

## Accreditation Agent's Role in Verification, Validation, and Accreditation (VV&A) of a Legacy Simulation

This document describes the role and responsibilities of the Accreditation Agent in the verification, validation, and accreditation (VV&A) of a legacy simulation. **Accreditation Agent** is the term used throughout the Recommended Practices Guide (RPG) to describe the organization, group, or person responsible for assessing the simulation's fitness for the intended use. The focus of the Accreditation Agent is on balancing risk and cost: balancing the production of the information needed to identify and manage the risks associated with using the simulation for the intended use with the costs (in time and resources) involved in producing it.

Other basic roles that support legacy simulation VV&A include:

- **User** – the role responsible for defining the problem (e.g., Modeling and Simulation (M&S) requirements, measures, acceptability criteria, referent), determining how to solve it, and making the accreditation decision
- **Verification and Validation (V&V) Agent** – the role responsible for providing evidence of the simulation's fitness for the intended use by ensuring that all the necessary V&V tasks are properly carried out
- **M&S Program Manager (PM)** – the role responsible for managing the modification of the simulation for the intended use, when needed
- **Developer** – the role responsible for providing technical expertise regarding simulation capabilities, preparing data for use in the simulation, and for making code modifications and developing new code, when needed
- **M&S Proponent** – the role responsible for managing the legacy simulation throughout its life cycle, including configuration management, application, and maintenance, and for approving all modifications to the authorized version of the simulation.

These roles can be filled in a variety of ways, such as:

- Each role can be performed by a different individual, group, or organization.
- Several roles can be performed by the same individual, group, or organization.
- All roles can be performed by the same individual, group, or organization.

The number of performers required for a given application is predicated on the needs of the application, the amount of work required in each role, the availability of resources,

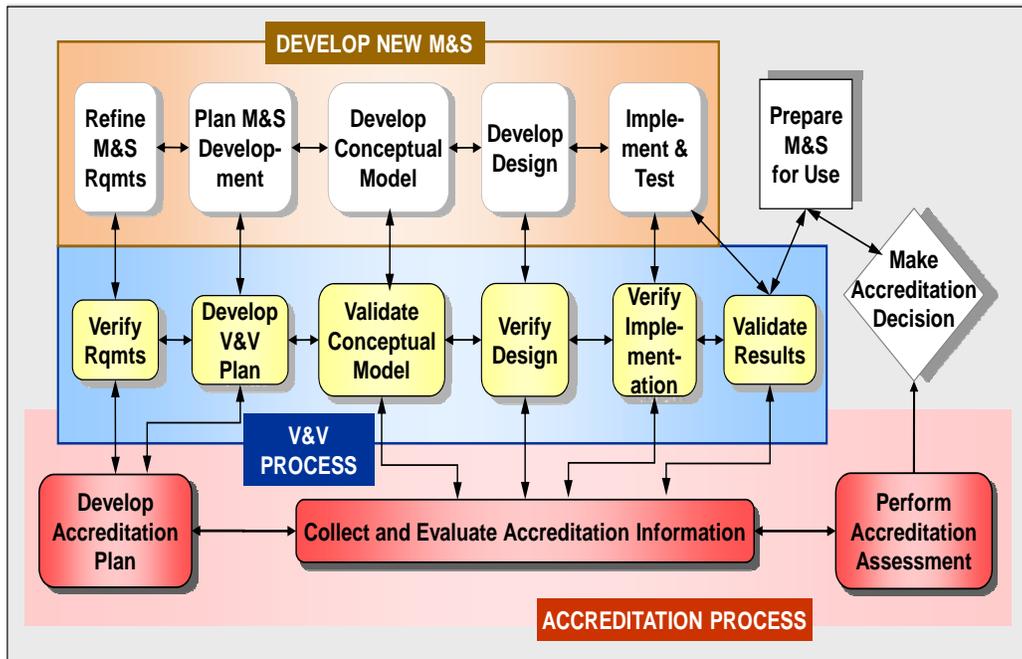
and the risks involved. When extensive simulation modifications are needed or when the issues being addressed involve critical concerns (e.g., health, safety), it is more likely that a separate individual, group, or organization will be designated for each role. When the pedigree of a legacy simulation is well documented, and the simulation has been used for similar applications in the past and requires little or no modification, it is likely that some roles may be performed by the same individual or group. For example, the Accreditation Agent may perform the V&V tasks.

In any case, the fundamental role of the Accreditation Agent is to ensure that the simulation has the capability, correctness, accuracy, and usability needed for the intended use. To fulfill this role, the Accreditation Agent determines what information is needed to conduct the accreditation assessment, provides guidance to the V&V effort to ensure necessary information is collected, conducts the accreditation assessment, and provides the results to the User for the accreditation decision.

### ***How Does This Differ from the Accreditation Agent Role in New Simulation VV&A?***

In the paradigm for new simulation development, there is a direct relationship between the M&S requirements for the intended use and the capabilities being built into the simulation. During planning, the Accreditation Agent identifies the accreditation information needs based on the M&S requirements, the priorities of the User, and the risks involved in developing and using the simulation. The accreditation information needs are then used in developing the V&V plan to identify appropriate V&V tasks.

The V&V effort is worked hand-in-hand with the development process, as illustrated in the following figure, assessing the various development artifacts and collecting evidence for the accreditation assessment. The V&V Agent provides information to the Accreditation Agent in an ongoing process, and feedback provided by the Accreditation Agent can impact the modification and V&V efforts.



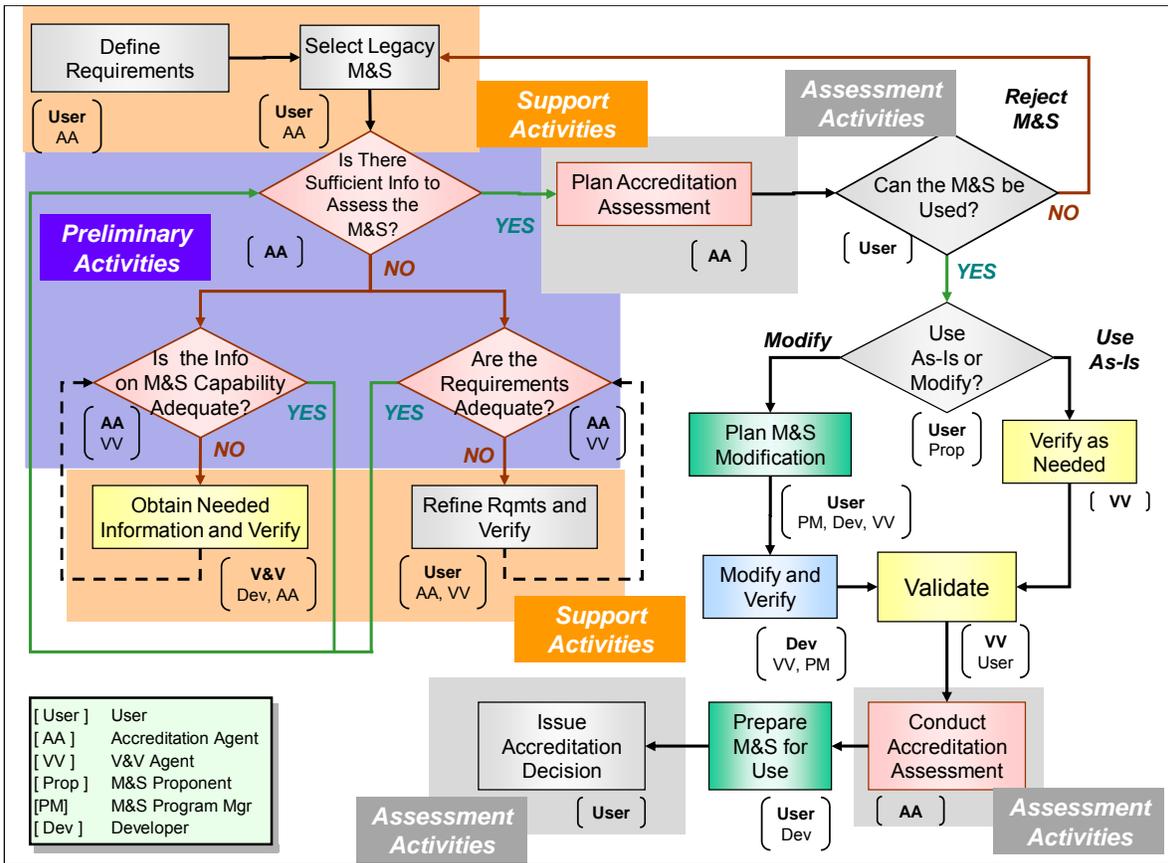
Accreditation Agent Involvement in the VV&A of New Simulations

In legacy simulation, as described in the [Core Documents>Legacy> Legacy Overview](#), the Accreditation Agent is faced with a slightly different problem. The legacy accreditation assessment is focused on understanding the capabilities of the existing simulation, identifying the risks associated with using it, and determining what needs to be done to ensure that it can satisfy the requirements of the intended use. The simulation was developed to address a specific set of requirements that may or may not be similar to the requirements of the intended use, and the simulation has a history of usage that may differ significantly from the intended use. The availability and quality of information about the simulation and the similarity between previous applications and the intended use are risk factors that impact the scope of the accreditation assessment. In addition, when more than one legacy simulation exists that appears suitable for the intended use, the Accreditation Agent may be called upon to support the User in selecting the most appropriate one.

The accreditation of a legacy simulation involves three separate sets of activities, which are illustrated in the flow diagram below.

- **Preliminary activities** associated with determining the scope of the assessment (shaded in purple in the figure)
- **Assessment activities** associated with determining the fitness of the simulation for the intended purpose (shaded in grey in the figure)

- **Support activities** that help the User, Developer or V&V Agent accomplish their activities (shaded in orange in the figure)



**Flow Diagram for the VV&A of a Legacy Simulation**

These activity groupings are used in the remainder of this document to facilitate discussion of the Accreditation Agent's responsibilities and functions.

## VV&A Responsibilities of the Accreditation Agent Role

The overall responsibility of the Accreditation Agent is to prepare for and conduct a cost-effective accreditation assessment that results in a logical, sufficient, and fully justified accreditation recommendation. The Accreditation Agent influences the entire VV&A effort by identifying what information is needed to conduct the accreditation assessment, determining its scope, analyzing the risks involved in using the legacy simulation for the intended use, establishing priorities for the V&V effort, and capturing this information in a detailed accreditation plan.

The following table summarizes the typical Accreditation Agent responsibilities associated with different functions and activities involved in the VV&A of a legacy simulation.

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Activity Set	Function	Typical Accreditation Agent Responsibilities
Support Activity	Support M&S requirement definition & refinements	<ul style="list-style-type: none"> <li>Assist User and V&amp;V Agent to ensure that M&amp;S requirements for the intended use are well-defined</li> </ul>
Support Activity	Support simulation selection	<ul style="list-style-type: none"> <li>Assist User in selecting most appropriate simulation for intended use</li> </ul>
Preliminary Activity	Establish acceptability criteria	<ul style="list-style-type: none"> <li>Select appropriate criteria for measuring success of the intended use</li> </ul>
Preliminary Activity	Assess risk	<ul style="list-style-type: none"> <li>Analyze operational risks to determine the amount of V&amp;V information needed for accreditation</li> <li>Identify and analyze inherent risks and development risks associated with modifications in code or software or changes in hardware or data</li> </ul>
Preliminary Activity	Collect and evaluate available simulation information	<ul style="list-style-type: none"> <li>Collect and review available simulation documentation and VV&amp;A history</li> <li>Determine what aspects of the legacy simulation need additional evaluation</li> <li>Determine the level of effort needed for the accreditation assessment</li> </ul>
Preliminary Activity	Identify accreditation information needs	<ul style="list-style-type: none"> <li>Identify accreditation information needs of the intended use</li> </ul>
Support Activity	Support simulation capabilities characterization	<ul style="list-style-type: none"> <li>Provide guidance to the Developer and V&amp;V Agent through accreditation information needs and priorities</li> <li>Monitor Developer progress</li> </ul>
Preliminary Activity	Determine scope of assessment	<ul style="list-style-type: none"> <li>Work with the User and V&amp;V Agent to develop an overall VV&amp;A strategy</li> <li>Develop the accreditation plan</li> </ul>
Assessment Activity	Develop accreditation plan	<ul style="list-style-type: none"> <li>Plan assessment</li> <li>Specify assessment activities</li> <li>Select subject matter experts (SMEs)</li> </ul>
Assessment Activity	Support V&V planning	<ul style="list-style-type: none"> <li>Provide guidance to focus the V&amp;V plan on the accreditation information needs and priorities</li> <li>Adjust V&amp;V guidance as needed to address changes in M&amp;S requirements and acceptability criteria</li> </ul>
Assessment Activity	Collect and evaluate accreditation information	<ul style="list-style-type: none"> <li>Monitor the ongoing V&amp;V effort</li> <li>Monitor modification effort</li> <li>Collect supplemental information</li> </ul>
Assessment Activity	Perform accreditation assessment	<ul style="list-style-type: none"> <li>Conduct the accreditation assessment</li> <li>Prepare accreditation report</li> </ul>

## VV&A Functions of the Accreditation Agent Role

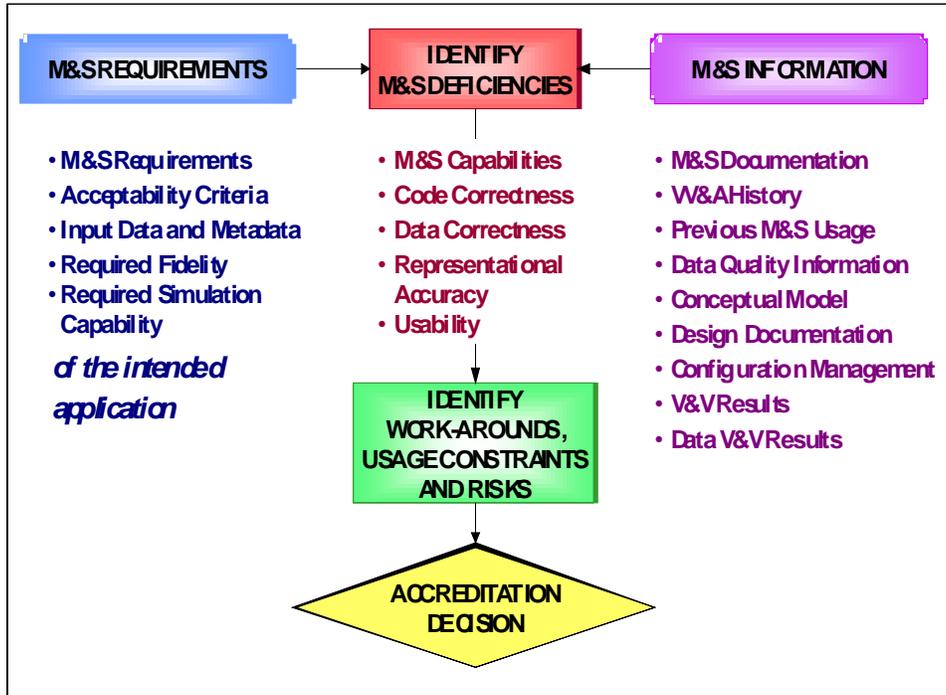
### *Accreditation Strategy*

Accreditation is always associated with a specific purpose or application because it involves the comparison of what the simulation can do with what the simulation needs to be able to do for the application. Much like building a body of evidence in a legal court case, the Accreditation Agent accumulates evidence that will support an objective assessment of a simulation's fitness for a specific intended use. The figure below illustrates a practical accreditation concept. It presents a logical depiction of the basic accreditation strategy in which information about the simulation (which addresses what the simulation can do) and the M&S requirements (which address what the simulation needs to do) are compared to determine fitness for the intended use.

### **Fitness Factors**

A simulation's fitness for the intended use is dependent on four key fitness factors:

- **Capability** – what the simulation can do in terms of functional representations, behaviors, relationships, and interactions
- **Correctness** – error-free code; appropriate, authoritative input data
- **Accuracy** – how closely the simulation results correspond to the intended view of reality (i.e., the referent)

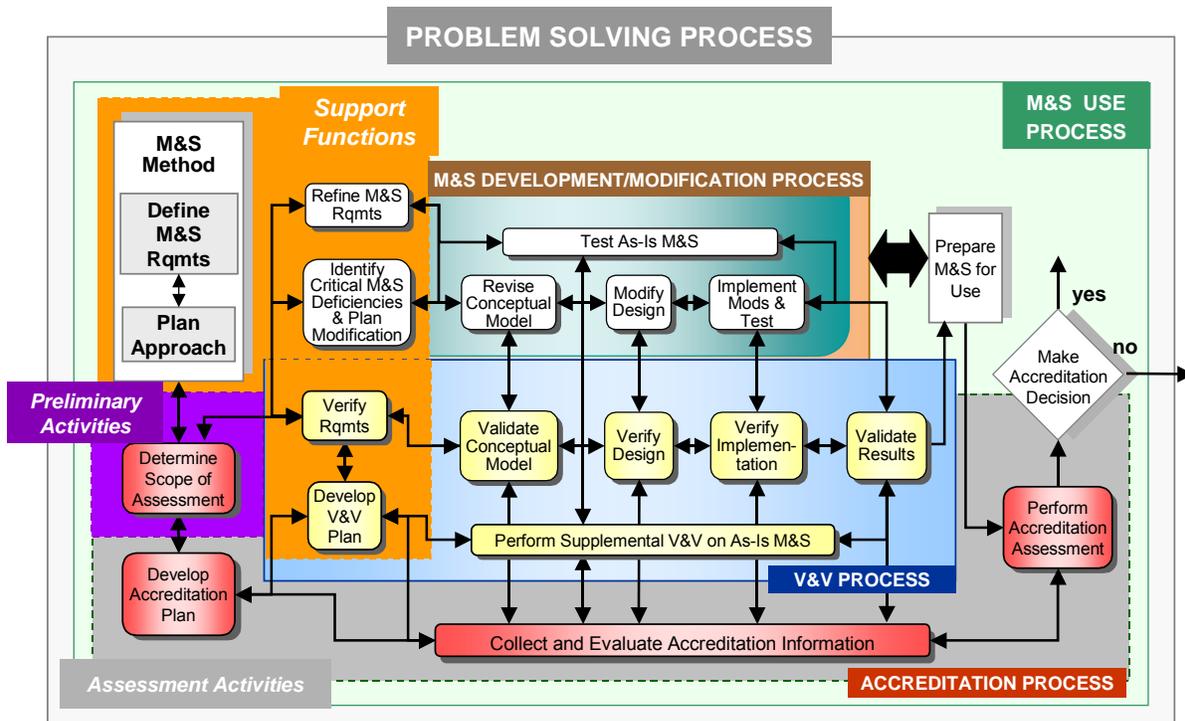


**A Practical Accreditation Concept**

- **Usability** – the existence and sufficiency of user-support features (e.g., manuals, training) which will enable the User to properly execute the simulation and analyze and/or employ the results

### Accreditation Process

The Accreditation Process shown in the following diagram implements this accreditation strategy as part of the overall Problem Solving Process described in the [Key Concepts](#). The three groups of accreditation activities depicted in the legacy simulation flow diagram are superimposed on this figure to illustrate where they fit in the overall process.



Accreditation in Legacy M&S VV&A

The remainder of this section discusses the tasks and functions that comprise the Accreditation Agent activities in the VV&A of a legacy simulation. To facilitate this discussion, the tasks and functions are presented in the three groups as illustrated in the process and flow diagrams:

### Preliminary Activities

This group of activities is initiated as soon as the Accreditation Agent is designated during the **M&S Use Process**. Its purpose is to determine the scope of and lay the foundation for the accreditation assessment. During the course of these activities, the Accreditation Agent answers the question,

***Is sufficient information available to perform an accreditation assessment?***

Answering this question involves four basic tasks, which are discussed below: establishing acceptability criteria, assessing risk, identifying accreditation information needs, and finally, collecting and evaluating the simulation information. Because of the evolving nature of information gathering and because of the interdependencies between the preliminary tasks, they are often performed concurrently or iteratively.

#### 1. Establish Acceptability Criteria

To establish the scope of the accreditation assessment, the Accreditation Agent needs a clear understanding of the requirements and objectives of the intended use. Without

clearly articulated requirements, every aspect of legacy assessment and preparation is made more difficult and error-prone, and the result is more likely to be a simulation that does not meet the needs of the application. After the requirements are defined, the User and Accreditation Agent determine how success for each requirement should be measured. This is accomplished by identifying appropriate measures (e.g., measures of effectiveness, measures of performance) and establishing the acceptability criteria (e.g., standards for success, thresholds) for each requirement. The acceptability criteria set the “pass/fail” data points for each of the prioritized requirements and consequently the priorities of both the V&V effort and the accreditation assessment. Examples are provided at [Simulation Acceptability Criteria](#).

Because initial requirement definitions frequently need to be refined and verified to ensure they are complete, consistent, and provide the level of detail necessary, obtaining them and establishing appropriate criteria can be an iterative process. Indeed, while determining the scope of the assessment, the Accreditation Agent may discover gaps or inconsistencies in the requirements. When possible, the Accreditation Agent should assist the User in refining the M&S requirements.

## 2. Assess Risk

Risk is a key factor in establishing the scope of the assessment. In legacy simulation re-use, there are three basic types of risk to be considered:

- **Development risks** – risks associated with the modification of the legacy simulation due to:
  - Compromises made because the simulation does not exactly meet the needs of the intended use (e.g., inadequate representations, insufficient accuracy)
  - Potential problems in addressing the technical, scheduling, or resourcing aspects of the modification effort
- **Operational risks** – risks arising from using simulation results that are incorrect and risks arising from not believing that simulation results that are correct
- **Inherited risks** – risks arising from effects carried forward from previous simulation development or usage, such as effects resulting from:
  - Undocumented assumptions, limitations, and constraints
  - Errors and defects that were either undetected or considered insignificant in previous applications

Simulations inevitably contain defects in their implementation (e.g., coding errors, incorrect algorithms or data, improper data preparation, faulty procedures). Defects remain in simulations either because they have not been detected or because they were considered to have no significant effect on the simulation's fitness for previous

applications. It is neither reasonable nor cost-effective to locate and correct all potential defects in a simulation, so each application has to balance the impact of a defect on that intended use against the cost of locating and fixing it.

The Accreditation Agent, in conjunction with the User, conducts the risk assessment that is used to establish the priorities that determine the scope of the modification and the V&V effort. Typical questions to be addressed during this assessment are shown in the table below.

<b>Legacy Simulation Risk Assessment Questions</b>
• What is the impact if a defect results in a failure of the simulation to satisfy a requirement?
• What is the probability that a defect in the simulation will cause such a failure?
• What is the likelihood that a defect will occur in the simulation?
• Does the simulation operate as required under all conditions matching the intended use?
• What is the impact of previously unresolved problems and uncorrected defects given the intended use?
• Do modifications to the simulation or data introduce unintended consequences?
• What risks are associated with incorrect simulation results?
• What is the nature of those risks (safety, financial, unit effectiveness, program jeopardy, etc.)?
• What organizations or groups might be affected by these risks?
• What is the likelihood that an incorrect decision or outcome will result if the model produces erroneous outputs or predictions?
• What visibility will an incorrect decision have?
• Does the User have any specific issues or concerns that should be considered as risks?

For more detailed information about performing a risk assessment see [Advanced Topics>Special Topics>Risk and Its Impact on VV&A](#).

### **3. Identify Accreditation Information Needs**

On the basis of the priorities established and problem areas defined during the risk assessment, the Accreditation Agent can determine the type, scope, and depth of information needed to assess the simulation's fitness for purpose. The simulation information normally used to support accreditation assessments can be separated into three categories: simulation overview information, functional characterization information, and detailed V&V information.

#### ***Simulation Overview Information***

Simulation overview information includes top-level information that allows a quick-look assessment of the basic suitability of a simulation for a particular application. This information allows the User to decide whether a particular simulation is a potential candidate. Key metrics that are part of the simulation overview answer the question,

***Are the basic capabilities and characteristics of the simulation well known and documented?***

Typical information issues that should be addressed are shown in the table below.

<b>Simulation Overview Information Set</b>	
<b>Issues</b>	<b>Rationale</b>
<b>Model Configuration Management Baseline Definition</b>	
<ul style="list-style-type: none"> <li>• What code and documentation set constitutes the “official” simulation baseline?</li> <li>• How are changes to it managed and supported?</li> </ul>	<ul style="list-style-type: none"> <li>• This tells the User if the version can be easily identified and characterized (what about it is different from the baseline version) and includes a description of configuration management policies and procedures for the simulation.</li> <li>• Without a sound configuration management program, the user cannot be sure that there is an “official baseline,” and without such assurance, there is no reasonable means of relating past V&amp;V work and usage history to any particular version of the simulation. Without a good configuration management program, all previous history and V&amp;V results are of little value to the current user.</li> </ul>
<b>Summary of Assumptions, Limitations and Errors</b>	
<ul style="list-style-type: none"> <li>• What assumptions, limitations, and errors are known and what is the impact on simulation usage of each?</li> </ul>	<ul style="list-style-type: none"> <li>• This tells which, if any, limitations exist that will affect the intended use. Obviously, to be useful, this list must be as comprehensive and as up to date as possible.</li> </ul>
<b>VV&amp;A Status and Usage History</b>	
<ul style="list-style-type: none"> <li>• Who has used the simulation before, and for what?</li> <li>• What is the simulation V&amp;V history and status?</li> <li>• Who has accredited before, and for what?</li> </ul>	<ul style="list-style-type: none"> <li>• A rich history of previous usage and record of VV&amp;A activities can increase confidence in simulation use, especially if previous applications are similar to the intended use.</li> </ul>
<b>Documentation Assessment</b>	
<ul style="list-style-type: none"> <li>• How well is the simulation documented relative to accepted standards?</li> </ul>	<ul style="list-style-type: none"> <li>• This indicates how much effort will be needed to acquire the necessary information from available source documents and how much effort will be involved in training participants. This element is especially important if the analysts who will use the simulation are unfamiliar with it.</li> </ul>
<b>Software Quality Assessment</b>	
<ul style="list-style-type: none"> <li>• How “good” is the software relative to accepted standards?</li> </ul>	<ul style="list-style-type: none"> <li>• Well-structured software that is easy to follow tends to have far fewer coding errors than “spaghetti code,” especially if the simulation has undergone several modifications and version changes. Errors detected are easier to find and correct. Code modifications, when necessary, are easier to implement.</li> </ul>

The simulation overview elements should provide enough information for a User to quickly determine whether a particular simulation is an appropriate candidate for use in the given application.

**Functional Characterization Information**

The functional characterization information set, shown in the following table, focuses on simulation credibility metrics that relate to how the simulation is designed. It answers these questions:

***Are the functional characteristics of the simulation defined, well designed, and reasonable?***

***Does the design of this simulation have the accuracy that I need to address my problem?***

Functional Characterization Information Set	
Issues	Rationale
<b>Functional Decomposition</b>	
<ul style="list-style-type: none"> <li>• What are the basic functional elements of the simulation? i.e., what does it simulate, and to what level of detail?</li> </ul>	<ul style="list-style-type: none"> <li>• This information indicates if the simulation even addresses the basic representational requirements of the application.</li> <li>• A functional decomposition is often a new M&amp;S V&amp;V product, frequently generated with automated design tools.</li> </ul>
<b>Simulation Conceptual Model Description</b>	
<ul style="list-style-type: none"> <li>• How are simulation functions and behaviors integrated to produce simulation outputs?</li> </ul>	<ul style="list-style-type: none"> <li>• This addresses issues related to simulation construction, and whether the simulation has the flexibility to address the User's particular problem. Such information is routinely generated through typical software development and V&amp;V activities.</li> </ul>
<b>Detailed Software Specification</b>	
<ul style="list-style-type: none"> <li>• What are the design requirements for each of the simulation functional elements? How are they coded?</li> </ul>	<ul style="list-style-type: none"> <li>• This information helps determine if the fidelity is appropriate for those functional elements that are important to the current problem.</li> <li>• These specifications should be available from the M&amp;S Proponent (configuration manager) or the original developer. If they are not, they can be generated through reverse engineering.</li> </ul>

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<b>Functional Characterization Information Set (continued)</b>	
<b>Issues</b>	<b>Rationale</b>
<b>Logical Verification</b>	
<ul style="list-style-type: none"> <li>• For what set of problems do simulation assumptions and limitations yield correct results?</li> <li>• How do assumptions, limitations, errors and approximations affect potential uses of the simulation?</li> <li>• Are assumptions, limitations, and approximations reasonable for certain specific applications?</li> </ul>	<ul style="list-style-type: none"> <li>• Answers to these questions come from assessments of the simulation by previous users, and they should be evaluated in light of intended use requirements.</li> <li>• A logical verification is done with the design requirements representing the intended use, normally during simulation modification.</li> <li>• If the intended use fits within the scope of the original design requirements, the logical verification done in parallel with modification will provide valuable information to support the accreditation assessment.</li> </ul>
<b>Sensitivity Analysis</b>	
<ul style="list-style-type: none"> <li>• What are the key simulation sensitivities, and are they reasonable?</li> </ul>	<ul style="list-style-type: none"> <li>• Sensitivity analysis identifies function level and overall simulation sensitivities to variations in the input data.</li> <li>• It can indicate which functions have the greatest impact on key simulation outputs, and it can be used to support the V&amp;V effort.</li> <li>• Sensitivity analysis can also establish accuracy requirements for validation data.</li> </ul>

Functional characterization elements provide the detailed information that allows a potential User to evaluate simulation design and implementation relative to the functional requirements of his particular application. The simulation's conceptual model, if it exists, should include sufficient information to characterize its functionality.

***Detailed V&V Information***

Detailed V&V information, shown in the table below, includes those simulation credibility elements that delve into the correlation between simulation outputs, design, and the real world. It answers the questions,

***Is the simulation software built in accordance with its design?***

***How well do simulation inputs and outputs compare with the real world?***

<b>Detailed V&amp;V Information Set</b>	
<b>Issues</b>	<b>Rationale</b>
<b><i>Data Verification and Validation</i></b>	
<ul style="list-style-type: none"> <li>• Are instance data well defined and consistently used?</li> <li>• Do instance data agree with best estimates or intelligence information?</li> <li>• What is the impact of identified data limitations on simulation use?</li> </ul>	<ul style="list-style-type: none"> <li>• Data V&amp;V indicates if there are data issues which could impact use of the simulation and the interpretation of its outputs.</li> </ul>

<b>Detailed V&amp;V Information Set (continued)</b>	
<b>Issues</b>	<b>Rationale</b>
<b><i>Simulation Conceptual Model Validation</i></b>	
<ul style="list-style-type: none"> <li>• Does a conceptual model exist for this version of the simulation? Is it complete and consistent?</li> <li>• Do modifications need to be to ensure it accurately describes the simulation being used?</li> <li>• How well do the simulation capabilities described in the conceptual model address the M&amp;S requirements of the intended use?</li> </ul>	<ul style="list-style-type: none"> <li>• The conceptual model indicates how well simulation capabilities and features are described, how thoroughly the configuration management process is maintaining control of model versions, and can provide good information regarding what needs to be done to ensure the simulation addresses the requirements of the intended use.</li> <li>• Conceptual model validation indicates how well the model addresses the M&amp;S requirements.</li> <li>• Conceptual model validation is done for the intended use; however, when details of previous uses match the intended one, aspects of previous conceptual model validation efforts may be usable.</li> </ul>
<b><i>Code Verification</i></b>	
<ul style="list-style-type: none"> <li>• Does the code correctly implement the design?</li> <li>• What is the impact on simulation use of any limitations discovered?</li> </ul>	<ul style="list-style-type: none"> <li>• Code verification indicates how well the software conforms to its design, what the configuration management process is or is not doing about any non-conforming code, and whether any of those non-conformities are important to his problem.</li> <li>• Code verification is normally conducted in conjunction with the simulation development or modification effort. The challenge is to find the documentation of those results to review exactly what was done, and determine its applicability to the version being used.</li> </ul>
<b><i>Results Validation</i></b>	
<ul style="list-style-type: none"> <li>• How well do simulation outputs compare with the <i>referent</i>?</li> <li>• How were they assessed?</li> <li>• What is the impact on simulation use of any limitations discovered?</li> </ul>	<ul style="list-style-type: none"> <li>• Validation results offer the best and final proof to the User that simulation results are of sufficient accuracy for the intended use.</li> <li>• Because results validation is done from the perspective of the intended use, it should be done for each new use. However, when details of previous applications match the intended one, some aspects of those validation efforts should be usable.</li> <li>• Previous validation tests may be used in creating new tests</li> <li>• Previous validation results may serve as the baseline to determine if code modifications have affected other areas of the code.</li> </ul>

#### **4. Collect and Evaluate Available Simulation Information**

The pedigree of the simulation is a key factor in determining the scope of the accreditation assessment. The information gathered about the legacy simulation serves as the basis for determining the scope and for identifying what modifications may be needed and what additional V&V work is necessary. The Accreditation Agent collects and reviews all available documentation about the legacy simulation to determine if it is adequate to assess the capabilities, limitations, and usability for the intended purpose.

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Information about the simulation can be found in the technical documentation, artifacts, and products (e.g., M&S requirements, simulation conceptual model, design, code) resulting from simulation development and modification efforts; reports and records of its prior usage (e.g., study reports, simulation handbooks and user manuals), configuration management documentation, and the simulation's VV&A history. Sources for this information include the M&S Proponent, the simulation's configuration control board, previous Developer(s), and/or previous Users. See the link [Legacy Simulation Information Sources](#) for additional information.

When all available information has been gathered and it is still not adequate to demonstrate the simulation's fitness for the intended use, then the necessary information may need to be generated by analysis or reverse engineering. To assist in this effort, the Accreditation Agent may need SMEs with expertise in technical and functional areas. Experts familiar with simulation development and with the legacy simulation itself (e.g., former Developers or Users) are able to judge the technical composition of the simulation as well as the effectiveness of historical V&V activities that may not be well documented. Experts familiar with the concepts, systems, and functions being represented within the simulation may be needed to assess historical V&V results to determine if there are limitations, deficiencies, or anomalies that may impact the intended use.

To determine if the information collected is sufficient, it needs to be compared with the accreditation information needs. One method for accomplishing this is to develop a matrix showing the correspondences and gaps. Gaps indicate where additional work is needed to generate necessary information. The following table gives examples of specific pieces of information in each of the categories discussed.

<b>Simulation Fitness Information</b>	
<b>Information</b>	<b>Description</b>
<b><i>Simulation Overview Information</i></b>	
Configuration management baseline definition	<ul style="list-style-type: none"> <li>Code, documentation, and input data baseline; what specific items are managed, and how? What User support services exist? What is the hardware and software compatibility of the simulation? Is there a configuration management plan in place, and is it being followed?</li> </ul>
Assumptions, limitations and defects	<ul style="list-style-type: none"> <li>Known assumptions, limitations, and defects; expected impacts of each on the intended use</li> </ul>
VV&A status and usage history	<ul style="list-style-type: none"> <li>Previous applications of this simulation; past V&amp;V and accreditation history and results</li> </ul>
Documentation quality	<ul style="list-style-type: none"> <li>How well User documentation conforms to standards for information content and usability</li> </ul>
Software quality	<ul style="list-style-type: none"> <li>Software quality as compared with standards; how well software is structured</li> </ul>

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<b>Simulation Fitness Information (continued)</b>	
<b>Information</b>	<b>Description</b>
<b><i>Functional Characterization Information</i></b>	
Simulation conceptual model description (functional characterization)	<ul style="list-style-type: none"> <li>Basic functions and behaviors represented, level of detail at which each function represented, algorithm descriptions, data needs, etc.</li> </ul>
Detailed software specification	<ul style="list-style-type: none"> <li>Detailed design requirements for each M&amp;S object or component; how each is coded</li> </ul>
Logical verification	<ul style="list-style-type: none"> <li>Verify behaviors and interactions; accuracy; identify assumptions, limitations, constraints, approximations</li> </ul>
Sensitivity analysis	<ul style="list-style-type: none"> <li>Key sensitivities; whether they are reasonable; identification of most critical input parameters and functions</li> </ul>
<b><i>Detailed V&amp;V Information</i></b>	
Data V&V	<ul style="list-style-type: none"> <li>Input data and hard-wired data well-defined, consistently used, in agreement with best estimates or intelligence data, of appropriate fidelity, from authoritative sources, etc.</li> </ul>
Conceptual model validation	<ul style="list-style-type: none"> <li>Conceptual model complete, consistent representation of M&amp;S requirements and M&amp;S capabilities</li> </ul>
Code verification	<ul style="list-style-type: none"> <li>Design correctly implemented, free of logical or coding errors</li> </ul>
Results validation	<ul style="list-style-type: none"> <li>How well simulation outputs compare to real world</li> </ul>

In assessing the adequacy of available legacy simulation information, the focus should be on obtaining substantive information regardless of its form or source. There might not be a one-to-one correlation between the kinds of documentation listed in this guide (see the link [Legacy Simulation Information Sources](#)) and the kinds of documents that exist for a given simulation. Available documentation should be reviewed to determine if the necessary substantive information is present in any combination of the existing documents.

**Example:**

The available simulation documentation consisted only of design descriptions of the individual modules within the simulation. These design description documents also included design requirements and V&V plans. However, when reviewing this information, the Accreditation Agent noticed that different V&V tasks were performed for different modules and concluded there was a need to determine if the V&V tasks performed on the individual modules were adequate, considering they did not follow the normal V&V procedures. Analysis of this situation resulted in identification of the need for some additional V&V tasks to be performed on selected modules and the development of an overall simulation requirements document to complement the individual module documents.

### **Assessment Activities**

This group of activities focuses on assessment of the fitness of the simulation for the intended use. It consists of the same activities as those involved in the accreditation

process for new simulations, because the responsibilities and tasks associated with simulation assessment remain essentially the same regardless of the age of the simulation.

## 1. Develop Accreditation Plan

Accreditation planning should begin as soon as the scope of the accreditation assessment has been determined. Ideally, this begins as soon as the simulation has been selected and the Accreditation Agent has been designated so that accreditation planning can effectively influence information collection, V&V planning, and any planning for simulation modification. Some of the issues considered during planning include assessment planning factors, assessment activity specification, V&V planning support, SME selection, and terminology.

### *Assessment Planning Factors*

An effective accreditation assessment should address each of the fitness factors. It should involve a disciplined comparison between the simulation's capabilities and the M&S requirements of the intended use, assessments of software and data correctness, representation accuracy, and simulation usability, and an evaluation of the adequacy of the overall depth and scope of the evidence in view of operational risks to determine the simulation's overall fitness for the intended use.

- **Assessment of simulation capability** must address whether the simulation satisfies the M&S requirements of the intended use. This assessment depends on a definitive set of M&S requirements and acceptability criteria and the quality and completeness of the information about the existing simulation and any modifications made.
- **Assessment of simulation and data correctness** includes reviewing code verification tasks to ensure they are sufficiently comprehensive to address the needs of the intended use, evaluating code verification results to ensure they demonstrate an acceptable level of accuracy, and evaluating input data quality and appropriateness. This assessment depends on past and current implementation verification information and the metadata associated with each of the input data sets and hard-wired data elements involved.
- **Assessment of simulation accuracy** includes evaluation of data and output accuracy. Data V&V and results validation are the normal means of generating this evidence. While the V&V plan should identify the specific validation tasks and techniques involved, the accreditation plan should identify any past validation results that can be used in this part of the assessment.
- **Assessment of simulation usability** evaluates the simulation's user support features (e.g., user documentation, graphical user interfaces, interfaces, training) in view of the experience levels and expertise of the operators and analysts who will be using the selected simulation to generate outputs for the

User. Therefore, the accreditation plan should identify the expected categories of operators and analysts and the general qualification level needed for each.

- **Assessment of the scope and depth of the evidence** depends on understanding the operational risks (and inherited and development risks when appropriate). The accreditation plan should make provision for updating the risk assessment if the intended use is modified in any way.

The issues to be addressed in each of these areas, examples of the information and sources involved, and their importance with respect to the level of risk involved are provided at the link [accreditation assessment guidance](#).

The accreditation assessment involves a number of factors, which, if not adequately addressed, could detract from an effective and efficient assessment process and could degrade the final results.

Accreditation Assessment Factors
<ul style="list-style-type: none"><li>• Nature of the assessment activity (e.g., face-to-face meeting, video teleconference), location, length of time</li></ul>
<ul style="list-style-type: none"><li>• Types of expertise expected in participants</li></ul>
<ul style="list-style-type: none"><li>• Expected sources of the participants</li></ul>
<ul style="list-style-type: none"><li>• Methods to assist participants in preparation for the assessment (e.g., orientation steps, read-ahead materials, training)</li></ul>
<ul style="list-style-type: none"><li>• Types of personnel needed to perform the accreditation assessment (e.g., facilitator, recorder, particular types of SMEs)</li></ul>
<ul style="list-style-type: none"><li>• Methodology (e.g., mechanisms for capturing the results of the deliberations; methods for reviewing preliminary results, resolving conflicts, and gaining consensus)</li></ul>
<ul style="list-style-type: none"><li>• Expected approach to preparing an accurate report of the deliberations</li></ul>

For additional information access the link [accreditation assessment success factors](#).

### **Assessment Activity Specification**

Assessment activities are conducted to assess:

- Adequacy of existing or planned documentation in light of expected operational risk levels
- Ability of planned and/or executed V&V activities to provide the necessary information in light of expected operational risk levels
- Ability of the simulation to meet M&S requirements in light of the defined acceptability criteria

In specifying the assessment activities to be conducted, the Accreditation Agent should determine the number and type of assessment activities needed and select assessment

team members and SMEs to participate in each activity. For each assessment activity, the Accreditation Agent should plan to address the factors listed in the Accreditation Assessment Factor table above. For additional information on establishing the assessment process, access the link [accreditation assessment success factors](#).

### ***V&V Planning Support***

The sufficiency of the evidence collected during the V&V effort is affected by the quality and specificity of the accreditation plan and associated guidance. On the basis of the accreditation information needs and deficiencies, the Accreditation Agent should coordinate with the V&V Agent to outline a list of appropriate V&V tasks, such as:

- Tasks to verify and validate existing parts of the simulation to obtain missing information
- Data V&V tasks to ensure both data previously used in the simulation and new data are appropriate for the intended use
- Tasks to verify and validate any modifications involved

The Accreditation Agent should ensure that V&V activities focus on the critical problem areas identified during operational risk assessment and identification of accreditation information needs.

### ***SME Selection***

The Accreditation Agent should identify the areas of expertise needed to address each M&S requirement and ascertain the necessary qualifications for SMEs in each area. Accreditation assessment typically requires expertise in a number of different areas, such as the problem domain of the intended use; the problem domain that the legacy simulation was developed to address; and the programming language, software, and hardware of the existing simulation. For further information in team selection and operation, access the link [selecting appropriate team members](#).

### ***Terminology***

When developing and documenting the accreditation plan, the Accreditation Agent should pay careful attention to the use of clearly defined and well-understood terminology. Pertinent glossaries should be included or referenced in each document to provide readers with a means of clarifying terms and avoiding misunderstandings.

**Example:**

In one program, development testers used the term probability of kill to mean the results of a single shot against single target (i.e., single shot kill probability). Operational testers, in the same program, used the same term to mean the results of a two shot salvo against a single target (their normal operating practice). This difference in terminology was not recognized until well into the VV&A program, which used the probability of kill as a prime metric.

In another case, a simulation User defined the term "miss distance" differently than the Developer, causing a number of misunderstandings until it was detected.

## 2. Collect and Evaluate Accreditation Information

To determine the scope of the assessment, the Accreditation Agent identifies the accreditation information needs based on operational risks associated with the application. To fulfill these needs, the Accreditation Agent should collect information resulting from the V&V effort, information generated by any modification activities, and information from additional sources (e.g., data producers). The Accreditation Agent should also monitor the simulation preparation and V&V efforts to ensure that their products will satisfy the accreditation information needs. Specific tasks involved in this activity include:

- **Monitor Simulation Modification Activities** – If the simulation is being modified for the intended use, the Accreditation Agent should maintain close contact with the Developer, M&S PM, and V&V Agent to ensure that appropriate information is being generated to support assessment of the modified areas. In addition, close contact with the User is also necessary to obtain and incorporate any changes to the application that would affect the accreditation information needs. The Accreditation Agent should also coordinate with the V&V Agent to ensure that priorities are adjusted and plans modified to reflect any changed needs of the accreditation assessment.
- **Monitor V&V Effort** – V&V activities and tasks should be monitored to ensure that they conform to the V&V plan and address the accreditation information needs. The Accreditation Agent should participate in any V&V meetings between the V&V Agent and the User, M&S PM, and Developer to assess the adequacy of information exchange and to review the V&V products as they are generated to ensure they provide sufficient information for the accreditation assessment.
- **Collect Supplemental Information** – Although much of the information needed for the accreditation assessment is obtained from the V&V effort, some information is obtained from other sources. The Accreditation Agent should collect this information and ensure that it is suitably documented to support the accreditation decision and any subsequent reviews of that decision. Typical supplemental information gathered for a new simulation assessment is shown in the table below.

<b>Typical Supplemental Information and Sources</b>	
<b>Information</b>	<b>Source</b>
<ul style="list-style-type: none"> <li>• Model documentation (e.g., user, programmer, analyst manuals)</li> </ul>	M&S Proponent (configuration manager), previous Users and Developers, M&S repository
<ul style="list-style-type: none"> <li>• History of past usage</li> </ul>	Previous Users, study reports
<ul style="list-style-type: none"> <li>• VV&amp;A history</li> </ul>	M&S Proponent, original Developer, previous Users, M&S repository
<ul style="list-style-type: none"> <li>• Simulation descriptive documentation (e.g., specifications, simulation conceptual model, design documents)</li> </ul>	M&S Proponent, original Developer
<ul style="list-style-type: none"> <li>• Configuration management evidence (e.g., plans, meeting minutes, trouble reports)</li> </ul>	M&S Proponent
<ul style="list-style-type: none"> <li>• Input data metadata indicating data quality, validity and precision</li> </ul>	Data producers, data warehouses, data repositories
<ul style="list-style-type: none"> <li>• User support resources</li> </ul>	M&S Proponent, previous Users

### 3. Perform Accreditation Assessment

The accreditation assessment of a legacy simulation should be performed after development and testing of any needed modifications and after planned V&V activities are completed. Depending on the complexity of the simulation or its intended use, this assessment can be done either by a single person or by a team. If the application is straightforward, the simulation simple, and the level of risk is relatively low, a single person may do the assessment. If either the simulation or the application is complex, if extensive modifications have been made, or if the level of operational risk is relatively high, an assessment team with a variety of expertise is usually better suited to consider all aspects of the application, the M&S requirements, and simulation features. A team of experts that contributes both breadth and depth of experience is considered essential when a high level of objectivity is needed. (For more information access the link [selecting appropriate team members](#)).

Ideally, an accreditation assessment performed by a single analyst or by a team would produce the same basic result. However, the team approach is typically imbued with more credibility owing to the perception of greater objectivity resulting from the team's increased breadth of technical expertise. A typical procedure used in team assessment is shown in the table below:

<b>Typical Team Assessment Procedure</b>
<ul style="list-style-type: none"> <li>• Notify and brief all participants in the assessment</li> </ul>
<ul style="list-style-type: none"> <li>• Ensure participant availability for all meetings and associated activities</li> </ul>
<ul style="list-style-type: none"> <li>• Provide pre-meeting information</li> </ul>
<ul style="list-style-type: none"> <li>• Conduct meeting and record discussion</li> </ul>
<ul style="list-style-type: none"> <li>• Document all deficiencies (in simulation and in the accreditation information), their effects and associated risks if they remain uncorrected</li> </ul>
<ul style="list-style-type: none"> <li>• Identify potential workarounds for each deficiency</li> </ul>

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<b>Typical Team Assessment Procedure (continued)</b>
• Prepare a draft assessment report complete with recommendations
• Submit draft report for review and concurrence by all assessment team members
• Prepare final report
• Present report and recommendations to the User

A successful accreditation assessment involves a review of evidence collected about the four fitness factors (capability, correctness, accuracy and usability). The M&S requirements are the basis for evaluating capability. Verification results provide the basis for software and data correctness. Acceptability criteria and validation results provide the basis for evaluating representational data and output accuracy. (Acceptability criteria are used indirectly to assess accuracy of the input data and the software.) Information about personnel requirements, the ease of operation, reliability of hardware and software, and the support elements available, (e.g., user manuals, graphical user interfaces, interfaces, on-line help menus, training) is used to evaluate usability.

The success of an accreditation assessment is facilitated by a structured approach that includes the establishment of objectives, focused deliberations, building consensus, and complete and accurate reporting. Additional information on these success factors is provided at the link [accreditation assessment success factors](#).

The nine questions listed in the table below need to be answered before an accreditation decision can be made.

<b>Essential Questions in Accreditation Assessment</b>
<b>Establishing the Standards against which the Simulation is Judged</b>
1) What is the application in which the simulation will be used (i.e., what is the usage context for the simulation)?
2) What things or functions do you need the simulation to simulate to support this application and to what level of detail?
3) How accurate must the simulation results be to satisfy your requirements (i.e., how close to the real world do you need simulation outputs to come)?
4) How much credibility does the simulation need to have (i.e., how much risk is associated with accepting and acting upon potentially incorrect simulation results)?
<b>Characterizing the Capabilities and Limitations of the Simulation</b>
5) What does the simulation under consideration for accreditation actually do (i.e., what does it simulate and to what level of detail)?
6) How good is the software (i.e., what was done to minimize the potential for coding errors and what were the results)?
7) How well do simulation results compare to the referent, and on what basis was this determination made?
8) Can the simulation be used properly (e.g., how capable are the personnel running the simulation and interpreting its outputs)?
9) Are the input data that drive the simulation appropriate and realistic enough to suit the purpose, and on what basis was this determination made?

The first four questions are normally addressed during the problem analysis. They establish the standards or requirements against which the candidate simulation must be judged. The last five questions, considered the essential questions of accreditation assessment, deal with the selected simulation itself, characterizing the simulation capabilities and limitations. Answers to these questions provide the information that is used to judge the adequacy of the simulation in relation to the requirements of the application.

Since legacy simulations are used widely with varying levels of resource support, the Accreditation Agent may face a situation where sufficient suitable information cannot be made available to conduct an assessment as described above. In this case, a different approach is needed to obtain sufficient information to complete the assessment. Examples of some alternative techniques are listed in the table below.

<b>Examples of Alternative Assessment Approaches</b>
<b>Inadequate simulation descriptive material</b>
<ul style="list-style-type: none"> <li>• Have SMEs with in-depth knowledge of the simulation participate. Include in-depth descriptive material as an appendix to accreditation report.</li> </ul>
<b>Inadequate verification reports &amp; insufficient resources to conduct necessary verification</b>
<ul style="list-style-type: none"> <li>• Possible alternatives:               <ul style="list-style-type: none"> <li>– Rely on history of successful uses.</li> <li>– Complete oral history of verification activities during development and evaluate it by team of software SMEs.</li> <li>– Conduct software quality assessment to determine likelihood of software errors.</li> </ul> </li> </ul>
<b>Documentation structure that differs from that described in this RPG (for descriptive or V&amp;V documentation)</b>
<ul style="list-style-type: none"> <li>• Review existing documents to determine if any information is missing. Determine impact of the missing information on effectiveness of accreditation assessment and take steps to obtain information that is critical.</li> </ul>
<b>Inadequate evidence of good configuration management</b>
<ul style="list-style-type: none"> <li>• Interview M&amp;S Proponent to determine the extent and effectiveness of configuration management efforts. Present information to the assessment team. If configuration management is inadequate, trace history of the selected simulation back to a version with known and documented capabilities. Identify changes and evidence to support credibility of changes.</li> </ul>

Once the accreditation assessment is completed, the Accreditation Agent submits the report and a recommendation for accreditation. Normally, this accreditation recommendation is provided to the User in the same form that the final decision is to take. The standard accreditation decision options (and recommendation options) are listed in the table below.

<b>Standard Accreditation Decision Options</b>	
<b>Full accreditation</b>	<ul style="list-style-type: none"> <li>The simulation produces results that are sufficiently credible to support the intended use.</li> </ul>
<b>Limited or conditional accreditation</b>	<ul style="list-style-type: none"> <li>Constraints should be placed on how the simulation can be used to support the intended use.</li> </ul>
<b>Modification of the simulation is needed</b>	<ul style="list-style-type: none"> <li>The simulation's capabilities are insufficient to support either full or conditional accreditation; modifications and subsequent V&amp;V are needed to correct the deficiencies.</li> </ul>
<b>Additional information is needed</b>	<ul style="list-style-type: none"> <li>The information obtained about the simulation is insufficient to support either full or conditional accreditation; additional information should be generated or obtained, supplemental verification, validation and/or testing should be conducted to provide the necessary information before the accreditation decision is made.</li> </ul>
<b>No accreditation</b>	<ul style="list-style-type: none"> <li>The results of the assessment show that the simulation does not adequately support the intended use.</li> </ul>

## ***Support Activities***

The Accreditation Agent also supports several activities, for which the other roles (e.g., User, V&V Agent) have primary responsibility, including M&S requirements definition, and refinement, legacy simulation selection, and simulation capabilities characterization.

### **1. Support M&S Requirement Definition and Refinement**

To support an intended use, a simulation needs to be able to address the M&S requirements associated with that intended use. These requirements are defined, for the most part, by the User. The User defines requirements that focus on the subject of the application and its field of use (i.e., requirements that originate in the user and problem domains). Additional requirements may be provided by the Developer to define what the simulation needs to accommodate the intended use (e.g., operating systems, level of fidelity, data formats). The Accreditation Agent can support this effort by ascertaining which requirements are in need of further refinement, determining appropriate metrics and acceptability criteria, and identifying simulation deficiencies and associated operational risks. This information can also be used to determine the scope of the accreditation assessment.

In determining the scope of the accreditation assessment, the Accreditation Agent may discover that the M&S requirements are incomplete or inconsistent. Similarly, the V&V Agent may discover problems during requirements verification. In either case, the User should be brought in to resolve any problems with the requirements. As the role responsible both for defining the requirements and for deciding on the fitness of the simulation to meet them, the User should also be responsible for decisions concerning their modification or correction. The Accreditation and V&V Agents can provide support by identifying which requirements need refinement. They can also recommend specific derivations and refinements of the User's more broadly stated requirements; however,

any changes, derivations, or refinements should be approved by the User and verified for consistency and completeness.

## 2. Support Legacy Simulation Selection

When the User decides to use a legacy simulation, there may be a single, appropriate, credible simulation available or there may be several simulations available that appear equally able to address the needs of the intended use. In the latter case, the User may need assistance in determining which simulation to use (e.g., which simulation is the best fit, which involves least cost or work to prepare). The Accreditation Agent can support this effort by identifying selection criteria and coordinating an assessment of the candidates that focuses on the advantages and disadvantages of each with respect to the intended use. The Accreditation Agent should support this effort because of its impact on the overall accreditation assessment:

- The simulation's advantages and disadvantages identified during the selection process help determine the scope of the accreditation assessment.
- Criteria that are critical for simulation selection are also critical for determining the simulation's fitness for the intended use.

For additional information, access the link [legacy simulation selection](#).

## 3. Support Simulation Capabilities Characterization

The process of determining the scope of the accreditation assessment may reveal that insufficient information exists to describe the legacy simulation's representational capabilities. This should precipitate a discovery process to better characterize the simulation's capabilities. The magnitude of this effort may require the involvement of a Developer to perform the actual discovery work, which may involve extensive baselining or reverse engineering. The Accreditation Agent participates, with the V&V Agent, in this discovery activity by defining the information needs and then monitoring the Developer's progress. The Accreditation Agent provides this guidance in the form of prioritized accreditation information needs and assists with the development of the V&V plan. The Accreditation Agent should also monitor discovery activities to ensure that the information collected meets the accreditation standards.

## **VV&A Challenges of the Accreditation Agent Role**

The seven basic challenges influencing the accreditation of a legacy simulation are listed below and discussed in the following paragraphs.

## **1. Ensuring Comprehensive Definition of the Intended Use**

A comprehensive description of the problem being addressed is needed to ensure that those participating in the simulation's assessment and preparation have an adequate understanding of the intended use. A thorough understanding of the intended use increases the likelihood that requirements will be adequately defined, operational risks will be recognized, and the accreditation information needs identified will result in a cost-effective and efficient accreditation assessment. The Accreditation Agent can help ensure a comprehensive definition of the intended use by supporting M&S requirements definition and refinement and M&S requirement verification, and by maintaining an open communication with the User and other participants in the assessment and preparation process. For more information regarding M&S requirements see [Advanced Topics>Special Topics>Requirements](#).

## **2. Using Existing V&V Documentation**

The available V&V history of a legacy simulation may be incomplete. Depending on the simulation's configuration management program, V&V documentation from individual applications may not be considered part of the simulation documentation and may, instead, be maintained by the individual Users. Not only does this make it difficult to locate V&V reports, but it means that the content of each V&V report was prepared to meet specifications set by the individual User and may or may not include the information needed, such as:

- What was examined (e.g., requirements, acceptability criteria)
- What techniques were used
- What tests were performed and their components (e.g., scenarios, data, and results)
- What assumptions were made
- What limitations and problems were identified

When faced with incomplete V&V information, the Accreditation Agent can attempt to generate such information from sources such as listed in the following table.

Sources for Legacy V&V Information
<ul style="list-style-type: none"><li>• M&amp;S databases and repositories (e.g., Model and Simulation Resource Repository [MSRR])</li></ul>
<ul style="list-style-type: none"><li>• M&amp;S Proponent (configuration manager)</li></ul>
<ul style="list-style-type: none"><li>• Original and subsequent Developers</li></ul>
<ul style="list-style-type: none"><li>• Accreditation packages</li></ul>
<ul style="list-style-type: none"><li>• User group records</li></ul>
<ul style="list-style-type: none"><li>• Previous Users</li></ul>

Additional information on sources is provided at the link [legacy simulation information sources](#).

When the available information is deemed insufficient for accreditation, a V&V effort targeted at the deficit may be needed. Alternatively, the necessary information may be obtained by involving SMES in the accreditation assessment process, depending on the extent of operational risks involved. SMEs with extensive experience with the simulation, particularly in connection with similar applications, should be included because they can provide information from their experience and help recreate tests that may reduce the need for additional V&V activities. Ideally two or more SMEs should be involved to provide a broader knowledge base.

### **3. Coping With Configuration Management Deficiencies**

Legacy simulation configuration management practices range from extremely structured (e.g., the M&S Proponency includes a configuration control board) to extremely open (e.g., multiple versions exist and there is no designated approval authority for changes). For legacy simulations under strict configuration control, the availability of consistent and complete documentation can reduce the amount of uncertainty associated with the simulation (inherited risk) and facilitate its assessment and preparation for use. However, when the selected version is not the one under configuration control, the baseline documentation from the configuration-managed version should be used only with appropriate caveats.

Strict configuration management practices also control when and how a simulation can be modified. The User of a legacy simulation under strict configuration control must seek approval from the M&S Proponent (or configuration control board) for modifications. Configuration control boards tend to meet on a regular basis (e.g., semiannually) to consider modification requests and often dictate when and how the modifications can be done. The Accreditation Agent needs to consider the risks associated with having the modification request delayed, controlled, or denied altogether.

Conversely, for simulations under less stringent configuration control, the simulation information may be limited and incomplete. Multiple versions of the simulation may exist, and as a result, the available information may not pertain to the version being

used. Under these circumstances, more resources need to be devoted to assessing the available information and obtaining additional information, which can be both time-consuming and costly. The Accreditation Agent needs to consider the inherited and operational risks involved in using the simulation in the intended use.

#### **4. Locating Appropriate SMEs**

A major challenge for the Accreditation Agent is the identification of SMEs to participate in the accreditation assessment. The user community is usually the best source for experts in the problem domain, and often the User can either supply these people or make recommendations about whom to request and how to secure their help. Additional SMEs may be needed with expertise in other areas, such as software development methods or a specific academic discipline (e.g., mathematics, physics), as well as knowledge of the simulation itself. In addition to areas of expertise, additional criteria to consider when selecting SMEs include background or formal training in analytical disciplines (e.g., operations research), availability, interest, experience, and willingness and ability to support the effort during the specified time.

#### **5. Overcoming Delay in Appointment of the Accreditation Agent**

The decision to appoint an Accreditation Agent may not occur until after the legacy simulation has been selected and its preparation has begun. Sometimes, the appointment of an Accreditation Agent does not occur until after the simulation has already been run and the User discovers that the results will not be accepted without the accreditation. In either case, the Accreditation Agent has to play "catch up" to identify and arbitrate problems that could have been anticipated and avoided earlier. Obviously, the cost-effectiveness of the entire accreditation effort in such cases is less than ideal.

#### **6. Obtaining Needed Resources**

Legacy simulation use is associated with smaller budgets and shorter timelines.

- Programs may choose to use legacy simulations in part to save time and money.
- Smaller budgets and shorter timelines may be allocated to programs using legacy simulations because they are not developing a simulation.
- Users may have an implicit expectation that a legacy simulation comes *ready-to-use*.

What is missing from such assumptions is the realization that time and resources are still needed to ensure that the legacy simulation is fit for the intended use. A major concern for the Accreditation Agent is that insufficient time and resources will be available to perform the tasks needed to ensure a reasonable accreditation assessment. This problem is compounded by a concern that funding may be allocated

before the Accreditation Agent has been able to determine the scope of the assessment.

The challenge is to determine the time and resources needed to conduct an adequate accreditation assessment. If the time and resources available are inadequate, then the Accreditation Agent should conduct a risk analysis to determine the impact of reducing or omitting various tasks. Presenting the User with a clear, logical explanation of the risks involved if the necessary V&V and accreditation assessment tasks are not accomplished and specific alternatives that can be pursued may be sufficient to obtain additional time or funding.

### ***7. Communicating the Benefits of the Accreditation Assessment***

Some Users perceive accreditation, particularly for a legacy simulation, as a mere bureaucratic wicket; others fail to recognize the value of the accreditation assessment for each specific use of a simulation. The Accreditation Agent is responsible for analyzing and prioritizing the risks involved and providing guidance on what evidence is needed to demonstrate the simulation's fitness for the intended use. The challenge for the Accreditation Agent is to persuade the User of the importance of accreditation as a way of mitigating risk, possibly using a cost-benefit tradeoff analysis, and that following a logical and disciplined accreditation assessment process is beneficial.

## **Accreditation Agent's Relationship with Other Roles**

### ***Information Exchanges***

To understand what the simulation needs to be able to do, the Accreditation Agent needs a description of the simulation's existing capabilities, limitations, and evidence of simulation accuracy and usability. To understand what the simulation needs to provide for the intended use, the Accreditation Agent also needs extensive information about:

- Risks associated with using this simulation for the intended use
- Data – both data types previously used in the simulation and new data types being introduced for this intended use
- Operators and analysts so that the assessment can evaluate the adequacy of the supporting documentation (e.g., user manuals, tutorials) that is available with the simulation

The table below shows the information exchanges between roles in the legacy simulation preparation process.

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Information Exchanges between Roles						
Information	User	VV	AA	PM	Dev	Prop
Existing simulation	R	R	R	R	R	P
Existing simulation documentation	R	R	R	R	R	P
Requirements	P	R	R	R	R	
Accreditation decision	P					
Plans	P	R	R	R	R	
Modification plans	A	R	R	P	R	A*
Funding/schedule	A	R	R	P	R	
Simulation conceptual model		R		A	P	R*
Design(s)		R		A	P	R*
Code		R		A	P	R*
Implementation		R		A	P	R*
Manuals		R		A	P	
Test plans and results		R		A	P	
V&V plans	R	P	A	R	R	
Verification results		P	A	R	R	R*
Validation results		P	A	R	R	R*
Accreditation plans	A	R	P	R	R	
Acceptability criteria	A	R	P	R	R	
Accreditation information needs		R	P	A	R	
Accreditation reports	A	R	P	R		
<i>*When version of simulation involved is under program configuration control.</i>						
P: Produces the artifact or product						
A: Approves or authorizes distribution of the artifact or product						
R: Receives or uses the artifact or product						

### Accreditation Agent Relationship with the User

The Accreditation Agent interfaces with the User throughout the entire M&S use process to ensure that the User's requirements are understood, updated as necessary, and serve as the underpinning of the accreditation process. The Accreditation Agent takes direction and receives funds from the User. In addition, the User may be called upon to identify or provide SMEs for the accreditation assessment. When a draft Accreditation Plan is prepared, it should be reviewed with the User to ensure that the planned activities can be funded.

The User should identify and fund the Accreditation Agent as soon as possible after the need to use a simulation is identified. An Accreditation Agent can provide valuable assistance to the User in defining the M&S requirements and selecting a suitable simulation. An Accreditation Agent can also assist in refining requirements, identifying and prioritizing risks, determining appropriate measures and acceptability criteria for each, and establishing priorities for both the V&V effort and simulation modification.

If any significant amount of time transpires between the accreditation planning phase and the assessment phase, the Accreditation Agent should coordinate with the User to

identify any changes that have been made to the intended use and objectives so that the accreditation information needs can be updated as necessary. At the end of the accreditation assessment, the Accreditation Agent provides a report and a set of possible accreditation options to the User:

### ***Accreditation Agent Relationship with the M&S Proponent, M&S PM, and Developer***

Typically, the Accreditation Agent interacts with the M&S Proponent, the M&S PM, and the Developer to obtain information to use in planning and performing the simulation assessment. The Accreditation Agent interfaces with the M&S Proponent to obtain information about the simulation, about the configuration control measures in effect, and about any configuration changes that involve the version of the simulation being considered for use. The M&S Proponent may also be asked to provide V&V and usage histories or identify sources for them. The Accreditation Agent coordinates with the M&S PM, when one has been designated, to ensure that event schedules are coordinated and on time and that sufficient resources are allocated. The Accreditation Agent may call upon the Developer, when one has been designated, to provide information about simulation capabilities and limitations.

### ***Accreditation Agent Relationship with the V&V Agent***

The relationship between the Accreditation Agent and the V&V Agent is critical for a successful and cost-effective accreditation effort. The Accreditation Agent should work with the V&V Agent to ensure that V&V activities are focused on providing the information needed for accreditation. The Accreditation Agent serves as both a guide for and a customer of the V&V Agent. As a guide, the Accreditation Agent provides accreditation information needs and V&V priorities to the V&V Agent to shape the V&V plan and process. As a customer, the Accreditation Agent receives information about the simulation's capabilities and limitations to use in the accreditation assessment. The V&V Agent should provide draft V&V reports to the Accreditation Agent as they are generated. By reviewing these drafts, the Accreditation Agent can provide feedback on their structure and utility.

The Accreditation Agent should coordinate with the V&V Agent (as well as with the User and the M&S PM) to help identify accreditation assessment team members. The V&V Agent usually can help identify personnel who are familiar with the simulation or who are familiar with the technology involved in developing this or similar simulations. In some cases the V&V Agent may actually be a member of the accreditation assessment team, since the V&V Agent probably has a great deal of knowledge about how the simulation works and what shortfalls might exist.

## Documentation Requirements

The accreditation effort should result in the following products: Accreditation Plan, Accreditation Assessment Report, and Accreditation Report.

The accreditation plan defines the acceptability criteria for the simulation and the accreditation information needs in addition to outlining the different tasks that must be performed to contribute to the accreditation assessment. The accreditation assessment and accreditation reports recommend an accreditation outcome and contain enough evidence to support that conclusion to enable the User to confidently make the accreditation decision. All of the other roles receive the accreditation plan, and the User receives the accreditation reports.

To generate these products, the Accreditation Agent requires:

- M&S requirements from the User
- Verification results from the V&V Agent
- Validation results from the V&V Agent

In addition, the Accreditation Agent needs the information obtained during the discovery activity, the modification plan, and funding and scheduling information from the M&S PM to properly pace the accreditation activities.

### ***Accreditation Plan***

The essential elements to include in the accreditation plan are listed in the table below and discussed in the following paragraphs.

<b>Basic Elements of the Accreditation Plan</b>
• Intended use statement and problem objectives
• Verified M&S requirements and their associated measures and acceptability criteria
• Risk assessment and resulting accreditation Information needs <ul style="list-style-type: none"><li>– V&amp;V information needed</li><li>– Supplemental information</li></ul>
• Pertinent regulatory information (e.g., Accreditation Authority, documentation and archiving requirements, approval chain)
• Accreditation assessment plan
• Schedule of accreditation activities and resource allocation
• Accreditation report structure and outline

The information identified below can be contained in either the accreditation plan or in other documents referenced in the plan.

### **Accreditation Plan: Intended Use Statement and Problem Objectives**

The problem or intended use statement and objectives provided by the User serve as the starting point for any accreditation. If these items are documented somewhere else, they may be summarized in the Accreditation Plan along with a reference to the source document. The essential point to consider when documenting the intended use and objectives is that the level of detail be sufficient to support development of M&S requirements. The intended use statement may have to undergo several iterations before the Accreditation Plan is finalized.

### **Accreditation Plan: Verified M&S Requirements, Associated Metrics, and Acceptability Criteria**

M&S requirements are derived from the objectives to define the capabilities needed by the simulation. During problem analysis the User, assisted by the Accreditation Agent, identifies appropriate metrics (e.g., measures of effectiveness, measures of performance) for each problem objective. On the basis of these metrics, the analysis should yield a set of parameters that are needed from the simulation (i.e., model outputs) and the set of objects, functions, and behaviors that must be represented within the simulation. The analysis should also yield the acceptability criteria, which are the standards that define the required simulation accuracy (how well the simulation must represent each object, function, or behavior).

The Accreditation Plan should specify and describe the M&S requirements and acceptability criteria in sufficient detail to support the accreditation assessment. The analysis process that yielded these requirements and criteria should be briefly summarized. Any documentation that describes the process used to determine the metrics and the acceptability criteria should be referenced.

For more information see [Advanced Topics>Special Topics>Requirements](#) and [Advanced Topics>Special Topics>Acceptability Criteria](#).

### **Accreditation Plan: Risk Assessment and Accreditation Information Needs**

The results of the risk assessment conducted to establish the basis for the accreditation information needs should be documented in the plan. A description of the risk assessment should be included as an appendix to the plan or as a reference. This description should include a list of risks addressed, their respective impacts, and the probability of occurrence for each, given an error in simulation results.

A product of the risk assessment that should also be included in the accreditation plan is a prioritization of the functions within the simulation that have the greatest impact on the simulation outputs of interest to the User. This prioritized list of functions may be documented by reference to some other document.

Accreditation information needs should be defined in terms of the types, scope, and depth of information needed for the accreditation assessment and which facet of fitness (capability, accuracy, correctness, or usability) is being addressed. Tables illustrating this organization are provided at the link [accreditation assessment guidance](#).

### **Accreditation Plan: Regulatory Information**

Each service and department within DoD has unique VV&A policies and requirements. This section of the plan should identify the policies and regulations governing the program and describe the steps that should be followed to accommodate them within the scope of the accreditation assessment. Any requirement for a review of the assessment, either before or after approval by the Accreditation Authority, or other required procedures, should be included in the plan. Any requirements for posting or archiving the accreditation assessment report and the supporting information should also be detailed.

### **Accreditation Plan: Accreditation Assessment Plan**

A detailed plan for conducting the accreditation assessment should include the following information:

- Type of assessment (single person or team effort) with supporting rationale
- Nature of the assessment activity (e.g., face-to-face meeting, video teleconference), location, length of time
- Types of expertise expected in participants and anticipated sources for these people
- Planned methods to assist participants in preparing for the assessment (e.g., orientation steps, read-ahead materials, training)
- Schedule of activities and resources allocated
- Support personnel needed to conduct the assessment (e.g., facilitator, recorder)
- Assessment methods and procedures to be followed (e.g., assess capability by reviewing each M&S requirement sequentially)
- Documentation methodology (e.g., mechanisms for capturing the results of the deliberations and methods for reviewing preliminary results, resolving conflicts, and gaining consensus)
- Approach to preparing an accurate report of the deliberations

## Accreditation Plan: Accreditation Assessment Report Description

As an aid in focusing the assessment planning, the intended assessment report should be outlined. Such an outline serves as a checklist to ensure that supporting plans (i.e., V&V plan, accreditation assessment plan) are structured to generate the necessary information. It also helps the person who leads the accreditation assessment to focus the efforts on producing the required information. The essential elements of an Accreditation Assessment Report are discussed in subsequent paragraphs.

### Accreditation Assessment Report

The essential elements of the accreditation assessment report are listed in the table below and discussed in the following paragraphs.

Essential Elements of the Accreditation Report
• M&S requirements and acceptability criteria
• Simulation capabilities, assumptions and limitations
• Results of the accreditation assessment with references to supporting documentation
• Accreditation recommendation

Summary information can be provided as long as the references for detailed information are identified. The Accreditation Agent should ensure that the User recognizes the importance of archiving this information and should work with the User to develop appropriate formats and techniques for capturing it.

### Accreditation Assessment Report: M&S Requirements and Acceptability Criteria

The M&S requirements and acceptability criteria can be documented in this accreditation assessment report, in the accreditation plan, or as a separate document. If they are not detailed in this report, appropriate references should be cited. This accreditation assessment report should also present a description of how these requirements and acceptability criteria were derived from the basic problem objectives and parameters. This information is needed to demonstrate that the M&S requirements and associated acceptability criteria are complete. It is also needed so that others can review and validate the requirements and acceptability criteria if necessary. In addition, this type of explanation facilitates the process of updating requirements and criteria in response to changes in the application.

### Accreditation Assessment Report: Simulation Capabilities, Assumptions, and Limitations

All simulation assumptions and limitations inherent in the simulation conceptual model or design or discovered through V&V activities should be documented, either in this report or in referenced documents. Simulation capabilities are described in the validated simulation conceptual model. For a capability description that is applicable to the

intended use, the simulation conceptual model should reflect the capabilities of the simulation version being used. If it does not, the simulation conceptual model should be modified to reflect this version and validated. If a formal simulation conceptual model does not exist, a surrogate can be developed from other simulation documentation (e.g., a description of the simulation's proven capabilities and limitations can be developed from the simulation handbooks, design documentation, and past or current V&V results) and validated.

### **Accreditation Assessment Report: Assessment Results**

The assessment results should address all aspects of simulation fitness (capability, correctness, accuracy, usability, and the completeness of the available information). The results should provide evidence showing how well the simulation satisfies the M&S requirements and acceptability criteria, discuss the results of software verification, data V&V, and results validation, and present the final assessment and the rationale for the conclusions reached.

If the simulation does not satisfy a requirement or one of the acceptability criteria, this document should discuss the impact of this failure, potential workarounds, and associated risks. If errors or deficiencies are identified in the code or data, the impacts of these limitations on the intended use and the risks resulting from using the simulation without corrections should be discussed. Such impact discussions allow tasks to be reprioritized and resources redistributed objectively to meet acceptability criteria and accreditation information needs.

The assessment report should also include:

- Appropriate references and explanations for each conclusion, so that the rationale can be traced back to original sources and supporting information (e.g., accreditation plans, risk assessments, requirement reports, V&V plan, a specific V&V report, data quality assessment)
- Evaluations of the adequacy of simulation configuration management and any impacts on the currency of evidence used in the assessment
- Discussion of the operators' and analysts' experience and capability to properly run the simulation and interpret its results; if their experience is limited, the report should discuss the adequacy of user support resources (e.g., model documentation, training, user groups, on-call support) to help ensure proper simulation operation

### **Accreditation Assessment Report: Accreditation Recommendation**

The accreditation recommendation is typically a concise (one-page) executive summary that includes:

- A synopsis of the rationale for the accreditation recommendation

- A list of the limitations and recommended constraints on the accreditation
- An approval statement for the User to sign

By itself, the accreditation recommendation shows only that an accreditation assessment has been completed. However, when signed by the User and included in a package accompanied by supporting documents that contain detailed information and cross-references to source data, the entire package becomes the Accreditation Report.

### ***Accreditation Report***

The Accreditation Report is a package of all formal documentation associated with the accreditation. It should contain a copy of the accreditation plan, the accreditation assessment report, and the signed accreditation decision.

The accreditation assessment report is the essential document needed by the User in making the accreditation decision. The accreditation decision consists of the accreditation option selected by the User with details of all caveats, qualifications, constraints, and limitations to be addressed.

## **Cost Implications and Resourcing**

For many legacy simulation applications, the accreditation assessment is a major cost driver. Several cost-related issues are listed below and discussed in the following paragraphs.

### ***Impact of Cost Constraints on VV&A***

In any simulation effort, cost constraints always force some prioritization on the tasks that are planned and executed. In a legacy reuse situation, the accreditation information needs are identified through risk analysis. If funding is insufficient to obtain or generate all of the needed information, the Accreditation Agent, in consultation with the User, should identify the critical needs and balance these against the available funds.

- Rank the individual information needs according to their relative impact on overall simulation fitness. In a separate list, rank the information needs in the order of which will be most costly to address and determine the impact if not obtained. Then prioritize the information needs based on both importance and cost.
- Use sensitivity analysis to identify and rank the individual functions or modules within the simulation according to their relative impact on the simulation results being used for the application. Using this ranking of functions and the information priorities determined in the step above, determine if the cost of any information need can be reduced by focusing on specific functions.

- Using these priorities, work with the V&V Agent to tailor the V&V effort to address the highest priority needs first using the most cost-effective techniques.

In some cases the Accreditation Agent may have to convince the User that more funds are absolutely essential for a reasonable accreditation assessment. To prove this, the Accreditation Agent should be able to show the relationship between a lack in accreditation information, the increased risk of erroneous simulation results, and the effect on credibility.

### ***Cost Drivers of the VV&A Effort***

The major factors that affect legacy simulation VV&A costs are the amount, applicability, and utility of information available about the simulation and M&S requirements; the supplemental V&V activities involved; and the assessment and planning activities. (Documentation cost is not addressed separately but is included with the cost of the overall VV&A effort.)

### **Available Information and the VV&A Effort**

The major cost drivers in a VV&A effort for legacy simulations depend on two factors: how much credibility is needed and how much V&V information already exists. When little documented V&V information exists about the version of the simulation being used, cost is likely to be higher because of the need for more extensive verification and validation. This is particularly true when a high level of simulation credibility is needed (e.g., when safety, health, or national security are at risk). The amount, applicability, and utility of existing documentation depend on the efficacy of the configuration management program and the completeness, correctness, and availability of:

- Simulation development products and artifacts
- Documentation identifying the version of the simulation being used
- Documentation describing previous uses (e.g., study reports)
- VV&A history of this version of the simulation

It can be assumed that if the information available from an official source (e.g., development products, study reports) is under configuration control, then it is acceptable. The V&V effort should be tailored to address only those areas where information is unavailable and to cover additional needed preparation activities.

### **Accreditation Assessment**

The cost of the accreditation assessment includes the cost of planning and preparing for meetings, obtaining SME services, and documenting results. Preparation cost varies depending on the complexity of the simulation and the application and on the amount of simulation training needed for participants. The costs associated with running the

assessment are a function of the amount of time available and the number of people involved.

When the time is short, additional expertise regarding the simulation and its intended use may be needed to avoid excessive training. The selected SMEs may cost more because of their greater expertise; however, this added cost per person might be offset by the avoidance of training costs.

Documentation cost will vary somewhat according to the complexity of the simulation and application. Greater complexity will typically be linked to more voluminous reports and thus greater cost. The Accreditation Agent can control reporting cost by planning for an efficient method of *documenting meeting results*.

## Planning

The cost of planning the accreditation effort probably has the least impact on overall VV&A cost. Actual planning is performed in coordination with the V&V Agent and User; however, the pre-planning activities, such as assessing risk, identifying the accreditation information needs, and determining the scope of the assessment can require participation from a number of SMEs. Typically, the planning cost is directly proportional to the amount of support and involvement of the User and the completeness of the problem description and the M&S requirements.

## VV&A Cost Controls

The Accreditation Agent should use every information source available to determine if the simulation satisfies the M&S requirements and should explore any alternative that can balance the accreditation information requirements with the cost of fulfilling them. The two major factors for controlling costs with careful planning are to ensure that there is a complete and clear definition of the application and that there are a definitive set of M&S requirements with precise acceptability criteria.

The Accreditation Agent should pay particular attention to team composition, meeting sites, and report formats.

- **Team composition** – The accreditation assessment team, when needed, should be carefully selected according to the considerations outlined at the link [selecting appropriate team members](#).
- **Meeting sites** – Meeting sites should be convenient to the majority of participants. Alternative meeting methods should be considered (e.g., video teleconferencing and teleconferencing). Particular care should be taken during preparation when all or some members are joining via telephone to ensure that read-ahead packages are made available in a timely manner and that agendas are closely followed.

- **Report formats** – Using report formats can serve as a framework for the meeting discussions, expedite preparation of reports, and save costs associated with multiple reviews and revisions.

### ***Cost Benefits of Standardized Documentation***

In any credibility-building effort involving a legacy simulation, the Accreditation Agent should seek out past V&V reports, accreditation reports, and simulation usage history to provide information on:

- Demonstrated capabilities and functionality of the simulation
- Assumptions, constraints, and limitations under which it has been used
- Types of applications in which it was successfully used

Unfortunately this information must often be gleaned from a miscellaneous collection of documents, notes, and even verbal reports from a variety of sources. Such information can be difficult to understand and interpret because it was prepared by different people with varying roles and interests, at different times, for different reasons. In addition, most technical reports are written using technical terminology, making them difficult for anyone without the same technical background to understand. Because this information is critical to both the V&V and the accreditation efforts, a great deal of time, energy, and resources can be expended in first locating and then reviewing it. Documentation standards ensure that the information provided is complete, and they aid in readability.

If all documentation could be prepared according to a standardized structure, the information captured would be much more understandable and usable for both current and future Users. These benefits are achievable if V&V reports and design documents highlight simulation limitations and impacts in addition to the usual information (e.g., plans, methods, tools, techniques, and results). The limitations arise from simulation approximations and assumptions or deficiencies discovered through verification or validation. The impact statements describe the effects of these limitations on potential applications in terms of the user. This information can be organized as shown in the table below. Information presented in this way will be much more understandable and useful to both current and future Users.

<b>Standardized Documentation Structure</b>	
<b>Impact Statements</b>	<b>Description (in Operational Terms)</b>
Impact <i>a</i>	<ul style="list-style-type: none"><li>• Impact on or limitation to usage</li></ul>
Impact <i>b</i>	<ul style="list-style-type: none"><li>• Impact on or limitation to usage</li></ul>
Impact <i>m</i>	<ul style="list-style-type: none"><li>• Impact on or limitation to usage</li></ul>

Standardized Documentation Structure (continued)			
Result Summaries	Result Categories		
	Assumption	Limitation	Proven capability
Result 1	x		
Result 2			x
Result <i>n</i>		x	
Concluding statement	<ul style="list-style-type: none"> <li>• Characterizing the actual usability of the simulation for the specific application</li> </ul>		

Using standard formats and structures to prepare the V&V and accreditation reports can provide benefits and cost savings both to those preparing the reports and to those who read them (e.g., Users, Accreditation Agents, V&V Agents). They reduce preparation time, help ensure that the information provided is complete and consistent, and decrease the amount of time needed for review. Documentation standards also aid future Users by providing easy access to the particular information they need.

## References

1. JTCG/AS-97-M-008: "V&V From A to Z," March 1997.

## Acronyms

AA	Accreditation Agent
DMSO	Defense Modeling and Simulation Office
DoD	Department of Defense
JTCG/AS	Joint Technical Coordination Group for Aircraft Survivability.
M&S	Modeling and Simulation
PM	Program Manager
RPG	Recommended Practices Guide
SME	Subject Matter Expert
V&V	Verification and Validation
VV	Verification and Validation Agent
VV&A	Verification, Validation, and Accreditation

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