

**MARS 2020**  
**Independent Verification and Validation (IV&V)**  
**Project Execution Plan (IPEP)**  
**Full Project Lifecycle**  
**Version 1.2**

## IV&V PROJECT EXECUTION PLAN

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### **1 Introduction**

#### **1.1 Document Organization**

The IPEP is divided into two major parts: the body of the document and its appendices. The sections within the document body focus generically on the “rules of engagement” that will be followed by the IV&V Team and the Mars 2020 Project over the course of the Project lifecycle. Specifically, it includes the basic tenets for an agreement between the IV&V Team and the Project, including the roles and responsibilities, communications paths, and artifacts anticipated to be shared between the organizations. It is expected that this data is rather static and, once agreed upon, will not change much, if at all.

The second part of the document, the appendices, focuses more on the fiscal year activities for the IV&V efforts. The appendices contain data that are more dynamic in nature and are expected to change over the course of the Project’s lifecycle. The appendices include the results of the IV&V Heritage Review, IV&V Portfolio Based Risk Assessment (PBRA) data and subsequent Risk Based Assessments (RBA), focus of IV&V effort, and detailed information for each planned execution year (including items such as IV&V goals/objectives, required resources, schedule, and risks).

From this point forward, the Mars 2020 Project will be referred to as “the Project.”

#### **1.2 Document Purpose**

The purpose of this IPEP is two-fold. First, it is to communicate IV&V interactions, interfaces, roles and responsibilities, technical products, and reporting methods with the Project. Second, the IPEP serves as the operational document for the IV&V efforts. The IPEP is prepared and maintained by the IV&V Project Manager (PM). The IV&V PM coordinates the creation and maintenance of this document with affected individuals and organizations (within the NASA IV&V Program as well as with the Project).

In signing the document, the Mars 2020 IV&V Point of Contact understands that their concurrence signature reflects the agreements identified within the body of the document, excluding the appendices, and the Mars 2020 Project Manager understands that their concurrence signature reflects the agreements identified within Section 3.3 only. Signatures of NASA IV&V personnel reflect their understanding of the entire document, appendices included.

This IPEP will be in effect from the signing thereof until completion of the IV&V efforts for the Project or until terminated at the request of the NASA IV&V Program or the Project.

### **1.3 Intended Audience**

The intended audience of this document includes entities within the NASA IV&V Program as well as within the Project. Entities within the NASA IV&V Program include the NASA IV&V Program Manager and IV&V Office Management. Entities within the Project that this IPEP is intended for include the Project Manager, IV&V Point of Contact (i.e. – PSSE), and the Mission Assurance Manager (MAM).

## 2 IV&V Overview

### 2.1 IV&V Goals and Objectives

The IV&V Team will conduct independent, verification and validation analyses to ascertain “goodness of product” for the Project’s system software. Validation-related analysis will allow the IV&V Team to evaluate Project development artifacts to ensure that the “right behaviors” have been defined in the artifacts. “Goodness of product” and the “right behaviors” are those attributes, features and qualities that adequately describe what the system is supposed to do, what the system is not supposed to do, and what the system is supposed to do under adverse conditions. These attributes, features and qualities address the NASA IV&V Three-Questions of the project’s mission software defined in the NASA IV&V System Level Procedure (SLP) [IV&V 09-1](#), *Independent Verification and Validation Technical Framework*. The validation-related analysis performed will strive to ensure that the system software performs to the user’s needs under operational conditions. Verification-related analysis will allow the IV&V Team to determine whether the products of each development activity fulfill the requirements or conditions imposed by a previous development activity.

### 2.2 IV&V Approach

The IV&V Team functions technically, managerially, and financially independent of the Project. The IV&V approach will consist of validation- and verification-related analysis. Validation and verification are described further below, including the artifacts generally required for specific analysis objectives. For additional information regarding verification- and validation -related analyses, see SLP [IV&V 09-1](#), *Independent Verification and Validation Technical Framework*.

#### 2.2.1 Verification and Validation

Specific analyses that the IV&V Team may perform includes verification and validation of: Concept Documentation, Requirements Documentation, Design Documentation, Test Documentation, Implementation Artifacts, and Operations and Maintenance Content. The IV&V Team may also perform independent testing that may use simulators, test environments, and/or other test systems provided by either the IV&V Program or the Project.

Examples of artifacts the IV&V Team needs to accomplish these analyses are depicted in Table 2-1. For the IV&V efforts, the IV&V Team anticipates that these artifacts are necessary to support verification-and-validation related analyses. In the event that any of these artifacts cannot be provided to the IV&V team, and/or the IV&V analyses are required to be performed on-site at the development organization, the IV&V PM and the IV&V POC will closely coordinate impacts to the technical work as well as cost and schedule. The IV&V team does not drive or mandate the creation of specific software artifacts, but will work with available information and content in most formats, as long as the artifacts provided includes the data

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necessary to verify and validate the developer's software, and to draw credible assurance conclusions on the software's mission suitability.

Results of the verification and validation will serve as a basis for assessing the goodness of the Project software in terms of the capabilities delineated in the IV&V PBRA Results. These capabilities are assessed with respect to the Project's mission success criteria and the software's ability to perform and/or support expected system/software behaviors.

The typical outputs of the V&V related analyses will include requirements analysis reports, test design analysis reports, build analysis reports, and issues and risks. Refer to Section 4 of this document for additional information on these products.

**Table 2-1: Project Targeted Verification & Validation Artifacts**

Artifact Name	Need/Applicable Analysis
Operations Concept Document/Data	Verify and Validate Concept Documentation
Early concept/design review documentation/data	Verify and Validate Concept Documentation
Heritage Analysis / Reuse Plans	Verify and Validate Concept Documentation
Hazard Analyses (PHA, FTAs, FMECA, etc.)	Verify and Validate Concept / Verify and Validate Requirements / Verify and Validate Test Documentation
Project Software Management Plan	Verify and Validate Concept / Verify and Validate Requirements / Verify and Validate Test Documentation / Verify and Implementation
FSW Software Management Plan	Verify and Validate Concept / Verify and Validate Requirements / Verify and Validate Test Documentation / Verify and Implementation
Level 1 requirements	Verify and Validate Requirements
Mission Requirements Document	Verify and Validate Requirements
Spacecraft Element Requirements Document	Verify and Validate Requirements
Software Requirements Document	Verify and Validate Requirements
Interface Requirements Documents	Verify and Validate Requirements
Traceability Related Data (L2 – L6, showing traceability between the various levels of system/software requirements)	Verify and Validate Requirements / Verify and Validate Test Documentation
Command and Telemetry Dictionary	Verify and Validate Requirements / Verify and Validate Test Documentation / Verify and Validate Implementation
Fault Protection Monitor and Response Dictionary	Verify and Validate Requirements / Verify and Validate Test Documentation / Verify and Validate Implementation
System Test Plan	Verify and Validate Test Documentation
System Test Cases / Procedures	Verify and Validate Test Documentation

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Artifact Name	Need/Applicable Analysis
Build Level Test Plan	Verify and Validate Test Documentation
Build Level Test Cases / Procedures	Verify and Validate Test Documentation
Integration Test Plans	Verify and Validate Test Documentation
Integration Test Cases / Procedures	Verify and Validate Test Documentation
Software Unit Level Tests	Verify and Validate Test Documentation
Traceability related data (showing traceability from requirements to test cases)	Verify and Validate Test Documentation
FSW Architecture Description Documentation	Verify and Validate Design
Functional Design Documentation	Verify and Validate Design
Interface Control Documentation	Verify and Validate Design
Software Design Documentation	Verify and Validate Design
Software Design Models / State Charts	Verify and Validate Design
Source Code	Verify and Validate Implementation
Software Build delivery/release packages/Version Description documentation/data	Verify and Validate Implementation
Test results (at varying levels including build level, integration level and system level)	Verify and Validate Test Documentation
Discrepancy reports from test activities	Verify and Validate Test Documentation
Traceability related data (showing traceability from requirements to design – to code to test)	Verify and Validate Test Documentation
Test Scripts	Verify and Validate Implementation
Compile and build procedures	Verify and Validate Implementation

### 2.3 IV&V Focus

As part of Software Assurance, IV&V plays an important role in the overall software risk mitigation strategy applied throughout the entire software lifecycle to improve the safety and quality of software systems. To understand the risk profile, the IV&V team performs assessments of software risks on Mission Projects. These assessments meet two objectives:

1. Create a portfolio to support prioritization of technical scope across all IV&V projects, and
2. Create a mission-specific view to support planning and scoping of IV&V Project work on each individual IV&V Project.

The IV&V Team uses a two phase process to support both of these objectives. Phase-One, known as Portfolio Based Risk Assessment (PBRA), supports objective 1 while Phase-Two, known as Risk Based Assessment (RBA), supports objective 2.

For Phase-One, the IV&V Team utilizes the PBRA process as the means to prioritize and optimize IV&V resources. The PBRA process assesses the top-level capabilities of the system, for which software contributes, in terms of impact of a limitation (defect) and likelihood of a limitation. The result of this assessment is an overall rating for each capability that is mapped

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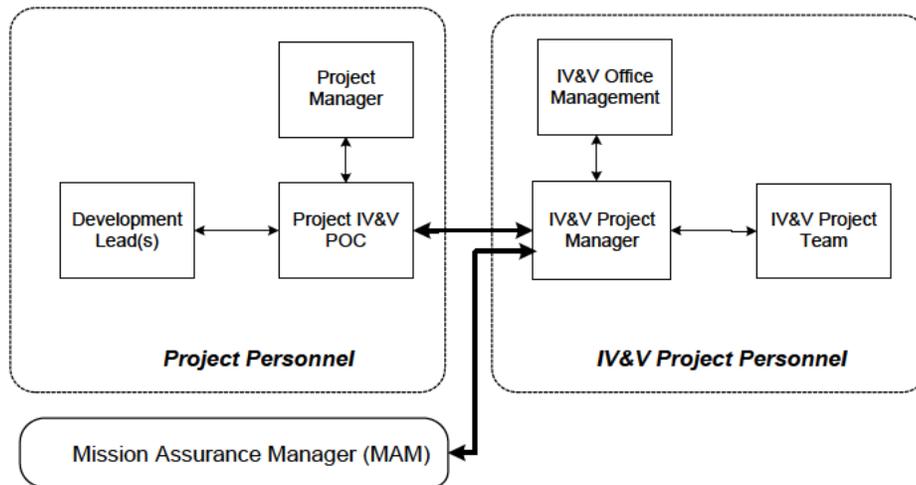
against a 5x5 risk matrix used to prioritize the IV&V efforts across the NASA IV&V Program as well as within a particular IV&V Project.

For Phase-Two, The RBA process is used for planning and scoping the IV&V Project. The updated entity-to-capability mapping produced by this phase provides a view of the system that serves as a useful tool for discussing and deciding where to apply IV&V effort.

The IV&V Team will share PBRA/RBA results/assessment ratings with Project and Agency stakeholders. Input and feedback on this data from the Project is encouraged. The IV&V Team will revisit the PBRA/RBA results and assessment ratings for the Project every six months (or more frequently, if warranted), and any changes to this data will be communicated to the Project. PBRA and RBA results for these IV&V efforts are contained in Appendix A and Appendix B, respectively. For additional information on the PBRA/RBA process, see [S3106, \*PBRA and RBA Process\*](#).

### 3 Roles, Responsibilities and Interfaces

To facilitate successful execution of the IV&V efforts as described in this plan, various roles, responsibilities, and interfaces are maintained. These roles and responsibilities can be described in terms of personnel within the NASA IV&V Program and personnel within the Project. The subsections below describe these roles and responsibilities. Figure 3-1 depicts the interfaces associated with these roles.



**Figure 3-1 – IV&V Team and Project Interfaces**

#### 3.1 IV&V Program

##### 3.1.1 Research Support

The NASA IV&V Program conducts research in various areas that directly contribute to the effectiveness of IV&V. NASA IV&V researchers require actual Project data to accomplish realistic research. All Project data will be closely protected and not released outside the NASA IV&V Program and its research contractors. No proprietary or export-controlled Project data will be used to support NASA IV&V research unless there is a non-disclosure agreement in place between the NASA IV&V researchers and the owner of the proprietary data. Any such authorized use of Project data will be in compliance with all United States export control laws and regulations. The Project agrees that non-proprietary; non-export-controlled, non-SBU Project data may be used to support software IV&V-related research. The NASA IV&V Program agrees that any related research will not affect Project or subcontractor personnel or resources. The NASA IV&V Program agrees not to publish or allow publication of any research document that can be referenced back to the Project without specific, prior written approval of the Project PM.

##### 3.1.2 IV&V Metrics Support

The NASA IV&V Program strives to ascertain the value and effectiveness of the IV&V efforts. Some of these efforts require the comparison of software issues (discrepancies) identified by IV&V and software issues identified by the Project, as well as ascertaining post-launch software anomalies. The IV&V Team may request data from the Project in support of these efforts. The Project, subject to the IV&V POC's discretion, will provide access to the data, or the actual data necessary to support these efforts. The IV&V PM will work with the IV&V POC to identify the specific data of interest, but it is expected that this data will be of the following nature:

- (a) Software issues: description of the software issues identified by the developers, including issue type, phase introduced, phase found, relevant Computer Software Configuration Item (CSCI), severity of issue, and efforts to fix if available and
- (b) Post-launch software anomalies: description of the software issue, overall impact, relevant CSCI, root cause/contributing cause, associated fix/resolution to the defect/anomaly.

Access to the data can be in the form of access to Project/developer problem reporting systems, post-launch anomaly tracking systems or via periodic reports delivered to the IV&V PM. Any access to existing systems would be on a non-interfering basis to minimize impact to the Project.

### **3.2 IV&V Team**

Primarily, the IV&V Team consists of an IV&V PM and an analyst group.

The IV&V PM serves as the primary interface with the Project in support of the IV&V efforts. The IV&V PM is responsible for the overall leadership and direction of the IV&V efforts. The IV&V PM is responsible for establishing the goals and objectives of the IV&V efforts, performing the PBRA and subsequent RBAs, performing project management, tracking and oversight, and conducting risk management of the IV&V efforts. The IV&V PM is responsible for ensuring that the commitments with the Project as defined in this plan are met.

In addition, the IV&V Team is supported by IV&V analysts that perform verification - and validation -related analysis. At times and at the request/direction of the IV&V PM, the IV&V analyst(s) may interface with the Project. The interaction of IV&V analyst(s) with the Project is not depicted in Figure 3-1 as this only occurs on as-needed basis.

### **3.3 Project Personnel**

#### **3.3.1 IV&V POC**

The Project will provide an IV&V POC for formal interactions between the Software IV&V Team and the Project. The Project Software Systems Engineer (PSSE), reporting to the Mars 2020 Project Systems Engineer, is designated as the IV&V POC. The PSSE will facilitate the

IV&V tasks to be performed through coordination between all M2020 Project personnel including Project's Safety and Mission Assurance (SMA) personnel, and the IV&V Project Manager. Project personnel will only be directly accessible on a non-interfering basis to minimize impact to the Project.

### **3.3.2 IV&V Artifacts and Electronic Access**

The Project would make available to IV&V all FSW releases as they are released from FSW Integration Testing (FIT) and would include all source code and makefiles in the tarball so that they can build for full code analysis, if desired. The Project will provide the IV&V Team read access to the JPL Large File Transfer that will provide the capability for the secure file downloads of flight software source code and makefiles in the tarball.

The Project will provide the IV&V Team read access to the M2020 FSW Confluence space that will provide the single repository of flight software development folders, software release information, and test plans. This access will only be necessary after the Mars 2020 FSW development team begins code development.

The Project will provide the IV&V Team read/write access to the M2020 FSW JIRA database that will provide the capability to maintain the current and final state of each TIM and the fix. This access will only be necessary after the Mars 2020 FSW development team begins the TIM resolution process. The Project will enter the accepted TIMs into a Mars2020 FSW JIRA Database. The Project will provide the IV&V Team read/write access to the FSW JIRA Database. IV&V will verify the completed fix and will change its status to "Verified" in FSW JIRA Database and "Closed" in IV&V TIM Database, if IV&V agrees with the fix.

IV&V will identify IV&V artifacts from the Mars2020 Product Deliverable List and will submit the IV&V artifact request via email and include the document name, document id (if known), and a brief description of the purpose of the request. The Project will provide the IV&V team read access to a Project's Docushare IV&V drop-box. The Project will provide the configuration managed (CM) released version of all agreed to documents in the Docushare IV&V drop-box. Upon the receipt of IV&V's request for any additional documents, the PSSE will work with the document owner to determine the acceptance or reject of the request and, if applicable, the appropriate date to release to the IV&V Team.

### **3.3.3 IV&V TIM Resolution**

The Project, through the PSSE, is responsible for working with the IV&V Team to resolve issues/risks identified by the IV&V Team. Issues of severity rating 1-3 require a formal disposition/response by the Project and must be verified to have been addressed prior to closure. Issues of severity rating 4 also require a formal disposition/response by the project, but do not require a formal resolution and confirmation thereof. Issues of severity rating 5 may be reviewed

by the Project, but do not require a formal response/resolution. Resolving severity rating 4 and 5 issues, nonetheless, will certainly improve the quality of the Project’s software and reduce or eliminate risks associated with maintenance of the software product.

**3.3.4 IV&V Research Support**

The Project, through the IV&V POC, will support the research and metrics support related initiatives on a non-interfering basis to minimize impact to the Project.

**3.3.5 Future Discussion**

Availability and utilization of the Mars2020 Workstation Test Set (WSTS), DOORS NG, and DMS by IV&V personnel will be discussed further in future years.

**3.3.6 Contact Information**

For these IV&V efforts, applicable contact information is identified in Tables 3-1 and 3-2 below.

**Table 3-1 – IV&V Team Contact Information**

<b>NASA IV&amp;V Program</b>		
<b>Position</b>	<b>Name</b>	<b>Contact Information</b>
IV&V Director	Gregory Blaney	304-367-8387 <a href="mailto:Gregory.D.Blaney@nasa.gov">Gregory.D.Blaney@nasa.gov</a>
IV&V Deputy Director	Ken Vorndran	304-367-8247 <a href="mailto:Kenneth.A.Vorndran@nasa.gov">Kenneth.A.Vorndran@nasa.gov</a>
IV&V Associate Director	Marcus Fisher	304.367.8337 <a href="mailto:Marcus.S.Fisher@nasa.gov">Marcus.S.Fisher@nasa.gov</a>
IV&V Office Lead	Wesley Deadrick	304-367-8329 <a href="mailto:Wesley.W.Deadrick@nasa.gov">Wesley.W.Deadrick@nasa.gov</a>
IV&V Project Manager	Ricky Forquer	304-367-8256 <a href="mailto:Ricky.A.Forquer@nasa.gov">Ricky.A.Forquer@nasa.gov</a>

**Table 3-2 – Project Contact Information**

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<b>Project</b>		
<b>Position/Role</b>	<b>Name</b>	<b>Contact Information</b>
Mars 2020 Project Manager	John McNamee	818-393-7879 <a href="mailto:John.B.Mcnamee@jpl.nasa.gov">John.B.Mcnamee@jpl.nasa.gov</a>
IV&V Point of Contact	Jane Oh	818-354-0705 <a href="mailto:Jane.C.Oh@jpl.nasa.gov">Jane.C.Oh@jpl.nasa.gov</a>
Mission Assurance Manager (MAM)	Randy Blue	818-354-9795 <a href="mailto:Randel.C.Blue@jpl.nasa.gov">Randel.C.Blue@jpl.nasa.gov</a>

**4 IV&V Products and Communication/Reporting Methods**

The IV&V Team generates various products and utilizes various communication/reporting methods throughout the lifecycle. The subsections below describe the IV&V products and associated communication/reporting methods further.

**4.1 IV&V Products**

**4.1.1 Analysis Reports**

Over the course of the lifecycle, the IV&V Team may generate analysis reports that document the results of the analyses performed. These reports will typically describe what the IV&V Team analyzed (Project artifacts), a high-level description of the process/approach and tools used (if applicable), and associated results. The IV&V Team will forward the analysis reports to the Project as defined in Appendices G - L for each fiscal year.

**Table 4-1: IV&V Analysis Reports**

Product Name	Recipient
Software Requirements Analysis Reports	IV&V POC
Software Design Analysis Reports	IV&V POC
Software Build Analysis Reports	IV&V POC
Software Test Analysis Reports	IV&V POC

**4.1.2 Lifecycle Review Support**

Throughout the lifecycle, the IV&V Team supports formal Project lifecycle/milestone reviews (e.g., the Preliminary Design Review [PDR], etc.) by providing information that portrays the status of IV&V efforts, including overall goodness of product data, at the time of the review. At a minimum, and as required by the NASA Agency’s Chief SMA Officer, the IV&V Team will present status of the IV&V efforts and associated recommendations at the Safety and Mission Success Review (SMSR).

**4.1.3 Issues**

An issue (aka, Technical Issue Memorandum, TIM) is a type of output from an IV&V analysis task. An issue documents one or more instances of a defect identified within a development artifact. IV&V formally communicates issues to the Project. Each issue has a documented impact and is assigned a severity rating between 1 (highest severity) and 5 (lowest severity) as defined in Table 4-2 below. Issues of severity rating 1-3 require a formal disposition/response

by the Project and must be verified to have been addressed prior to closure. Issues of severity rating 4 also require a formal disposition/response by the project, but do not require a formal resolution and confirmation thereof. Issues of severity rating 5 may be reviewed by the Project, but do not require a formal response/resolution. Resolving severity rating 4 and 5 issues, nonetheless, will certainly improve the quality of the Project's software and reduce or eliminate risks associated with maintenance of the software product.

*Issue Resolution Path:* The Project will review the issue data as provided by the IV&V Team. If the Project concurs that the issue is legitimate, the Project will propose a solution. When the project identifies that they plan to fix the issue, the issue will be put in a "To Be Verified" state. Subsequent to the proposed solution being made, the Project will notify the IV&V Team that the corrective action has been made and will provide the appropriate evidence (e.g., updated development artifacts, etc.) to the IV&V Team for verification and subsequent closure of the issue. If verification of the corrective action cannot be completed, the IV&V Team will request additional feedback/data from the Project.

If there is a dispute at any time in the issue resolution process, the issue may be placed in an "In Dispute" state, at which time the Project and IV&V Team can continue dialog on the issue. Subsequent to these discussions, the issue may be withdrawn, placed in the "Project Accepts Risk" state, or it may be reverted to the "To Be Verified" state.

If the Project does not concur that the limitation described in the issue is legitimate, the Project will provide appropriate data and/or explanation to support this conclusion. The IV&V Team will review and consider this data and if the IV&V Team is in agreement, the issue will be withdrawn. If the IV&V Team is not in agreement, additional dialog and discussion between the Project and IV&V Team may be required and an appropriate course of action will be determined.

**Table 4-2: Issue Severity Rating and Description<sup>1</sup>**

Severity	Capability Affected	Success Criteria	Safety	Test	Cost & Schedule	Other
<b>1</b> <b>Catastrophic</b>	Loss of an essential capability  OR  Complete loss of mission critical asset	Inability to achieve minimum mission success criteria	Causes loss of life or injury	N/A	N/A	N/A
<b>2</b> <b>Critical</b>	Degradation of an essential capability  OR  Damage/destruction to mission asset which affects performance	Impact to the accomplishment of a mission objective	N/A	Essential capability not tested	Significant cost increases or schedule slip	Significant reduction to requirements margins or design margins
<b>3</b> <b>Moderate</b>	Degradation of system dependability  OR  Loss of a non-essential capability	Impact to the accomplishment of extended/ optional mission objectives	N/A	Essential capability inadequately tested	Cost or schedule impact resulting from redesign, reimplementation, and/or retest	Degradation of an essential capability or inability to accomplish mission objective, but with a known workaround
<b>4</b> <b>Minor</b>	Degradation of a non-essential capability	N/A	N/A	Non-essential capability inadequately tested	Defect impacting maintainability on current mission or reuse on future missions	Creates inconvenience for operators, crew or other projects' personnel
<b>5</b> <b>Communications</b>  <b>Or Editorial</b>	Defect impacting documentation and communication clarity					

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<sup>1</sup> Source: [S3105, Guidelines for Writing IV&V TIMs](#)

### 4.1.4 Risks

By conducting IV&V analysis, simple routine awareness, and/or interactions over the course of the lifecycle, the IV&V Team may become aware of circumstances or data points that represent a potential undesirable event for the Project. The IV&V Team will document such items as risks and will formally communicate these risks to the Project. The IV&V Team will assess all risks based on the likelihood and consequence of the undesired event using the Project's likelihood and consequence ranking criteria (as defined in the Project's risk management plan). The IV&V Team may also provide recommendations to eliminate, reduce, or mitigate the risks. The IV&V Team will coordinate all risks with the Project prior to formal submission. To facilitate the submission of risks, the IV&V Team may request access to the Project's Risk Management System (RMS) or repository, and the IV&V Team and IV&V POC will work together to determine the appropriate level of access (e.g., read-only, write, none) to the RMS/repository.

Typically, Projects retain residual risks throughout the lifecycle. As such, the IV&V Team may choose to assess the Project's residual risks. At minimum, and as required by the Chief SMA Officer, the IV&V Team will evaluate residual risk data as provided by the Project in preparation for the SMSR. The IV&V Team will communicate their stance with regards to such residual risk data to the Project prior to the SMSR.

*Risk Resolution Path:* The Project will review risks as provided by the IV&V PM. If the Project agrees with the nature of the risk they may choose to take ownership of the risk. Subsequently, the Project will document/capture the risk and associated mitigation plan(s) in the Project's RMS. It is expected that the Project actively manages, tracks, and mitigates such risk. The IV&V Team will monitor the progress or lack thereof of these activities until the risk is closed. This monitoring may be performed independently or via the Project providing status data to the IV&V Team. If the IV&V Team determines that the risk is not being actively managed, the IV&V Team will discuss this with the Project IV&V POC and determine an appropriate course of action.

If the Project decides not to accept, mitigate, and manage a risk, the Project will provide appropriate data and/or explanation to support this conclusion. The IV&V Team will review/consider this data and if the IV&V Team is in agreement, they will withdraw the risk. If the IV&V Team is not in agreement, additional dialog/discussion between the Project and IV&V Team may be required and an appropriate course of action will be determined.

### 4.1.5 Item Tracking/Monitoring and Escalation

All data such as issues and risks are recorded and provided to the Project as they are identified and/or as per an agreed-to schedule. The IV&V Team will evaluate Project feedback/response to this data and update the status of this data in terms of tracking towards closure/resolution in the appropriate data repository at the NASA IV&V Facility. In addition, this "goodness of product" data will be documented in other IV&V products including but not limited to lifecycle review presentations, analysis reports and recurring/ad hoc status reports as applicable.

Given the reporting data mentioned above, any areas of disagreement regarding this data that cannot be resolved between the IV&V Team and the Project within an appropriate period, the IV&V PM will elevate the issue to IV&V Office Management. The IV&V PM will ensure that the Project is aware that the issue is being elevated. The final level of resolution will be the Program Management Council (PMC) responsible for the Project.

**4.2 IV&V Communication and Reporting Methods**

Communications and reporting methods between the IV&V Team and the Project occur in both formal and informal fashion. Formal communication and reporting methods include delivery/receipt of IV&V analysis reports and associated technical data, IV&V briefings at lifecycle reviews and associated forums, and dialog between the IV&V Team and Project regarding scope, priorities, access to resources, etc. consistent with the data in this plan. Informal communications and reporting methods include recurring telecons and tag-ups between the IV&V Team and Project IV&V POC, requests for and provision of development artifacts, technical discussion on IV&V analysis results and dialog/exchange of relevant data to facilitate resolution of IV&V issues and risks.

**4.2.1 Lifecycle Reviews**

The IV&V PM will provide IV&V status data and associated results/conclusions of the IV&V efforts prior to various Project lifecycle/milestone reviews as defined in the appendices for each fiscal year, as appropriate.

**4.2.2 Agency/Mission Directorate/Center Management Briefings**

Throughout the course of the lifecycle, the IV&V Team is required and/or requested to present IV&V status to various stakeholders including but not limited to Center Management, Mission Directorates, etc. The IV&V Team will communicate and coordinate the overall message/content of these presentations with the Project prior to the actual review as defined in Table 4-4 below.

**Table 4-4: Additional Reporting Events**

<b>Milestone Review</b>	<b>Project Recipient</b>	<b>Input Due</b>
GSFC Monthly Status Review (MSR)	IV&V POC	5 days prior to review
IV&V Board of Advisor (IBA) Semi-Annual Briefings	IV&V POC	5 days prior to review

### 4.2.3 Routine Tag-ups

The IV&V Team will work with Project personnel to establish routine tag-ups to discuss overall IV&V status, development artifacts needs/requests, results of IV&V analyses (issues and risks), status of Project schedule and artifacts, resolution of IV&V issues and risks, and delivery of formal IV&V reports, etc. Such tag-ups may occur on a weekly, bi-weekly, or monthly basis as agreed to by both parties. These routine tag-ups represent the preferred method for communicating and resolving any issues and/or risks that the IV&V Team has identified.

Current plan is for monthly teleconferences to be held the final Thursday of each month from 7:00-8:00 AM PT (10:00-11:00 AM ET). Specific time and dates will be modified as agreed to between the Program and IV&V, if necessary.



## IV&V PROJECT EXECUTION PLAN

Table A-1: Mars 2020 PBRA Results

Id	Capability	Impact	Likelihood	RAC
E2	EDL: Maintain Safe Attitude and Navigation	5	4	24
E3	EDL: Fault Management, including Hot-Swap Capability	5	4	24
S2	Surface: Safely Navigate the Rover, both Ground Commanded and Autonomous	4	4	22
C1	Cruise: Maintain Safe Attitude	5	3	21
C2	Cruise: Fault Management	5	3	21
E7	EDL: Execute Descent & Deployments	5	3	21
S1	Surface: Re-establish Power-Positive Communicating State after Landing	5	3	21
S3	Surface: Fault Management	5	3	21
S10	Surface: Collect and Store Planetary Samples for Later Retrieval	3	5	20
L2	Launch: Establish Safe Attitude upon Separation from Upper Stage	4	3	19
C3	Cruise: Execute Trajectory Correction Maneuvers	5	2	17
C4	Cruise: Telecommand Spacecraft and Instruments	5	2	17
C5	Cruise: Collect and Store Spacecraft and Instrument Housekeeping Data	5	2	17
C7	Cruise: Telemeter Spacecraft and Instrument Housekeeping Data	5	2	17
S4	Surface: Maintain Power Positive State	5	2	17
G1	Ground Operations	3	3	15
S7	Surface: Collect and Store Instrument Science Data	3	3	15
L1	Launch: Detect Observatory Separation from Upper Stage	4	2	14
S5	Surface: Telecommand Spacecraft and Instruments	4	2	14
S6	Surface: Collect and Store Spacecraft and Instrument Housekeeping Data	4	2	14
S8	Surface: Telemeter Spacecraft and Instrument Housekeeping Data	4	2	14
S9	Surface: Telemeter Instrument Science Data	3	2	11
C6	Cruise: Collect and Store Instrument Science Data	2	2	8
C8	Cruise: Telemeter Instrument Science Data	2	2	8
E6	EDL: Collect and Store Instrument Science Data	2	2	8
E1	EDL: Re-establish Power-Positive Communicating State upon Separation from Cruise Stage	1	2	2
E5	EDL: Collect and Store Spacecraft and Instrument Housekeeping Data	1	2	2
E4	EDL: Telemeter Spacecraft and Instrument Housekeeping Data	1	1	1

The complete PBRA is located on NASA IV&V's Enterprise Content Management (ECM) system in the following location:

[Enterprise/IV&V PROJECTS/M2020/Workspace/Init/Planning/PBRA/RBA/Mars2020 PBRA – Rev1.1.xlsx](#)

**Appendix B: IV&V RBA Results**

Figure B-1 and Table B-1, below, depict the Mars 2020 RBA results. The RBA color scheme follows the same convention described for the PBRA. The supporting data/rationale for this data is maintained by the IV&V PM and is available upon request.

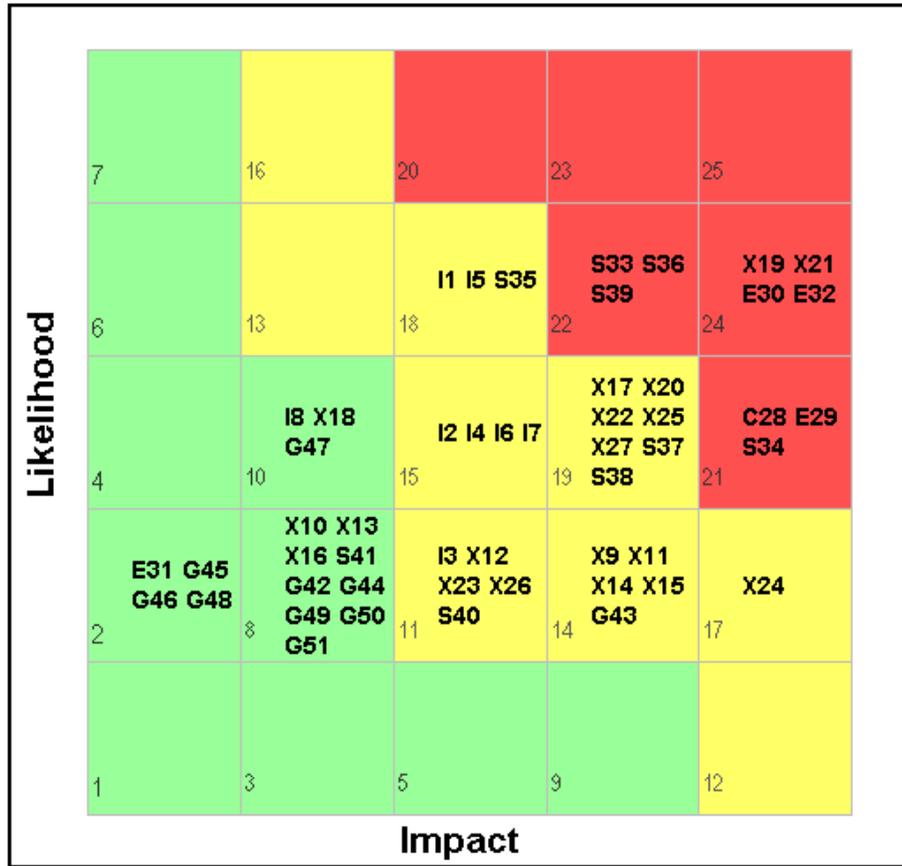


Figure B-1: Mars 2020 RBA Results

## IV&V PROJECT EXECUTION PLAN

Table B-1: Mars 2020 RBA Results

ID	Entity	Impact	Likelihood	RAC
X19	XCutting - System Fault Protection (SFP)	5	4	24
X21	XCutting - Rover Compute Element (RCE)	5	4	24
E30	EDL - Events and Controls	5	4	24
E32	EDL - Actuators	5	4	24
S33	Surface - Surface Systems Behavior and Coordination	4	4	22
S36	Surface - Robotic Arm	4	4	22
S39	Surface - Navigation	4	4	22
C28	Cruise - Cruise Attitude Estimation Control and Propulsion	5	3	21
E29	EDL - GNC Sensors	5	3	21
S34	Surface - Surface Attitude, Positioning, and Pointing (SAPP)	5	3	21
X17	XCutting - Spacecraft Modes	4	3	19
X20	XCutting - Thermal	4	3	19
X22	XCutting - Remote Engineering Unit (REU)	4	3	19
X25	XCutting - Power and Power and Analog Module (PAM)	4	3	19
X27	XCutting - Actuators and Motor Control (MOT)	4	3	19
S37	Surface - Remote Sensing Mast (RSM)	4	3	19
S38	Surface - Mobility	4	3	19
I1	Instrument - Mastcam-Z	3	4	18
I5	Instrument - Mars Oxygen ISRU Experiment (MOXIE)	3	4	18
S35	Surface - Sampling Caching Subsystem (SCS)	3	4	18
X24	XCutting - Pyros	5	2	17
I2	Instrument - SuperCam	3	3	15
I4	Instrument - Scanning Habitable Environments with Raman & Luminescence for Organics and Chemicals (SHERLOC)	3	3	15
I6	Instrument - Mars Environmental Dynamics Analyzer (MEDA)	3	3	15
I7	Instrument - Radar Imager for Mars' Subsurface Experiment (RIMFAX)	3	3	15
X9	XCutting - Wakeup and Shutdown	4	2	14
X11	XCutting - Telecommunications	4	2	14
X14	XCutting - Uplink and Command	4	2	14
X15	XCutting - Data Management and Transmission (DMX)	4	2	14
G43	Ground - Data Acquisition and Command Subsystem (DACS)	4	2	14
I3	Instrument - Planetary Instrument for X-ray Lithochemistry (PIXL)	3	2	11
X12	XCutting - Intercommunications (Intercomm)	3	2	11
X23	XCutting - Remote Serial Bus (RSB)	3	2	11

## IV&V PROJECT EXECUTION PLAN

ID	Entity	Impact	Likelihood	RAC
X26	XCutting - Hardware Commands and Discrettes	3	2	11
S40	Surface - High Gain Antenna (HGA)	3	2	11
I8	Instrument - Mars EDL Instrumentation-2 (MEDLI2)	2	3	10
X18	XCutting - Clocks and Time	2	3	10
G47	Ground - Science Processing and Long-term Archive	2	3	10
X10	XCutting - Dream Mode	2	2	8
X13	XCutting - Coordinated Communication Behavior Manager (CBM)	2	2	8
X16	XCutting - Sequencing	2	2	8
S41	Surface - Enhanced Engineering Cameras (EECAM)	2	2	8
G42	Ground - Launch Processing	2	2	8
G44	Ground - Activity Planning and Sequencing Subsystem (APSS)	2	2	8
G49	Ground - Engineering Analysis Subsystem (EAS)	2	2	8
G50	Ground - Mission Design and Navigation Subsystem (MDNS)	2	2	8
G51	Ground - Science Ops Analysis Subsystem (SOAS)	2	2	8
E31	EDL - Communications	1	2	2
G45	Ground - Information and Data Management Subsystem (IDMS) and Anc. Info Subsystem (AIS)	1	2	2
G46	Ground - Ops Product Generation Subsystem (OPGS)	1	2	2
G48	Ground - Mission Data Processing and Control Subsystem (MPCS)	1	2	2

The complete RBA is located on NASA IV&V's Enterprise Content Management (ECM) system in the following location:

[Enterprise/IV&V PROJECTS/M2020/Workspace/Init/Planning/PBRA/RBA/Mars2020 RBA – Rev1.2.xlsx](#)

The entity-to-capability mapping produced as part of the RBA process is located on NASA IV&V's ECM system in the following location:

[Enterprise/IV&V PROJECTS/M2020/Workspace/Init/Planning/PBRA/RBA/Mars2020 Capability to Entity Mapping –Rev1.1.xlsx](#)

### **Appendix C: IV&V Heritage Review & Applicable Lessons Learned**

The purpose of the heritage review is to survey prior NASA IV&V programs for applicability of their results to the Mars 2020 program and to document references to applicable project results for use in Mars 2020 IV&V work.

At the beginning of each new analysis activity, planning cycle, and other appropriate activities, the IV&V team will review the applicable Lessons Learned from the Mars 2020 Heritage Review report to determine which ones are relevant to the activity about to begin and review the relevant Lessons Learned and apply them as appropriate. As new Lessons Learned are documented, the IV&V team will review them for applicability to Mars 2020 and update the Mars 2020 Heritage Review document accordingly.

The Mars 2020 Heritage Review document, including applicable Lessons Learned, is located on IV&V's ECM system in the following location:

[Enterprise/IV&V PROJECTS/M2020/Workspace/Init/Planning/Heritage Review/M2020 IVV Heritage Review -Initial.docx](#)

### Appendix D: Technical Scope & Rigor (TS&R)

The Mars 2020 Technical Scope & Rigor (TS&R) document outlines where IV&V's effort will be applied on the Mars 2020 Project for FY16 and the approaches considered for performing technical tasks. The Mars 2020 TS&R document is located on IV&V's ECM system in the following location and available upon request:

[Enterprise/IV&V PROJECTS/M2020/FA & Project Plans/TS&R/M2020 FY16 TSR v1.0 \(IPEPv1.1\).docx](#)

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 D-1 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:

[Enterprise/IV&V PROJECTS/M2020/Workspace/Init/Planning/PBRA/RBA/Mars2020 Capability to Entity Mapping -Rev1.1.xlsx](#)

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 D-1 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 D-2 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 D-2 represent the highest level of rigor (rigor level 1 is the highest) that will be applied to that Capability/ S/W entity combination.



**IV&V PROJECT EXECUTION PLAN**

Table D-1: M2020 Scope and Rigor Levels

<b>PBRA Rating</b>	<b>MSL Reuse Plan</b>	<b>MSL IV&amp;V Coverage</b>	<b>Planned M2020 Scope and Rigor</b>
<b>Green</b>	All	All	<u>Rigor Level 5:</u> - 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	<u>Rigor Level 4:</u> - 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	<u>Rigor Level 3:</u> - 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	<u>Rigor Level 2:</u> - 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	<u>Rigor Level 1:</u> - 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	



**Appendix E: Reference Documentation**

Table E-1: Relevant Documentation

<b>Document</b>	<b>Title</b>	<b>Link or Date</b>
IVV 09-1	Independent Verification and Validation Technical Framework	<a href="#">IVV 09-1</a>
S3105	Guidelines for Writing IV&V TIMs	<a href="#">S3105</a>
S3106	PBRA and RBA Process	<a href="#">S3106</a>
NASA-STD-8719.13C	NASA Software Safety Standard	<a href="#">NASA-STD-8719.13C</a>
NPR 8715.3C	NASA General Safety Program Requirements	<a href="#">NPR 8715.3C</a>

For more information regarding the Mars 2020 mission, see the Project's website at: <http://mars.jpl.nasa.gov/mars2020/>.

### Appendix F: Acronyms

CDR	Critical Design Review
CSCI	Computer Software Configuration Item
ECM	Enterprise Content Management
FMECA	Failure Mode Effects and Critical Analysis
FTA	Fault Tree Analysis
ICD	Interface Control Document
IPEP	IV&V Project Execution Plan
IV&V	Independent Verification and Validation
MRR	Mission Readiness Review
MSR	Monthly Status Review
NASA	National Aeronautics and Space Administration
NODIS	NASA Online Directives Information System
PBRA	Portfolio Based Risk Assessment
PDR	Preliminary Design Review
PHA	Preliminary Hazard Analysis
PM	Project Manager
PMC	Program Management Council
POC	Point of Contact
RBA	Risk Based Assessment
RMO	Resource Management Office
RMS	Risk Management System
SBU	Sensitive But Unclassified
SMA	Safety and Mission Assurance
SMSR	Safety and Mission Success Review
TQ&E	Technical Quality and Excellence
TS&R	Technical Scope & Rigor

### Appendix G: Fiscal Year 2015 (FY15) IV&V Efforts

#### G.1 FY15 Goals/Objectives

The major factor driving the goals/objectives of the Mars 2020 IV&V effort in FY15 is the intent to provide assurance that the selected safety-critical and mission-critical Mars 2020 software will operate reliably and safely under nominal and selected off-nominal conditions and that the software will not introduce unintended features. The goals/objectives, below, reference the associated full lifecycle IV&V Assurance Objectives, which are maintained in the following file on NASA IV&V's ECM system:

[Enterprise/IV&V PROJECTS/M2020/Workspace/Init/Planning/Assurance Design/NASA IV&V Mars 2020 Assurance Objectives –Rev1.1.xlsm](#)

The goals/objectives of the FY15 IV&V efforts to support the Mars 2020 Program include the following:

- Work with the Mars 2020 IV&V POC to identify, communicate and resolve risks, focusing on factors that are likely to impact IV&V and Program objectives in areas of performance, safety, schedule and cost.
- Work with the Mars 2020 IV&V POC to identify, communicate, disposition and resolve technical issues in a timely and consistent manner, as a result of IV&V analyses performed throughout the fiscal year.
- Support selected management and technical reviews by assessing the review materials, attending the reviews, providing requested status and/or data to the Program, presenting at the reviews, and providing task reports and anomaly reports as necessary.
- The M2020 IV&V efforts shall assure that the software planned for reuse adequately meets the needs of the current mission
- The M2020 IV&V efforts shall assure that the system architecture consists of the necessary computing elements required to accomplish the mission and satisfy user needs
- The M2020 IV&V team shall assure that known software based hazard causes, contributors, and controls are identified and documented and that the hazard identification meets the requirements of JPL and NASA safety guidelines
- The M2020 IV&V efforts shall assure that the Level 2 and 3 system requirements are of high quality and appropriately define the system architecture required to accomplish the mission as they pertain to system software.
- The M2020 IV&V efforts shall assure that the Level 4 and 5 software requirements (and any sub-levels) are complete and correct as they correlate to the in-focus critical capabilities
- The M2020 IV&V efforts shall assure that the software control and operation of the Data Acquisition and Command Subsystem GSW module, as that module supports the Ground Operations during all phases of the mission, will meet the operational needs under off-nominal conditions and that no unintended features are introduced.

- The M2020 IV&V efforts shall assure that the software responsible for protecting both the ground system and the flight system from possible security threats will operate reliably and safely
- The M2020 IV&V efforts shall assure that the software responsible for performing the in-focus capabilities utilizing the associated software entities, as detailed in Table G-1, will operate reliably and safely and will meet the operational needs under nominal and off-nominal conditions and that no unintended features are introduced. The table represents planned requirements, design, implementation and test analysis for the fiscal year in the specified focus areas.



**G.2 FY15 Targeted External Milestones**

**Table G-2: Program Targeted External Milestones**

<b>Key Milestone</b>	<b>Current Planned Date</b>
SCS Cache PDR	6/23/2015
SCS Arm PDR	7/8/2015
Instrument PDR	7/15/2015
SCS PDR	7/22/2015
Project PDR, Part 1	9/15/2015

**G.3 FY15 Internal Milestones**

**Table G-3: IV&V FY15 Internal Milestones**

<b>Milestone</b>	<b>Current Planned Date</b>
FY16 Planning Session	07/2015
TQ&E Checkpoint Review (Regarding Project PDR)	08/2015
Project PDR: IV&V Input	08/2015

**G.4 FY15 Schedule**

The schedule is maintained by the IV&V PM and is available upon request. The latest copy is stored on IV&V's ECM system in the following location:

[Enterprise/IV&V PROJECTS/M2020/Workspace/Init/Planning/Schedules/M2020 IV&V FY15 Schedule.mpp](#)

**G.5 FY15 Risks**

The following table is a listing of the internal and external risks for the Mars 2020 IV&V effort in FY15.

**Table G-4: IV&V Identified Risks**

<b>Risk Title</b>	<b>Risk Statement/Description</b>
R-272 (IV&V INTERNAL): Plan for high MSL reuse could change	Given that the M2020 Project is planning for high reuse of MSL flight software; there is the possibility that the reuse level may change due to the need or desire to modify or upgrade the software; adversely impacting NASA IV&V's plan, which is heavily influenced by the Project's planned reuse and IV&V's efforts on MSL; leading to an impact in both cost and schedule.
R-274 (IV&V INTERNAL): M2020 requirements configuration management concerns	Given that the M2020 Project has announced that MSL requirements would be the initial baseline for M2020 requirements, and that there were severe requirements CM issues on the MSL program; there is the possibility that 1) those same CM issues will be propagated to the M2020 program; and 2) that the baseline requirements set would have missing requirements, out of date requirements, and/or improperly traced requirements due to the CM issues experienced on MSL and the migration to a new configuration management tool and project requirement structure; adversely impacting M2020 requirements analysis; leading to increased time and effort needed to evaluate the software level (Level 4 and Level 5) requirements.

**G.6 FY15 IV&V Deliverables**

The following table defines the deliverables for the Mars 2020 IV&V effort for FY15.

**Table G-5: FY15 IV&V Deliverables**

<b>ID</b>	<b>Title</b>	<b>Delivery Date</b>
FY15-1	M2020 Software Architecture Analysis Report	08/2015

### Appendix H: Fiscal Year 2016 (FY16) IV&V Efforts

#### H.1 FY16 Goals/Objectives

The major factor driving the goals/objectives of the Mars 2020 IV&V effort in FY16 is the intent to provide assurance that the selected safety-critical and mission-critical Mars 2020 software will operate reliably and safely under nominal and selected off-nominal conditions and that the software will not introduce unintended features. The goals/objectives, below, reference the associated full lifecycle IV&V Assurance Objectives, which are maintained in the following file on NASA IV&V's ECM system:

[Enterprise/IV&V PROJECTS/M2020/Workspace/Init/Planning/Assurance Design/NASA IV&V Mars 2020 Assurance Objectives –Rev1.1.xlsm](#)

The goals/objectives of the FY16 IV&V efforts to support the Mars 2020 Program include the following:

- Work with the Mars 2020 IV&V POC to identify, communicate and resolve risks, focusing on factors that are likely to impact IV&V and Program objectives in areas of performance, safety, schedule and cost.
- Work with the Mars 2020 IV&V POC to identify, communicate, disposition and resolve technical issues in a timely and consistent manner, as a result of IV&V analyses performed throughout the fiscal year.
- Support selected management and technical reviews by assessing the review materials, attending the reviews, providing requested status and/or data to the Program, presenting at the reviews, and providing task reports and anomaly reports as necessary.
- The M2020 IV&V efforts shall assure that the software planned for reuse adequately meets the needs of the current mission
- The M2020 IV&V efforts shall assure that the proposed software architecture for the mission satisfies the needs of the system and is feasible
- The M2020 IV&V team shall assure that known software based hazard causes, contributors, and controls are identified and documented and that the hazard identification meets the requirements of JPL and NASA safety guidelines
- The M2020 IV&V efforts shall assure that the Level 2 and 3 system requirements are of high quality and appropriately define the system architecture required to accomplish the mission as they pertain to system software.
- The M2020 IV&V efforts shall assure that the Level 4 and 5 software requirements (and any sub-levels) are complete and correct as they correlate to the in-focus critical capabilities
- The M2020 IV&V efforts shall assure that the software control and operation of the Data Acquisition and Command Subsystem GSW module, as that module supports the Ground Operations during all phases of the mission, will meet the operational needs under off-nominal conditions and that no unintended features are introduced.

- The M2020 IV&V efforts shall assure that the software responsible for protecting both the ground system and the flight system from possible security threats will operate reliably and safely
- The M2020 IV&V efforts shall assure that the software responsible for performing the in-focus capabilities utilizing the associated software entities, as detailed in Table H-1, will operate reliably and safely and will meet the operational needs under nominal and off-nominal conditions and that no unintended features are introduced. The table represents planned requirements, design, implementation and test analysis for the fiscal year in the specified focus areas.



**H.2 FY16 Targeted External Milestones**

**Table H-2: Program Targeted External Milestones**

<b>Key Milestone</b>	<b>Current Planned Date</b>
Surface FSW PDR	12/01/2015
Project PDR	02/02/2016
Mission System PDR	03/15/2016
Rover CDR	07/14/2016
FSW CDR	07/29/2016
Instrument CDR	08/15/2016
Project CDR	11/01/2016

**H.3 FY16 Internal Milestones**

**Table H-3: IV&V FY16 Internal Milestones**

<b>Milestone</b>	<b>Current Planned Date</b>
Project PDR: IV&V Input	01/2016
FY16 Mid-Year Planning Session	03/2016
TQ&E Checkpoint Review (Regarding Project CDR)	09/2016
FY17 Planning Session	07/2016
Project CDR: IV&V Input	10/2016

**H.4 FY16 Schedule**

The schedule is maintained by the IV&V PM and is available upon request. The latest copy is stored on IV&V's ECM system in the following location:

<Enterprise/IV&V PROJECTS/M2020/Workspace/Init/Planning/Schedules/M2020 IV&V FY16 Schedule.mpp>

**H.5 FY16 Risks**

The following table is a listing of the internal and external risks for the Mars 2020 IV&V effort in FY16. This will be completed at the appropriate update to this document prior to the initiation of the FY16.

**Table H-4: IV&V Identified Risks**

<b>Risk Title</b>	<b>Risk Statement/Description</b>
R-272 (IV&V INTERNAL): Plan for high MSL reuse could change	Given that the M2020 Project is planning for high reuse of MSL flight software; there is the possibility that the reuse level may change due to the need or desire to modify or upgrade the software; adversely impacting NASA IV&V's plan, which is heavily influenced by the Project's planned reuse and IV&V's efforts on MSL; leading to an impact in both cost and schedule.
R-274 (IV&V INTERNAL): M2020 requirements configuration management concerns	Given that the M2020 Project has announced that MSL requirements would be the initial baseline for M2020 requirements, and that there were severe requirements CM issues on the MSL program; there is the possibility that 1) those same CM issues will be propagated to the M2020 program; and 2) that the baseline requirements set would have missing requirements, out of date requirements, and/or improperly traced requirements due to the CM issues experienced on MSL and the migration to a new configuration management tool and project requirement structure; adversely impacting M2020 requirements analysis; leading to increased time and effort needed to evaluate the software level (Level 4 and Level 5) requirements.

**H.6 FY16 IV&V Deliverables**

The following table defines the deliverables for the Mars 2020 IV&V effort for FY16.

**Table H-5: FY16 IV&V Deliverables**

<b>ID</b>	<b>Title</b>	<b>Delivery Date</b>
FY16-1	M2020 Software Reuse Analysis Report	01/2016
FY16-2	M2020 System Requirement Analysis Report	09/2016
FY16-3	M2020 Software Requirement Analysis Report - Init	08/2016

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<b>ID</b>	<b>Title</b>	<b>Delivery Date</b>
FY16-4	M2020 Hazard Analysis Report	05/2016
FY16-5	M2020 Software Design Analysis Report -Init	09/2016
FY16-6	M2020 Project Security Analysis Report	07/2016

### Appendix I: Fiscal Year 2017 (FY17) IV&V Efforts

#### I.1 FY17 Goals/Objectives

The major factor driving the goals/objectives of the Mars 2020 IV&V effort in FY17 is the intent to provide assurance that the selected safety-critical and mission-critical Mars 2020 software will operate reliably and safely under nominal and selected off-nominal conditions and that the software will not introduce unintended features. The goals/objectives, below, reference the associated full lifecycle IV&V Assurance Objectives, which are maintained in the following file on NASA IV&V's ECM system:

[Enterprise/IV&V PROJECTS/M2020/Workspace/Init/Planning/Assurance Design/NASA IV&V Mars 2020 Assurance Objectives –Rev1.1.xlsm](#)

The goals/objectives of the FY17 IV&V efforts to support the Mars 2020 Program include the following:

- Work with the Mars 2020 IV&V POC to identify, communicate and resolve risks, focusing on factors that are likely to impact IV&V and Program objectives in areas of performance, safety, schedule and cost.
- Work with the Mars 2020 IV&V POC to identify, communicate, disposition and resolve technical issues in a timely and consistent manner, as a result of IV&V analyses performed throughout the fiscal year.
- Support selected management and technical reviews by assessing the review materials, attending the reviews, providing requested status and/or data to the Program, presenting at the reviews, and providing task reports and anomaly reports as necessary.
- The M2020 IV&V team shall assess changes to Project artifacts that IV&V has analyzed in previous FYs to determine the impact of the changes to mission success. Results and conclusions of these assessments will be added to the appropriate technical reports and provided to the Project.
- The M2020 IV&V efforts shall assure that the Level 2 and 3 system requirements are of high quality and appropriately define the system architecture for the EDL phase of the mission as they pertain to system software.
- The M2020 IV&V efforts shall assure that the Level 4 and 5 software requirements (and any sub-levels) are complete and correct as they correlate to the in-focus EDL and Surface phase critical capabilities
- The M2020 IV&V efforts shall assure that the software control and operation of the Data Acquisition and Command Subsystem GSW module, as that module supports the Ground Operations during all phases of the mission, will meet the operational needs under off-nominal conditions and that no unintended features are introduced.
- The M2020 IV&V efforts shall assure that the software responsible for protecting both the ground system and the flight system from possible security threats will operate reliably and safely

- The M2020 IV&V efforts shall assure that the software responsible for performing the in-focus capabilities utilizing the associated software entities, as detailed in Table I-1, will operate reliably and safely and will meet the operational needs under nominal and off-nominal conditions and that no unintended features are introduced. The table represents planned requirements, design, implementation and test analysis for the fiscal year in the specified focus areas.



**I.2 FY17 Targeted External Milestones**

**Table I-2: Program Targeted External Milestones**

<b>Key Milestone</b>	<b>Current Planned Date</b>
M2020 SCS CDR	10/3/2016
M2020 MS CDR (Cruise)	07/17/2017

**I.3 FY17 Internal Milestones**

**Table I-3: IV&V FY17 Internal Milestones**

<b>Milestone</b>	<b>Current Planned Date</b>
TBD	

**I.4 FY17 Schedule**

The schedule is maintained by the IV&V PM and is available upon request. The latest copy is stored on IV&V’s ECM system in the following location:

<Enterprise/IV&V PROJECTS/M2020/Workspace/Init/Planning/Schedules>

**I.5 FY17 Risks**

The following table is a listing of the internal and external risks for the Mars 2020 IV&V effort in FY17. This will be completed at the appropriate update to this document prior to the initiation of the FY17.

**Table I-4: IV&V Identified Risks**

<b>Risk Title</b>	<b>Risk Statement/Description</b>
TBD	

**I.6 FY 2017 IV&V Deliverables**

The following table defines the deliverables for the Mars 2020 IV&V effort for FY17.

**Table I-5: FY17 IV&V Deliverables**

<b>ID</b>	<b>Title</b>	<b>Delivery Date</b>
FY17-1	M2020 Software Implementation Analysis Report - Init	TBD

### Appendix J: Fiscal Year 2018 (FY18) IV&V Efforts

#### J.1 FY18 Goals/Objectives

The major factor driving the goals/objectives of the Mars 2020 IV&V effort in FY18 is the intent to provide assurance that the selected safety-critical and mission-critical Mars 2020 software will operate reliably and safely under nominal and selected off-nominal conditions and that the software will not introduce unintended features. The goals/objectives, below, reference the associated full lifecycle IV&V Assurance Objectives, which are maintained in the following file on NASA IV&V's ECM system:

[Enterprise/IV&V PROJECTS/M2020/Workspace/Init/Planning/Assurance Design/NASA IV&V Mars 2020 Assurance Objectives –Rev1.1.xlsm](#)

The goals/objectives of the FY18 IV&V efforts to support the Mars 2020 Program include the following:

- Work with the Mars 2020 IV&V POC to identify, communicate and resolve risks, focusing on factors that are likely to impact IV&V and Program objectives in areas of performance, safety, schedule and cost.
- Work with the Mars 2020 IV&V POC to identify, communicate, disposition and resolve technical issues in a timely and consistent manner, as a result of IV&V analyses performed throughout the fiscal year.
- Support selected management and technical reviews by assessing the review materials, attending the reviews, providing requested status and/or data to the Program, presenting at the reviews, and providing task reports and anomaly reports as necessary.
- The M2020 IV&V team shall assess changes to Project artifacts that IV&V has analyzed in previous FYs to determine the impact of the changes to mission success. Results and conclusions of these assessments will be added to the appropriate technical reports and provided to the Project.
- The M2020 IV&V efforts shall assure that the software control and operation of the Data Acquisition and Command Subsystem GSW module, as that module supports the Ground Operations during all phases of the mission, will meet the operational needs under off-nominal conditions and that no unintended features are introduced.
- The M2020 IV&V efforts shall assure that the software responsible for protecting both the ground system and the flight system from possible security threats will operate reliably and safely
- The M2020 IV&V efforts shall assure that the software responsible for performing the in-focus capabilities utilizing the associated software entities, as detailed in Table J-1, will operate reliably and safely and will meet the operational needs under nominal and off-nominal conditions and that no unintended features are introduced. The table represents planned requirements, design, implementation and test analysis for the fiscal year in the specified focus areas.



**J.2 FY18 Targeted External Milestones**

**Table J-2: Program Targeted External Milestones**

<b>Key Milestone</b>	<b>Current Planned Date</b>
M2020 Project SIR	11/15/2017
M2020 MS CDR (Surface)	09/17/2018

**J.3 FY18 Internal Milestones**

**Table J-3: IV&V FY18 Internal Milestones**

<b>Milestone</b>	<b>Current Planned Date</b>
TQ&E Checkpoint Review (Regarding Project SIR)	10/2017
Project CDR: IV&V Input	10/2017

**J.4 FY18 Schedule**

The schedule is maintained by the IV&V PM and is available upon request. The latest copy is stored on IV&V’s ECM system in the following location:

<Enterprise/IV&V PROJECTS/M2020/Workspace/Init/Planning/Schedules>

**J.5 FY18 Risks**

The following table is a listing of the internal and external risks for the Mars 2020 IV&V effort in FY18. This will be completed at the appropriate update to this document prior to the initiation of the FY18.

**Table J-4: IV&V Identified Risks**

<b>Risk Title</b>	<b>Risk Statement/Description</b>
TBD	

**J.6 FY18 IV&V Deliverables**

The following table defines the deliverables for the Mars 2020 IV&V effort for FY18.

**Table J-5: FY18 IV&V Deliverables**

<b>ID</b>	<b>Title</b>	<b>Delivery Date</b>
FY18-1	M2020 Software Test Analysis Report - Init	TBD
FY18-2	M2020 System Integration Test Analysis Report - Init	TBD

### Appendix K: Fiscal Year 2019 (FY19) IV&V Efforts

#### K.1 FY19 Goals/Objectives

The major factor driving the goals/objectives of the Mars 2020 IV&V effort in FY19 is the intent to provide assurance that the selected safety-critical and mission-critical Mars 2020 software will operate reliably and safely under nominal and selected off-nominal conditions and that the software will not introduce unintended features. The goals/objectives, below, reference the associated full lifecycle IV&V Assurance Objectives, which are maintained in the following file on NASA IV&V's ECM system:

[Enterprise/IV&V PROJECTS/M2020/Workspace/Init/Planning/Assurance Design/NASA IV&V Mars 2020 Assurance Objectives –Rev1.1.xlsm](#)

The goals/objectives of the FY19 IV&V efforts to support the Mars 2020 Program include the following:

- Work with the Mars 2020 IV&V POC to identify, communicate and resolve risks, focusing on factors that are likely to impact IV&V and Program objectives in areas of performance, safety, schedule and cost.
- Work with the Mars 2020 IV&V POC to identify, communicate, disposition and resolve technical issues in a timely and consistent manner, as a result of IV&V analyses performed throughout the fiscal year.
- Support selected management and technical reviews by assessing the review materials, attending the reviews, providing requested status and/or data to the Program, presenting at the reviews, and providing task reports and anomaly reports as necessary.
- The M2020 IV&V team shall assess changes to Project artifacts that IV&V has analyzed in previous FYs to determine the impact of the changes to mission success. Results and conclusions of these assessments will be added to the appropriate technical reports and provided to the Project.
- The M2020 IV&V efforts shall assure that the system integration level testing for the mission adequately addresses the in-phase correlated critical capabilities of the system under nominal and off-nominal conditions and that no unintended features are introduced.
- The M2020 IV&V efforts shall assure that the software control and operation of the Data Acquisition and Command Subsystem GSW module, as that module supports the Ground Operations during all phases of the mission, will meet the operational needs under off-nominal conditions and that no unintended features are introduced.
- The M2020 IV&V efforts shall assure that the software responsible for protecting both the ground system and the flight system from possible security threats will operate reliably and safely
- The M2020 IV&V efforts shall assure that the software responsible for performing the in-focus capabilities utilizing the associated software entities, as detailed in Table K-1, will operate reliably and safely and will meet the operational needs under nominal and off-nominal conditions and that no unintended features are introduced. The table represents

planned requirements, design, implementation and test analysis for the fiscal year in the specified focus areas.



**K.2 FY19 Targeted External Milestones**

**Table K-2: Program Targeted External Milestones**

<b>Key Milestone</b>	<b>Current Planned Date</b>
None specified to date	

**K.3 FY19 Internal Milestones**

**Table K-3: IV&V FY19 Internal Milestones**

<b>Milestone</b>	<b>Current Planned Date</b>
TBD	

**K.4 FY19 Schedule**

The schedule is maintained by the IV&V PM and is available upon request. The latest copy is stored on IV&V’s ECM system in the following location:

<Enterprise/IV&V PROJECTS/M2020/Workspace/Init/Planning/Schedules>

**K.5 FY19 Risks**

The following table is a listing of the internal and external risks for the Mars 2020 IV&V effort in FY19. This will be completed at the appropriate update to this document prior to the initiation of the FY19.

**Table K-4: IV&V Identified Risks**

<b>Risk Title</b>	<b>Risk Statement/Description</b>
TBD	

**K.6 FY19 IV&V Deliverables**

The following table defines the deliverables for the Mars 2020 IV&V effort for FY19.

**Table K-5: FY19 IV&V Deliverables**

<b>ID</b>	<b>Title</b>	<b>Delivery Date</b>
TBD		

### Appendix L: Fiscal Year 2020 (FY20) IV&V Efforts

#### L.1 FY20 Goals/Objectives

The major factor driving the goals/objectives of the Mars 2020 IV&V effort in FY20 is the intent to provide assurance that the selected safety-critical and mission-critical Mars 2020 software will operate reliably and safely under nominal and selected off-nominal conditions and that the software will not introduce unintended features. The goals/objectives, below, reference the associated full lifecycle IV&V Assurance Objectives, which are maintained in the following file on NASA IV&V's ECM system:

[Enterprise/IV&V PROJECTS/M2020/Workspace/Init/Planning/Assurance Design/NASA IV&V Mars 2020 Assurance Objectives –Rev1.1.xlsm](#)

The goals/objectives of the FY20 IV&V efforts to support the Mars 2020 Program include the following:

- Work with the Mars 2020 IV&V POC to identify, communicate and resolve risks, focusing on factors that are likely to impact IV&V and Program objectives in areas of performance, safety, schedule and cost.
- Work with the Mars 2020 IV&V POC to identify, communicate, disposition and resolve technical issues in a timely and consistent manner, as a result of IV&V analyses performed throughout the fiscal year.
- Support selected management and technical reviews by assessing the review materials, attending the reviews, providing requested status and/or data to the Program, presenting at the reviews, and providing task reports and anomaly reports as necessary.
- The M2020 IV&V team shall assess changes to Project artifacts that IV&V has analyzed in previous FYs to determine the impact of the changes to mission success. Results and conclusions of these assessments will be added to the appropriate technical reports and provided to the Project.
- The M2020 IV&V efforts shall assure that the system integration level testing for the mission adequately addresses the in-phase correlated critical capabilities of the system under nominal and off-nominal conditions and that no unintended features are introduced.
- The M2020 IV&V efforts shall assure that the software control and operation of the Data Acquisition and Command Subsystem GSW module, as that module supports the Ground Operations during all phases of the mission, will meet the operational needs under off-nominal conditions and that no unintended features are introduced.
- The M2020 IV&V efforts shall assure that the software responsible for protecting both the ground system and the flight system from possible security threats will operate reliably and safely
- The M2020 IV&V efforts shall assure that the software responsible for performing the in-focus capabilities utilizing the associated software entities, as detailed in Table L-1, will operate reliably and safely and will meet the operational needs under nominal and off-nominal conditions and that no unintended features are introduced. The table represents

planned requirements, design, implementation and test analysis for the fiscal year in the specified focus areas.



**L.2 FY20 Targeted External Milestones**

**Table L-2: Program Targeted External Milestones**

<b>Key Milestone</b>	<b>Current Planned Date</b>
M2020 PSR	12/16/2019
M2020 ORR	04/01/2020
M2020 MRR	05/01/2020
M2020 CoFR	TBD
M2020 SMSR	06/01/2020
M2020 FRR	06/15/2020
M2020 Launch Period	07/16/2020 – 08/04/2020

**L.3 FY20 Internal Milestones**

**Table L-3: IV&V FY20 Internal Milestones**

<b>Milestone</b>	<b>Current Planned Date</b>
TQ&E Checkpoint Review (Regarding Project SMSR)	5/2020
Project SMSR: IV&V Input	5/2020

**L.4 FY20 Schedule**

The schedule is maintained by the IV&V PM and is available upon request. The latest copy is stored on IV&V’s ECM system in the following location:

<Enterprise/IV&V PROJECTS/M2020/Workspace/Init/Planning/Schedules>

**L.5 FY20 Risks**

The following table is a listing of the internal and external risks for the Mars 2020 IV&V effort in FY20. This will be completed at the appropriate update to this document prior to the initiation of the FY16.

**Table L-4: IV&V Identified Risks**

<b>Risk Title</b>	<b>Risk Statement/Description</b>
TBD	

**L.6 FY20 IV&V Deliverables**

The following table defines the deliverables for the Mars 2020 IV&V effort for FY20.

**Table L-5: FY20 IV&V Deliverables**

<b>ID</b>	<b>Title</b>	<b>Delivery Date</b>
FY20-1	M2020 IV&V Final Report	TBD