

 Independent Verification & Validation Program	Guidelines for Writing IV&V TIMs	S3105 Version: F Effective Date: June 27, 2013
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AUTHORITY		DATE
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REFERENCE DOCUMENTS	
Document Number	Document Title
IVV QM	NASA IV&V Quality Manual
IVV 09-1	Independent Verification and Validation Technical Framework
NASA-STD 8709.22	Safety and Mission Assurance Acronyms, Abbreviations, and Definitions

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**Independent
Verification &
Validation Program**

**Guidelines
for
Writing IV&V TIMs**

**S3105
Version: F
Effective Date:
June 27, 2013**

VERSION HISTORY

Version	Description of Change	Rationale for Change	Author	Effective Date
Basic	Initial Release		Kenneth Costello	09/25/2007
A	Changed "IV&V Facility" to "IV&V Program"		Stephanie Ferguson	02/19/2009
B	Updated content to reflect latest guidance, move to ORBIT, and additional required fields. Included additional state descriptions, IV&V Severity definitions, and Defect definitions.		Jeff Northey	01/27/2011
C	Updated IV&V Severity Definitions, remove PITS		Jeff Northey	04/24/2012
D	Added clarity and guidance. Updated some definitions.	PAR 2012-P-377: 1. There is no guidance for the newly added ORBIT "defer" flag functionality; 2. The closure criteria is inadequate in the guidance so the reasoning for closures of the issue is not always defined clearly. 3. "Count" definition in section 2.1.14 is inadequate and does not fully address need to utilize the field and the ramifications thereof with regard to closure of the	Cheryl Vandegrift	02/13/2013

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		issue as a result. 4. "Ready to Submit" state is not discussed in guidance documentation. 5. Guidance provided for "Ready for Severity 1 and 2 Reviews" is misleading; 6. Guidance contained for the phase introduced (2.1.8) and phase found (2.1.9) fields are obscure and can lead to individuals choosing the wrong phases. 7. "In dispute" definition in section 3.7 needs further clarification. 8. Currently the defect category/defect type field is mandatory and yet no metrics are being pulled from it and no one is actively using the data that comes out of it.		
E	Removed defect category/type definitions and replaced with issue category/types consistent with IVV 09-1 IV&V Technical Framework SLP.	PAR 2012-P-377: 8. Currently the defect category/defect type field is mandatory and yet no metrics are being pulled from it and no one is actively using the data that comes out of it. This standardization of issue type categories will help to ensure consistent issue type metrics collection across the IVVO organization.	Cheryl Vandegrift	04/01/2013

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F	<ul style="list-style-type: none">Added references to Table 2 as a required field under ORBIT.Added section 2.1.3 "References" and deleted references notation in section 2.1.2.Section 3.9-"Project Accepts Risk"- Deleted the severity level 5 reference and added additional supportive detailsMiscellaneous editorials.	Per PAR 2013-P-391 and subsequent DCR 844: Document was contradictory with regard to stating that severity level 5 issues can be placed in the PAR state when section 5.0 currently states that severity level 5 issues are editorial in nature and do not pose a risk for the project. Additionally, the "References" field needed to be added as a separate "required" field for clarity and to ensure the data gets captured correctly.	Cheryl Vandegrift	06/27/2013

1.0 Purpose of the Issue Writing Guidelines Document

The purpose of this document is to provide guidelines for writing a Technical Issue Memorandum (TIM) in the Observations, Risks (or Requirements), Backlogs, and Issue Tracking (ORBIT) tool. This document describes TIMs from two viewpoints: that of the NASA IV&V Project, and that of the NASA IV&V Program. The introductory sections of this document focus on discussing how metrics data from ORBIT is used by the IV&V Program to demonstrate its effectiveness to the Agency. The introductory sections are included because information about IV&V Program-level metrics is not widely known or understood, and inconsistencies in IV&V Project data can cause issues with the IV&V Program data. Using IV&V Project TIMs to communicate with Mission Projects is commonly performed, however, so there is little introductory discussion regarding this practice.

1.1 Scope

The guidelines contained herein apply only to issues documented as TIMs in ORBIT for IV&V Office projects. However, personnel using ORBIT for other projects may find these guidelines useful.

1.2 Importance of IV&V Issues

One of the primary outputs of the IV&V process is the documentation of issues found while performing analysis on Mission Project artifacts. These TIMs provide value at both the IV&V Project level and IV&V Program levels.

At the IV&V Project level, a TIM is one of the primary communication tools. The IV&V Team uses TIMs to document issues and share them with the Mission Project. The intent of the TIM is to describe what the issue is and how it affects the Mission Project. To successfully communicate the issue with the Mission Project, it is important to have clear, concise, and understandable data in the “Subject”, “Description”, “Impact”, and “Recommended Actions” fields in ORBIT. These four fields form the basis by which the Mission Project understands the type of issue that the IV&V Team has found and how the issue impacts the project.

At the IV&V Program level, TIMs are also used for communication, though the goal of the communication is different from the goal at the IV&V Project level. At the IV&V Program level, TIMs are generally aggregated into categories that demonstrate how the work being performed by the IV&V Program affects the Agency as a whole. To substantiate this effect, it is important that the TIMs contain information regarding when the issue was found by the IV&V Team (e.g., requirements, design, or code

phases), when the issue was introduced by the Mission Project team, the severity of the issue, and the state of the issue.

Overall, each of the above-mentioned fields provides some information to the IV&V Project or the IV&V Program and should be as clear, accurate, and concise as possible.

1.3 Understanding the Effect of IV&V at the Agency Level

In order to discuss the effect that the IV&V Program has on the Agency, it is important to be able to classify the issues contained within ORBIT. When issues are aggregated into classes, some classes have little to no effect on the Agency, while others have a significant effect.

To perform this classification between issues, each issue is categorized based on its current state of disposition. These categories are named “Impact” and “Non-impact”, and include the following states:

<u>Impact States</u>	<u>Non-impact States</u>
Not To Be Verified	Draft
To Be Verified	Not An Issue
In Dispute	Closed Before Submitted
Closed	Withdrawn
Project Accepts Risk	Ready to Submit
	Submitted

Table 1 – Impact and Non-impact Final Disposition States

It is important to note the general approach to creating these two categories. The goal of the “Impact State” category is to capture issues that cause a change to the Mission Project (i.e., that impact the project in some meaningful way). In some cases, assumptions are made about whether or not an issue causes a change to a project. For example, considering the “Project Accepts Risk” as an impact state assumes that making the Mission Project aware of the issue allows Mission Project management to make a more informed decision about the type and level of risk they are choosing to accept. Other details about the issue may also affect whether or not the issue is considered to have had an impact (e.g., a Severity 5 issue in the “Not To Be Verified” state may not be considered impactful).

Even though metrics represent a snapshot in time, it is very important to make sure that the final state of a TIM is the correct state, and that the issue is documented correctly overall. The interpretation of “documented” may change over the lifetime of the issue, but its correctness should not.

This means that the level of detail in an issue may change from the time it is drafted until the time it is moved into a final disposition state, but the issue should remain as correct as possible, given whatever is known about that issue at that time. Changes in an issue generally occur whenever a state-change occurs. It is at these points that the level of documentation may change. A guiding principle is that the issue should always contain enough information to allow the IV&V Team to “defend” the issue and its characteristics (e.g., severity, impact to the project) at any point in the issue’s life cycle. Additionally, the information contained within the TIM should be sufficient for an external reviewer (i.e., someone not from the IV&V Team) to be able to understand the issue and its disposition from concept to final resolution. Figure 1 below shows the current TIM state machine as implemented in ORBIT. The states are discussed in detail in Section 3.0 of this document

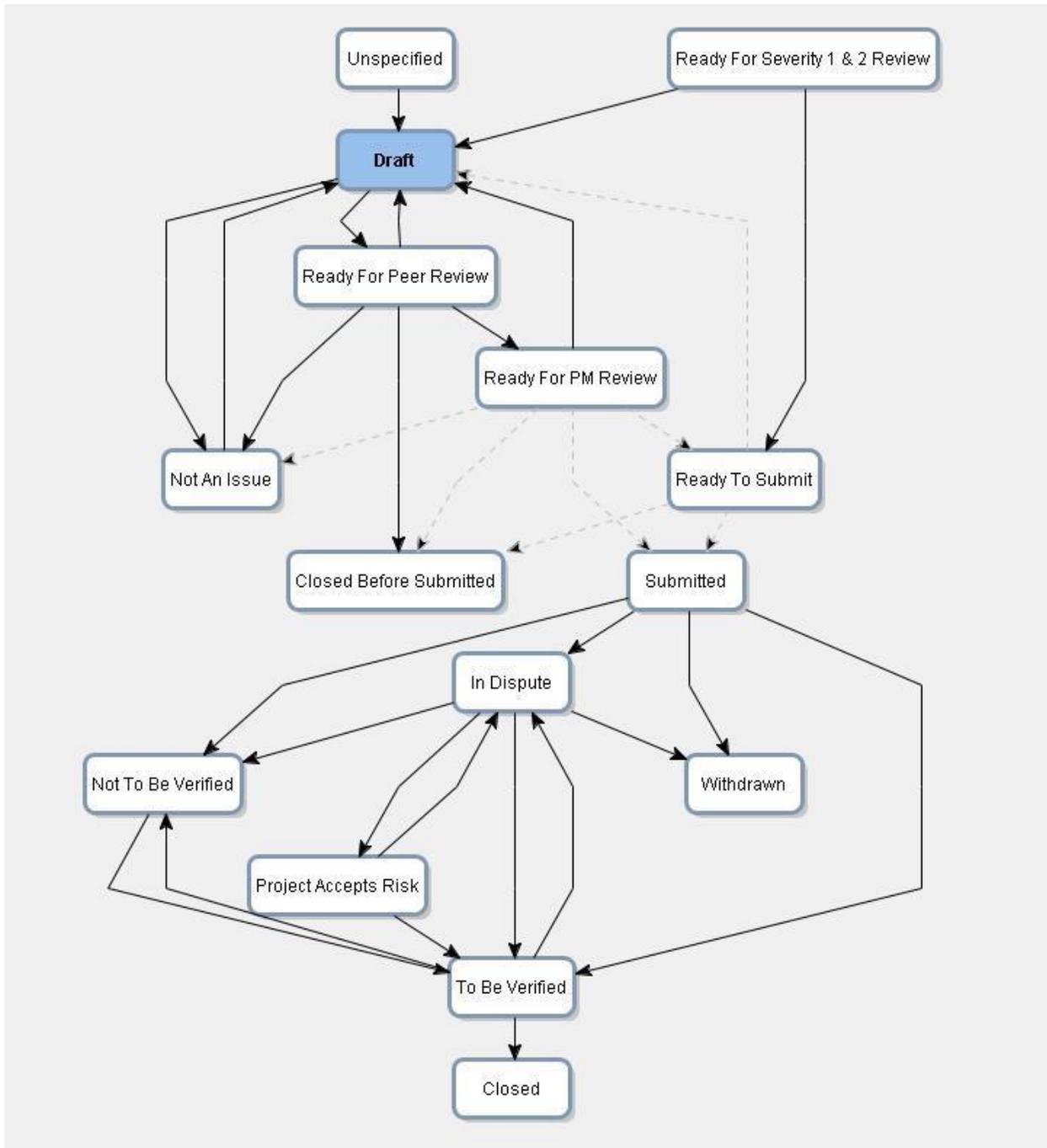


Figure 1 – Current IV&V TIM State Machine (in ORBIT)¹

Finally, it is important that all projects use the approved state machine and only change the state machine upon approval from the appropriate level of management.

¹ There are no lines going into “Ready for Severity 1 & 2 Review” since the state is automatically entered by the tool. The user cannot put the issue into this state.

1.4 Capturing our potential findings in a common repository

IV&V captures potential findings in a common repository (i.e., ORBIT). There are a number of reasons why we choose to do this, and several of those are listed below in this section. This information is included in this document because in order for us to take advantage of these benefits, the issues we write must be of high quality.

- *Data availability and searchability.* Storing the data in a common repository makes the data available and searchable for the entire IV&V Program without caveats or risk of being overlooked.
- *Cross-project knowledge sharing.* Other IV&V Projects may analyze similar content, due to heritage or other factors. Understanding project response and why issues were deemed invalid can increase mission, system, and software understanding and lead to improved future IV&V.
- *Intra-project knowledge sharing.* Understanding project response and why issues were deemed invalid can increase mission, system, and software understanding and lead to improved future IV&V.
- *Capturing/ensuring quality checks*
 - Peer reviews – Peer reviews help to ensure quality TIM's and also provide an opportunity for knowledge sharing, increased domain knowledge, perspective. Utilizing the tool captures evidence of these reviews.
 - Severity 1 & 2 extra review – TIMs are one of our most important products, and high severity TIMs are of particular importance. This extra review helps to ensure the quality of these TIMs. Utilizing the tool captures evidence of these reviews.
- *Using common fields for quality/clarity/understanding.* We have common, required fields for a number of reasons. These fields help us formulate a clear understanding of the issue and the issue's potential impact on the system, and help us capture that understanding in clear, high quality format that can be used to facilitate communication with the Mission Project. This also ensures that the issue is captured with sufficient detail that an IV&V analyst other than the author can perform issue resolution and closure in the future.
- *Opportunity for continuous improvement.* Understanding why issues were withdrawn can help us improve our processes and identify issues with timely receipt of Mission Project artifacts.
- *Understanding our impact/value.* The collection of TIM's across IV&V Projects serves as a significant representative of the value of the IV&V Program.
- *Capture Mission Project response as evidence.* When IV&V raises an issue and the Mission Project provides a response that convinces IV&V that the issue is not valid, that response serves as evidence of

the existence of appropriate system/software capability, documentation, etc.

2.0 General Guidelines for writing a TIM

The guidelines for writing a TIM follow the two principles discussed previously: providing sufficient information for an external reviewer, and supporting the defense of the issue and its characteristics.

2.1 Minimum Fields for a TIM

The following table lists the minimum required fields for all TIMs.

Required TIM Fields (i.e., fields that must be filled out for the TIM to leave the Draft state in ORBIT):
Subject
Description
References
IV&V Severity
IV&V Process, IV&V Activity, IV&V Task
Phase Introduced
Phase Found
Capability
Impact
Recommended Actions
Resolution Chronology
Issue Category, Issue Type (required for IV&V Severity 1-3)
Available but not “required” (but use them):
Phase Resolved
Duplicate Issue (i.e., the Mission Project found it, too).
Count

Table 2 –TIM Fields

2.1.1 Subject

The “Subject” field should contain a clear, concise title for the issue. Generally, the subject should be a single sentence or sentence fragment, and should be as unique as possible.

2.1.2 Description

The “Description” field exists primarily to communicate the substance of the issue to the Mission Project. The goal is to create a sufficiently detailed description so that the Mission Project can immediately begin assessing the issue. The description should be detailed enough so that the Mission Project need not reference additional information to understand the context of the issue. The description generally should not contain impacts or corrective actions. However, if it is necessary to include this information to make the description complete, ensure that the “Impact” and “Corrective Action” fields duplicate the information in the description.

The description should describe why the result of the analysis is an issue. Do not use simplistic descriptions such as, “This is wrong — fix it,” as such a description does not tell the Mission Project why it is an issue.

Also, do not use simple characteristics to describe the issue, such as, “The requirement is ambiguous.” The description should describe the ambiguity and offer examples of alternate interpretations.

Keep the language in the issue precise and formal. Try to avoid the use of idioms, slang, or pejorative expressions.

State each issue as if it is a new issue. For example, do not say, “The pointer is still not initialized.” Rather, create a new issue and state, “The pointer is not initialized.”

State the bottom line as early as possible, and be consistent across issues with respect to the format of the Description, so that Mission Project personnel reviewing issues can become familiar with the format of the issues.

2.1.3 References

The “References” field exists primarily to communicate to the mission project the corresponding Mission Project artifacts that support identification of the issue.

This field should reference the appropriate Mission Project artifacts and include corresponding ID #s and text (e.g., requirement # and requirement text, or design section # and text). This field is a mandatory field by design and provides the following benefits:

- Provides for consistency of reference information collection across projects; this information is critical for projects in understanding where the underlying issue resides and provides supportive information for the issue.
- Reduction of rework by the IV&V project to correct any errors previously identified in this area;
- Reduction in QA time performing reviews of issue(s) as this common error is now addressed and will not have to be documented anymore;
- Applies continuous improvement back to the IV&V program by reducing the overall number of errors found in the description and increasing the quality of TIMs being submitted.

2.1.4 IV&V Severity

Each TIM should have a severity assigned to it based upon the IV&V Program definition of severity (included in Section 5.0 of this document). The “IV&V Severity” field plays an important role in the communication with the Mission Project and in the development of IV&V Program metrics; thus it is important to correctly document the “IV&V Severity” field.

It is also important to note that the severity of an issue can change throughout its lifetime. Changes can occur due to changes in the system (e.g., a Severity 3 issue written against a component may increase to a 2 or a 1 following an architectural redesign), or due to acquiring more knowledge about the system. For example, a Severity 2 error may be reduced to a Severity 3 error when the Mission Project provides additional information to the IV&V Team that shows that the issue is not a Severity 2.

The severity should be congruent with the impact statement in the “Impact of Issue” field. That is, the impact statement should provide the rationale for the severity score.

Other severity information (e.g., project-specific severity information) may be included in a customized Project Fields tab in the ORBIT database. However, that is an addition above and beyond the minimum required fields, and it does not serve as a replacement for the “IV&V Severity” field.

2.1.5 Impact

The “Impact” field provides the rationale for the assigned severity, and is therefore very important. The “Impact” field should answer the question, “How does the issue impact the system?” Think, “(worst case) Impact (if the issue is not fixed)”.

The format of the impact should show a logical flow that describes not only what can happen, but how the system reached this state. It is not sufficient to simply state that the system fails (or explodes, detonates, destructs, etc.).

The impact statement should assume that the defect has propagated into operations.

As noted in Section 2.1.4, *IV&V Severity*, the “Impact” field should be congruent with the assigned severity as described in Section 5.0, *IV&V Severity Definitions*, of this document.

2.1.6 IV&V Task

The “IV&V Task” field should simply state the task that was being performed when the issue was found.

2.1.7 Capability

This field is used to indicate the system capability or capabilities that would be impacted by the issue. This is currently implemented by a multi-select field in ORBIT. If more than one capability would be affected, select each affected capability.

2.1.8 Issue Category/Type

The intent of these fields is to gain a better understanding of the types of defects being found in the performance of IV&V analysis. “Issue Category” is defined as high level (Concept, Requirements, Design, Code, Test, Operations and Maintenance (O&M)) categories. “Issue Type” is the specific type of issue defect found. In ORBIT, “Issue Type” is automatically filtered based on the “Issue Category” field. Issue type descriptions can be found in Section 6.0 of this document. Issue Category/Type replaces the prior Defect Category/Defect fields.

2.1.9 Phase Introduced

This field should capture the development life-cycle phase of the project, at the CSCI level (or similar), when the issue was first introduced. Phase introduced fields include the following: concept, requirements, design, implementation, test and operations and maintenance phases. To accurately fill out this field, some root cause analysis is required. Ask, “Did this problem originate somewhere other than where I found it?” For example, a design defect may have been caused by missing or ambiguous requirements. If a design defect is found, check the associated requirements to determine if this is the case, and if so, the phase introduced value should be “Requirements.” Additionally, a defect may be found in the testing phase where a test procedure incorrectly tests a behavior of a function as stated in the requirements. Further analysis performed revealed that the function was incorrectly identified in the requirements. Therefore, the phase introduced would be “requirements.” This field, along with Phase Found is also used to determine “phase containment” metrics for the IV&V Metrics Data.

2.1.10 Phase Found

This field should capture the development life-cycle phase of the project, at the Computer Software Configuration Item (CSCI) level (or similar), when IV&V first identified the issue. Examples of Phase found fields include the following: concept, requirements, design, implementation, test and operations and maintenance phases. Ask, “What phase of development is the CSCI currently in?” For example, if the CSCI is in the testing phase and you identify a requirement is not being fully tested in the test procedure, the phase found would be testing. The operations and maintenance phase is as the name implies once the project has completed all of the other lifecycles and is currently in functioning mode. This field, along with Phase Introduced is also used to determine “phase containment” metrics for the IV&V Metrics Data.

2.1.11 Phase Resolved

This field should capture the development life-cycle phase of the project, at the CSCI level (or similar), when the issue reached its final state.

2.1.12 Recommended Actions

The “Recommended Actions” field communicates closure expectations to the Mission Project. The field should state what needs to happen to move the issue to the closed state. It is not a place to state what the IV&V Team did to close the issue, as that information should go in the “Resolution Chronology” field.

Although the goal is to provide a statement of what needs to be done to close the issue, the statement should not provide a complete solution to the problem. This can be a difficult task. The goal is to provide possible courses of action without specifying exactly “how” to the Mission Project.

2.1.13 Resolution Chronology and Comments

After a TIM leaves the draft state, rationale for significant updates to the TIM shall be captured in either the “Comments” or the “Resolution Chronology” field. Determining which field to document in is dependent upon whether or not the issue has reached the “Submitted” state yet. The Comments field is to be used to capture all comments and suggested changes generated during the formal peer review and PM review before the issue gets to “Submitted”. Not all transitions before “Submitted” are required to be logged in the “Comments” field.

The following table details the required conditions for comments entry:

State Transition From:	State Transition To:	Comments logging required?	Detail Required:
Initial draft	Ready for Peer Review	No	N/A, first time through no additional data is required outside of what is already provided by the history tab.
Subsequent “Draft” states	Ready for Peer Review	Yes	Detail should be provided that correlates whatever changes were made to the issue that were required as a result of it being sent back to the “Draft” state. This ensures whatever changes required were made, etc. It gives us the complete picture of the issue.
Ready for Peer Review	Not an Issue	Yes	Describe why the issue is not an issue, (e.g., IV&V received further documentation that revealed the issue was not an issue).

State Transition From:	State Transition To:	Comments logging required?	Detail Required:
Ready for PM Review	Not an Issue	Yes	Describe why the issue is not an issue, (e.g., IV&V received further documentation that revealed the issue was not an issue).
Ready for Peer Review	Ready for PM Review	Yes	Formal peer review should be annotated. It should annotate any suggested changes and suggested “next state” of the TIM. Author of the issue should annotate the changes made and his next applicable state transition. NOTE: If there are no suggested changes then an entry should be made in the Comments field to indicate that the review was conducted and the state was (or is recommended to be) transitioned to the next applicable state.
Ready to Submit	Ready for Severity 1 & 2 Review	No	N/A. ORBIT automatically makes this transition therefore, no additional detail is required.
Ready for PM Review	Closed Before Submitted	Yes	Detail should be provided as to why the issue is now closed before submitted (the developer project released a new version of the artifact that fixed the issue)
Ready for PM Review	Submitted	Yes	PM documents his PM review comments, (e.g., No issues, recommend issue submittal)
Ready for PM Review	Draft	Yes	Detail should be provided as to why the issue was returned to draft (what additional information needs to be provided)
Ready to Submit	Submitted	No	The PM/PL should annotate when the issue was submitted to the project, (e.g., Submitted via email from PM John Doe to Jane Doe on 5/12/13).

Table 3 – Comments Logging Requirements

The “Resolution Chronology” field shall be used to document all changes to a TIM once the issue has reached the “Submitted” state (in ORBIT, the “Resolution Chronology” field is not available until the TIM has reached the “Submitted” state).

The goal is to include rationale for each change in a TIM. This is important whether the change is to the “State” or to some other field. For example: If the IV&V Team finds that the initial IV&V Severity of an issue was not correct and updates the IV&V Severity, an entry should be made in the “Resolution Chronology” (assuming the TIM has been submitted) field denoting why the IV&V Severity was changed.

Entries in the “Resolution Chronology” and “Comments” field should be clear and concise. Entries should minimally note why the TIM is being updated and how the TIM is changed.

For example: An entry about changing an issue’s state may read, “After reviewing the newly updated requirements document, XXX-XXX-YY, the corrective action has been completed and the issue has been moved to the ‘Closed’ state.”

Differences between “Resolution Chronology” and “Comments”: By default, “Comments” are only visible to “internal” IV&V personnel. So a Mission Project point of contact would be able to see any “Resolution Chronology” entries, but NOT any “Comments” entries. Also note that in ORBIT, the “Resolution Chronology” and “Comments” fields are logging fields, and therefore entries cannot be edited.

2.1.14 Duplicate Issue

If it is known for certain that the Mission Project also found this issue, then select “Yes”. If it is known for certain that the Mission Project did not find this issue, then select “No”. If unsure, leave this field blank.

2.1.15 Count

If this TIM is being used to capture more than one issue, then indicate the total number of issues in the “Count” field. For example, if you chose to write a single Severity 5 TIM with 17 editorial issues, then the “Count” field should be 17. Once a TIM has been “Submitted”, the “Count” field should not be modified.

The following are questions that should be answered when considering whether or not to combine issues using the “Count” field:

- 1) Does the issue exist across multiple artifacts?
- 2) Are the issues more than one IVV severity level?
- 3) Are the issues substantially different from one another?

If the answer is yes to any of these questions then these issues should not be combined.

Issues with multiple counts have metrics and issue resolution impacts. Therefore, before utilizing the “count” field functionality take extra care to ensure each usage of the instance represented by the multiple counts is accurately depicted. Also consider whether or not the IV&V team will take action to verify closure of the multiple issues captured in the TIM. If so, consider the impacts if the developer does not correct all of the issues in a single release of the common artifact.

See also Section 3.11, *Closed*.

2.2 Customized Fields

Additional information may be included in a customized Project Fields tab in the ORBIT database. These fields are specific to each project and may only be included via a request to the SWAT team. These fields contain information that may be relevant to the Project or IV&V Project team, but are not required or tracked facility-wide.

2.2.1 Defer Issue

One specific customized field is the Defer Issue field. The Defer Issue is used to note an issue where the Development project will not be addressing the issue any time soon (up to a year or longer possibly) due to factors such as the overall planned duration of certain project phases or the project has been re-baselined in a manner such that the issue is valid for a later scheduled release. The Defer Issue field allows IV&V to continue to track valid issues that will not be addressed short term without negatively impacting standard project metrics collection.

An issue can be deferred at any state in the current IV&V TIM state machine. To defer an issue, the Defer Issue field must be set to “True” and the following information provided:

- 1) Reminder date must be entered to define when ORBIT will send the first Reminder e-mail notification.
- 2) Reminder User defines the ORBIT user(s) to receive the reminder e-mail notification.
- 3) Reminder Note defines why the related issue has a Reminder.

While the Defer Issue is set true, the issue may not be moved to a different state. Additionally, while the Defer Issue is set true, the issue will not be included in the standard project metrics collection.

3.0 General Guidelines for Dispositioning a TIM

As noted earlier, it is important to disposition each TIM correctly. The state in which the TIM resides affects the metrics that the IV&V Program uses internally and the metrics that it presents to the Agency. The goal of this section is to provide some general guidelines about dispositioning TIMs. All TIMs originate in the Draft state. Once the TIM is formulated and deemed valid by the originator, the TIM is subjected to peer and approval reviews. Sections 3.1 – 3.2 discuss the Draft state and the review states in more detail. Once the reviews are completed and the determination is made that the TIM is valid, the TIM will be transitioned to the “Ready to Submit” or “Submitted” state. These states are described in Sections 3.3 and 3.4.

Prior to the “Submitted” state, there are two final states: “Not An Issue” and “Closed Before Submitted”. These states are further discussed in sections 3.5 and 3.6.

Beyond the “Submitted” state, there are five final states and one transitional state. The “To Be Verified” state is the transitional state and is described in detail in Section 3.7. The final states include: “Not To Be Verified”, “Closed”, “Project Accepts Risk”, “In Dispute”, and “Withdrawn.” It is possible to move a TIM out of the “Not To Be Verified”, “In Dispute”, and “Project Accepts Risk” states, but for the purposes of this discussion, they are considered final states. All of these states can only be reached once a TIM has been submitted to the Mission Project. By this point, each TIM should have received some attention from the Mission Project. It is important to understand what each of these states means and when to move a TIM to a given state. Each state is discussed in more detail in Sections 3.8 – 3.12.

3.1 Draft

All TIMs originate in the Draft state. An issue in the “Draft” state is still being formulated. It may or may not have passed through internal review states such as “Ready for Review”.

3.2 Review States

There are a number of review states that may or may not be visited between the time when an issue is “Draft” and when the issue is “Submitted” to the Mission Project or transitioned to a final state. These review states are intended to indicate responsibility for reviewing the content and quality of the issue. Currently these review states include:

“Ready for Peer Review”, “Ready for Severity 1 & 2 Review”, and “Ready for PM Review”. When a “Draft” issue is ready for internal review, the issue should be transitioned to the next possible review state. All of the review states other than “Ready for Severity 1 & 2 Review” are initiated by the reviewer whereas the “Severity 1 & 2 Review” state is an automatic state that ORBIT places severity level 1 & 2 issues in once the issue is transitioned out of the “Ready for PM Review” state. In this “Severity 1 & 2 Review” state an email notification is sent to the TQ&E Lead and the IVVO Lead to review the issue for content. If the issue content is approved then the issue is automatically sent to the “Ready to Submit” state. If the issue is not approved then the issue is placed in the “Draft” state. Comments are left by the reviewers detailing any further actions that need to be taken, as appropriate. Resolutions to the comments should be addressed with the reviewer prior to transitioning the TIM to the next state.

3.3 Ready to Submit

There are two reasons an issue should be placed in the “Ready to Submit” state.

- Issues are placed in this state automatically by the ORBIT tool after a severity 1 or 2 issue has left the severity 1 & 2 Review state after being approved by the IVVO Lead and TQ&E Lead for submittal to the project.
- Additionally, the state could be used as a staging area to collect a number of TIMs to be submitted as a set before being submitted together.

Note: At no point should an issue be languishing in the “Ready to Submit” state. Activity is expected to be reported on every issue.

3.4 Submitted

A “Submitted” issue has been communicated to the Mission Project, but the Mission Project has not yet responded. Once the Mission Project has responded, then the TIM should be transitioned out of “Submitted” and into the appropriate state.

3.5 Not An Issue

“Not An Issue” is used for invalid issues that have not been submitted to the Mission Project. If at any point during formulation or peer review of the issue, the issue is deemed invalid, then “Not An Issue” is the appropriate state.

3.6 Closed Before Submitted

This state is used when the Mission Project has fixed the issue PRIOR to IV&V's submitting the issue. For example, suppose IV&V has identified a missing requirement in Rev A of an SRS. While the issue is still being formulated or peer reviewed, Rev B of the SRS is released, and IV&V confirms that Rev B contains the missing requirement, resolving IV&V's issue. The issue would be moved to "Closed Before Submitted", indicating that the issue was valid, even though it was never communicated to the Mission Project.

3.7 To Be Verified

If the Mission Project has agreed that the issue is valid and there is an acceptable resolution identified, and IV&V intends to confirm the fix after it has been implemented, then the issue should be transitioned to "To Be Verified". Once the IV&V Team has verified the proposed resolution has been implemented, the TIM should be transitioned out of "To Be Verified" and into the "Closed" state. If the proposed resolution was not completely or correctly implemented, then the TIM should remain in the "To Be Verified" state and the Resolution Chronology updated to reflect the conclusions of the IV&V team's verification activity. The IV&V Team should then inform the Mission Project of the status of the TIM.

3.8 Not To Be Verified

Only TIMs of Severity 4 and 5 should be placed in this state. The IV&V Team uses this state when the Mission Project understands the issue documented in the TIM and may or may not fix the issue. However, due to the low severity, the IV&V Team is not going to evaluate the artifact to see if the fix has actually been made. If the severity of a TIM changes to something other than a 4 or a 5, then the TIM should be moved out of this state and back to the "To Be Verified" state.

3.9 Project Accepts Risk

The IV&V Team moves an issue to this state when the Mission Project has chosen to not address the issue directly and instead agrees to accept the associated residual risk, and IV&V agrees with that decision. This state is only applicable to TIMs of severity 3 and 4. Higher severity TIMs (Severity 1 or 2) that the Mission Project is choosing not to address should use a different state, such as "In Dispute." Severity level 5 TIMs cannot be in this state since this state does not imply any risk associated to the IV&V project based on IV&V Severity Definitions (section 5.0). The final state for severity level 5 TIMs is "Not to Be Verified."

While the Mission Project is not required to track the issue/risk in its risk tracking system, the IV&V Team should consider recommending Mission Project risk tracking for all severity 3 TIMs in the “Project Accepts Risk” state to facilitate awareness for project management and review boards at each major milestone decision point.

From this state a TIM can only move to the “In Dispute” or “To Be Verified” states. The TIM may change states due to changes in severity or in the Mission Project’s intent to correct the issue rather than accept the risk.

3.10 Withdrawn

This state is used when the IV&V Team and the Mission Project both agree that the issue documented in the submitted TIM is not valid. Generally, this occurs when the Mission Project presents additional information that the IV&V Team did not have during its initial analysis. For this reason (and other potential reasons), placing a TIM in the Withdrawn state is not necessarily viewed negatively. “Withdrawn” is considered a non-impact state (see Section 1.3 above), because the TIM did not result in any changes or acceptance of risk by the Mission Project. Issues of any severity can be placed in the “Withdrawn” state.

3.11 Closed

This state is used when the Mission Project accepts an issue and responds to the issue with a specific correction to resolve the issue or a change that results in the issue being “Overcome by the Events” and the IV&V Team verifies the correction or change is correct and complete. Determining whether a TIM should be closed can sometimes be difficult. This difficulty can be exacerbated by TIMs that have multiple counts or are based on a number of repeat occurrences in an artifact. With regard to multiple counts being used, be sure to refer to the appropriate sections of this document to ensure that each count actually represents a separate issue of the identical severity. Before submitting an issue with multiple counts, it is imperative that the IV&V team discuss and have a plan for how to disposition and track the issue if only some counts may be fixed while leaving others unfixed. If there is significant possibility of being in a “partial closure” situation, it is recommended that multiple issues be used instead of the counts field. If an issue is a single count, but is based on a number of essentially identical artifact defects, it is important for the IV&V team to have decided, before submission, how many of the instances must be accepted and fixed for the issue to be closed. In most cases, it is unrealistic to expect all instances to be fixed. Consideration should be given to how many instances aggregate to support the severity. This is important to avoid the situation where instances are corrected, and the IV&V team is faced with downgrading the severity. Instead, the severity

should be maintained, and the issue closed. If some important level of “residual” issue remains, the IV&V team may open a new issue that has the lower severity. To the extent possible, this up-front thought should be captured in the TIM Recommended Actions so both the project and IV&V is clear on what constitutes acceptable closure of the issue.

3.12 In Dispute

This state is used when the IV&V Team and the Mission Project disagree about whether or not the issue documented in the TIM is valid, or when the IV&V Team and the Mission Project disagree about a proposed or implemented resolution to the TIM. In the case where the Mission Project agrees that a severity 3 issue is valid but does not agree to accepting the risk and documenting the rationale or correcting the issue, and the IV&V Team feels that not doing so is unacceptable, then “In Dispute” is appropriate, and the issue can remain in this state indefinitely.

4.0 Summary

The information captured in ORBIT is used by both the NASA IV&V Projects and the NASA IV&V Program. The IV&V Projects use the data to communicate their issues to the Mission Projects. The IV&V Program uses the data in ORBIT to demonstrate the Program’s effectiveness through the Agency Metrics Report and also various Agency briefings in which effect on the Agency is discussed (e.g., the IV&V Board of Advisors meeting).

The information contained in a TIM should be sufficient for an external reviewer to understand the issue and its disposition from conception to final resolution. The information must be complete to allow for “defendability” of the issue and its characteristics (e.g., severity, impact to project, etc.) at any point in the issue’s life cycle.

For more information, discussion, or assistance in using this document, see the Technical Quality and Excellence (TQ&E) Lead.

5.0 IV&V Severity Definitions

TIM severity is assigned a numerical value ranging 1-5 based on the definitions in the following table:

Severity	Capability Affected	Success Criteria	Safety	Test	Cost & Schedule	Other
1 Catastrophic	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
2 Critical	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
3 Moderate	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
4 Minor	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
5 Communications Or Editorial	Defect impacting documentation and communication clarity					

Table 4 – IV&V Severity Definitions

Note that the severity definitions convey concepts to cover a broad range of situations or conditions. Due to the diversity of Projects not all definitions may apply directly. Further clarification of some terms used in the above table is provided as follows:

- Capability – the action or reaction of the system desired to satisfy a mission objective
 - Essential Capability - what the system must be capable of doing in order to achieve minimum mission success
 - Non-Essential Capability – a capability that is not specifically required to achieve minimum mission success

- System Dependability – Probability that a computer or other system will perform its intended functions in its specified environment without significant degradation.

- Mission Success:
 - Minimum Mission Success Criteria/Objective – a primary goal of the mission. Inability to meet a primary goal will result in mission failure
 - Mission Objective – a goal of the mission that is desired but not considered minimum mission success criteria
 - Extended/Optional Mission Objective – an extension of a goal of the mission (an objective related to a system component or functionality which maybe depended on by an essential or non-essential capability), not considered a mission success criteria

- Loss – An inability to function or perform as needed to meet an objective
 - Loss of Essential Capability or mission critical asset will lead to inability to achieve minimum success criteria (mission failure)
 - Loss of Non-Essential Capability will lead to inability to achieve extended/optional mission objective (failure of functionality that is system or component dependent or part of non-essential capability, but will not result in mission failure)

- Degradation – A gradual impairment in ability to perform one or more functions².
 - Meets minimum success criteria
 - May no longer meet one or more Mission or Extended/Optional Mission Objectives

² NASA-STD 8709.22, Safety and Mission Assurance Acronyms, Abbreviations, and Definitions

6.0 Issue Category/Type Definitions

Issue Category	Type	Definition
Concept	Incomplete Reuse Concept	<p>The reuse planning documentation does not meet the needs of the new application.</p> <p>As an example, a function within the concept documentation (e.g., Concept of Operations) describes a capability associated with the heritage system that the reuse documentation does not mention.</p>
Concept	Missing Architecture Concept	The documented architecture (subsystems, components, etc.) does not demonstrate the capabilities required to carry out the mission.
Concept	Insufficient Computing Concept	The proposed concept documentation contains capabilities that cannot be supported by the intended computing resources.
Concept	Inconsistent Feasibility Concept	Key decisions made by the mission are not supported by feasibility studies that have been performed.
Concept	Incomplete Software Hazard Causes Concept	Software based hazard causes, contributors, and controls are not documented, and may not be known.
Concept	Incomplete Security Threats Concept	Security threats and risks are not documented (and may not be known), and/or governing requirements have not been identified.
Requirements	Ambiguous Requirement	The requirement is not concisely stated or has nontechnical jargon, undefined terms/acronyms, or other esoteric verbiage. The requirement is subject to more than one interpretation.
Requirements	Incomplete Requirement	The requirement is not fully stated or has incomplete information.
Requirements	Inconsistent Requirement	The requirement contradicts other requirements or is not fully consistent with all authoritative documentation.
Requirements	Incorrect Requirement	The requirement is not correct as written in the documentation.

Issue Category	Type	Definition
Requirements	Missing Requirement	An important system/software requirement is missing.
Requirements	Extraneous Requirement	An unnecessary, extraneous, or redundant requirement.
Requirements	Insufficient Requirement Traceability	There is a missing, incomplete, or incorrect trace between parent and child requirements.
Requirements	Unverifiable Requirement	The requirement cannot be verified through inspection, demonstration, testing, or analysis.
Requirements	Configuration Management	Requirements are not sufficiently documented, controlled, and accounted for throughout the software development lifecycle.
Design	Ambiguous Design	The design element is not concisely stated or has nontechnical jargon, undefined terms/acronyms, or other esoteric verbiage. The design element is subject to more than one interpretation.
Design	Insufficient Design Traceability	There is a missing, incorrect, or bad trace between the system architecture and design elements, or trace between requirements and design.
Design	Incomplete Design	The design element is not fully stated or has incomplete information.
Design	Inconsistent Design	One design element contradicts another or is not fully consistent with all authoritative documentation.
Design	Incorrect Design	The design element is not correct as written in the documentation.
Design	Missing Design	An important design element is missing.
Design	Extraneous Design	An unnecessary, extraneous, or redundant design element.
Design	Defective Test Design	A defect with the design of a test (off-nominal conditions that may not be included in test design). This issue would be introduced before a Test Procedure is written.
Code	Incomplete Code	The code does not completely address an associated requirement.

Issue Category	Type	Definition
Code	Inconsistent Code	The module or function is written in a manner that conflicts with other modules or functions in the code. Including but not limited to inconsistent data conversions, inconsistent coding standards, and inconsistent nomenclature.
Code	Incorrect Code	The module or function is incorrect as written. Including but not limited to: incorrect logic, incorrect expressions, incorrect syntax, and incorrect usage of signs.
Code	Missing Code	An important module or function is missing from the current build of code. Also, essential requirements that cannot be traced to code.
Code	Extraneous Code	Unnecessary, extraneous, or redundant code. Also, segments of code that cannot be traced back to a requirement.
Code	Unreachable Code	A section of code is not reachable by any path through the software.
Code	Insufficient Code Documentation	Documentation of code is incomplete, inconsistent, incorrect, or ambiguous.
Test	Ambiguous Test Article	The test article (plan, procedure, script, etc.) is not concisely stated or has nontechnical jargon, acronyms without definitions, or other esoteric verbiage. The test article is subject to more than one interpretation.
Test	Incomplete Test Article	The test article (plan, procedure, script, etc.) is not fully stated in one place or has incomplete information.
Test	Inconsistent Test Article	One test article (plan, procedure, script, etc.) contradicts another or is not fully consistent with all authoritative documentation.
Test	Incorrect Test Article	The test article (plan, procedure, script, etc.) is not correct as written.
Test	Missing Test Article	An important test article (plan, procedure, script, etc.) is missing.

Issue Category	Type	Definition
Test	Incomplete Test Results	The test results are not fully documented or have incomplete information.
Test	Inconsistent Test Results	The test results are not consistent with expected output or are not consistently documented.
O & M	Insufficient Disaster Recovery Plan	The disaster recovery plan does not adequately describe necessary activity to restore critical operation to the system in the case of an extended system outage.
O & M	Incomplete Software Deployment Readiness	The plans for operational readiness and deployment of the software are not well formulated.
O & M	Inconsistent Operating Procedures	The operating procedures are either not consistent with user documentation and/or do not conform to system or mission requirements.
O & M	Insufficient Analysis of Software Anomalies	A software anomaly has occurred but the determination of its cause and the proposed/implemented fix is incorrect or inadequate.
O & M	Insufficient Operations Training Documentation	Training documentation for system operators does not provide enough (or correct) guidance to enable the correct use of the system (as it is expressed in system design and implementation).
O & M	Insufficient Software Transition Plan	Software Transition Plan does not fully or correctly address the migration needs of the software, does not express the impact on existing systems/databases, and/or describe the necessary actions to archive software, does not adequately address the transition to a new software product, or contains errors.

Issue Category	Type	Definition
O & M	Insufficient Software Retirement Plan	Operations environment does not fully address the retirement needs of the software, does not express the impact on existing systems/databases, and/or describe the necessary actions to archive software, does not address the transition to a new software product and/or provide user notification.
O & M	Inconsistent End-User Documentation	User documentation is not consistent with the implementation and does not communicate the use of the user-accessible system functions.