4 (Partial). TF3.4 is only addressed to the level that the system level requirements address interfaces. No Software requirements will be analyzed using this activity; they will be addressed in another activity.
Technical Goal:	3.1 (Full) Ensure that the system requirements are of high quality and are consistent with acquirer needs as they relate to the system's software. (IVV 09-1 Rev N) 3.4 (Partial) Ensure that the requirements for software interfaces with hardware, user, operator, and other systems are adequate to meet the needs of the system with respect to expectations of its customer and users, operational environment, dependability and fault tolerance, and both functional and non-functional perspectives. (IVV 09-1 Rev N)
WBS Coverage:	IVV 9-1 IV&V Technical Framework, Rev N: 3.1(F), 3.4(P)
Scope:	All Level 2 and Level 3 Requirements associated with the entities given in the Mars 2020 RBA that are in scope for this activity
Target Artifacts:	Required Artifacts: <Redacted>
Inputs (includes Technical Reference):	Technical Reference will need to be developed to align the in-scope requirements with the critical capabilities from the PBRA and the S/W entities from the RBA. <Redacted>
Prerequisites:	Delivery of all appropriate requirements documentation at Level 2 and Level 3.

Success Criteria:	- Confirmation that all in-scope L2 and L3 requirements are of high quality and are consistent with mission needs and that any identification of defects in the requirements is identified. - Confirmation that all in-scope L2 and L3 requirements completely address the IV&V critical capabilities and that any identification of missing requirements are identified in TIMs - Confirmation that the L2 and L3 requirements are consistent with the IV&V PBRA/RBA artifacts and that no missing capabilities or entities are missing from the PBRA/RBA
Activity Assumptions:	There are no assumptions that had to be made in order to perform this task, outside of the usual assumption that all Level 2 and Level 3 requirements documents will be made available to NASA IV&V.
Rationale for Approach:	This method has been used successfully by many other projects, and is very mature. It will allow for NASA IV&V to achieve the Technical Framework goals and objectives for TF 3.1. In addition, the NASA IV&V owner of this method is a member of the Mars 2020 team.
Concerns:	
Method Application Notes: The method is straightforward and specific M2020-based worksheets have been developed for this task. While this method's effectiveness is largely a function of the analyst(s) performing it, it can nevertheless be applied in a relatively short time period to provide valuable feedback to a mission project Other methods may need to be applied to garner additional rigor and confidence in the correctness, completeness, and overall consistency of the requirements	
Required Tools:	ATS MS Office (Excel, Word) RESOLVE
Empirical Evidence:	Engineering worksheets (or database) documenting the results of the assessment of the quality attributes for each requirement and conclusions about the completeness and correctness of the set(s) of analyzed requirements. Evidence must include an indication that each requirement was examined for every qualitative attribute (i.e. correctness, completeness, etc.) and the version of the requirements that was assessed.

Output (include updates to Project Technical Reference):	The analysis worksheets used to document the work performed on each requirements document analyzed should be available as outputs for this activity, and a list of Technical Issue Memorandums (TIMs) that came about because of this analysis. In addition, an Activity Report that includes metrics, and results of the analysis shall be provided as output. Additionally, evaluation of the configuration management of the requirements will need to be performed as a summary to this task to better understand if any CM risks are starting to materialize.
Basis of Estimate:	See Mars 2020 IV&V FY16 Schedule
Other:	Assurance Objectives: 1.15, 2.12, 3.15

Activity 5: FY16-05: Validate Requirements by Performing Bi-Directional Traces for Mars 2020

Method:	M-3, Version 1.3 (Current Status: Approved)
Method Title:	Validate Requirements by Inspecting Bidirectional Traces
Method Synopsis	Method for tool-supported manual inspection of a set of requirements to assess and document the degree to which they adequately specify a logical decomposition of the parent requirements, and any functional allocations identified by the developer. This method addresses the integrity of the requirements structure, and identifies faults in correctness, completeness, consistency, and bi-directional tracing of parent to child requirements.
Subsystem/Entity	Project System; Flight System; Payload System
Required Method Revisions (if any)	No method revisions are anticipated.
Technical Goal:	Assess the quality of the requirements (set) and the degree to which they adequately specify a logical decomposition of the parent requirements Technical Goal 3.1: Ensure that the system requirements are of high quality and are consistent with acquirer needs as they relate to the system's software. (Partial) (IVV 09-1 Rev O) Technical Goal 3.2: Ensure that all (in-scope) parent requirements are represented in the appropriate child requirements and that the child requirements do not introduce capability that is not required. (IVV 09-1 Rev O) Technical Goal 3.3: Ensure that the software requirements are of high quality and adequately meet the needs of the system with respect to expectations of its customer and users, operational environment, and both functional and non-functional perspectives. (Partial) (IVV 09-1 Rev O)
WBS Coverage:	IVV 9-1 IV&V Technical Framework, Rev O
Scope:	Bi-directional traces must be performed on all Level 2 through Level 5 requirement sets (and Level 6 as necessary) for each in-focus entity represented in the Mars 2020 RBA
Target Artifacts:	<Redacted>

Inputs (includes Technical Reference):	- Requirement traces developed by the Mission Project - Additional Reference Artifacts to understand the requirements to be assessed, including IV&V Project Technical Reference - Technical references created from TF3.1 and TF3.3 analysis tasks will be input for this task. - Capabilities defined to level of analysis (PBRA, RBA) [focus] Higher level documents: <Redacted>
Prerequisites:	Requirements and developer provided traces loaded into traceability tool (spreadsheet / analysis tool)
Success Criteria:	- Confirmation that all requirements are correctly trace to the applicable parent requirement(s) and the applicable child requirement(s) and that no orphan children or parents result - Confirmation that the set of requirements needed to implement the IV&V critical capabilities are either missing requirements or that extraneous requirements are present. - Confirmation that all technical issues arising from the traceability analysis have been satisfactorily resolved
Activity Assumptions:	The major assumption is that the appropriate Level 1 through Level 5 (and possibly Level 6) requirements documentation is made available to NASA IV&V in a timely fashion.
Rationale for Approach:	This method has been used extensively by NASA IV&V on a wide variety of programs. This method is sufficient for achieving the goal and objectives of TF 3.2.
Concerns:	Requirements documents within the scope of this activity may not be available to NASA IV&V in a timely fashion. In addition to that, if the developer's traceability matrices are not included in the body of the requirements, then there is a concern that they will also not be available to NASA IV&V in a timely fashion.
Method Application Notes: Application of this method is straightforward, and should not require any program specific instructions.	
Required Tools:	ATS MS Office (Excel, Word) RESOLVE
Empirical Evidence:	Completeness/correctness/consistency status in

	engineering worksheets (or analysis tools) for each requirement, list of orphans, list of childless parents
Output (include updates to Project Technical Reference):	Analysis worksheets used to conduct bi-directional tracing; list of issues (TIMs) identified as a result of this analysis; Activity Report containing metrics and results.
Basis of Estimate:	See Mars 2020 IV&V FY16 Schedule
Other:	Assurance Objectives: 1.15, 2.12, 3.15, 1.3.1, 1.3.2, 1.3.3, 1.3.4, 1.3.5, 1.3.6, 1.3.7, 1.4.1, 1.4.2, 1.4.3, 1.4.4, 1.4.5, 1.4.6, 1.4.7, 1.4.8, 1.4.9, 1.4.10, 1.4.11, 1.4.12, 1.4.13, 1.4.14, 1.4.15, 1.4.16, 1.4.17, 1.4.18, 1.4.19, 1.4.20, 1.4.21, 1.4.22, 1.4.23, 1.4.24, 1.4.25, 1.4.26, 1.7.1, 1.9.1, 1.9.2, 1.9.3, 1.9.4, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, 2.2.7, 2.2.8, 2.2.9, 2.2.10, 2.2.11, 2.2.12, 2.2.13, 2.2.14, 2.3.1, 2.3.2, 2.3.3, 2.3.4, 2.3.5, 2.3.6, 2.3.7, 2.3.8, 2.3.9, 2.3.10, 2.3.11, 2.3.12, 2.3.13, 2.3.14, 2.3.15, 2.3.16, 2.3.17, 2.3.18, 2.3.19, 2.7.1, 2.7.2, 2.7.3, 2.7.4, 2.7.5, 2.7.6, 2.7.7, 2.7.8, 2.7.9, 2.7.10, 2.7.11, 2.7.12, 2.7.13, 2.7.14, 2.7.15, 2.7.16, 2.7.17, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.1.7, 3.1.8, 3.1.9, 3.1.10, 3.1.11, 3.1.12, 3.2.1, 3.2.2, 3.2.3, 3.2.4, 3.2.5, 3.2.6, 3.2.7, 3.2.8, 3.2.9, 3.2.10, 3.2.11, 3.2.12, 3.2.13, 3.2.14, 3.2.15, 3.2.16, 3.2.17, 3.2.18, 3.2.19, 3.2.20, 3.3.1, 3.3.2, 3.3.3, 3.3.4, 3.3.5, 3.3.6, 3.3.7, 3.3.8, 3.3.9, 3.3.10, 3.3.11, 3.3.12, 3.3.13, 3.3.14, 3.3.15, 3.3.16, 3.3.17, 3.3.18, 3.3.19, 3.3.20, 3.3.21, 3.3.22, 3.3.23, 3.3.24, 3.3.25, 3.3.26, 3.3.27, 3.3.28, 3.3.29, 3.3.30, 3.3.31, 3.3.32, 3.3.33, 3.5.1, 3.5.2, 3.5.3, 3.5.4, 3.5.5, 3.5.6, 3.5.7, 3.6.1, 3.7.1, 3.7.2, 3.7.3, 3.7.4, 3.7.5, 3.7.6, 3.7.7, 3.7.8, 3.7.9, 3.7.10, 3.7.11, 3.7.12, 3.7.13, 3.7.14, 3.7.15, 3.8.1, 3.8.2, 3.8.3, 3.8.4, 3.8.5, 3.8.6, 3.9.1, 3.9.2, 3.9.3, 3.9.4, 3.9.5, 3.9.6, 3.10.1, 3.10.2, 3.10.3, 3.10.4, 3.10.5, 3.10.6, 3.10.7, 3.10.8, 3.10.9, 3.10.10, 3.10.11, 3.10.12, 3.10.13, 3.10.14, 3.10.15, 3.10.16, 3.10.17, 3.10.18

Activity 6: FY16-06: Validate Interface Requirements for Mars 2020

Method:	M-70, Version 1.0 (Current Status: Approved)
Method Title:	Validate System Interface Requirements by Inspection Against Documentation
Method Synopsis	This method was written to facilitate the system interface analysis of the Interface Control Document (ICD) deliverables. It provides the general method used to perform interface analysis by inspecting the ICDs to provide an assessment to obtain mission and safety evidence based on the Evidence-Based Assurance process and document results in the project Technical Reference (TR) worksheet / Access Database IV&V Analysis tool used for this method.
Subsystem/Entity	<Redacted>
Required Method Revisions (if any)	No revisions for this method are anticipated.
Technical Goal:	3.4 Ensure that the requirements for software interfaces with hardware, user, operator, and other systems are adequate to meet the needs of the system with respect to expectations of its customer and users, operational environment, dependability and fault tolerance, and both functional and non-functional perspectives. Verify and validate the requirement interfaces with hardware, users, operators, software, and other systems for correctness, consistency, completeness, accuracy, and testability. Correctness - Validate that the external and internal interface requirements are in the context of system requirements. Consistency - Verify that the interface requirements are consistent interface specifications for the system components and services. Completeness - Verify that each interface is described and includes data format and performance criteria (e.g., timing, bandwidth, accuracy, safety, and security). Accuracy - Verify that each interface provides information with the required accuracy. Testability - Verify that there are objective acceptance

	criteria for validating the interface requirements. Using the available artifacts and the TR / Access Database IV&V Analysis tool to produce data and knowledge evidence, the analyst will assess the quality goodness of the requirement interfaces based on the '3 Questions' and their required capabilities. Also, the assessment will evaluate the degree to which they deviate from the TR / Access Database IV&V Analysis tool, and the degree to which they comply with general best practices.
WBS Coverage:	IVV 9-1 IV&V Technical Framework, Rev O: Sub-section 3.4 of the 3.0 Verify and Validate Requirements section:
Scope:	All Interface Requirements associated with the entities given in the Mars 2020 RBA are in focus for this activity.
Target Artifacts:	<Redacted>
Inputs (includes Technical Reference):	Technical Reference (TR) Model, Evidence-Based Assurance Guidance Document, Major System Use Cases, Subsystem Use Cases and approved ICDs (see Target Artifacts). <Redacted>
Prerequisites:	IEEE Standard 1012™-2012 for System and Software Verification and Validation; Safety critical or Software Class A by using NPR 7150.2 Software Engineering Requirements; NASA STD-8739.9 (Software Assurance Standard with safety criticality as the highest criteria); NASA-STD-8719.13B Software Safety Standard.
Success Criteria:	- Confirmation that all in-scope ICD requirements are of high quality and are consistent with mission needs and that any identification of defects in the requirements is identified. - Confirmation that all in-scope ICD requirements completely address the IV&V critical capabilities and that any identification of missing requirements are identified in TIMs - Confirmation that the ICD requirements are consistent with the IV&V PBRA/RBA artifacts and that no missing capabilities or entities are missing from the PBRA/RBA
Activity Assumptions:	The assumption must be made that all relevant ICD's are made available to NASA IV&V in a timely fashion.
Rationale for Approach:	This method has been used with good results before by many NASA IV&V programs. The method is sufficient to

	achieve the goals and objectives of TF 3.5.
Concerns:	<Redacted>
Method Application Notes: The method is straightforward and does not require additional, M2020 specific instructions.	
Required Tools:	ATS MS Office (Excel, Word) RESOLVE
Empirical Evidence:	1. Provide evidence that the current release of the system interface requirements meets the current system nominal behavior (Q1). Also, provide evidence that the system interface requirements prevent adnominal behavior (Q2) and handle adverse conditions (Q3). 2. All required services are specified in coherently organized interfaces assigned to components which either provide or require those interfaces. 3. All the services in the provided interfaces are actually required by some component to perform a required behavior. That is to say, the interface requirements are not in support of unauthorized functionality. 4. All data types for input and output (return) parameters in the services of provided and required interfaces are adequately and consistently defined. 5. All protocols for security and service invocation at system interfaces are consistently and adequately specified, and consistent with supporting required behaviors in which the components participate.
Output (include updates to Project Technical Reference):	The analysis worksheets used to document the work performed on each requirements document analyzed should be available as outputs for this activity, and a list of Technical Issue Memoranda (TIMs) that came about because of this analysis. In addition, an Activity Report that includes metrics, and results of the analysis shall be provided as output.
Basis of Estimate:	See Mars 2020 IV&V FY16 Schedule
Other:	Assurance Objectives: 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9, 1.10, 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9, 3.10

Activity 7: FY16-07: Validate Software Level Requirements for Mars 2020

Method:	M-2, Version 1.3 (Current Status: Approved)
Method Title:	Validate Requirements by Inspecting Against Quality Criteria and System/Software Background Artifacts
Method Synopsis	Method for tool-supported manual inspection of a set of requirements to assess and document the degree to which they individually and collectively exhibit desired quality attributes (Unambiguous, Verifiable, Consistent, Correct, Complete, Design Independent, Feasible). Use documents that inform the validation target to insure that the requirements are complete and correct.
Subsystem/Entity	Flight System; Payload System
Required Method Revisions (if any)	This activity will concentrate on providing assurance against TF goals 3.3 (Fully) and 3.4 (Partial). TF3.4 is only addressed to the level that the software level requirements address interfaces. No System requirements will be analyzed using this activity; they will be addressed in another activity.
Technical Goal:	3.3 (Full) Ensure that the software requirements are of high quality and adequately meet the needs of the system with respect to expectations of its customer and users, operational environment, and both functional and non-functional perspectives. (IVV 09-1 Rev N) 3.4 (Partial) Ensure that the requirements for software interfaces with hardware, user, operator, and other systems are adequate to meet the needs of the system with respect to expectations of its customer and users, operational environment, dependability and fault tolerance, and both functional and non-functional perspectives. (IVV 09-1 Rev N)
WBS Coverage:	IVV 9-1 IV&V Technical Framework, Rev N: 3.3(F), 3.4(P)
Scope:	All Level 4 and Level 5 Requirements associated with the entities given in the Mars 2020 RBA that are in scope for this activity.
Target Artifacts:	Required Artifacts: <Redacted>
Inputs (includes Technical Reference):	Needs, Goals and Objectives document, opsCon, trades, and any other additional background materials to understand the requirements to be assessed.

	Higher level documents: <Redacted>
Prerequisites:	Delivery of all appropriate requirements documentation at Level 4 and Level 5.
Success Criteria:	- Confirmation that all in-scope L4, L5, and L6 requirements are of high quality and are consistent with mission needs and that any identification of defects in the requirements is identified. - Confirmation that all in-scope L4, L5, and L6 requirements completely address the IV&V critical capabilities and that any identification of missing requirements are identified in TIMs - Confirmation that the L4, L5, and L6 requirements are consistent with the IV&V PBRA/RBA artifacts and that no missing capabilities or entities are missing from the PBRA/RBA
Activity Assumptions:	There are no assumptions that had to be made in order to perform this task, outside of the usual assumption that all Level 4 and Level 5 requirements documents will be made available to NASA IV&V.
Rationale for Approach:	This method has been used successfully by many other projects, and is very mature. It will allow for NASA IV&V to achieve the Technical Framework goals and objectives for TF 3.3. In addition, the NASA IV&V owner of this method is a member of the Mars 2020 team.
Concerns:	Timely delivery of the software level requirement to support the IV&V operating schedule.
Method Application Notes: The method is straightforward and does not require additional, M2020 specific instructions. While this method's effectiveness is largely a function of the analyst(s) performing it, it can nevertheless be applied in a relatively short time period to provide valuable feedback to a mission project Other methods may need to be applied to garner additional rigor and confidence in the correctness, completeness, and overall consistency of the requirements	
Required Tools:	ATS MS Office (Excel, Word) RESOLVE
Empirical Evidence:	Engineering worksheets (or database) documenting the results of the assessment of the quality attributes for each requirement and conclusions about the

	completeness and correctness of the set(s) of analyzed requirements. Evidence must include an indication that each requirement was examined for every qualitative attribute (i.e. correctness, completeness, etc.) and the version of the requirements that was assessed.
Output (include updates to Project Technical Reference):	The analysis worksheets used to document the work performed on each requirements document analyzed should be available as outputs for this activity, and a list of Technical Issue Memoranda (TIMs) that came about because of this analysis. In addition, an Activity Report that includes metrics, and results of the analysis shall be provided as output.
Basis of Estimate:	See Mars 2020 IV&V FY16 Schedule
Other:	Assurance Objectives: 1.3.1, 1.3.2, 1.3.3, 1.3.4, 1.3.5, 1.3.6, 1.3.7, 1.4.1, 1.4.2, 1.4.3, 1.4.4, 1.4.5, 1.4.6, 1.4.7, 1.4.8, 1.4.9, 1.4.10, 1.4.11, 1.4.12, 1.4.13, 1.4.14, 1.4.15, 1.4.16, 1.4.17, 1.4.18, 1.4.19, 1.4.20, 1.4.21, 1.4.22, 1.4.23, 1.4.24, 1.4.25, 1.4.26, 1.7.1, 1.9.1, 1.9.2, 1.9.3, 1.9.4, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, 2.2.7, 2.2.8, 2.2.9, 2.2.10, 2.2.11, 2.2.12, 2.2.13, 2.2.14, 2.3.1, 2.3.2, 2.3.3, 2.3.4, 2.3.5, 2.3.6, 2.3.7, 2.3.8, 2.3.9, 2.3.10, 2.3.11, 2.3.12, 2.3.13, 2.3.14, 2.3.15, 2.3.16, 2.3.17, 2.3.18, 2.3.19, 2.7.1, 2.7.2, 2.7.3, 2.7.4, 2.7.5, 2.7.6, 2.7.7, 2.7.8, 2.7.9, 2.7.10, 2.7.11, 2.7.12, 2.7.13, 2.7.14, 2.7.15, 2.7.16, 2.7.17, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.1.7, 3.1.8, 3.1.9, 3.1.10, 3.1.11, 3.1.12, 3.2.1, 3.2.2, 3.2.3, 3.2.4, 3.2.5, 3.2.6, 3.2.7, 3.2.8, 3.2.9, 3.2.10, 3.2.11, 3.2.12, 3.2.13, 3.2.14, 3.2.15, 3.2.16, 3.2.17, 3.2.18, 3.2.19, 3.2.20, 3.3.1, 3.3.2, 3.3.3, 3.3.4, 3.3.5, 3.3.6, 3.3.7, 3.3.8, 3.3.9, 3.3.10, 3.3.11, 3.3.12, 3.3.13, 3.3.14, 3.3.15, 3.3.16, 3.3.17, 3.3.18, 3.3.19, 3.3.20, 3.3.21, 3.3.22, 3.3.23, 3.3.24, 3.3.25, 3.3.26, 3.3.27, 3.3.28, 3.3.29, 3.3.30, 3.3.31, 3.3.32, 3.3.33, 3.5.1, 3.5.2, 3.5.3, 3.5.4, 3.5.5, 3.5.6, 3.5.7, 3.6.1, 3.7.1, 3.7.2, 3.7.3, 3.7.4, 3.7.5, 3.7.6, 3.7.7, 3.7.8, 3.7.9, 3.7.10, 3.7.11, 3.7.12, 3.7.13, 3.7.14, 3.7.15, 3.8.1, 3.8.2, 3.8.3, 3.8.4, 3.8.5, 3.8.6, 3.9.1, 3.9.2, 3.9.3, 3.9.4, 3.9.5, 3.9.6, 3.10.1, 3.10.2, 3.10.3, 3.10.4, 3.10.5, 3.10.6, 3.10.7, 3.10.8, 3.10.9, 3.10.10, 3.10.11, 3.10.12, 3.10.13, 3.10.14, 3.10.15, 3.10.16, 3.10.17, 3.10.18

Activity 8: FY16-08: Validate M2020 Software Requirements by Tracing to Critical Scenarios

Method:	M-7, Version 1.3 (Current Status: Approved)
Method Title:	Validate Requirements by Inspecting Traces to Scenarios
Method Synopsis	Develop and apply operational scenarios that exercise nominal and off-nominal critical behaviors of system components; validate the operational scenarios via manual walk-through exercises; trace requirements to scenarios and determine missing or orphaned requirements; document the correctness and completeness status for each requirement. Also has UML/SRM analysis steps as an additional option.
Subsystem/Entity	Flight System; Payload System
Required Method Revisions (if any)	Critical Scenarios will be created during this activity. TR from the Hazard Analysis will be used to create the scenarios.
Technical Goal:	1. Determine correctness and completeness in the context of the scenario 3.3 Ensure that the software requirements are of high quality and adequately meet the needs of the system with respect to expectations of its customer and users, operational environment, and both functional and non-functional perspectives. 3.4 Ensure that the requirements for software interfaces with hardware, user, operator, and other systems are adequate to meet the needs of the system with respect to expectations of its customer and users, operational environment, dependability and fault tolerance, and both functional and non-functional perspectives. 3.5 Ensure that software requirements meet the dependability and fault tolerance required by the system and provide the capability of controlling identified hazards and do not create hazardous conditions.
WBS Coverage:	IVV 9-1 IV&V Technical Framework, Rev N: 3.3, 3.4, 3.5 (each partial, from the perspective of the scenarios)
Scope:	All Levels 2 through 5 requirements associated with the critical capabilities defined in the M2020 PBRA and the entities given in the Mars 2020 RBA are in focus for this activity.
Target Artifacts:	All Level 5 Software Requirements <Redacted>
Inputs (includes	PBRA/RBA result

Technical Reference):	<Redacted>
Prerequisites:	1. A qualitative assessment of the software requirements has been performed 2. Requirements are correlated to a Technical Reference supporting previous qualitative assessment (i.e. correlated to PBRA mission capabilities, RBA entities, software nominal, preventative, and responsive behaviors) 3. Target and Input artifacts available for analysis
Success Criteria:	Each requirement has been inspected for correctness and completeness against scenarios.
Activity Assumptions:	Analysts have clear understanding of scenarios. SMEs available to answer questions. Scenarios are defined at a useful level of detail.
Rationale for Approach:	For IV&V critical scenarios, the goal is to ensure the proper requirements are documented to drive implementation and support testing analysis and possibly execution later in the lifecycle.
Concerns:	None
Method Application Notes: None	
Required Tools:	ATS MS Office (Excel, Word) RESOLVE
Empirical Evidence:	Completeness/correctness status for each requirement Validated Operational Scenarios Mapping (with rationale) between scenarios and requirements Summary Report describing in-scope behaviors assessed, significant concerns, risks, and all resulting findings. Resolve Issue Entries
Output (include updates to Project Technical Reference):	Requirement Validation Report Update
Basis of Estimate:	See Mars 2020 IV&V FY16 Schedule
Other:	Assurance Objectives: 1.16, 2.13, 3.16

Activity 9: FY16-09: Evaluate Software Design to Ensure that it Meets System Needs, and is Feasible

Method:	M-103, Version 1.0 (Current Status: Approved)
Method Title:	Verify and Validate Requirement Implementation using Flow Diagrams to Uncover Missing, Conflicting, or Unnecessary Behavior
Method Synopsis	Method uses Flow Diagrams to analyze software implementation of requirements to ensure the correct and complete implementation of requirements on a system level as well as an atomic level. (Level is dependent upon the abstraction in the modeling chosen by the analyst as well as the available level of artifacts being targeted). Further, the method is applied to the source code that is not specified by requirements or not specified directly.
Subsystem/Entity	Flight System; Payload System
Required Method Revisions (if any)	This activity will only use this method to address TF5.3 Objectives in this FY.
Technical Goal:	5.3 Ensure that the proposed software architecture satisfies the needs of the system, and that it is a feasible solution (i.e. will successfully satisfy the needs of the system, while still being practical). 1. Gain system/software level understanding 2. Uncover ambiguous or missing behaviors 3. Uncover conflicting or undesired behaviors 4. Uncover failure scenarios (identify whether the FSW is protected against off-nominal/adverse conditions/inputs)
WBS Coverage:	For FY16 analysis, this activity will be focused on IVV 9-1 IV&V Technical Framework, Rev O: TF 5.3 (F)
Scope:	The Mars 2020 RBA identifies the entities to be used in our analysis. Each of these is within focus for this activity.
Target Artifacts:	Mars 2020 PDR1 Package, Planned for 2015.09.15 Mars 2020 PDR2 Package, Planned for 2015.12.01
Inputs (includes Technical Reference):	Applicable Technical Reference (i.e. use case scenarios, critical capability based scenarios) <Redacted> System Requirements Documents Software Requirements Documents Available System Design Documents
Prerequisites:	FY15-02 TS&R Activity regarding examining the Mars

	2020 System Architecture is completed with associated technical references. FSW is not developed using behavior models (uml activity, state, or similar), the models are not of high enough fidelity to analyze code behavior, or the models are not sufficient to provide system level understanding. The process of generating the diagrams can be used to gain system level understanding even when the diagrams duplicate developer products.
Success Criteria:	- Confirmation that proposed software architecture satisfies the needs of the system as identified in the identified in the FY15-02 TS&R activity - Confirmation that proposed software architecture is feasible (i.e. practical for the user's needs) - Confirmation that the software design adequately traces from software architecture - Confirmation that the design does not violate any NASA or IEEE standards.
Activity Assumptions:	All requirements must be validated in order provide up-to-date requirements flowcharts. Design documents are delivered to NASA IV&V in a timely fashion.
Rationale for Approach:	Method M-103 is approved, operational, and is currently being used in other NASA IV&V programs. It has the capability of covering TF 5.3 in an acceptable manner, and will also be very useful for implementation objectives. This means that both requirements and design flowcharts will already be available.
Concerns:	The major concern is whether or not the appropriate documents are made available to NASA IV&V in a timely fashion to support the IV&V operating schedule
Method Application Notes: This method is labor intensive up front, in developing requirements and design flow charts. However, once the flowcharts are created, they may be used (with or without possible modifications or upgrades) repeatedly during the course of the analysis. As mentioned above in the Rationale field, this will also come in handy for the implementation objectives.	
Required Tools:	MagicDraw ATS MS Office (Excel, Word) RESOLVE
Empirical Evidence:	- Control Flow diagrams and corresponding notes capture IV&V analysis, questions, and concerns. -

	"Analysis/Findings Report" - Diagrams show/trace the behaviors and their source - "Coverage Reports." 2) Test/Analysis Scenarios (nominal and off-nominal) derived from flow paths - "Scenario Report"
Output (include updates to Project Technical Reference):	TIMs written to RESOLVE Requirements and Design Flowcharts (created in Visio or some other drawing package) Activity report containing metrics from the analysis and observation from the results of the analysis.
Basis of Estimate:	See Mars 2020 IV&V FY16 Schedule.
Other:	Assurance Objectives: 1.13, 2.10, 3.13

Activity 10: FY16-10: Evaluate Software Design to Ensure that All In-Scope Requirements are Represented in the Design

Method:	M-39, Version 1.3 (Current Status: Approved)
Method Title:	Verify Software Design by Inspecting Traces to Requirements and Software Architecture
Method Synopsis	Method supports manual evaluation of the integrity of the software design to ensure that all requirements are represented in the appropriate elements of the design and that the design does not introduce capability that is not required, and to identify defects in its satisfaction of the software architecture and validated software requirements. Software design documentation is also evaluated to ensure that the design provides the required capability (meeting software architecture and software requirements), is able to reliably meet user needs, and is sufficiently stable to proceed with implementation, and to identify defects in consistency, ambiguity, correctness, completeness, and testability.
Subsystem/Entity	Flight System; Payload System
Required Method Revisions (if any)	This activity will be used to address TF5.2 and TF5.6 for FY16. Any steps in this method that do not apply to TF5.2 and TF5.6 will not be used. The other TFs that this method addresses will be fulfilled using other methods.
Technical Goal:	5.2 Ensure that the design provides the required capability (meeting software architecture and software requirements), is able to reliably meet user needs, and is sufficiently stable to proceed with implementation. 5.6: Ensure that the design provides the dependability and fault tolerance required by the system and that the design is capable of controlling identified hazards and does not create hazardous conditions.
WBS Coverage:	IVV 9-1 IV&V Technical Framework, Rev O: 5.2(P), 5.6(P)
Scope:	The Mars 2020 RBA identifies the entities to be used in this analysis. Each of these is within focus for this activity.
Target Artifacts:	System Design Documents: Mars 2020 PDR1, Planned for 2015.09.15 Mars 2020 PDR2, Planned for 2015.12.01 Software Design Documents: Mars 2020 FSW IRCR, Held 2015.07.28 Mars 2020 FSW PDR, Planned for 2015.10.26

	Mars 2020 Instrument PDRs Mars 2020 FSW wiki
Inputs (includes Technical Reference):	1. Validated software requirements and identified issues and risks. 2. Software Interface Control Documents (ICDs) 3. System Preventative/Responsive Behaviors from project's Technical Reference 4. Adverse Conditions from project's Technical Reference 5. Project-specific evaluation criteria from project's Technical Reference (if applicable) 6. Technical Reference resultant from the 3.5 requirements validation for dependability /fault tolerance 7. IV&V Magic Draw representation of the system architecture 8. Hazard Analysis Artifacts a. Failure Modes Effects Analysis b. Preliminary Hazards Analysis
Prerequisites:	Validation of system and software requirements
Success Criteria:	1. Confirmation that all in-scope requirements are represented in the design. 2. Confirmation that the design elements are appropriate for each requirement tracing to it. 3. Confirmation that the design does not introduce any capability that is not required.
Activity Assumptions:	We must assume that all systems and software requirements that are in-scope have been previously validated. Interface requirements are out-of-scope for this analysis, so will not require validation. All artifacts (systems level and software level requirements documents) must be made available to the NASA IV&V team at the earliest possible time, to ensure that the appropriate validation activities are complete before the beginning of this analysis
Rationale for Approach:	Method M-39 is operational at NASA IV&V, and has been used on several programs. It is the best method available to the M2020 team to accomplish this activity.
Concerns:	The biggest concern is that the required target artifacts will not be made available <Redacted> to NASA IV&V in a timely enough fashion to complete the work in line with the IV&V operating schedule.
Method Application Notes: When tracing design elements back to requirements and/or architecture, it is not	

unreasonable to suspect that quality issues may also arise in the design. These will be written up as part of the TF 5.1 analysis.	
Required Tools:	MagicDraw ATS MS Office (Excel, Word) RESOLVE
Empirical Evidence:	• Engineering worksheets documenting results. The worksheets should include: - the requirements (document, section title, number, description) - traces to design artifacts and identified behaviors (including specific Adverse Conditions considered during the analysis), software dependability and identified hazards. - assessment of the software architecture, software design, and software algorithms with respect to the requirement sets and identified behaviors (including specific Adverse Conditions considered during the analysis) - assessment of the software design with respect to each individual requirement (analyzed across documentation) - assessment of the software design with respect to each identified hazard control (analyzed across documentation) - additional analyst comments as needed to support assessment.
Output (include updates to Project Technical Reference):	Technical issue memoranda (written up in RESOLVE) Analysis worksheets (EXCEL) Activity Report, including metrics achieved, and interpretation of results from worksheets
Basis of Estimate:	See Mars 2020 IV&V FY16 Schedule
Other:	Assurance Objectives: 1.3.1, 1.3.2, 1.3.3, 1.3.4, 1.3.5, 1.3.6, 1.3.7, 1.4.1, 1.4.2, 1.4.3, 1.4.4, 1.4.5, 1.4.6, 1.4.7, 1.4.8, 1.4.9, 1.4.10, 1.4.11, 1.4.12, 1.4.13, 1.4.14, 1.4.15, 1.4.16, 1.4.17, 1.4.18, 1.4.19, 1.4.20, 1.4.21, 1.4.22, 1.4.23, 1.4.24, 1.4.25, 1.4.26, 1.7.1, 1.9.1, 1.9.2, 1.9.3, 1.9.4, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, 2.2.7, 2.2.8, 2.2.9, 2.2.10, 2.2.11, 2.2.12, 2.2.13, 2.2.14, 2.3.1, 2.3.2, 2.3.3, 2.3.4, 2.3.5, 2.3.6, 2.3.7, 2.3.8, 2.3.9, 2.3.10, 2.3.11, 2.3.12, 2.3.13, 2.3.14, 2.3.15, 2.3.16, 2.3.17, 2.3.18, 2.3.19, 2.7.1, 2.7.2, 2.7.3, 2.7.4, 2.7.5, 2.7.6, 2.7.7, 2.7.8, 2.7.9, 2.7.10, 2.7.11, 2.7.12, 2.7.13, 2.7.14, 2.7.15,

	2.7.16, 2.7.17, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.1.7, 3.1.8, 3.1.9, 3.1.10, 3.1.11, 3.1.12, 3.2.1, 3.2.2, 3.2.3, 3.2.4, 3.2.5, 3.2.6, 3.2.7, 3.2.8, 3.2.9, 3.2.10, 3.2.11, 3.2.12, 3.2.13, 3.2.14, 3.2.15, 3.2.16, 3.2.17, 3.2.18, 3.2.19, 3.2.20, 3.3.1, 3.3.2, 3.3.3, 3.3.4, 3.3.5, 3.3.6, 3.3.7, 3.3.8, 3.3.9, 3.3.10, 3.3.11, 3.3.12, 3.3.13, 3.3.14, 3.3.15, 3.3.16, 3.3.17, 3.3.18, 3.3.19, 3.3.20, 3.3.21, 3.3.22, 3.3.23, 3.3.24, 3.3.25, 3.3.26, 3.3.27, 3.3.28, 3.3.29, 3.3.30, 3.3.31, 3.3.32, 3.3.33, 3.5.1, 3.5.2, 3.5.3, 3.5.4, 3.5.5, 3.5.6, 3.5.7, 3.6.1, 3.7.1, 3.7.2, 3.7.3, 3.7.4, 3.7.5, 3.7.6, 3.7.7, 3.7.8, 3.7.9, 3.7.10, 3.7.11, 3.7.12, 3.7.13, 3.7.14, 3.7.15, 3.8.1, 3.8.2, 3.8.3, 3.8.4, 3.8.5, 3.8.6, 3.9.1, 3.9.2, 3.9.3, 3.9.4, 3.9.5, 3.9.6, 3.10.1, 3.10.2, 3.10.3, 3.10.4, 3.10.5, 3.10.6, 3.10.7, 3.10.8, 3.10.9, 3.10.10, 3.10.11, 3.10.12, 3.10.13, 3.10.14, 3.10.15, 3.10.16, 3.10.17, 3.10.18

Activity 11: FY16-11: Validate Interface Design by Analyzing Interface Requirements and Design Artifacts

Method:	M-41, Version 1.1 (Current Status: Approved)
Method Title:	Verify Software Interface Design by Inspection Against Interface Requirements
Method Synopsis	Method supports manual evaluation of the integrity of the software requirements to interface design transformation, and detects defects in hardware/user/operator/software/other systems interface coverage completeness/correctness/accuracy and capability for implementation in software.
Subsystem/Entity	<Redacted>
Required Method Revisions (if any)	None
Technical Goal:	5.1 Ensure that all (in-scope) requirements (e.g. SRS and IRS) are represented in the appropriate elements of the design (e.g. SDD and IDD) and that the design does not introduce capability that is not required. 5.4 Provide Evidence that the assurance goals related to the internal and external software interface designs are adequately achieved for all interfaces with hardware, user, operator, software, and other systems and that they provide sufficient detail to enable the development of software components that implement the interfaces.
WBS Coverage:	For FY16 analysis, this activity will be focused on IVV 9-1 IV&V Technical Framework, Rev O: TF 5.1(P), TF 5.4(F)
Scope:	The Mars 2020 RBA identifies the entities to be used in this analysis. Each of these is within focus for this activity.
Target Artifacts:	ICD Documents: Flight to Ground ICD Launch Vehicle ICD Flight Systems ICDs (including instruments) Level 3 ICDs <Redacted> System Design Documents: <Redacted> Software Design Documents: <Redacted>
Inputs (includes Technical Reference):	List of validated interface requirements and identified issues and risks

	System Architecture Technical Reference Mars 2020 FSW wiki Other High Level Documents: <Redacted>
Prerequisites:	Target and input artifacts are available for analysis Validation of the interface requirements
Success Criteria:	Evidence is provided indicating that the proposed software detailed design adequately satisfies the validated software interface requirements
Activity Assumptions:	None
Rationale for Approach:	This method is operational and has been utilized by several of our IV&V team members in the past. Other methods for 5.4 require modeling inputs for UML or Rational Rose.
Concerns:	None
Method Application Notes: None	
Required Tools:	MagicDraw ATS MS Office (Excel, Word) RESOLVE
Empirical Evidence:	• Engineering worksheets, databases, etc. documenting the results and comments of the requirements to design trace and the design to requirements trace. • TIMs • Risks and findings documented in Interface Design Verification Report
Output (include updates to Project Technical Reference):	TIMs Evidence Software Design Analysis Report
Basis of Estimate:	See Mars 2020 IV&V FY16 Schedule
Other:	Assurance Objectives: 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9, 1.10, 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9, 3.10

Activity 12: FY16-12: Perform Dynamic Analysis of the Critical System Behaviors Utilizing Design Artifacts

Method:	M-40, Version 1.1 (Current Status: Approved)
Method Title:	Validate System Behaviors Dynamically by Executing Simulations/Models
Method Synopsis	Method applies MATLAB/Simulink (or similar continuous/discrete event modeling tool) to assist analysts in gaining system level understanding of component behaviors, uncovering ambiguous or missing behaviors, uncovering conflicting or undesired behaviors, and uncovering failure scenarios.
Subsystem/Entity	Flight System; Payload System
Required Method Revisions (if any)	This activity will be used to address TFs: 3.1(P), 3.3(P), 3.4(P), 3.5(P), 5.2(P), 5.3(P), 5.4(P), 5.5(P), 5.6(P) for FY16. Any steps in this method that do not apply to these TFs will not be used. The other TFs that this method addresses will be fulfilled using other methods.
Technical Goal:	1. Gain system level understanding 2. Uncover ambiguous or missing behaviors 3. Uncover conflicting or undesired behaviors 4. Uncover failure scenarios 3.1 Ensure that the system requirements are of high quality and are consistent with acquirer needs as they relate to the system's software. 3.3 Ensure that the software requirements are of high quality and adequately meet the needs of the system with respect to expectations of its customer and users, operational environment, and both functional and non-functional perspectives. 3.4 Ensure that the requirements for software interfaces with hardware, user, operator, and other systems are adequate to meet the needs of the system with respect to expectations of its customer and users, operational environment, reliability and fault tolerance, and both functional and non-functional perspectives. 3.5 Ensure that software requirements meet the reliability and fault tolerance required by the system and provide the capability of controlling identified hazards and do not create hazardous conditions. 5.2 Ensure that the design provides the required capability (meeting software architecture and software requirements), is able to reliably meet user needs, and is

	sufficiently stable to proceed with implementation. 5.3 Ensure that the proposed software architecture satisfies the needs of the system, and that it is a feasible solution (i.e. will successfully satisfy the needs of the system, while still being practical). 5.4 Ensure that the internal and external software interface designs are provided for all (in-scope) interfaces with hardware, user, operator, software, and other systems and that they provide sufficient detail to enable the development of software components that implement the interfaces. 5.5 Ensure that complex algorithms have been correctly derived, provide the needed behavior under off nominal conditions and assumed conditions, and that the derivation approach is known and understood to support future maintenance. 5.6 Ensure that the design provides the dependability and fault tolerance required by the system and that the design is capable of controlling identified hazards and does not create hazardous conditions.
WBS Coverage:	IVV 09-1 IV&V Technical Framework, Rev O: 3.1(P), 3.3(P), 3.4(P), 3.5(P), 5.2(P), 5.3(P), 5.4(P), 5.5(P), 5.6(P)
Scope:	The Mars 2020 RBA identifies the entities to be used in this analysis.
Target Artifacts:	System Design Documents: Mars 2020 PDR1, Planned for 2015.09.15 Mars 2020 PDR2, Planned for 2015.12.01 Software Design Documents: Mars 2020 FSW IRCR, Held 2015.07.28 Mars 2020 FSW PDR, Planned for 2015.10.26 Mars 2020 Instrument PDRs Mars 2020 FSW wiki
Inputs (includes Technical Reference):	1. System Level Specifications 2. System or Software Artifacts to be analyzed 3. Detailed System Schematic (optional - increases model fidelity) 4. As-Run Test Results (optional - increases model fidelity) 5. Source Code (optional - increases model cohesion with actual code) 6. Technical Reference of the System Architecture in MagicDraw
Prerequisites:	Subject matter expert is available or system

	understanding is sufficient for modeling.
Success Criteria:	Each focus critical capability has been assessed against the system/software design and shown to either be adequately addressed in the design or the deficiencies have been identified
Activity Assumptions:	None
Rationale for Approach:	This method has been proven to provide assurance for other IV&V projects. It will also provide the M2020 team with a testable system model to help in overall understanding of the mission and operations.
Concerns:	Adequate design artifacts not being available to perform this task. Also requires a program investment to identify a usable platform.
Method Application Notes: The method itself identifies how the analysis is to be completed. Part of the task for M2020 will be to also develop a model on an acceptable platform and define the associated scenarios that need to be exercised on it.	
Required Tools:	A 3D simulation package that supports ground based movement with appropriate contact constraints over terrain. ATS MS Office (Excel, Word) RESOLVE
Empirical Evidence:	Evidence Based Assurance covered by the following empirical evidence: 1. Behavior deficiencies (ambiguous, incomplete, missing, conflicting) uncovered during modeling and analysis 2. Simulation inputs and outputs (describing scenarios/paths of execution)
Output (include updates to Project Technical Reference):	Output will include data logs or reports from the simulation tool Issues Enhance Technical Reference Models of the Rover
Basis of Estimate:	See Mars 2020 IV&V FY16 Schedule
Other:	Assurance Objectives: 1.3.1, 1.3.2, 1.3.3, 1.3.4, 1.3.5, 1.3.6, 1.3.7, 1.4.1, 1.4.2, 1.4.3, 1.4.4, 1.4.5, 1.4.6, 1.4.7, 1.4.8, 1.4.9, 1.4.10, 1.4.11, 1.4.12, 1.4.13, 1.4.14, 1.4.15, 1.4.16, 1.4.17, 1.4.18, 1.4.19, 1.4.20, 1.4.21, 1.4.22, 1.4.23, 1.4.24, 1.4.25, 1.4.26, 1.7.1, 1.9.1, 1.9.2, 1.9.3, 1.9.4, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, 2.2.7, 2.2.8, 2.2.9, 2.2.10, 2.2.11, 2.2.12, 2.2.13, 2.2.14, 2.3.1, 2.3.2, 2.3.3, 2.3.4, 2.3.5, 2.3.6, 2.3.7, 2.3.8, 2.3.9, 2.3.10, 2.3.11, 2.3.12, 2.3.13, 2.3.14, 2.3.15, 2.3.16, 2.3.17, 2.3.18,

	2.3.19, 2.7.1, 2.7.2, 2.7.3, 2.7.4, 2.7.5, 2.7.6, 2.7.7, 2.7.8, 2.7.9, 2.7.10, 2.7.11, 2.7.12, 2.7.13, 2.7.14, 2.7.15, 2.7.16, 2.7.17, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.1.7, 3.1.8, 3.1.9, 3.1.10, 3.1.11, 3.1.12, 3.2.1, 3.2.2, 3.2.3, 3.2.4, 3.2.5, 3.2.6, 3.2.7, 3.2.8, 3.2.9, 3.2.10, 3.2.11, 3.2.12, 3.2.13, 3.2.14, 3.2.15, 3.2.16, 3.2.17, 3.2.18, 3.2.19, 3.2.20, 3.3.1, 3.3.2, 3.3.3, 3.3.4, 3.3.5, 3.3.6, 3.3.7, 3.3.8, 3.3.9, 3.3.10, 3.3.11, 3.3.12, 3.3.13, 3.3.14, 3.3.15, 3.3.16, 3.3.17, 3.3.18, 3.3.19, 3.3.20, 3.3.21, 3.3.22, 3.3.23, 3.3.24, 3.3.25, 3.3.26, 3.3.27, 3.3.28, 3.3.29, 3.3.30, 3.3.31, 3.3.32, 3.3.33, 3.5.1, 3.5.2, 3.5.3, 3.5.4, 3.5.5, 3.5.6, 3.5.7, 3.6.1, 3.7.1, 3.7.2, 3.7.3, 3.7.4, 3.7.5, 3.7.6, 3.7.7, 3.7.8, 3.7.9, 3.7.10, 3.7.11, 3.7.12, 3.7.13, 3.7.14, 3.7.15, 3.8.1, 3.8.2, 3.8.3, 3.8.4, 3.8.5, 3.8.6, 3.9.1, 3.9.2, 3.9.3, 3.9.4, 3.9.5, 3.9.6, 3.10.1, 3.10.2, 3.10.3, 3.10.4, 3.10.5, 3.10.6, 3.10.7, 3.10.8, 3.10.9, 3.10.10, 3.10.11, 3.10.12, 3.10.13, 3.10.14, 3.10.15, 3.10.16, 3.10.17, 3.10.18

Activity 13: FY16-13: Perform Independent Testing of Critical Capabilities via WSTS for M2020

Method:	M-14, Version 1.2 (Current Status: Approved)
Method Title:	Verify Software Behavior for Off-Nominal Conditions using Independent Testing
Method Synopsis	This method provides an approach for testing software behavior for IV&V Q2 (software will not do what it is not supposed to do) and Q3 (software behaves adequately under adverse conditions). Test scripts are independently created and executed within the IV&V Test environment.
Subsystem/Entity	Flight System; Payload System
Required Method Revisions (if any)	For FY16, this activity will focus on the development of a test strategy and test plan, as well as development of scenarios that will be explored via Independent Testing. Out years will focus on the implementation of the test plan into test scripts/procedures and execution on the test bed, provided that access is available to IV&V.
Technical Goal:	6.2 Ensure that the source code components can reliably perform required capabilities under nominal and off-nominal conditions, perform no undesired behaviors, and that the documentation (both embedded and stand-alone) can facilitate code maintenance. (Partial) 6.3 Ensure that the source code that interfaces with hardware, user, operator, software, and other systems reliably provides the right services and data and receives data for internal use. (Partial) 6.5 Ensure that the source code components provide the dependability and fault tolerance required by the system and that the source code is capable of controlling identified hazards and does not create hazardous conditions. (Partial) Notes: • The method is designed to verify the TF goal 6.2 partially, i.e., it verifies that the software can perform reliably under off-nominal conditions (IV&V Q3) and does not produce undesired behavior (IV&V Q2) • Depending on the software behaviors tested, this method provides partial coverage of TF 6.3 and 6.5. If interfaces are involved, then TF 6.3 could receive

	coverage and to a limited extent testing the Q2/Q3 aspects could ensure the software implements proper fault tolerance (TF 6.5).
WBS Coverage:	IVV 09-1 IV&V Technical Framework, Rev O
Scope:	The Mars 2020 RBA identifies the entities to be focused on in this analysis.
Target Artifacts:	<Redacted>
Inputs (includes Technical Reference):	• Technical Reference • Developer Test Artifacts (Test Plan, Test Scenarios, Test Procedures) • Requirements • Requirements Traceability Matrix • Interface Control Documents (ICDs) • Source Code
Prerequisites:	Software under test (source preferred but binary required), validated IV&V Test Environment
Success Criteria:	Completed testing of the resulting Test Procedure on all assigned builds
Activity Assumptions:	Assumptions will be built into the test plans, cases and procedures.
Rationale for Approach:	Independent Testing utilizes the WSTS to perform scenario based testing as well as execution of developer's verification and validation procedures. Testing is prioritized based on risk assessment of the scenarios and the capability of the WSTS.
Concerns:	IV&V access to the WSTS platform has not yet been approved by the Project. Independent Testing will likely not be an option if that access is not granted.
Method Application Notes: None	
Required Tools:	WSTS Platform ATS MS Office (Excel, Word) RESOLVE
Empirical Evidence:	• Analysis of IV&V's Test Results/Log Files captured in worksheet or database which objectively shows the software will operate correctly under the off-nominal conditions
Output (include updates to Project Technical Reference):	Output expectations will be built into the test plans, cases and procedures.
Basis of Estimate:	See Mars 2020 IV&V FY16 Schedule
Other:	Assurance Objectives: 1.3.1, 1.3.2, 1.3.3, 1.3.4, 1.3.5, 1.3.6, 1.3.7, 1.4.1, 1.4.2, 1.4.3, 1.4.4, 1.4.5, 1.4.6, 1.4.7,

	1.4.8, 1.4.9, 1.4.10, 1.4.11, 1.4.12, 1.4.13, 1.4.14, 1.4.15, 1.4.16, 1.4.17, 1.4.18, 1.4.19, 1.4.20, 1.4.21, 1.4.22, 1.4.23, 1.4.24, 1.4.25, 1.4.26, 1.7.1, 1.9.1, 1.9.2, 1.9.3, 1.9.4, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, 2.2.7, 2.2.8, 2.2.9, 2.2.10, 2.2.11, 2.2.12, 2.2.13, 2.2.14, 2.3.1, 2.3.2, 2.3.3, 2.3.4, 2.3.5, 2.3.6, 2.3.7, 2.3.8, 2.3.9, 2.3.10, 2.3.11, 2.3.12, 2.3.13, 2.3.14, 2.3.15, 2.3.16, 2.3.17, 2.3.18, 2.3.19, 2.7.1, 2.7.2, 2.7.3, 2.7.4, 2.7.5, 2.7.6, 2.7.7, 2.7.8, 2.7.9, 2.7.10, 2.7.11, 2.7.12, 2.7.13, 2.7.14, 2.7.15, 2.7.16, 2.7.17, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.1.7, 3.1.8, 3.1.9, 3.1.10, 3.1.11, 3.1.12, 3.2.1, 3.2.2, 3.2.3, 3.2.4, 3.2.5, 3.2.6, 3.2.7, 3.2.8, 3.2.9, 3.2.10, 3.2.11, 3.2.12, 3.2.13, 3.2.14, 3.2.15, 3.2.16, 3.2.17, 3.2.18, 3.2.19, 3.2.20, 3.3.1, 3.3.2, 3.3.3, 3.3.4, 3.3.5, 3.3.6, 3.3.7, 3.3.8, 3.3.9, 3.3.10, 3.3.11, 3.3.12, 3.3.13, 3.3.14, 3.3.15, 3.3.16, 3.3.17, 3.3.18, 3.3.19, 3.3.20, 3.3.21, 3.3.22, 3.3.23, 3.3.24, 3.3.25, 3.3.26, 3.3.27, 3.3.28, 3.3.29, 3.3.30, 3.3.31, 3.3.32, 3.3.33, 3.5.1, 3.5.2, 3.5.3, 3.5.4, 3.5.5, 3.5.6, 3.5.7, 3.6.1, 3.7.1, 3.7.2, 3.7.3, 3.7.4, 3.7.5, 3.7.6, 3.7.7, 3.7.8, 3.7.9, 3.7.10, 3.7.11, 3.7.12, 3.7.13, 3.7.14, 3.7.15, 3.8.1, 3.8.2, 3.8.3, 3.8.4, 3.8.5, 3.8.6, 3.9.1, 3.9.2, 3.9.3, 3.9.4, 3.9.5, 3.9.6, 3.10.1, 3.10.2, 3.10.3, 3.10.4, 3.10.5, 3.10.6, 3.10.7, 3.10.8, 3.10.9, 3.10.10, 3.10.11, 3.10.12, 3.10.13, 3.10.14, 3.10.15, 3.10.16, 3.10.17, 3.10.18

Appendix A: Acronyms

Acronym:	Description:
CY	Calendar Year
CvE	Capabilities versus Entities
CDR	Critical Design Review
ECM	Enterprise Content Management
FSW	Flight Software
FDD	Functional Design Document
IV&V	Independent Verification and Validation
ICD	Interface Control Document
IMS	Integrated Master Schedule
IPEP	IV&V Project Execution Plan
KDP	Key Decision Point
M2020	Mars 2020
MSL	Mars Science Laboratory
PBRA	Portfolio Bases Risk Assessment
PSR	Pre-Ship Review
RBA	Risk Based Assessment
SCS	Sample Collection System
SIR	Systems Integration Review
TF	Technical Framework
TIM	Technical Issue Memorandum
TQ&E	Technical Quality and Excellence
TS&R	Technical Scope and Rigor