S3105: Guidelines for Writing IV&V TIMs

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Note: The official version of this document is maintained in IV&V's internal IV&V Management System Website (https://confluence.ivv.nasa.gov:8445/display/IMS). This document is uncontrolled when printed.

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 Resolve issue tracking repository.   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 Resolve is used by the IV&V Program to demonstrate its effectiveness to the Agency. The introductory sections are included in an attempt to assure that IV&V Program-level metrics are widely known and understood by producers and consumers of this data. The desired result is that IV&V Project data will be more consistent and better understood; thus yielding more meaningful and credible IV&V Program data.

1.1 Scope

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

guidelines useful. Reference the [Static Code Analysis TIM Writing Guidelines](#) for specific information relating to writing static code analysis TIMs.

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", "References", "Impact", and "Recommended Actions" fields in Resolve. These 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; however, they are also used individually to highlight the value being provided by the individual IV&V Teams. 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 Resolve. 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:

Impact States	Non-impact States

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 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.

Even though metrics represent a snapshot in time, it is very important to make sure that the current and final state of a TIM are correct, 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 Resolve. The states are discussed in detail in Section 3.0 of this document.

Another key metric is "Phase Containment". The goal of this metric is to articulate the value of the early detection of defects and to measure the degree of alignment with the system and software development. While it is rare that a NASA development project follows a true Waterfall or linear/sequential software development lifecycle, the concept of phase containment remains relevant given that it is focused on ascertaining whether or not IV&V is identifying defects in the same phase they were introduced. While the Waterfall model for software development does not readily offer the flexibility needed to effectively construct the complex safety and mission critical systems evaluated by NASA IV&V, the model is effective in serving as a straightforward representation of the software development

lifecycle (SDLC) and as well as a basis for communicating the effectivity of timely issue resolution through the application of IV&V.

It is most common for IV&V projects to observe a derivate of an iterative or incremental approach to the software development; however, the use of Agile approaches and constructs are being observed on a number of systems and subsystems receiving IV&V. The use of such approaches do present some complications for ascertaining phase containment; however, the metric is still applicable and determination of phase containment is still very much attainable. Irrespective of the development model followed, somewhat traditional software products (Ex. concept documentation, architecture specifications, requirements at varying levels of specificity, design specifications, code and code products, and verification and validation test products at various levels) are still developed under most models; however, the approach to how those products are developed as well as the content of those products will vary.

In aiding the IV&V Program in calculating this metric, the Phase Introduced and Phase Found parameters are captured in the IV&V generated TIMs. Both of these parameters are focused on what activity the **developer** was performing when the issues were both introduced and then subsequently detected by IV&V. The PM and PL can serve as a valuable resources in helping make this determination when questions arise regarding the correct determination.

Phase Found tends to be a more straightforward determination and is focused more so on the phase and product in which the defect was identified by IV&V. While phase and product may not always be synonymous, for the purposes of calculating this parameter it is recommended the product under evaluation be used as a basis for the initial determination of the Phase Found. This approach aid in a more consistent determination, thus reducing error and noise in the metric, but also help address the nuances associated with delayed product delivery to IV&V.
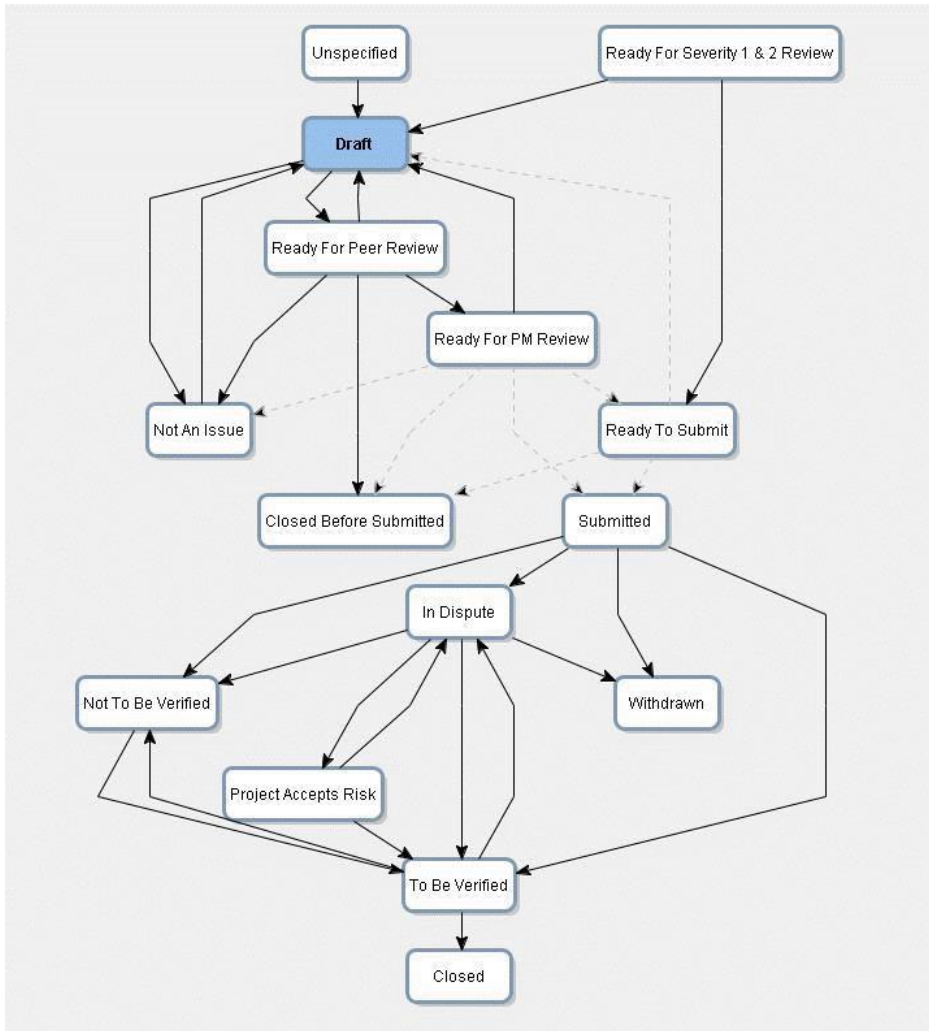
Figure 1 – Current IV&V TIM State Machine (in Resolve)[1]

[1] There are no lines going into "Ready for Severity 1 & 2 Review" since the state is automatically entered by the tool once the issue is promoted from the "Ready for PM Review" state.

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 using the specified waiver process.

1.4 Capturing our potential findings in a common repository

IV&V captures potential findings in a common repository (i.e., Resolve). 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.

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  - *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 valid,invalid, how issues were found, and how they were resolved can increase mission, system, and software understanding and lead to improved future IV&V.
  - *Intra-project knowledge sharing.* Understanding how the issue evolved, how the project responded and why issues were deemed valid/invalid can facilitate calibration of IV&V delivery to minimize unproductive churn and ensure timely disposition of issues.
  - *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.

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  - *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.

It is the guidance of the IV&V Office to not formally document Severity 5 TIMs in Resolve. Before writing any TIM, evaluate whether it would be Severity 5 or not (refer to IV&V Severity Definitions in Section 5.0 of this document). If the TIM would be Severity 5, pass the issue along informally (e.g., verbally or via email) to the Mission Project. Also consider communicating Severity 5 level concerns informally to the Mission Project's Software Quality Assurance (SQA) representative, as they may indicate process breakdowns.

In the following guidelines, all references to Severity 5 TIMs are assumed to be TIMs that were believed to be a higher severity when they were written but have since been downgraded to Severity 5.

2.1 Required Fields for a TIM

The following fields are required:

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. It is advisable to include the requirement ID or the artifact name where the issue was identified in the subject.

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 are consistent with 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 simply use 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.

For Severity 4 TIMs, the contents of this field should be brief. That is -- does this give the developer enough information to understand the issue and IV&V enough information to close it?

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:

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  - o Enables the collection 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.
  - o Reduction of rework by the IV&V project to correct any errors previously identified in this area;
  - o Reduction in QA time performing reviews of issue(s) as this common error is now addressed and will not have to be documented anymore;
  - o 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.

For Severity 4 TIMs, the contents of this field should be brief.

2.1.4 Method

The "Method" field exists to link the technical issue with the IV&V method from the Catalog of Methods, as documented in COMPASS, that was employed in the identification of the issue.

If the TIM is not a result of method-based analysis, then select the "Non Method Analysis – See Comments" option, and indicate how the TIM was found in the Comments field.

2.1.5 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.

As noted at the beginning of Section 2.0, Severity 5 TIMs are not required. Issues can be downgraded from a higher severity (typically Severity 4) down to a Severity 5 issue based on new information that is discovered.

Other severity information (e.g., project-specific severity information) may be included in a customized Project Fields tab in the Resolve issue tracking repository. 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.

2.1.6 Impact

The "Impact" field provides the rationale for the assigned severity, and is therefore essential. When writing Impact Statements, the TIM author should consider the following questions as guidelines:

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  - How does this defect affect the next step in the development of the system?
    - The goal in the answer to this question is to help the developer understand the impacts of this defect on the system development. It helps provide the developer with some near-term focus and

allows them to see how the defect affects their future development efforts.

- o   If left uncorrected, what is the most impactful negative consequence that can reasonably be projected to occur?
  - ▪   The question provides the developer with insight into the realization of the defect as a failure in the system. The answer should discuss a realistic scenario in which the defect may be realized as a failure.
  - ▪   The impact of test issues should normally not propagate beyond the test program, unless an extenuating circumstance can be proven, meaning the test category of the Severity definitions should only be used for test issues.

Although IV&V Severity ratings aren't accompanied with an explicit likelihood assessment, the probability that the stated impact will be realized should be reasonable and defendable. If a multi-fault scenario is described, the *Impact* should reflect, and demonstrate IV&V's understanding of the fault tolerance requirements of the system.

Sound engineering judgment should be applied when determining IV&V Severity and developing Impact Statements. The goal of this assessment is to understand and communicate the negative consequence of the issue if not corrected by the developer on both the development of the system as well as the operation of the system. Plausibility of the asserted impact is critical, as it conveys IV&V's system understanding and convinces the developers of the nature of the issue and the need to correct it.

The Impact statements should describe a logical flow that not only explains what can happen, but explains how the system may reach this state. It is not sufficient to simply state that the system fails.

As noted in Section 2.1.5, *IV&V Severity*, the operational portion of the Impact Statement should be congruent with the assigned IV&V Severity as described in Section 5.0, *IV&V Severity Definitions,* of this document. The Impact Statement should provide sufficient rationale for the severity assigned when congruency to the definitions is not clear.

For efficiency, Severity 4 TIMs' Impact Statements should simply be a copy of the description provided in the IV&V Severity level definition table in Section 5.0, without elaboration on those details. Brief alternate text is acceptable for the rare cases when the rationale for Severity 4 does not fit definition text.

2.1.7 Technical Framework (IVV 09-1) Version

This field is the current version of the IVV 09-1 Independent Verification and Validation Technical Framework System Level Procedure (SLP) the IV&V project is

currently adhering to when the analysis that results in the issue is performed. This is the version referenced in the IV&V Project Execution Plan and mapped to in the project's Technical Scope and Rigor document.

2.1.8 Technical Framework Level 1 Objective

This field is the top level objective of the NASA IV&V Technical Framework IVV 09-1 the TIM relates to. For example, for version "O" of the IV&V Technical Framework the work breakdown structure choices would include the following:

1. Management and Planning
2. Verify and Validate Concept Documentation
3. Verify and Validate Requirements
4. Verify and Validate Test Documentation
5. Verify and Validate Design
6. Verify and Validate Implementation
7. Verify and Validate Operations and Maintenance Content

This value will change based on what version of the technical framework the project is adhering to.

It is possible that the TIM is not the result of IV&V Technical Framework based analysis. If this is the case, the "Non-Technical Framework Analysis" option should be selected.

2.1.9 Technical Framework Level 2 Objective

This field states which sub-objective the issue relates to. For example, for version "O" of the IVV 09-1 IV&V Technical Framework if an analyst is working on 4.0 Verify and Validate Test Documentation then the selections would be the following:

4.1   Ensure that the planned tests are sufficient to: <see below for 4.1.1 through 4.1.5 - TF Level 3 Objective>

4.2   Ensure that valid relationships are defined between the Test Plans, Designs, Cases, and Procedures for test types and documents subject to IV&V test analysis.

4.3   Ensure that the planned regression testing to be performed when changes are made to any previously examined software products is sufficient to identify any unintended side effects or impacts of the change on other aspects of the system.

4.4   Ensure that any simulations are sufficiently complete, correct, and accurate to perform the intended testing.

4.5   Ensure that the Test Cases under analysis specify the correct test inputs, predicted results, and sets of execution conditions necessary to satisfy their intended test objectives (covering both nominal and off-nominal conditions).

4.6   Ensure that the Test Procedures under analysis specify the correct sequence of actions necessary for the execution of the tests to satisfy their intended test objectives.

4.7   Ensure that the Test Designs under analysis correctly specify the details of the test approach for the covered software feature or combination of software features and identify the associated tests.

4.8   Ensure that the test environment is sufficiently complete, correct, and accurate to perform the intended testing.

2.1.10 Technical Framework Level 3 Objective

The Technical framework level three objective states which sub-level 3 objective the issue relates to. For example, for version "O" of the IVV 09-1 Technical Framework if an analyst is performing 4.1 of Verify and Validate Test Documentation then these would be the options available:

4.1.1   Ensure that the software correctly implements system and software requirements in an operational environment under nominal and off-nominal conditions.

4.1.2   Ensure that the complete, integrated system complies with its specified system requirements allocated to software and to validate whether the system meets its original objectives.

4.1.3   Ensure that the software meets all of the (in-scope) software requirements and is ready to be integrated with system hardware.

4.1.4   Ensure that the software correctly implements the software requirements and design as each software component (e.g., units or modules) is incrementally integrated with each other.

4.1.5   Ensure that the software components (e.g., units, source code modules) correctly implement software component requirements.

This field is automatically populated by Resolve based on which Technical Framework Level 2 Objective was chosen.

2.1.11 Capability

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

2.1.12 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 Resolve, "Issue Type" is automatically filtered based on the "Issue Category" field.   The listing of issue types can be found in Resolve.

Any changes to issue category/types go through an approval process and subsequently are updated in Resolve and communicated to the IV&V community.

2.1.13 Phase Introduced

When assessing Phase Introduced, the TIM author needs to ascertain what activity was being performed, from a SW development standpoint, when the defect was initially created. This may be straightforward in many cases, but in others may require some root cause analysis to determine when and where the defect ultimately originated.

This field is one of the two fields used for calculating issue "phase containment". Phase introduced records the development life-cycle phase of the project, build, release, 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 may be 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."

2.1.14 Phase Found

This field is one of the two fields used for calculating issue "phase containment". It should capture the development life-cycle phase of the project, build, release, 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.

2.1.15 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.

For Severity 4 TIMs, the contents of this field should be brief.

2.1.16 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 "Resolution Chronology" field shall be used to document all changes to a TIM once the issue has reached the "Submitted" state (in Resolve, 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. Reference the level of detail required in Confluence or at the following ECM location: Enterprise/IV&V OFFICE/TQ&E/01 - Guidance Documents/ Resolution Chronology and Comments.docx

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 Resolve, the "Resolution Chronology" and "Comments" fields are logging fields, and therefore entries cannot be edited.

2.1.17 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.

2.1.18 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 TIM with 17 instances of the issue, 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.

While a specific numerical limit has not been established for the Count Field, it should be noted that 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. Finally, the presence of multiple instances of an issue may be indicative of a broader, systemic risk which may be a more appropriate way (i.e., external risk) to address the concern.

See also Section 3.11, *Closed*.

2.1.19 Reason for Return to Draft

Entry into this field is only required when an issue is being returned to Draft from the Ready for PM Review state. The PM is required to select one of the "Reason for Return to Draft" issue categories. A detailed listing of the "Reason for Return to Draft" fields is located in Confluence and also at the following location under ECM:

Enterprise/IV&V OFFICE/TQ&E/01 - Guidance Documents/

Reason for Return to Draft Categories and Guidance.docx

In some cases additional information is required to be captured in the comments. See also Section 2.1.16, *Resolution Chronology and Comments*, for a listing of the additional information required.

2.2 Customized Fields

Additional information may be included in a customized Project Fields tab in the Resolve repository. 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

The Issue Defer capability is a method to place an issue on hold (defer) that may not be otherwise addressed by the Development Project in the near future. The capability allows a user to defer an issue for up to a year before being reminded that the issue was deferred.

Deferring issues before they are submitted is appropriate only in situations where the issue is viable, but the developer is unable or unwilling to process it until a future date.

For more information about this capability, go to the Deferring Issues page on the SWAT space.

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.

If the originator or reviewers determine that a drafted TIM is Severity 5 prior to reaching the "Submitted" state, the TIM should be transitioned to the "Not An Issue" state.

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.

IV&V projects are allowed discretion as to whether Severity 4 TIMs should be verified or not. IV&V project managers are ultimately responsible for this determination. Multiple factors may influence the decision to verify or not verify the resolution of a Severity 4 TIM. In determining whether or not to verify the resolution of a Severity 4 TIM, the IV&V PM shall consider the resource impact to IV&V and balance that with the expected value that will come from verifying resolution by the Project. The IV&V PM should maintain awareness that the presence of a large number of related Severity 4 issues could indicate a larger, systemic issue or process breakdown and may present the aggregate implication of these issues as a risk to the project.

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 Peer 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 Resolve 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. When the PM returns the issue to Draft state, the PM must choose a reason from the "Reason for Return to Draft" field. See section 2.1.19, *Reason for Return to Draft,* for more details. Details are required to be input into the Comments field per section 2.1.16, *Resolution Chronology and Comments*.

For Severity 4 TIMs, the review should be simplified and should focus on verifying that the correct severity has been chosen, i.e., that we are not mistakenly dealing with a higher (or lower) severity issue.

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 Resolve repository 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 for an extended or indefinite period of time 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.   Once the Mission Project has responded with appropriate resolution plans, corrections or information that IV&V accepts, the TIM should be transitioned 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, and it is the IV&V Office's position that the Not To Be Verified state be utilized for all Severity 4 and 5 TIMs . The IV&V Team uses this state when the Mission Project acknowledges the issue documented in the TIM is valid but may or may not fix the issue. 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.

Any TIM that has reached "Submitted" state and is then downgraded to a Severity 4 or Severity 5 should be transitioned to "Not To Be Verified" state. No further tracking is done at this point for such TIMs.

Acknowledgement by the Mission Project can be any response of receipt (e.g., verbal, email, etc.); document the acknowledgement in the Resolution Chronology field.

Also consider communicating informally to the Mission Project's Software Quality Assurance (SQA) representative any Severity 5 TIMs downgraded from a higher severity, as Severity 5 issues may indicate process breakdowns.

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."

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 Resolve 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 Resolve 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	Oth
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 resulting from immediate or downstream development impacts	Signific reductio requirem margins 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	Moderate cost or schedule impact resulting from redesign, reimplementation, and/or retest	Degrada of an es capabili inability accomp mission objectiv with a k workaro
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 inconve for oper crew or projects personn
5 **Communications** **Or Editoria**l	Defect impacting documentation and communication clarity and poses no risk to the Missio Project.					

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 - a set of behaviors the system must be capable of performing in order to achieve minimum mission success
    - Non-Essential Capability – secondary behaviors that are 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
    - *NOTE: Maintain awareness of the potential for errors or inconsistences between operations documents and implemented capabilities to impact mission success (i.e. user manual specifies action that could damage an instrument)*

- 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 functions [1].

    - Meets minimum success criteria
    - May no longer meet one or more Mission or Extended/Optional Mission Objectives
    - *NOTE: Maintain awareness that the presence of a large number of related Severity 4 issues could indicate a larger, systemic issue*

- Adequacy - the degree to which something meets requirements
    - Not every binary condition must be tested for adequate coverage, some may be redundant
    - Adequate coverage ensures the minimum viable set of behaviors have been verified to meet nominal and off-nominal requirements

- Workaround - this is a formally documented procedural approach to partially or fully mitigating the impact of an issue
    - Normally would be part of user guide or policy, included in formal operations documents (not a code hack or an undocumented procedure)
    - The presence of a viable workaround will always result in downgrading the severity, with 3 generally being the highest reasonable severity with a workaround documented

[1] NASA-STD 8709.22, Safety and Mission Assurance Acronyms, Abbreviations, and Definitions

References

REFERENCES	
Document ID/Link	**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
ECM…/IV&V OFFICE/TQ&E/01 - Guidance Documents/…5618931	Issue Category and Type Definitions
ECM…/IV&V OFFICE/TQ&E/01 - Guidance Documents/…5618948	Resolution Chronology and Comments
ECM…/IV&V OFFICE/TQ&E/01 - Guidance Documents/…5618305	Reason for Return to Draft Categories and Guidance
COMPASS Tool	Catalog Of Methods Process Asset Selection System
Confluence...9961661	TQ&E TIM Guidance
ECM.../IV&V OFFICE/ SWAT/ TASC SWAT Support/ SCAWG/ Products/ 2014 Products/ TIM Writing Guidelines/...5716752	Static Code Analysis TIM Writing Guidelines

If any procedure, method, or step in this document conflicts with any document in the NASA Online Directives Information System (NODIS), this document shall be superseded by the NODIS document. Any external reference shall be monitored by the Document Owner for current versioning.

Version History

VERSION HISTORY			
Version	**Description of Change**	**Rationale for Change**	**Author**
Basic	Initial Release		Kenneth Costello
A	Changed "IV&V Facility" to "IV&V Program"		Stephanie Ferguson
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 Northe
C	Updated IV&V Severity Definitions, remove PITS		Jeff Northey

| 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 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 | Cheryl Vandegrift |

VERSION HISTORY			
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Basic	Initial Release		Kenneth Costello
		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

VERSION HISTORY			
Version	**Description of Change**	**Rationale for Change**	**Author**
Basic	Initial Release		Kenneth Costello
F	• 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 details. • Miscellaneous 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

VERSION HISTORY			
Version	**Description of Change**	**Rationale for Change**	**Author**
Basic	Initial Release		Kenneth Costello
G	- Added detail to sections 2.1.12, 3.2 and subsequent section 2.1.15 depicting the return to Draft field requirement. - Removed Table 2, *TIM Fields*. - The comments example in Table 2 (was Table 3), *"Comments Logging Requirements"* for Ready for PM Review (RPMR) to submitted state was modified to state best practice. - Miscellaneous editorials.	The "Reason for Return to Draft" field is necessary to provide additional detail as to why the issue is required to be returned to the "Draft" state from the RPMR state. This assists with continuous improvement in that area. Additionally, the resolution chronology field was included under an incorrect example in Table 2. Modification of the comments required for logging from the RPMR state to Submitted needed to be modified to better reflect best practice.	Cheryl Vandegrift

H	- Added the Method field to section 2.0. - Removed Tables 2, 3 and 5 and replaced them with references (links to ECM and Confluence). - Deleted section 6.0 as it is now obsolete. - Added the following categories to section 2.1: Included the Technical Framework Level Objective 1, 2, 3 and the IVV 09-1 Technical Framework version field.	The Method field is necessary in order to provide a link between the Catalog of Methods and the technical issues found through the use of those Methods, to support the Catalog of Methods continuous improvement efforts. Removed the tables: "Reason for Return to Draft", "Issue Category/Type Definitions", and "Comments Logging requirements" since their information is at a level of detail that is subject to change frequently; this allows those changes to occur quicker and maintenance of S3105 is easier. In order to ensure that data being captured in ORBIT is up-to-date with the IVV 09-1 version changes, the Technical Framework field and subsequent Technical Framework level objective 1, 2, and 3 fields were necessary to be captured.	Cheryl Vandegrift
I	Updated the "Submitted"	"Submitted" definition change needed for	Cheryl Vandegrift

VERSION HISTORY			
Version	**Description of Change**	**Rationale for Change**	**Author**
Basic	Initial Release		Kenneth Costello
	state definition. • Added a reference to the SCAWG's TIM Writing Guidelines in "References" section and added a note to section 1.1 referencing the Static Code Analysis TIM Writing Guidelines. • Miscellaneous grammatical and formatting changes.	clarification and to help delineate between "Submitted" and "To Be Verified" states in the cases where projects have received feedback from developers but have yet to review and agree on the action taken. The SCAWG reference provides the needed correlation to the static code analysis TIM writing guidelines to provide additional assistance where needed. The grammatical and formatting changes were necessary for formatting consistency and clarity.	

VERSION HISTORY			
Version	**Description of Change**	**Rationale for Change**	**Author**
Basic	Initial Release		Kenneth Costello
J	- Add new guidance to relax Severity 4 TIM processing and remove requirement to formally document Severity 5 issues. - Clarify that Severity 4 and 5 TIMs are not considered impactful and are not included in IV&V metrics.	Changes were needed to improve the efficiency and reduce the cost of handling lower severity (4 and 5) issues. Clarification was needed for better understanding by IV&V analysts and other users of this document.	Darilyn Dunkerley

VERSION HISTORY			
Version	**Description of Change**	**Rationale for Change**	**Author**
Basic	Initial Release		Kenneth Costello
K	Sections: 2.0, clarify no/ few Sev 5 TIMS in Resolve; 2.1.6, expand guidelines for Impact statements; 2.1.12, guidance in Resolve; 2.1.18, clarify Count usage; 3.0, update disposition of TIMs; Many - ORBIT to Resolve.	To reflect the inclusion of lessons learned related to the development of impact statements, issue counts, and tracking of Sev 5 issues. Additionally, IVVO implemented a new repository (Resolve) for issue management and tracking which needed to be reflected in the guidelines.	Wesley Deadrick

VERSION HISTORY			
Version	**Description of Change**	**Rationale for Change**	**Author**
Basic	Initial Release		Kenneth Costello
L	added clarification that waivers to this guide should follow the IMS waiver process in IVV 13; 1.3, 2.1.13, 2.1.14, added discussion about phase containment; 1.4, clarified intra vs cross project benefits; 2.1.1, best practice to ID source of issue in subject; 2.1.4, Removed TS&R reference; 2.1.6, added clarification regarding test impacts; 2.2.1, clarified use case for deferring TIMS before submission; 3.8, resolved ambiguity over protocol for NTBV; Table 4, update Test column to include other verification; 5.0, added definitions and clarifying text to resolve ambiguities.	S3105 has been found to contain ambiguities that were previously non-impactful, but have become a concern as the state of IV&V practice has evolved. Various trigger events have occurred that suggest the need for a revision to S3105, including TIMs cycling through the review process due to misunderstanding of certain ambiguous clauses in the guide, PL's noticing insufficient field options to correctly identify the requested information on non-waterfall life cycle development approaches, and input from the IV&V office lead.	Larry Ullon