

# Accreditation Agent Role in the VV&A of Legacy Simulations

## VV&A Recommended Practices Guide (RPG) Core Document

15 September 2006

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*This document corresponds to the web version of the VV&A RPG Core Document of the same name and date. It has been modified to make it suitable for printing. This document replaces the 8/15/04 version. It contains updated material and formatting changes.*

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## Introduction

### ***What is the Role of Accreditation Agent in Legacy Simulation VV&A?***

This document describes the role and responsibilities of the Accreditation Agent in the verification, validation, and accreditation (VV&A) of a legacy simulation.<sup>1</sup> **Accreditation Agent** is the term used throughout the RPG to describe the organization, group, or person responsible for assessing the simulation's fitness for the intended purpose. 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 purpose with the costs (in time and resources) involved in producing it. In the home-buying analogy presented in the *Key Concepts*,<sup>2</sup> the Accreditation Agent represents the Building Inspector who is responsible for determining what inspections need to be made, for assessing the results of those inspections, and for issuing a final report on the status of the house and also the prospective owner's agent, who is responsible for ensuring that the prospective owner's requirements are met.

Other basic roles that perform and support legacy simulation VV&A include

- **User** – the role responsible for defining the problem (e.g., M&S requirements, measures, acceptability criteria, referent), determining how to solve it, and making the accreditation decision
- **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, for preparing data for use in the simulation, and for making code modifications and developing new code, when needed
- **M&S Proponent (M&S Pro)** – the role responsible for managing the legacy simulation throughout its lifecycle, including configuration management, application, and maintenance, and for approving all modifications to the authorized version of the simulation<sup>3</sup>

Each role can be performed by a different individual, group, or organization; or, multiple roles can be performed by the same individual, group, or organization. The number of

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<sup>1</sup> Throughout this document the term *simulation* is used to denote either a model or a simulation and the term *legacy simulation* is used to denote any model or simulation that has been used previously or was developed for a different application.

<sup>2</sup> See the RPG menu item *Key Concepts* for additional information.

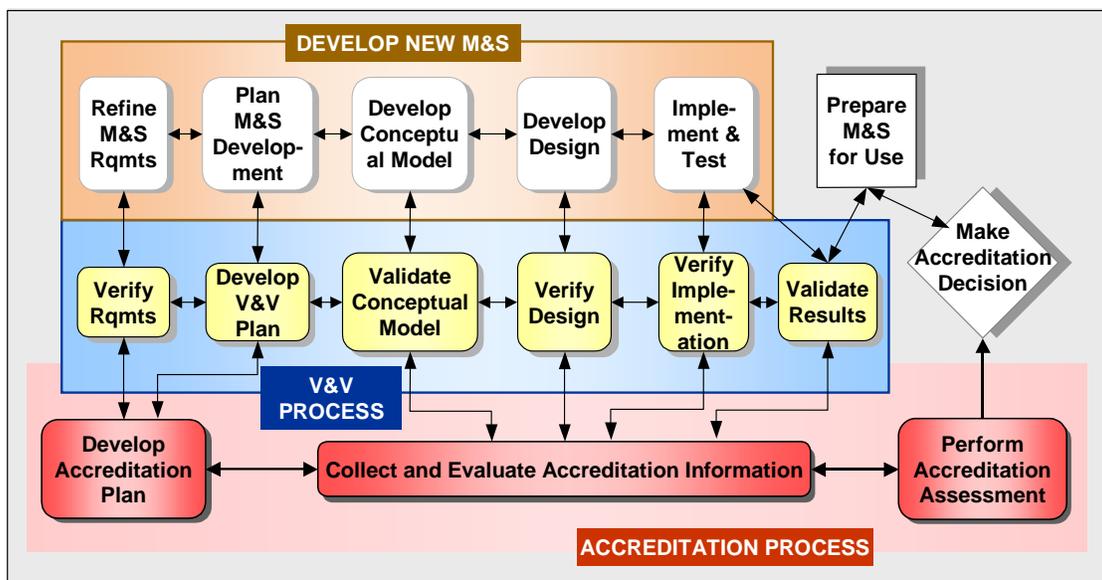
<sup>3</sup> Note that the M&S Proponent role is responsible to the simulation program.

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 end up performing 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 application and the capabilities being built into the simulation. During planning, the Accreditation Agent identifies the accreditation information needs based on the M&S requirements and 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.



**Accreditation Agent Involvement in the VV&A of New Simulations**

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.

In legacy simulation, as described in the *Legacy Simulation Overview*,<sup>4</sup> 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 it can satisfy the requirements of the intended application. The simulation was developed to address a specific set of requirements that may or may not be similar to the requirements of the intended application and the simulation has a history of usage that may differ significantly from the intended application. The availability and quality of information about the simulation and the similarity between previous applications and the intended application are risk factors that impact the scope of the accreditation assessment. In addition, when more than one legacy simulation exists that appear suitable for the intended purpose, the Accreditation Agent may be called upon to support the User in selecting the most appropriate one.

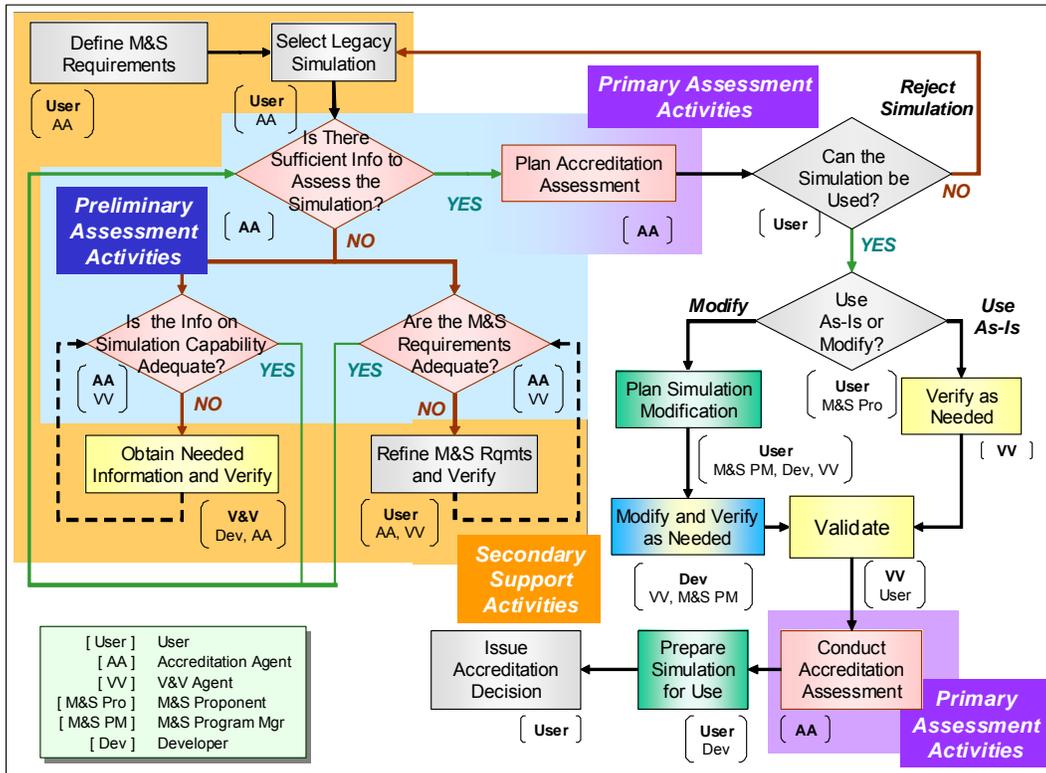
Accreditation Agent involvement in the VV&A of a legacy simulation can be grouped into three sets of activities shown in the following [figure](#) and listed below.

- **Preliminary assessment activities** that establish the scope for the VV&A effort (shaded in blue in the figure)
- **Primary Assessment activities**, in which the Accreditation Agent plays the major role in determining the fitness of the simulation for the intended purpose (shaded in purple in the figure)
- **Secondary Support activities, in which the Accreditation Agent provides support as needed** (shaded in orange in the figure)

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

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<sup>4</sup>See the core document on the VV&A of Legacy Simulations Overview.



Accreditation Agent Activities in the VV&A of a Legacy Simulation

## 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 purpose, establishing priorities for the V&V effort, and capturing this information in a detailed accreditation plan.

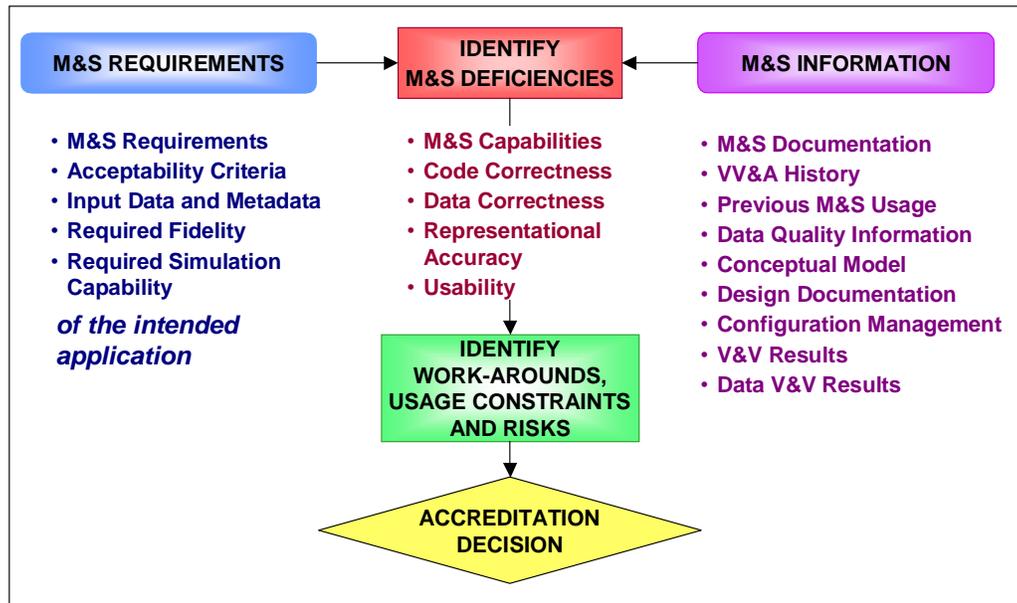
The following table summarizes the typical Accreditation Agent responsibilities associated with different functions and activities involved in the VV&A of a legacy simulation.

<b>Accreditation Agent VV&amp;A Responsibilities</b>	
<b>Accreditation Agent Function</b>	<b>Typical Accreditation Agent Responsibilities</b>
<b>Preliminary Assessment Activities</b>	
<a href="#">Establish Acceptability Criteria</a> [p. 8]	<ul style="list-style-type: none"> <li>• select appropriate criteria for measuring success of the intended application</li> </ul>
<a href="#">Assess Risk</a> [p. 8]	<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>
<a href="#">Collect and Evaluate Available Simulation Information</a> [p. 10]	<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 scope and level of effort needed for the accreditation assessment</li> </ul>
<a href="#">Identify Accreditation Information Needs</a> [p. 12]	<ul style="list-style-type: none"> <li>• identify accreditation information needs of the intended application</li> </ul>
<b>Primary Assessment Activities</b>	
<a href="#">Develop Accreditation Plan</a> [p. 17]	<ul style="list-style-type: none"> <li>• Consider assessment planning factors</li> <li>• specify assessment activities</li> <li>• select SMEs</li> </ul>
<a href="#">Collect and Evaluate Accreditation Information</a> [p. 20]	<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>
<a href="#">Perform Accreditation Assessment</a> [p. 21]	<ul style="list-style-type: none"> <li>• conduct the accreditation assessment</li> <li>• prepare accreditation report</li> </ul>
<b>Secondary Support Activities</b>	
<a href="#">Support M&amp;S Requirement Definition &amp; Refinement</a> [p. 24]	<ul style="list-style-type: none"> <li>• Assist User and V&amp;V Agent to ensure M&amp;S requirements for the intended application are well-defined</li> </ul>
<a href="#">Support Simulation Selection</a> [p. 24]	<ul style="list-style-type: none"> <li>• Assist User in selecting most appropriate simulation for intended use</li> </ul>
<a href="#">Support Simulation Capabilities Characterization</a> [p. 25]	<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>
<a href="#">Support V&amp;V Planning</a> [p. 25]	<ul style="list-style-type: none"> <li>• help focus V&amp;V plan on 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>

## 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 application. The [Practical Accreditation Concept](#) figure [p. 6] presents a logical depiction of the basic accreditation strategy in which information about the simulation (which talks to what the simulation can do) and the M&S requirements (which talks to what the simulation needs to do) are compared to determine *fitness for purpose*.



A Practical Accreditation Concept

A simulation's fitness for purpose is dependent on four key fitness factors:<sup>5</sup>

- **Capability** -- what the simulation can do in terms of functional representations, behaviors, relationships, and interactions
- **Correctness** -- error-free code; appropriate, authoritative input data<sup>6</sup>

<sup>5</sup> Another factor sometimes considered when assessing a legacy simulation is documentation completeness – the comprehensiveness and availability of the information pertaining to the version of the simulation being used.

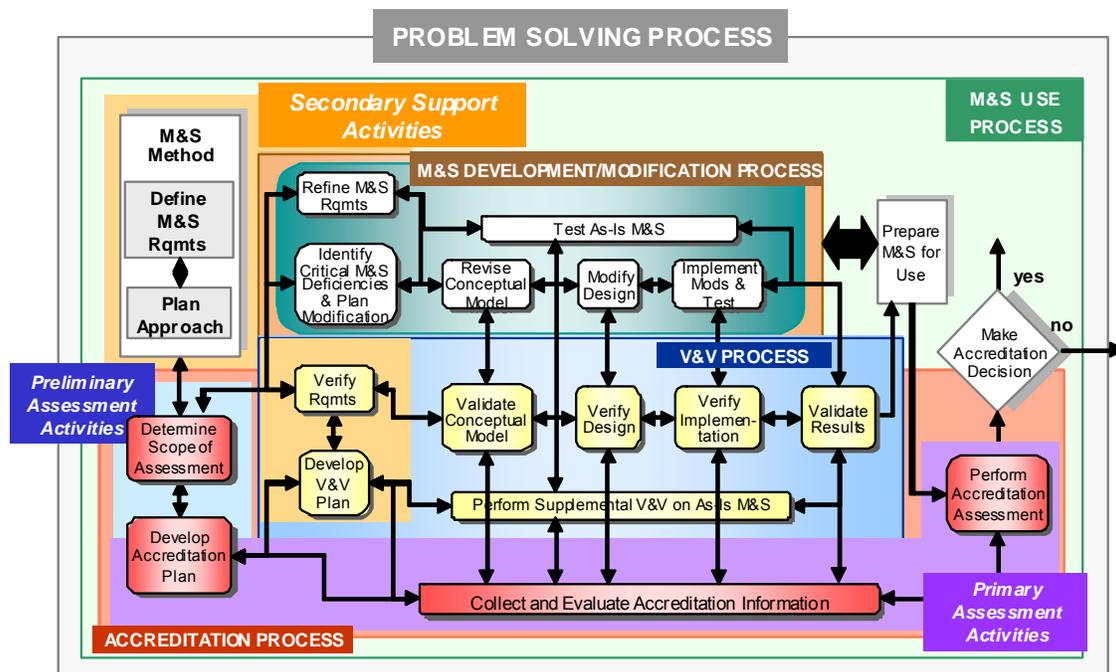
<sup>6</sup> See the reference document on M&S Data Concepts and Terms for additional information.

- **Accuracy** -- how closely the simulation results correspond to the intended view of reality (i.e., the referent)
- **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

**Completeness** of the available information is often regarded as a fifth aspect of simulation fitness, particularly when the scope and depth of the evidence impact the assessment of risk associated with employing the simulation in the intended use.

### Accreditation Process

The Accreditation Process shown in the following diagram implements this accreditation strategy as part of the overall **Problem Solving Process**.<sup>7</sup> The three groups of accreditation activities depicted in the legacy simulation [flow diagram](#) [p. 4] 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 illustrated in the

<sup>7</sup> See the description of the overall problem solving process in the Key Concepts.

[process](#) and [flow](#) diagrams and described in the [Accreditation Agent VV&A Responsibilities](#) table:

- [Preliminary Assessment Activities](#) [p. 8]
- [Primary Assessment Activities](#) [p. 17]
- [Secondary Support Activities](#) [p. 24]

## ***Preliminary Activities***

This group of activities is initiated as soon as the Accreditation Agent is designated during the ***M&S Use Process***. Their 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 listed in the [Accreditation Agent VV&A Responsibilities](#) table: establish the acceptability criteria, assess risk, collect and evaluate available simulation information, and identify accreditation information needs. Because of the evolving nature of information gathering and because of the interdependencies between the preliminary tasks, they are often performed concurrently or iteratively.

## **Establish Acceptability Criteria**

To establish the scope of the accreditation assessment, the Accreditation Agent needs a clear understanding of the requirements<sup>8</sup> and objectives of the intended application. Without clearly articulated requirements, every aspect of legacy assessment and preparation is made more difficult and error-prone and more likely to result in 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 [MOEs], measures of performance [MOPs])<sup>9</sup> 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 of acceptability criteria are provided in [Appendix A](#).

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

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<sup>8</sup> See the special topic on Requirements for additional information.

<sup>9</sup> See the special topic on Measures for additional information.

gaps or inconsistencies in the requirements. When possible, the Accreditation Agent should assist the User in refining the M&S requirements (see [Support M&S Requirement Definition and Refinement](#) [p. 24]).

## 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 application (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 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 usually 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<sup>10</sup> 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.

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<sup>10</sup> See the special topic on Risk and Its Impact on VV&A for additional information.

<b>Legacy Simulation Risk Assessment Questions</b>
<ul style="list-style-type: none"> <li>• What is the impact if a defect results in a failure of the simulation to satisfy a requirement?</li> </ul>
<ul style="list-style-type: none"> <li>• What is the probability that a defect in the simulation will cause such a failure?</li> </ul>
<ul style="list-style-type: none"> <li>• What is the likelihood that a defect will occur in the simulation?</li> </ul>
<ul style="list-style-type: none"> <li>• Does the simulation operate as required under all conditions matching the intended use?</li> </ul>
<ul style="list-style-type: none"> <li>• What is the impact of previously unresolved problems and uncorrected defects given the intended use?</li> </ul>
<ul style="list-style-type: none"> <li>• Do modifications to the simulation or data introduce unintended consequences?</li> </ul>
<ul style="list-style-type: none"> <li>• What risks are associated with incorrect simulation results?</li> </ul>
<ul style="list-style-type: none"> <li>• What is the nature of those risks (safety, financial, unit effectiveness, program jeopardy, etc.)?</li> </ul>
<ul style="list-style-type: none"> <li>• What organizations or groups might be affected by these risks?</li> </ul>
<ul style="list-style-type: none"> <li>• What is the likelihood that an incorrect decision or outcome will result if the model produces erroneous outputs or predictions?</li> </ul>
<ul style="list-style-type: none"> <li>• What visibility will an incorrect decision have?</li> </ul>
<ul style="list-style-type: none"> <li>• Does the User have any specific issues or concerns that should be considered as risks?</li> </ul>

### **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 also serves as the basis for identifying what modifications may be needed and what additional V&V work is necessary. During the preliminary assessment, the Accreditation Agent 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.

Information about the simulation can be found in the technical documentation, artifacts, and products (e.g., M&S requirements, validated 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 (CCB), previous Developer(s), and/or previous Users. See [Appendix B](#) for additional information on information sources.

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 to the accreditation information needs (as described in [Identify Accreditation Information Needs](#) [p. 12]). 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><a href="#">Simulation Overview Information</a></b> [p. 12]	
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 (CM) 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 to standards; how well software is structured</li> </ul>
<b><a href="#">Functional Characterization Information</a></b> [p. 11]	
Simulation conceptual model description	<ul style="list-style-type: none"> <li>Basic functions and behaviors represented, level of detail at which each function represented, algorithm descriptions, data needs,</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><a href="#">Detailed V&amp;V Information</a></b> [p. 14]	
Data V&V	<ul style="list-style-type: none"> <li>Input and hard-wired data well-defined, consistently used, in agreement with best estimates or intelligence data, of appropriate fidelity, authoritative sources, etc.</li> </ul>

Simulation Fitness Information	
Information	Description
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 [Appendix B](#)) 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.

## Identify Accreditation Information Needs

Based on 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](#) [p. 12]
- [Functional Characterization Information](#) [p. 14]
- [Detailed V&V Information](#) [p. 15]

### **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>	
What code and documentation set constitutes the “official” simulation baseline? How are changes to it managed and supported?	<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 (CM) policies and procedures for the simulation.</li> <li>• Without a sound CM 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 CM 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>	
What assumptions, limitations, and errors are known and what is the impact on simulation usage of each?	<ul style="list-style-type: none"> <li>• This tells which, if any, limitations exist that will affect the intended application. 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>	
Who has used the simulation before, and for what? What is the simulation V&V history and status? Who has accredited before, and for what?	<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 intended application.</li> </ul>
<b>Documentation Assessment</b>	
How well is the simulation documented relative to accepted standards?	<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>	
How “good” is the software relative to accepted standards?	<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, will be 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 the 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>	
What are the basic functional elements of the simulation? i.e., what does it simulate, and to what level of detail?	<ul style="list-style-type: none"> <li>This 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>	
How are simulation functions and behaviors integrated to produce simulation outputs?	<ul style="list-style-type: none"> <li>This addresses issues related to simulation construction, and whether it 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>	
What are the design requirements for each of the simulation functional elements? How are they coded?	<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>
<b>Logical Verification</b>	

<b>Functional Characterization Information Set</b>	
<b>Issues</b>	<b>Rationale</b>
<p>For what set of problems do simulation assumptions and limitations yield correct results?</p> <p>How do assumptions, limitations, errors and approximations affect potential uses of the simulation?</p> <p>Are assumptions, limitations, and approximations reasonable for certain specific applications?</p>	<ul style="list-style-type: none"> <li>• Answers to these questions come from assessments of the simulation by previous users, and should be evaluated in light of intended application requirements.</li> <li>• A logical verification is done with the design requirements representing the intended application 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 your accreditation assessment.</li> </ul>
<b>Sensitivity Analysis</b>	
<p>What are the key simulation sensitivities, and are they reasonable?</p>	<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 that have the greatest impact on key simulation outputs, and 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<sup>11</sup>, if it exists, should include sufficient information to characterize its functionality. For the capability description to be applicable to the intended application, the simulation conceptual model should reflect the simulation version being used. If not, it should either be modified to incorporate this version and validated or a surrogate conceptual model should be developed. When a formal simulation conceptual model does not exist, a surrogate can be developed from other simulation documentation (e.g., simulation handbooks, development/modification specifications, design documentation, and past or current V&V results) and validated.

***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?***

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<sup>11</sup>See the special topic on Simulation Conceptual Model Development and Validation for additional information.

<b>Detailed V&amp;V Information Set</b>	
<b>Issues</b>	<b>Rationale</b>
<b><i>Data Verification and Validation</i></b>	
<p>Are instance data well defined and consistently used?            Do instance data agree with best estimates or intelligence information?            What is the impact of identified data limitations on simulation use?</p>	<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><i>Simulation Conceptual Model Validation</i></b>	
<p>Does a conceptual model exist for this version of the simulation?            Is it complete and consistent?            Are modifications needed to ensure it accurately describes the simulation being used?            How well do the simulation capabilities described in the conceptual model address the M&amp;S requirements of the intended use?</p>	<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 application.</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>	
<p>Does the code correctly implement the design?            What is the impact on simulation use of any limitations discovered?</p>	<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>	

Detailed V&V Information Set	
Issues	Rationale
<p>How well do simulation outputs compare with the <i>referent</i>?<sup>12</sup></p> <p>How were they assessed?</p> <p>What is the impact on simulation use of any limitations discovered?</p>	<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 application.</li> <li>• Because results validation is done from the perspective of the intended application, 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>

### **Primary Assessment Activities**

This group of activities focuses on assessment of the fitness of the simulation for the intended use. It consists of the three activities listed in the [Accreditation Agent VV&A Responsibilities](#) table: develop accreditation plan, collect and evaluation accreditation information, and perform accreditation assessment. These are the same as the activities 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.<sup>13</sup>

#### **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 it can effectively influence information collection, V&V planning, and any planning for simulation modification. Some of the issues considered during planning include

- [Consider Assessment Planning Factors](#) [p. 18]
- [Specify Assessment Activities](#) [p. 19]
- [Select SMEs](#) [p. 20]

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<sup>12</sup>The referent is the codified body of knowledge about the thing being simulated. It is the reality against which test and validation results are measured. The referent may be composed of empirical data, previous test data, or data acquired from SMEs [RPG Glossary].

<sup>13</sup>See the core document on The Accreditation Agent Role in the VV&A of New Simulations for additional information.

### ***Consider Assessment Planning Factors***

An effective accreditation assessment should address each of the [fitness factors](#) [p. 6]. 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 light 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 application. 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 undertaken.
- **Assessment of simulation and data correctness** includes reviewing code verification tasks to ensure they are sufficiently comprehensive to address the needs of the intended application, evaluating code verification results to ensure they demonstrate an acceptable accuracy, and evaluating input data quality<sup>14</sup> 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<sup>15</sup>.
- **Assessment of simulation accuracy** includes evaluation of data and output accuracy. Data V&V<sup>16</sup> 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, GUIs, interfaces, training) based on 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 provide provisions for updating the [risk assessment](#) [p. 9] if the intended use is modified in any way.

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<sup>14</sup>See the RPG templates on Data Quality for additional information.

<sup>15</sup>See the reference document on M&S Data Concepts and Terms for additional information.

<sup>16</sup>See the special topic on Data V&V for Legacy Simulations for additional information.

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 in [Appendix C](#).

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.

<b>Accreditation Assessment Factors</b>
<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 their preparing 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 see [Appendix D](#).

### ***Specify Assessment Activities***

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 [p. 19]. For additional information on establishing the assessment process, see [Appendix D](#).

## Select SMEs

The Accreditation Agent should identify the areas of expertise needed to address each M&S requirement and ascertain the necessary qualifications for SMEs<sup>17</sup> in each area. Accreditation assessment typically requires expertise in a number of different areas, such as the problem domain of the intended application, the problem domain that the legacy simulation was developed to address, the programming language, software, and hardware of the existing simulation. For further information in team selection and operation, see [Appendix E](#).

## 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 the information resulting from the V&V effort, information generated by any modification activities, as well as 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 application, 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 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 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

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<sup>17</sup>See the special topic on Subject Matter Experts and VV&A for additional information.

supplemental information gathered for a new simulation assessment is shown in the table below.

Typical Supplemental Information and Sources	
Information	Source
<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

### Perform Accreditation Assessment

The accreditation assessment of a legacy simulation should be performed following 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 by either a single person or 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. (see [Appendix E](#)).

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 due to a perception of greater objectivity resulting from the increased breadth of technical expertise. A typical procedure used in team assessment is shown in the table below:

Typical Team Assessment Procedure
<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>

<b>Typical Team Assessment Procedure</b>
• Document all deficiencies (in simulation and in the accreditation information), their effects and associated risks if they remain uncorrected
• Identify potential work-arounds for each deficiency
• 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) [p. 6]. 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. Information about personnel requirements, the ease of operation, reliability of hardware and software, and the support elements available, (e.g., user manuals, GUIs, interfaces, on-line help menus, training) is used to evaluate usability.

The success of an accreditation assessment is facilitated by structured approach that includes the establishment of objectives, focused deliberations, building consensus, and complete and accurate reporting. (Additional information is provided in [Appendix D.](#))

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)?

<b>Essential Questions in Accreditation Assessment</b>
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 work-arounds:               <ul style="list-style-type: none"> <li>– Rely on history of successful uses</li> <li>– Get oral history of verification activities done during development and evaluate it by team of software SMEs</li> <li>– Conduct software quality assessment to determine likelihood of software errors<sup>18</sup></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 what information is missing. Determine impact of 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 extent and effectiveness of configuration management efforts. Present info to assessment team. If configuration management is inadequate, trace history of selected simulation back to a version with known and documented capabilities. Identify changes and evidence to support credibility of changes.</li> </ul>

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<sup>18</sup>Some methods and criteria for software quality assessment are described in the report JTCG/AS-95-M-016.

Once the accreditation assessment is completed, the Accreditation Agent submits the report (e.g., accreditation package) and a recommendation for accreditation. Normally, this accreditation recommendation is provided to the User in the form that the [accreditation decision](#) is to take.

## ***Secondary Support Activities***

This section identifies some additional activities in which Accreditation Agent provides support on an as-needed basis. These activities are listed in the [Accreditation Agent VV&A Responsibilities](#) table and described in the following paragraphs.

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

To support an intended application, a simulation needs to be able to address the M&S requirements associated with that application. The User defines M&S 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).<sup>19</sup> The Accreditation Agent can support this effort by ascertaining which M&S requirements are in need of further refinement, determining appropriate metrics and acceptability criteria, and identifying simulation deficiencies and associated operational risks.<sup>20</sup> 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.<sup>21</sup> As the one 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 reverified for consistency and completeness.

### **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 application. 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

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<sup>19</sup>See the special topic on Requirements for additional information.

<sup>20</sup>The User may obtain additional support from the V&V Agent and from SMEs with domain knowledge and/or experience with the legacy simulation (e.g., developers and previous users of the simulation).

<sup>21</sup>See the core document on The User Role in the VV&A of Legacy Simulations for additional information.

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 application. 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 on legacy simulation selection, see [Appendix F](#).

### **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 (*Identify Critical Deficiencies* in the [Problem Solving Process](#) diagram [p. 7]) 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 information collected meets the accreditation standards.<sup>22</sup>

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

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. Based on the accreditation information needs and deficiencies (see [Identify Accreditation Information Needs](#) [p. 12]), 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

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<sup>22</sup>See the core document on the V&V Agent Role in the VV&A of Legacy Simulations for additional information.

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.

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

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

- [Ensuring Comprehensive Definition of the Intended Use](#) [p. 26]
- [Ensuring Proper Understanding of Terms](#) [p.26]
- [Using Existing V&V Documentation](#) [p. 27]
- [Coping with Configuration Management Deficiencies](#) [p. 28]
- [Locating Appropriate SMEs](#) [p. 28]
- [Overcoming Delay in Appointment of The Accreditation Agent](#) [p. 29]
- [Obtaining Needed Resources](#) [p. 29]
- [Communicating the Benefits of the Accreditation Assessment](#) [p. 30]

### ***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](#) [p. 24] and M&S requirement verification,<sup>23</sup> and by maintaining an open communication with the User and other participants in the assessment and preparation process.

### ***Ensuring Proper Understanding of Terms***

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.

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<sup>23</sup>See the core document on V&V Agent Role in the VV&A of Legacy Simulations for additional information.

**Example:**

In one program, development testers used the term probability of kill (Pk) 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 term Pk 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 Pk 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.

## ***Using Existing V&V Documentation***

The available V&V history of a legacy simulation may not be complete. 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 how (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.

<b>Sources for Legacy V&amp;V Information</b>
• M&S databases and repositories (e.g., Model and Simulation Resource Repository [MSRR])
• M&S Proponent (configuration manager)
• original and subsequent Developers
• accreditation packages
• user group records
• previous Users

Additional information on sources is provided in [Appendix B](#).

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 to similar applications should be included because they can provide information based on their experience and help recreate tests that may reduce the need for additional V&V activities.<sup>24</sup> Ideally two or more SMEs should be involved to provide a broader knowledge base.

### ***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 [CCB]) 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 only be used 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 CCB) for modifications. CCBs 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 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 so the information that is available 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 application.

### ***Locating Appropriate SMEs***

A major challenge for the Accreditation Agent is the identification of SMEs<sup>25</sup> 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

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<sup>24</sup>Appropriate SMEs may be found either in organizations that frequently use the simulation or organizations that participated in its development or modification.

<sup>25</sup>See the special topic on Subject Matter Experts and VV&A for additional information.

people or make recommendations on 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., math, 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.

### ***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.

### ***Obtaining Needed Resources***

Limited resources is a driver in most simulation applications. This is particularly true in legacy simulation applications because

- 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 the legacy simulation is fit for the intended application. 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 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 different 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, as well as specific alternatives that can be pursued, may be sufficient to obtain additional time or funding.

## 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 trade-off analysis, 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 application, they also need extensive information about

- risks associated with using this simulation for the intended purpose
- data -- both data types previously used in the simulation and new data types being introduced for this application
- support documentation -- user manuals, tutorials, etc. used to train and support simulation operators and analysts

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

Information Exchanges between Roles						
Information	User	VV	AA	M&S PM**	Dev	M&S Proponent
Existing simulation information	R	R	R	R	R	P
Planning Information	P	P R	P R	P R	R	
M&S Requirements	P	R	R	R	R	R
Accreditation decision	P					
Intended Use Statement and Problem Objectives	P	R	R	R	R	
Funding / Schedule	A	R	R	P	R	

Information Exchanges between Roles						
Information	User	VV	AA	M&S PM**	Dev	M&S Proponent
V&V plans	A	P	A R	R	R	
Verification results		P	A	R	R	R*
Validation results	R	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		P			
When simulation modification is involved						
Modification Plans	A	R	R	P	R	A*
Simulation conceptual model	R	R	R	A	P	R*
Design(s)		R		A	P	R*
Data metadata	R	R	R	R	R	R
Code		R		A	P	R*
Implementation		R		A	P	R*
Manuals	R	R		A	P	
Test plans and results	R	R		A	P	
*When version of simulation involved is under program configuration control. **When there is no M&S PM, User performs the M&S PM role						
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 for simulation employment 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 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 the User and M&S PM) to help identify accreditation assessment team members. The V&V Agent usually is someone who 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 sit as 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.

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

Typically, the Accreditation Agent interacts with these supporting roles 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 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 event schedules are coordinated and on time and 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.

## Documentation Requirements

The accreditation effort should result in the following products:

- [Accreditation Plan](#) [p. 33]
- [Accreditation Report](#) [p. 36]
- [Accreditation Decision](#) [p. 38]

The accreditation plan identifies the accreditation information needs and outlines the different tasks to be performed during the accreditation assessment. The accreditation report provides the results of the assessment and recommendations for accreditation. The accreditation decision records the User's decision regarding the accreditation of the simulation for the intended application. The Accreditation Agent should ensure 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 Plan***

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

Basic Elements of the Accreditation Plan
• Intended use statement and problem objectives
• Verified M&S requirements and their associated measures and acceptability criteria
• Risk assessment and resulting accreditation information needs
• Pertinent regulatory information
• Accreditation assessment plan
• Schedule of accreditation activities and resource allocation
• Accreditation report requirements

This information can either be included in the accreditation plan or contained in other documents referenced by the 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 is sufficient to support development of

M&S requirements. The intended use statement may have to undergo several iterations before the accreditation plan is finalized.

- **Verified M&S requirements, associated metrics, and acceptability criteria.** M&S requirements<sup>26</sup> are the collection of requirements 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. Based on 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, 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. See [Appendix A](#) for examples.

- **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.<sup>27</sup> 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 [p. 6]) is being addressed. Tables illustrating this organization are provided in [Appendix C](#).

- **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

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<sup>26</sup> See the special topic on Requirements for additional information.

<sup>27</sup> See the special topic on Risk Assessment and Its Impact on VV&A for additional information.

accreditation assessment report and the supporting information should also be detailed.

- **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 report requirements.** The accreditation plan should describe what the report should include and how the report should be prepared. It should identify
  - report structure and format
  - tools to be used
  - authors and, when possible, their assigned roles
  - report classification designation
  - report distribution information
  - an outline of the information to be included

Such an outline can serve as a pseudo checklist to ensure that supporting plans (i.e., V&V plan, accreditation assessment plan) are structured to generate the necessary information. It can also help participants focus their efforts on producing the required information in appropriate forms.

## Accreditation Report

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

Essential Elements of the Accreditation Report
• Discussion of M&S requirements, associated measures and acceptability criteria development
• List of the simulation capabilities addressed during the assessment
• List of simulation assumptions and limitations
• Catalog of the evidence collected
• Discussion of the assessment
• Results of the assessment with references to supporting documentation
• Accreditation recommendation

Where appropriate, summary information can be provided as long as the references for detailed information are identified.

- **M&S requirements, associated measures, and acceptability criteria discussion.** The discussion should describe what M&S requirements refinements were needed, how the associated measures were selected, and how the acceptability criteria were derived. This information is used to verify that the M&S requirements and associated acceptability criteria are complete and the measures selected are appropriate. It can also be used to support validation of the M&S requirements and acceptability criteria and to facilitate the process of updating M&S requirements and criteria in response to changes in the application.
- **Simulation capabilities list.** This list should identify the simulation capabilities addressed by V&V and assessment activities and reference the validated simulation conceptual model associated with the version of the legacy simulation selected for use.
- **Assumptions and limitations list.** This list should include all simulation assumptions and limitations that pertain to the intended use and provide references of their discussion in other documents (e.g., simulation conceptual model, simulation design, V&V reports).
- **Evidence catalog.** This catalog should provide a listing of the documents, artifacts, reports, surveys, SME interviews, etc. used during the assessment.
- **Assessment.** The assessment discussion should identify the people involved and describe the methods, techniques, and tools employed. It should also identify and explain any deviations from the [accreditation assessment plan](#).

- **Assessment results.** The assessment results should address all the simulation [fitness factors](#) (e.g., capability, correctness, accuracy, usability, and the completeness of the available information). They should provide evidence showing how well the simulation satisfies the M&S requirements and acceptability criteria, discuss the results obtained from software verification, data V&V, and results validation efforts, and present the final assessment and the rationale for the conclusions reached.

The results should also include:

- appropriate references and explanations for each conclusion so 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

If the simulation fails to satisfy a requirement or meet an acceptability criterion, this section of the report 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 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.

- **Accreditation recommendation.** The accreditation recommendation is typically a concise (one page) executive summary that includes
  - the accreditation option recommended
  - a synopsis of the rationale for the accreditation recommendation
  - a list of the limitations, caveats, and recommended constraints and actions on the accreditation
  - an approval statement for the User to sign

By itself, the recommendation shows only that an accreditation assessment has been completed. However, when signed by the User, it becomes the **Accreditation Decision**.

## 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, references identifying the accreditation plan and accreditation report, and the User's signature. The standard accreditation decision options are listed in the following table.

Standard Accreditation Decision Options	
<b>Full accreditation</b>	<ul style="list-style-type: none"> <li>The simulation produces results that are sufficiently credible to support the application</li> </ul>
<b>Limited or conditional accreditation</b>	<ul style="list-style-type: none"> <li>Constraints are placed on how the simulation can be used to support the application</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, which are verified and validated, 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 application</li> </ul>

The accreditation decision can be prepared as a memorandum for inclusion in the User's final report for the intended use. It should also be packaged with the accreditation plan and accreditation report and maintained as part of the simulation's VV&A history.

## Documentation Support

The use of documentation templates and tools (e.g., DoD VV&A Documentation Tool, scheduled for release in 2007; Navy VV&A Documentation Tool) reduces documentation preparation time, helps ensure accuracy and consistency between documents and facilitates the document review process. The *DoD VV&A Documentation Standard*<sup>28</sup> provides guidance on the form and content of four basic VV&A documents: accreditation plan,<sup>29</sup> V&V plan, V&V report, and accreditation report<sup>30</sup>. However, the information to be included or referenced in these documents is frequently collected in supplemental documents. The RPG template on Common VV&A Product Formats describes some of the more common ones. For any given VV&A effort, the types of supplemental

<sup>28</sup> At this writing, the DoD VV&A Documentation Standard is scheduled for issuance in 2007. The templates contained in this standard for VV&A plans and reports are provided as appendices in this document.

<sup>29</sup> See the RPG template, Final Draft Standard Accreditation Plan Template for additional information.

<sup>30</sup> See the RPG template, Final Draft Standard Accreditation Report Template for additional information.

documents produced, and the information to be included in each, should be determined during planning and based on the needs of the intended application.

## **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](#) [p. 39]
- [Cost Drivers of the VV&A Effort](#) [p. 40]
- [VV&A Cost Controls](#) [p. 41]

### ***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 re-use situation, the accreditation information needs are identified through risk analysis. If funding is insufficient to obtain or generate all 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 the 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 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 V&V 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, national security are at risk). The amount, applicability, and utility of existing documentation depends on the efficacy of the configuration management program and the completeness, correctness, and availability of

- simulation development products and artifacts
- documentation concerning the version of the simulation being used
- documentation describing previous applications (e.g., study reports)
- VV&A history of this version of the simulation

It can be assumed that if information is available from an official source (e.g., development products, study reports) that 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 should include the cost of planning and preparing 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 are to ensure that a complete and clear definition of the application, a definitive set of M&S requirements, and precise acceptability criteria and careful planning.

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 in [Appendix E](#).
- **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 read-ahead packages are made available in a timely manner and agendas are closely followed.
- **Report formats** -- Using standardized formats can serve as a framework for the meeting discussions and expedite preparation of reports and saving costs associated with multiple reviews and revisions.

**Example:**

When the issue under discussion is the impact of simulation limitations, a format like the one shown can be used to record the relevant assessment information and also to maintain the group's focus. 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 user terms.

Standardized Documentation Structure			
Impact Statements	Description (in operational terms)		
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>		
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>		

## References

- DoD VV&A Documentation Standard (draft), May 2006.
- DoD VV&A Documentation Tool (draft), September 2006.
- Department of Defense Directive (DoDD) 5000.59: DoD Modeling and Simulation (M&S) Verification, Validation, and Accreditation, January 1994.
- Kilikauskas, M., "The SMART Road to Accreditation: Lessons from the Front," Proceedings Second International SIMTECT Conference, Canberra, Australia, pp. 499-502, 1997.
- Joint Accreditation Support Activity (JASA), Accreditation Information Requirements Guide (AIRGuide): A Guide for Determining the Type Scope and Depth of Evidence that is Needed to Support M&S Accreditation (draft), November 2000.
- JTCG/AS-97-M-008: "V&V From A to Z," March 1997.
- Muessig, Paul and Dennis Laack., "Accreditation of Survivability M&S," Aircraft Survivability, published by The Joint Technical Coordinating Group/Aircraft Survivability, Winter 1994/1995.

Muessig, Paul, Dennis Laack, and John Wroblewski, "Optimizing the Selection of VV&A Activities A Risk/Benefit Approach." Proceedings of the 1997 Summer Computer Simulation Conference. Arlington VA. pp 855-860.

Muessig, Paul, Dennis Laack, and John Wroblewski, An Integrated Approach to Evaluating Simulation Credibility. Proceedings, Summer Computer Simulation Conference, Vancouver, BC, July 2000.

## ***RPG References in This Document***

select menu item: "Key Concepts"

select menu: *RPG Core Documents*, select item: "Accreditation Agent Role in the VV&A of New Simulations"

select menu: *RPG Core Documents*, select item: "User Role in the VV&A of Legacy Simulations"

select menu: *RPG Core Documents*, select item: "V&V Agent Role in the VV&A of Legacy Simulations"

select menu: *RPG Core Documents*, select item: "VV&A of Legacy Simulations Overview"

select menu: *RPG Reference Documents*, select item: "M&S Data Concepts and Terms"

select menu: *RPG Special Topics*, select item: "Data V&V for Legacy Simulations"

select menu: *RPG Special Topics*, select item: "Measures"

select menu: *RPG Special Topics*, select item: "Requirements"

select menu: *RPG Special Topics*, select item: "Risk and Its Impact on VV&A"

select menu: *RPG Special Topics*, select item: "Simulation Conceptual Model Development and Validation"

select menu: *RPG Special Topics*, select item: "Subject Matter Experts and VV&A"

select menu: *RPG Templates*, select item: "Data Quality"

select menu: *RPG Template*, select item: "Final Draft Standard Accreditation Plan – May 2006"

select menu: *RPG Template*, select item: "Final Draft Standard Accreditation Report Templates – May 2006"

select menu: *RPG Templates*, select item: "Common VV&A Product Formats"

In the web-based version of this document, the appendix below appears as a hot link in the **Preliminary Activities** (*Establish Acceptability Criteria*), and **Accreditation Plan** (*Verified M&S Requirements, Associated Metrics, and Acceptability Criteria*) sections.

## Appendix A: Simulation Acceptability Criteria Examples

This document provides some notional examples of assessment methods and acceptability criteria for sample M&S requirements.<sup>1</sup> The following table lists a selection of sample M&S requirements that includes programmatic requirements (e.g., policy compliance requirements), from the user domain; technical requirements,<sup>2</sup> from the problem domain; and usability requirements from the simulation domain.<sup>3</sup> This selection is not intended to represent a complete set of requirements. Rather, it is hoped that these examples will give readers some ideas that can be tailored to their own needs.

The table lists an assessment method and an acceptability criterion for each requirement. The **assessment method** is the method used (or intended to be used) to evaluate the characteristics of the simulation or its input against the requirement. An **acceptability criterion** is the pass/fail condition or standard that the simulation or input data needs to meet to satisfy the requirement. For some requirements, the table also provides **auxiliary evidence**. Auxiliary evidence supports but is not the primary means of establishing compliance with the requirement. It is used whenever possible to increase confidence that the requirement is being satisfactorily addressed.

M&S Requirement and Acceptability Criteria Examples		
Assessment Method	Acceptability Criteria	Auxiliary Evidence
<b>Programmatic Requirement: <i>The Accreditation Process will follow SECNAVINST 5200.40.</i></b>		
The accreditation support agent will review the accreditation support plan and inspect the accreditation case to ensure that each requirement in SECNAVINST 5200.40 has been addressed.	The accreditation case will address each requirement in the SECNAVINST to the satisfaction of the accreditation support agent.  A table will be provided at the expert review of the accreditation case indicating how each requirement of SECNAVINST 5200.40 has been addressed.	The accreditation authority's representative will have an opportunity to review and sign the accreditation support plan and to participate in the expert review.

<sup>1</sup>These examples are taken from accreditation support work conducted by the Joint Accreditation Support Activity (JASA) for military acquisition programs.

<sup>2</sup>The technical requirements in these examples are relevant to engineering level simulations and their input data.

<sup>3</sup>See the special topic on requirements for additional information.

<b>M&amp;S Requirement and Acceptability Criteria Examples</b>		
<b>Assessment Method</b>	<b>Acceptability Criteria</b>	<b>Auxiliary Evidence</b>
<b>Usability Requirement: <i>Personnel qualified to run the simulations and analyze the simulation output must be available.</i></b>		
Individuals will be selected based upon their M&S and analysis experience, expertise in use of the M&S, and knowledge of the actual weapon system being represented and the simulations.	Individuals assigned to conduct simulation runs and analysis of output will be recommended by the M&S team lead and approved by the weapon system program manager.	Qualifications of personnel conducting the simulation runs and analysis will be available upon request from the weapon system program office.
<b>Usability Requirement: <i>Output for any given run shall contain all information necessary to reconstruct the run including simulation version number and input file parameters.</i></b>		
Inspection of output filenames and content.	Experienced analyst can reproduce run from content and/or filename of output file.	
<b>Technical Requirement: <i>The M&amp;S shall be capable of performing Monte Carlo runs on key parameters. Exact run list will be determined by mutual consent of the customer and the analysts doing the simulation runs.</i></b>		
Comparison of the list of parameters that can be varied in Monte Carlo fashion with the list of those that the final analysis plan indicates are to be varied.	Simulations have the capability of varying those parameters that the final analysis plan indicates are to be varied.	Documentation of Monte Carlo capabilities of the simulation is available.
<b>Technical Requirement: <i>The M&amp;S shall be capable of accepting input data characterizing a particular missile flight test.</i></b>		
Inspection of documentation of post-flight analysis for at least one test flight.	Analysis team is able to perform post-flight analysis/reconstruction with the simulations using conditions of the actual flight test as input.	
<b>Technical Requirement: <i>Interaction of the weapons direction/control system with the missile during flight shall be represented such that the contents of the uplink command can be calculated.</i></b>		
Inspection of code.	Weapons Control System algorithms and missile algorithms and logic that calculate contents of uplink command are contained in the simulations.	Records of peer reviews between subject matter experts (SMEs) including the developer of the weapons control system concluded that the weapons control system algorithms were correctly instantiated in the missile simulation.
<b>Technical Requirement: <i>Simulation shall include variations in ship pitch and roll and the effect on egress of the missile from the missile launcher.</i></b>		

<b>M&amp;S Requirement and Acceptability Criteria Examples</b>		
<b>Assessment Method</b>	<b>Acceptability Criteria</b>	<b>Auxiliary Evidence</b>
<p>Inspection of missile simulation code to ensure that pitch and roll rates are included in simulation initialization. (Note: Pitch and roll of ship do not have a significant effect on launcher egress and are therefore not modeled. Pitch and roll rates, however, are part of missile initialization and are modeled.</p>	<p>Pitch and roll rates are included in simulation initialization.</p>	
<p><b>Technical Requirement: <i>M&amp;S shall model aerodynamics of the missile.</i></b></p>		
<p>Post-flight analysis. Compare simulation predictions with TM for the following parameters: fin position and angle of attack for a given Mach number. See accreditation support plan for exact TM channels to be compared with these simulation parameters.</p>	<p>Simulation predictions shall match TM data to a degree that is acceptable to SMEs in the established program office simulation working group.                      (If an objective pass/fail number can be derived, or the SMEs can agree on a quantitative pass/fail criterion--e.g., the predicted value of a particular parameter in the simulation must match the measured value from an instrumented test data to within x% of the measured value-- the quantitative criteria should be listed.)</p>	<p>Module level V&amp;V on "AERO" adds validity to modeling in aerodynamic regions that do not occur in the flight tests examined. Aerodynamics is based on documented wind-tunnel tests.</p>
<p><b>Technical Requirement: <i>M&amp;S shall model propulsion including the thrust vector control system.</i></b></p>		
<p>Post-flight analysis. Compare simulation predictions with TM for the following parameter: axial acceleration.</p>	<p>Simulation predictions shall match TM data to a degree that is acceptable to (SME)s in the established program office simulation working group.</p>	<p>Documented comparisons between simulation and static firing data.</p>
<p><b>Technical Requirement: <i>M&amp;S shall model the mass properties for the Mk xx configuration.</i></b></p>		

<b>M&amp;S Requirement and Acceptability Criteria Examples</b>		
<b>Assessment Method</b>	<b>Acceptability Criteria</b>	<b>Auxiliary Evidence</b>
<p>Inspection of code to confirm that mass properties are modeled. Inspection of simulation documentation to confirm that the source of the mass property data is documented.</p>	<p>Mass properties are modeled and source of data in simulation is documented.</p>	<p>Model level V&amp;V of "PARAM" adds validity to mass property modeling. Mass property data is based upon mass estimates and measurements, both from the prime missile contractor. Mass property modeling in the version of the simulation used for this analysis will be checked against mass property documentation for production representative missiles.</p>
<p><b>Technical Requirement: <i>M&amp;S shall model the actuators.</i></b></p>		
<p>Compare CAA module predictions of phase/gain and nonlinearities with bench test data on representative CAA unit.</p> <p>Post flight analysis. Adjust model to match the phenomenology caused by CAA misalignment (low amplitude roll, pitch and yaw, oscillations in the correct frequency).</p>	<p>Simulation predictions shall match bench test results to a degree that is acceptable to (SME)s. These tests have already been conducted by the actuator manufacturer.</p>	<p>See the description in the user's manual of the module level V&amp;V conducted by the actuator manufacturer and the prime missile contractor. Note that the actuator model was developed by the actuator manufacturer.</p>
<p><b>Technical Requirement: <i>M&amp;S shall model the digital autopilot.</i></b></p>		
<p>Post-flight analysis. Take input to the digital autopilot from the TM, run that input through the autopilot model, and compare output of the autopilot model with actual TM of output from the real autopilot during the flight test. (See results of the Flight 1 post-flight analysis and the Flight 1a anomaly analysis report.)</p>	<p>Simulation predictions shall match TM data from instrumented flight tests to a degree that is acceptable to SMEs in the simulation working group.</p>	<p>Module level V&amp;V of "APSDM" adds validity to digital autopilot modeling.</p>
<p><b>Technical Requirement: <i>M&amp;S shall model the functions of the Inertial Measurement Unit (IMU).</i></b></p>		

<b>M&amp;S Requirement and Acceptability Criteria Examples</b>		
<b>Assessment Method</b>	<b>Acceptability Criteria</b>	<b>Auxiliary Evidence</b>
<p>Post-flight analysis. Compare simulation predictions with TM for the following parameters: accelerations and rates.</p>	<p>Simulation predictions shall match TM data from instrumented flight tests to a degree that is acceptable to (SME)s in the simulation working group.</p>	<p>Module level V&amp;V of "IMUHIFI" adds validity to IMU modeling, particularly comparisons of module output with bench tests conducted by the manufacturer. Low frequency effects are based upon data from the IMU manufacturer. Modeling of high frequency effects are based upon data from several instrumented flight tests.</p> <p>Note: Although no requirements are listed for the IRU, IMU functions affect IRU performance, which affects missile performance. IRU functions are also checked in post-flight analysis.</p>
<p><b>Technical Requirement: <i>M&amp;S shall represent the known radar cross sections of test targets and current and expected threats as defined in the current edition of Ship Air Defense Systems (ONI--TA-012-xx) and the acquisition program integrated threat document.</i></b></p>		
<p>Review documentation to confirm that all targets flown in test event these simulations are meant to support and all threats to be assessed using M&amp;S are included.</p>	<p>Test target and threat signature data will be documented. Source of data for target and threat signature data will be documented. Differences between target and threat signature used in model runs and signature described in ONI and ITD documents will be disclosed and justified.</p>	<p>In many cases, data from the sources cited are not sufficient to support analysis. Any additions or augmentations to data from cited sources will be documented.</p>

In the web-based version of this document, the appendix below appears as a hot link in the **Preliminary Activities** (*Identify Accreditation Information Needs*), and the **Using Existing V&V Documentation** sections.

## Appendix B: Legacy Simulation Information Sources

### Where To Find Information for a Legacy Simulation and What To Do with it

The following table [derived from Muessig, et. al] provides some insight into the issues revolving around simulation credibility and accreditation, what types of information are typically used to address the issues, and where that information might be found. This collection of information is based upon the experience of the Joint Accreditation Support Activity (JASA) in conducting accreditation support for acquisition programs. Legacy and modified legacy simulations were the M&S tools of interest in all of these programs.

Items Required	Item Description	Typical Sources
<b>Credibility Issue: Does the simulation do what you need it to do?</b>		
<ul style="list-style-type: none"> <li>• Functional breakdown</li> <li>• Description of model</li> </ul>	<p>Describes what the model actually does including</p> <ul style="list-style-type: none"> <li>• M&amp;S functions and relationships between functions</li> <li>• level of fidelity at which each function is modeled</li> <li>• function level input and output (I/O) and I/O relationships between functions</li> <li>• hardware, software and training needed to operate the model properly and interpret the output correctly</li> </ul>	<ul style="list-style-type: none"> <li>• user documentation (user programmer, and analyst manuals)</li> <li>• software design documentation, possibly including data flow diagrams</li> <li>• conceptual model documentation</li> </ul>
<ul style="list-style-type: none"> <li>• Limitations due to assumptions and errors</li> </ul>	<p>Describes model assumptions and known errors, and assesses their impact on model use.</p> <p>The resulting limitations should be correlated with each of the functions in the functional breakdown, but may also be useful at the overall simulation level.</p> <p>Should identify assumptions and/or errors of each M&amp;S function (or of the model as a whole) that are implicit or explicit in the model's design and/or coding, as well as the implications of these limitations on appropriate or acceptable uses of the simulation.</p>	<ul style="list-style-type: none"> <li>• software design documentation and user documentation are the most typical sources of inherent assumptions and limitations arising from the algorithms used</li> <li>• configuration management databases are useful for known errors</li> <li>• change requests</li> <li>• some assumptions and limitations may be found in verification or validation reports but may not be explicitly stated as an assumption, limitation or error</li> </ul>
<b>Credibility Issue: Do you have confidence that the simulation is being run properly?</b>		

Items Required	Item Description	Typical Sources
<ul style="list-style-type: none"> <li>Simulation portability across platforms (computer hardware and operating system suitability)</li> </ul>	<p>Test results that show that the hardware and operating systems used to host the simulation (if different than that used to develop the simulation) will allow it to run correctly and produce consistent results across platforms.</p>	<ul style="list-style-type: none"> <li>usually found in the user documentation associated with the simulation or can be obtained from test results when documentation is not available</li> </ul>
<ul style="list-style-type: none"> <li>Operator qualifications</li> </ul>	<p>Information to demonstrate that the operators have the expertise and knowledge to properly set up the simulation, execute it, and operate all associated tools and utilities.</p> <p>Typical information includes experience with the specific model being used, formal training on the model, and experience with the hardware, software, and interface devices being used.</p>	<ul style="list-style-type: none"> <li>biographies or interviews with the operators</li> </ul>
<p><b>Credibility Issue: Can you convince others of your interpretation of simulation outputs?</b></p>		
<ul style="list-style-type: none"> <li>Analyst qualifications</li> </ul>	<p>Information to demonstrate that the analysts using the simulation have the expertise and knowledge to properly generate the input data and interpret the outputs.</p> <p>Typical information includes experience with the specific model being used, formal training on the model, experience in performing similar analyses, and experience or training in simulation-based analysis techniques.</p>	<ul style="list-style-type: none"> <li>usually gathered from biographies or interviews with the analysts or may be found in prior accreditation assessment reports</li> </ul>
<ul style="list-style-type: none"> <li>Demonstration of pre- and post-processor acceptability</li> </ul>	<p>Information that shows that any auxiliary tools and utilities used to format or load input data, or to convert, record and visualize model outputs are suitable for the intended purpose(s).</p> <p>The type of information usually presented includes descriptive documentation of the tools and utilities being used for these purposes.</p>	<ul style="list-style-type: none"> <li>user documentation associated with the simulation may list tools and utilities that are comparable with it</li> <li>user documentation for the tools and utilities may contain information that will aid the determination of tool compatibility with the simulation</li> </ul>
<p><b>How much confidence do you have in the accuracy of the software?</b></p>		
<ul style="list-style-type: none"> <li>Software development process description</li> </ul>	<p>The process description should include:</p> <ul style="list-style-type: none"> <li>description of the development paradigm and how it is being implemented (including the use of CASE tools)</li> <li>a logical process for defining tracing, and testing requirements throughout development</li> <li>configuration management during the development process</li> <li>adequate provision for documentation of all of these activities</li> </ul>	<ul style="list-style-type: none"> <li>software development plan or a configuration management plan that outlines the development process used</li> </ul> <p>If the development is underway, these plans should describe the process currently being used.</p>

Items Required	Item Description	Typical Sources
<ul style="list-style-type: none"> <li>Software development resources description</li> </ul>	<p>The resource description should include:</p> <ul style="list-style-type: none"> <li>a description of the hardware environment and the software engineering tools that will be/were used</li> <li>qualifications of the personnel who will/did code the software and perform configuration management functions</li> <li>who will be/was responsible for production of key documentation and testing</li> <li>history of similar simulation development experience</li> </ul>	<p>Information should be provided in the software development plan or other management plans.</p> <p>If not documented, discussion with the software developers and managers is necessary to obtain as much information as possible, even if anecdotal.</p> <p>SEI Capability Maturity Model (CMM) evaluation report can provide evidence of simulation development qualifications.</p>
<ul style="list-style-type: none"> <li>Software development artifacts</li> </ul>	<p>Simulation development artifacts that provide evidence (usually documentary in nature) that software development is actually being implemented in accordance with the guidelines and specifications called out in the software development plan (or its equivalent).</p> <p>Documentary artifacts should comply with known (or acceptable) standards and practices for format, content, currency and applicability to the current versions of the software.</p>	<ul style="list-style-type: none"> <li>standard simulation documentation that reflects the current state of the software and that conforms to known standards of information content (e.g., configuration management histories and logs)</li> <li>model documentation (user, programmer and/or analyst manuals)</li> <li>software design documentation</li> <li>documented set of requirements and conceptual model</li> </ul>
<ul style="list-style-type: none"> <li>Software development results</li> </ul>	<p>V&amp;V results include all evidence that the code has been developed according to the design and is free of critical errors, including reports from</p> <ul style="list-style-type: none"> <li>design reviews</li> <li>code walk-throughs/formal code inspections</li> <li>regression testing on model changes</li> <li>software testing</li> <li>supplemental V&amp;V efforts of previous simulation users.</li> </ul>	<ul style="list-style-type: none"> <li>requirements trace reports</li> <li>reports of design reviews, peer reviews, and/or logical reviews</li> <li>code walkthrough/code inspection reports</li> <li>software problem change request logs</li> <li>module software test reports</li> <li>subsystem software test reports</li> <li>system software test reports</li> </ul>
<ul style="list-style-type: none"> <li>Software management process description</li> </ul>	<p>The process description should include</p> <ul style="list-style-type: none"> <li>a description of the post development management of the software</li> <li>processes for documenting, implementing, tracking and testing simulation changes resulting from either requirements changes or software errors</li> </ul>	<p>M&amp;S life cycle activities should be addressed in</p> <ul style="list-style-type: none"> <li>software management plan</li> <li>configuration management plan</li> <li>V&amp;V plan</li> <li>accreditation support plans</li> </ul>

Items Required	Item Description	Typical Sources
	Processes should also exist for keeping all software documentation current with the software.	Simulations developed within the Army should have a Simulation Support Plan (SSP).
<ul style="list-style-type: none"> <li>Software management resources description</li> </ul>	<p>The resource description should summarize the nature and extent of resources currently being applied to simulation management and support. The information should indicate whether sufficient funding and experienced personnel are being applied to ongoing documentation support, configuration management support, regression testing, user group support, training, technical support, etc.</p>	<p>Information should be included in management plans. If this information is not in existing documentation, discussion with the model managers and/or software developers is necessary to obtain as much of this information as possible, even if anecdotal.</p>
<ul style="list-style-type: none"> <li>Software management artifacts</li> </ul>	<p>The term <i>artifact</i> refers to the evidence (usually documentary in nature) that software maintenance is actually being conducted in accordance with the guidelines and specifications called out in the simulation management plan (SMP), SSP, or its equivalent.</p>	<ul style="list-style-type: none"> <li>configuration management database status reports, software change requests (SCRs) and/or system trouble reports</li> <li>up to date model documentation (users, programmers and analysts manuals)</li> <li>Configuration Control Board (CCB) and user group meeting minutes</li> <li>updated software design documentation</li> </ul>
<ul style="list-style-type: none"> <li>Post-development software V&amp;V results</li> </ul>		<ul style="list-style-type: none"> <li>software program change request (SPCR) logs that correlate V&amp;V results with specific versions of the software</li> <li>alpha or beta test reports for both new requirements testing and regression testing</li> <li>specific verification reports for the simulation version being used</li> <li>history of successful usage in similar applications</li> </ul>
<p><b>How much confidence do you have in the quality and suitability of input data obtained from outside sources?</b></p>		
<ul style="list-style-type: none"> <li>Data quality profile</li> </ul>	<p>A body of metadata (data about the data) that describes the data or database, its source, specifications, intended use, history, and method of collection.</p> <p>Metadata elements should exist at the database, data element, and data value levels.</p>	<ul style="list-style-type: none"> <li>metadata elements should be available from the data producer or may exist in the same archives that contain the database itself</li> </ul>

Items Required	Item Description	Typical Sources
<ul style="list-style-type: none"> <li>Independent assessment of data quality</li> </ul>	<p>An independent assessment is prepared by the data user when the data quality profile is inadequate, incomplete, or does not exist. This assessment addresses the key metadata elements in the data quality profile.</p>	<ul style="list-style-type: none"> <li>Information that indicates the quality of test data can generally be found in documents such as test plans, laboratory procedures, calibration records, test records, etc.</li> <li>Information that indicates the quality of data collected through surveys or monitoring operations can generally be found in data collection plans, reports, and raw notes</li> </ul>
<ul style="list-style-type: none"> <li>Data manipulation verification</li> </ul>	<p>This item refers to the verification of any data manipulation done by the user. Data manipulation includes operations such as editing, subset selection, merging, aggregation, transformation (from one coordinate convention to another, for example, or one set of units to another), estimation, interpolation, etc.</p> <p>Verification includes any activities that are done to ensure that the data manipulation steps are correct and do not introduce unknown errors.</p>	<ul style="list-style-type: none"> <li>Verification of data manipulation procedures may be documented in verification reports (when done in conjunction with simulation development).</li> <li>data manipulation verification performed as part of the simulation accreditation process should be included in the accreditation report.</li> </ul> <p>Documentation should describe the verification techniques that were used.</p>
<b><i>How much confidence do you have in the quality and suitability of self-generated input data?</i></b>		
<ul style="list-style-type: none"> <li>Quality assurance process for self-generated data</li> </ul>	<p>An assessment of the process, equipment, tools, instrumentation, etc. used in generating the data.</p> <p>This assessment should generate information similar to that included in the critical metadata elements of the data quality profile.</p>	<ul style="list-style-type: none"> <li>Information that indicates the quality of test data can generally be found in documents such as test plans, laboratory procedures, calibration records, test reports, etc.</li> <li>Information that indicates the quality of data collected through surveys or monitoring operations can generally be found in data collection plans, reports, and raw notes</li> </ul>
<ul style="list-style-type: none"> <li>Description of data quality assurance resources for self-generated data</li> </ul>	<p>Refers to the verification of any data manipulation done following receipt of the data by the User. Data manipulation includes operations such as editing, subset selection, merging, aggregation, transformation (e.g., from one coordinate convention to another, from one set of units to another), estimation, interpolation, etc.</p> <p>Verification of data manipulation includes any</p>	<ul style="list-style-type: none"> <li>verification of data manipulation or transformation procedures should be documented in M&amp;S verification reports</li> <li>other data manipulation may be reviewed and verified as part of the M&amp;S accreditation process and documented in</li> </ul>

Items Required	Item Description	Typical Sources
	<p>activities that are done to ensure that the data manipulation steps are correct and do not introduce unknown errors.</p>	<p>the accreditation assessment report</p> <p>Documentation should describe the verification techniques that were used.</p>
<p><b><i>How much confidence do you have in the simulation outputs?</i></b></p>		
<ul style="list-style-type: none"> <li>• Benchmarking results</li> </ul>	<p>These document the results of comparisons between simulation or simulation component outputs and those of a “standard” or widely accepted, comparable simulation or component.</p> <p>Benchmark results should include</p> <ul style="list-style-type: none"> <li>• the name and source of the standard simulation</li> <li>• why it is (or should be) considered a “reference” simulation</li> <li>• which parameters between simulations (or simulation components) were compared (and why)</li> <li>• what the results of the comparison were</li> <li>• what these results imply about the credibility of the outputs from the simulation under review</li> </ul> <p>Benchmark simulations generally possess greater credibility than the simulation (or component) under review and may be characterized by a “stamp of approval” from a recognized authority or professional organization.</p>	<ul style="list-style-type: none"> <li>• benchmarking results are usually found in either a validation report, a briefing that describes the results of the comparisons, or an accreditation support package (ASP)<sup>1</sup></li> </ul> <p>These reports would generally be prepared by previous users of the simulation. They might also be available through the model manager or in M&amp;S repositories (e.g., DoD and individual Service Modeling and Simulation Resource Repositories [MSRR]).</p> <p>If these results are for a previous version of the simulation, there also should be discussion of changes between that previous version and the version under consideration, and the implication of those changes.</p>
<ul style="list-style-type: none"> <li>• Face validation results</li> </ul>	<p>Describe the results of subject matter expert opinions about simulation realism and accuracy. This should be based on a structured review of simulation (or component) outputs, sensitivities, and/or design.</p> <p>When face validation is a review of the simulation design, the documentation should state whether the representations are realistic and whether any assumptions that underlie the design are acceptable from the perspective of the intended use.</p> <p>Documentation should describe which aspects of the simulation were reviewed (and why), who participated in the review, why one should trust their opinions (e.g., qualifications of the reviewers), what the results of the review were, and what these results imply about the credibility of the simulation.</p>	<ul style="list-style-type: none"> <li>• face validation reports, ASPs, or accreditation assessment reports (when the face validation was done as part of an accreditation assessment)</li> <li>• simulation design validations may be reported in a design verification report (either a formal report or a briefing). These reports would generally be prepared by previous users. They might also be available through the model manager or an M&amp;S repositories</li> </ul> <p>If these results are for a previous version of the simulation, differences between</p>

<sup>1</sup>The ASP is used in the JASA accreditation process and the AF Toolkit.

Items Required	Item Description	Typical Sources
		that previous version and the version under consideration and the implication of those differences should be considered.
<ul style="list-style-type: none"> <li>Results validation documentation</li> </ul>	<p>Describes the results of comparisons between simulation (or simulation component) outputs and data collected from tests or from operation of the real system(s) or process(es) being simulated.</p> <p>The documentation should include a description of the source data used in the comparison, from where and how it was obtained, and why it should be considered representative of the real world.</p> <p>Issues relating to data quality (e.g., instrumentation accuracy, calibration, test scenario realism, etc.) should be addressed in the validation report.</p> <p>The correlation between simulation outputs and real world data should be stated in quantitative terms if this is possible with a qualitative explanation of what the quantitative measure implies. Anomalies and their impact on model usage should be explained.</p>	<ul style="list-style-type: none"> <li>Results validation is typically documented in a validation report, accreditation assessment report or ASP.</li> <li>In some cases, results validation might be documented with an annotated briefing prepared by the simulation developer or previous users, but may also be available through the model manager or M&amp;S repositories.</li> </ul> <p>If these results are for a previous version of the simulation, differences between that previous version and the version under consideration and the implication of those differences should be considered.</p>

### **Obtaining Oral Testimony**

Locating information about a legacy simulation often involves talking with the people associated with its development, its maintenance, or its usage. It is important to ask the right questions.

- Engineers/analysts/programmers/scientists doing the simulation development tend to under-report the amount of V&V they have done, primarily because they tend not to use the terms “verification” and validation.” They tend to perform the kinds of tasks that V&V and Accreditation Agents call verification and validation as just a part of sound engineering practice. If asked what verification or validation has been performed, they may say, “nothing.” But if asked what was done to ensure that the simulation satisfied the specifications, performed as expected, or provided an appropriate level of realism, they will provide engineering notebooks describing tests or computer displays showing comparisons between the simulation and test data.
- Those who maintain a simulation almost always have a system for managing changes and maintaining control of the simulation even though it may not be called “configuration management.” If asked about “the configuration management plan,” they may say there is none; if asked how changes are

tracked, they often describe a well thought out, practical system for documenting changes and model versions.

Another key is to ensure there is documentation to corroborate the discussion.

- Conscientious Developers often keep wonderful engineering notes that may be undervalued because they are not formally documented. However, such notes may be more useful than more formal model documentation because they provide more technical content.
- Managers or users may not be able to provide specific technical information. They may not have complete knowledge of the V&V tasks performed, software engineering practices followed, the SEI CMM level, etc.

### ***Simulations in the Military Acquisition Process***

If the item being modeled is a military system, and the simulation was developed as a tool as part of the acquisition process, there are several possibilities for gathering information on the simulation.

- The simulation documentation and V&V information may have been deliverables in the contract for development of the military item. The contracting officer's technical representative should have a copy of all the deliverables under the contract or know where to get them.
- If a government agency had oversight (e.g., technical direction agent [TDA]), they may have been doing testing on the simulation including comparisons with test data as the acquisition program progresses. This can be a tremendous source of validation results and understanding of the assumptions and limitations of the simulation that may not be written down anywhere. Interviewing these folks can be very fruitful. It is also often the case that the government team has the most corporate knowledge of the simulation because there is often less turnover on the government teams than on the contractor teams.
- There may also be a simulation working group or M&S integrated product team (IPT) whose minutes or informal records can be a good source of information.

Another source of simulation information may be the system being simulated. During the development of a complicated system (military or otherwise), modeling and simulation is often employed as a tool. Before expensive tests are conducted, simulations may be used to make pre-test predictions. The M&S predictions may be included in the data presented at test readiness reviews. In addition, simulations may be run after the test using the actual test conditions to compare to the test data. This may be done specifically for simulation validation, or simply to help the Developer understand what happened in the actual test. Results of these comparisons may be included in the test readiness after action reports.

If the simulation is of an actual item being developed (military or otherwise), a review of the simulation may be held as part of the preliminary design review (PDR) or the critical design review (CDR) of the actual item. Most companies and organizations keep archives of presentations given at PDRs and CDRs and have careful records of conclusions reached at these reviews. This can be a very useful source of documentation of the simulation itself, results of any V&V conducted, and conclusions about the maturity and of credibility of the simulation by the review participants.

In the web-based version of this document, the appendix below appears as a hot link in the **Develop Accreditation Plan** (Assessment Planning Factors).

## Appendix C: Accreditation Assessment Guidance Tables

The tables below identify some of the basic issues to be addressed regarding the simulation and the data during the accreditation assessment. They provide examples of the types of information needed and potential sources for each, and recommended treatment of each based on the level of risk involved.

### [Simulation Assessment Issues](#) [p. C-1]

- [Simulation Capability](#) [p. C-1]
- [Software Correctness](#) [p. C-2]
- [Simulation Fitness for Purpose](#) [p. C-3]
- [Simulation Usability](#) [p. C-3]

### [Data Correctness Issues](#): [p. C-4]

- [Overall Data Correctness](#) [p. C-4]
- [Database Level Correctness](#) [p. C-4]
- [Data Element Level Correctness](#) [p. C-7]

### ***Simulation Assessment Issues***

The following four tables identify some of the basic simulation issues addressed during assessment. The following tables identify assessment issues, information needs and associated risks for [simulation capability](#) [p. C-1], [software correctness](#) [p. C-2], [fitness for purpose](#) [p. C-3], and [usability](#) [p. C-3].

Simulation Capability				
Information	Sources	What is needed when risk is . . .		
		Low	Moderate	High
ISSUE: Does the simulation do what it needs to do?				
<ul style="list-style-type: none"> <li>• Functional Breakdown and Description of Simulation</li> </ul>	<ul style="list-style-type: none"> <li>• User documentation</li> </ul>	Any Source	Required	Required
	<ul style="list-style-type: none"> <li>• Design documentation</li> </ul>		Any one	Either one
	<ul style="list-style-type: none"> <li>• Simulation conceptual model</li> </ul>			
<ul style="list-style-type: none"> <li>• List of limitations due to assumptions and errors</li> </ul>	<ul style="list-style-type: none"> <li>• Design documentation, user documentation, configuration management database, V&amp;V reports</li> </ul>	desirable		Required

Software Correctness				
Information	Sources	What is needed when risk is . . .		
		Low	Moderate	High
<b>ISSUE: How much confidence do you have in the correctness of the software?</b>				
<ul style="list-style-type: none"> <li>Simulation development process description</li> </ul>	<ul style="list-style-type: none"> <li>SW Development plan (SDP) or configuration management plan</li> </ul>	Either one	Required	Required
<ul style="list-style-type: none"> <li>Simulation development resources description</li> </ul>	<ul style="list-style-type: none"> <li>SDP, management plan, Developers, M&amp;S Proponent, SEI Capability Maturity Model (CMM) evaluation reports</li> </ul>		Any two	Required
<ul style="list-style-type: none"> <li>Simulation development artifacts and products</li> </ul>	<ul style="list-style-type: none"> <li>standard M&amp;S documentation, configuration management histories</li> </ul>			Any two
	<ul style="list-style-type: none"> <li>model documentation (user manual, programmer manual)</li> <li>Design documentation (documented requirements and simulation conceptual model)</li> </ul>			
<ul style="list-style-type: none"> <li>V&amp;V results (simulation conceptual model validation, design verification, implementation verification)</li> </ul>	<ul style="list-style-type: none"> <li>Rqmts trace reports</li> <li>Design, Peer, Logical Review reports</li> </ul>	Either one	Either one	Either one
	<ul style="list-style-type: none"> <li>Code walk-through reports</li> <li>Problem change request logs</li> </ul>	Any One	Any two	Any three
	<ul style="list-style-type: none"> <li>Module test reports</li> <li>Subsystem test reports</li> <li>System test reports</li> </ul>			
<ul style="list-style-type: none"> <li>Configuration Management Process description</li> </ul>	<ul style="list-style-type: none"> <li>Configuration management plan, configuration management plan, V&amp;V plan or other documentation that describes life-cycle management activities</li> </ul>	Any two	Required	Required
<ul style="list-style-type: none"> <li>Configuration Management Resources Description</li> </ul>	<ul style="list-style-type: none"> <li>management plans. model managers, Developers</li> </ul>		Desired	Desired
<ul style="list-style-type: none"> <li>Configuration Management Artifacts and Products</li> </ul>	<ul style="list-style-type: none"> <li>Configuration Management Database status reports, System Change Requests (SCRs), System Trouble Reports (STRs)</li> <li>Existing model documentation</li> <li>CCB and user group meeting minutes</li> <li>Existing design documentation</li> </ul>		Any one	Any Two
<ul style="list-style-type: none"> <li>V&amp;V results from later usage (e.g., different applications, different simulation versions)</li> </ul>	<ul style="list-style-type: none"> <li>Problem Change Request (SPCR) logs</li> </ul>		Either one coupled with configuration mgmt information above	Either one coupled with configuration mgmt information above
	<ul style="list-style-type: none"> <li>Alpha or Beta test reports on new requirements testing and regression testing</li> </ul>			
	<ul style="list-style-type: none"> <li>V&amp;V reports for specific simulation version</li> </ul>	Note 1	Note 1	Note 1
	<ul style="list-style-type: none"> <li>Similar application/usage histories</li> </ul>	Note 2		

*Note 1: If the scope and depth of the specific verification results equates to the scope and depth of development V&V required for a particular level of risk, this element can be substituted for all the information items dealing with the quality of the software in this issue*

*Note 2: This information alone can be used as evidence of sufficient quality for low risk applications (it can replace all other information items for this issue)*

Simulation Fitness for Purpose				
Information	Sources	What is needed when risk is . . .		
		Low	Moderate	High
<b>ISSUE: What does the simulation need to do?</b>				
<ul style="list-style-type: none"> <li>Application Description</li> <li>M&amp;S Requirements</li> <li>Input Data Metadata</li> </ul>	<ul style="list-style-type: none"> <li>User-defined problem statement, intended use statement</li> <li>User-defined objectives and requirements</li> <li>Data QA templates, data producer documentation</li> </ul>	Verbal description is sufficient	Required	Required
<b>ISSUE: How much confidence does the User need in the simulation results?</b>				
<ul style="list-style-type: none"> <li>Risk Analysis results</li> </ul>	<ul style="list-style-type: none"> <li>Risk Assessment Report for intended application</li> </ul>	Informal	Formal with documented results	Formal with documented results

Simulation Usability				
Information	Sources	What is needed when risk is . . .		
		Low	Moderate	High
<b>ISSUE: Do you have confidence that that the simulation is being run properly?</b>				
<ul style="list-style-type: none"> <li>Demonstration of suitability of computer HW and operating system (portability)</li> <li>Operator Qualifications</li> </ul>	<ul style="list-style-type: none"> <li>User documentation, test results</li> <li>Biographies and interviews with the operators</li> </ul>	Required	Required	Required
<b>ISSUE: Can you convince others of your interpretation of simulation outputs?</b>				
<ul style="list-style-type: none"> <li>Analyst qualifications</li> </ul>	<ul style="list-style-type: none"> <li>biographies and interviews with analysts and prior accreditation assessment reports</li> </ul>	Required	Required	Required
<ul style="list-style-type: none"> <li>Demonstration of pre- and post-processor acceptability (tool compatibility)</li> </ul>	<ul style="list-style-type: none"> <li>User documentation that lists tools and compatible tools</li> <li>User documentation for tools and utilities</li> </ul>			Required

## Data Correctness Issues

Data correctness issues should be addressed at several different levels: overall data level, database level, data element level, and data value level.<sup>1</sup> The following tables identify data correctness issues, information needs and associated risks for the [overall data](#) [p. C-4], [database](#) [p. C-4] and [data element](#) levels [p. C-7]. Evaluation of data correctness at the individual data value level is beyond the scope of this document.

Overall Data Correctness				
Information	Sources	What is needed when risk is . . .		
		Low	Moderate	High
<b>ISSUE: How much confidence do you have in the quality and suitability of input data obtained from outside sources?</b>				
<ul style="list-style-type: none"> <li>Data Quality Profile</li> </ul>	<ul style="list-style-type: none"> <li>Data Quality template, data producer metadata, database archives</li> </ul>	Either one. Depth of information determined at database level	Either one. Depth of information determined at database level	Either one. Depth of information determined at database level
<ul style="list-style-type: none"> <li>Independent data quality assessments</li> </ul>	<ul style="list-style-type: none"> <li>test plans, laboratory procedures, calibration records, test reports</li> <li>surveys, monitoring operations in data collection plans, reports, etc.</li> </ul>			
<ul style="list-style-type: none"> <li>Data manipulation/transformation verification results</li> </ul>	<ul style="list-style-type: none"> <li>data verification reports</li> <li>data transformation validation reports</li> <li>data V&amp;V techniques</li> </ul>	Required at cursory level	Required	Required
<b>ISSUE: How much confidence do you have in the quality and suitability of self-generated input data?</b>				
<ul style="list-style-type: none"> <li>Description of Data Quality Assurance process for self-generated data</li> </ul>	<ul style="list-style-type: none"> <li>test plans, laboratory procedures, calibration records, test reports</li> <li>surveys, monitoring operations in data collection plans, reports, etc.</li> </ul>	Required. Depth of information determined at database level	Required. Depth of information determined at database level	Required. Depth of information determined at database level
<ul style="list-style-type: none"> <li>Descriptions of Data Quality Assurance resources for self-generated data</li> </ul>	<ul style="list-style-type: none"> <li>data verification reports</li> <li>data transformation validation reports</li> <li>data V&amp;V techniques used</li> </ul>	Required at cursory level	Required	Required

Data Correctness: Database Level		What is needed when risk is . . .		
Information		Low	Moderate	High
<ul style="list-style-type: none"> <li><b>Description including meaning of exceptions, nulls, uncertainties</b></li> </ul>		Required	Required	Required
An overall textual characterization of the database including <ul style="list-style-type: none"> <li>discussion of its intended range of appropriate uses and any constraints on its intended use</li> <li>discussion of the meaning of exceptions, nulls, and uncertainties within the database</li> </ul>				

<sup>1</sup>See the reference document on M&S Data Concepts and Terms for additional information.

Data Correctness: Database Level	What is needed when risk is . . .		
Information	Low	Moderate	High
<p><b>• Access requirements</b></p> <p>Information about the requirements for gaining access to the database including</p> <ul style="list-style-type: none"> <li>- owning agency, POC access information</li> <li>- restrictions that apply to access and use</li> <li>- copyright, foreign distribution requirements and constraints</li> <li>- user requirements for SW, HW, pre- and post-processing, etc.</li> </ul>	Desirable	Required	Required
<p><b>• Resolution and rational</b></p> <p>Description of the overall level or resolution of the data in the database including</p> <ul style="list-style-type: none"> <li>- reasons for choosing the level with respect to the stated purpose of the database, its design, source, relationship to other databases</li> <li>- characterization of the database in terms of resolution, consistency</li> </ul>	Desirable	Required	Required
<p><b>• Usage (who, when, for what, with what model)</b></p> <p>The history of the database, including a POC for each instance of use and a description of what the database was used for (linked to V&amp;V audit trail)</p>	Desirable	Required	Required
<p><b>• V&amp;V audit trail</b></p> <p>History of quality assessment efforts applied to the database including records of V&amp;V results. Should be linked to the usage history metadata above and to the metadata for the V&amp;V audit trail at the data element and data value.</p>	Required	Required	Required
<p><b>• Classification</b></p> <p>Simple statement about the security level of the database.</p>	Required	Required	Required
<p><b>• Release authority</b></p> <p>Organization/Agency and/or POC authorized to release all or part of the database for use</p>	Desirable	Required	Required
<p><b>• Accuracy</b></p> <p>Discussion of the degree of agreement between a datum and source assumed to be correct (real world).</p>		Desirable	Required
<p><b>• Completeness in features and attributes</b></p> <p>Discussion of how the database satisfies all data content demands and requirements.</p>		Desirable	Required
<p><b>• Currency</b></p> <p>Discussion of how up-to-date the database is</p>		Required	Required
<p><b>• Data Sources</b></p> <p>Discussion of where the source information contained within the database came from (immediate source and original source) including agency/organization/POC, etc.</p>		Required	Required
<p><b>• Source credibility</b></p> <p>Discussion of the credibility of the agency/organization/POC providing the data in the database, identifying who has certified the immediate and original data sources as credible</p>		Required	Required
<p><b>• Descriptions of processes used</b></p>		Desirable	Required

<b>Data Correctness: Database Level</b>	<i>What is needed when risk is . . .</i>		
<b>Information</b>	<b>Low</b>	<b>Moderate</b>	<b>High</b>
Discussion of the processes that are used to derive, generate, collect, and transform the data and metadata in the database			
<ul style="list-style-type: none"> <li>• <b>Version history</b></li> </ul>	Desirable	Desirable	Required
Explicit version documentation showing which agents revised the database at which times and what kinds of changes they made, including descriptions of changes to structure, content, or meaning of both data and metadata at the conceptual level. An official record of changes to a database by the agency or organization that owns and has responsibility for maintaining it.			
<ul style="list-style-type: none"> <li>• <b>System specification and design document</b></li> </ul>		Desirable	Required
Formal description of the database structure and content			
<ul style="list-style-type: none"> <li>• <b>Standards</b></li> </ul>		Desirable	Required
Compliance with international, national, DoD, or M&S community standards (e.g., DDDS)			
<ul style="list-style-type: none"> <li>• <b>Specific Data Sets</b></li> </ul>		Desirable	Required
Instances/sessions of the database. Discussion of each data set for which the given database design is used. Each instance of a database may be static or dynamic, and this aspect should be documented as part of its description.			
<ul style="list-style-type: none"> <li>• <b>Overall database status</b></li> </ul>		Desirable	Required
Concise statement of the condition of the database, indicating whether it is in transition, how stable it is, and what expected future changes will affect it, including configuration management information that explains how versions are maintained and by whom, and references to descriptions of any standard methodology of software used for version control.			
<ul style="list-style-type: none"> <li>• <b>Description/rationale for structure and design</b></li> </ul>		Desirable	Desirable
A textual characterization of the database design and structure and a discussion of their rationale, relating them to the intended purpose and use of the database. It should include such overall aspects as the language and format. The rationale serves as consistency check against the discussion of intended use.			
<ul style="list-style-type: none"> <li>• <b>Global relationships to other databases</b></li> </ul>		Desirable	Desirable
An explicit description of the overall relationship of this database to any others. It should explain any semantic and/or historical relationships between this database and any others, making clear whether the relationship is expected (or required) to continue to hold true.			
<ul style="list-style-type: none"> <li>• <b>Reproducibility</b></li> </ul>		Desirable	Desirable
Ability of the producer to provide exact replications of a previously supplied database (new database instance)			
<ul style="list-style-type: none"> <li>• <b>Cross data element distribution measurement information</b></li> </ul>		Desirable	Desirable
A description of statistical checks to be applied to distributions of values across different data elements in the database. (Metadata for such checks applied to distributions of values of single data elements should be specified at the data element level.)			
<ul style="list-style-type: none"> <li>• <b>Rationale for using the processes</b></li> </ul>		Desirable	Desirable

Data Correctness: Database Level	<i>What is needed when risk is . . .</i>		
Information	Low	Moderate	High
Discussion of the reasons for choosing each process used for the derivation, generation, collection, and transformation of data (and metadata) within the database.			
<ul style="list-style-type: none"> <li>• <b>Owners of the processes (development, maintenance, execution)</b></li> </ul>		Desirable	Required
Agents responsible for choosing and developing the processes used for the derivation, generation, collection, and transformation of data (and metadata) within the database, including agency/organization, POC, etc.		Desirable	Desirable
<ul style="list-style-type: none"> <li>• <b>Update cycle information</b></li> </ul>		Desirable	Desirable
Statement of how often, how regularly, and how extensively the database is expected to be updated. Overlaps with 'currency' metadata, but the emphasis here is on giving an overview of when, how, and by whom the database is revised or reissued, rather than on how current the information within it may be at any given time.		Desirable	Desirable

Data Correctness: Data Element Level	<i>What is needed when risk is . . .</i>		
Information	Low	Information	Low
<ul style="list-style-type: none"> <li>• <b>Description including meaning of exceptions, nulls, uncertainties</b></li> </ul>		Desirable	Required
An overall textual characterization of the semantics of the data element, including a discussion of what it is intended to represent and what it is not. Includes a textual characterization of the meaning of nulls or any exceptional, special, or unknown values of this data element		Desirable	Required
<ul style="list-style-type: none"> <li>• <b>Degradation information</b></li> </ul>			Required
The 'mode' in which values of a data element are expected to degrade over time: some values become continuously less accurate or less meaningful as they age, whereas others remain entirely valid until they 'expire', i.e., when some event changes the reality which they represent.			Required
<ul style="list-style-type: none"> <li>• <b>Aggregation, derivation, or transformation information</b></li> </ul>		Desirable	Required
Whether and how values for this data element are derived from other data, including a discussion of any grouping or other derivation method used to generate this data element, and any other data values used in this derivation, or any transformations that are applied in generating this data element		Desirable	Required
<ul style="list-style-type: none"> <li>• <b>Resolution and precision</b></li> </ul>		Desirable	Required
The level of detail and number of significant digits in numerical values of this data element, including any representation issues (such as precision limits imposed by field-length or encoding).		Desirable	Required
<ul style="list-style-type: none"> <li>• <b>V&amp;V audit trail</b></li> </ul>		Desirable	Required
A high-level history of quality assessment efforts applied to the data element, allowing certification results to be recorded. This should be linked to the usage history metadata above and to the metadata for the V&V audit trail at the database and data value		Desirable	Required
<ul style="list-style-type: none"> <li>• <b>Entity name</b></li> </ul>		Desirable	Required

Data Correctness: Data Element Level	What is needed when risk is . . .		
Information	Low	Information	Low
The label of an entity; must be a noun or noun phrase with the entire phrase connected by hyphens; must accurately reflect its characteristics (attributes), especially its domain.			
<b>• Definition text</b>		Desirable	Required
The narrative description of what an entity is.			
<b>• Standard data element name</b>		Desirable	Required
The label of an attribute, comprised of a minimum of an entity and generic element; may contain property modifier(s) providing additional descriptions; may utilize generic data; must be a noun or noun phrase and accurately reflect the characteristics (metadata) of the attribute, especially domains.			
<b>• Source or sources and deconflicting processes and rationales</b>		Desirable	Required
Where the source information contained within the data element came from (immediate source versus original source) including agency/organization, POC, etc. Includes a qualitative, textual discussion of the 'goodness' of the database including information about the agency/organization, POC, etc making the credibility assessment. It should include a discussion of who has certified the certification official as credible.			
<b>• Changes or modifications of source element and effect on this data element</b>		Desirable	Required
The update-cycle metadata for the database as a whole, focusing on the revision of a particular data element, which may be different for different data elements within the database. Different levels of revision may occur, corresponding to more or less complete revisions by more or less authoritative sources or agents.			
<b>• Accessibility</b>		Desirable	Required
Statement of maintaining a data element in a condition that provides the ability to retrieve the specific information needed by the user.			
<b>• Release authority</b>	Desirable	Required	Required
Organization/agency/POC authorized to release the data element.			
<b>• Process control data</b>		Desirable	Required
Historical record of how the generation of the data element was controlled, including descriptions of process modeling methodology, or external descriptions of the process in some appropriate form or publication.			
<b>• Audit trail of changes to element</b>		Desirable	Required
History of any changes to the definition of this data element; i.e., its type, domain, units, or meaning, including times and sources of any such modifications and the changes themselves.			
<b>• History of changes or modifications</b>		Desirable	Required
Explicit version documentation showing which agents revised the data element at which times and what kinds of changes they made, including descriptions of changes to structure, content, or meaning of both data and metadata at the conceptual level. An official record of changes to a data element by the agency or organization that owns and has responsibility for maintaining it.			

*In the web-based version of this document, the appendix below appears as a hot link in the **Develop Accreditation Plan** (Assessment Planning Factors) and **Perform Accreditation Assessment** sections.*

## **Appendix D: Accreditation Assessment Success Factors**

A successful accreditation assessment depends primarily on the following factors:

- [Establishing Objectives and Procedures](#) [p. D-1]
- [Focused Deliberations](#) [p. D-2]
- [Building Consensus](#) [p. D-3]
- [Complete, Accurate Reporting](#) [p. D-4]

To ensure that these factors are properly implemented, there must be careful and thorough planning as well as careful selection of review team participants. The plan should identify the team members, describe their expertise, address all the considerations outlined below.

An essential part of a good assessment plan is a description of how the key discussion topics, viewpoints, and action items will be identified, recorded, and integrated into a report. One successful technique is to outline the intended product, even to the extent of developing an annotated outline that is missing only the review results. Such an outline can be used to guide discussions and help the assessment team focus on the real objectives. The planning effort should also include a scheme noting the essential points of the deliberations, reviewing the meeting notes, and then reducing them to a draft report.

### ***Establishing Objectives and Procedures***

Accreditation assessment planning should be based on a clear set of objectives and procedures. Although the objective (accreditation assessment) seems obvious, planners all too often lose sight of their goal and get wrapped up in addressing detailed issues raised by one of the team members. In other cases, review planners do not have a clear set of criteria by which to assess the selected simulation. As a result, the review turns into a design critique vice an assessment of whether or not the model or simulation fulfills the requirements of the application.

The basic information needed for a successful review includes:

- problem statement
- statement of objectives
- M&S requirements
- acceptability criteria

- description of the simulation and how it functions
- V&V documentation including scenarios, validation data, results of model runs and sensitivity analyses
- assessment objectives, procedures, and agenda

During the planning phase, all team members should be given the opportunity to become familiar with the application, the M&S requirements, and the simulation itself. Developer briefings can be used, as necessary, to aid in understanding model overall design, as well as its strengths, weaknesses. These background briefings can be conducted prior to the review, but are often more conveniently done at the beginning of the review.

### ***Focused Deliberations***

To have focused deliberations, all participants need to be aware of the issues to be discussed and the procedures to be followed. Well in advance of the meeting date, packages containing all the information outlined in the previous section should be provided to the review team. At the beginning of the actual review session, the leader should review the session's objectives and products and the evaluation process to be used. Any issues regarding the procedure should be resolved at the start.

The accreditation assessment may be conducted in one session or several. All team members should attend all review sessions to avoid repetitious discussions. Representatives of the Developer should be present to clarify and explain model capabilities as necessary. Representatives of the User should be present to answer questions about requirements when they arise. One person, preferably a representative of the User or the Accreditation Agent, should be the facilitator, to keep the discussions focused on simulation *fitness* for the intended purpose.

One technique to keep the discussions focused is to have an outline of the final report including the key questions that must be answered. This outline and the key questions should be used to frame the deliberations, both in terms of the judgments needed and the technical issues to be considered.

The deliberations should begin with a review of the problem, objectives, M&S requirements, and acceptability criteria followed by a description of simulation capabilities and design with time allowed for discussion. The actual assessment is usually done one requirement at a time. The requirement is presented and evidence of any shortcomings in model functionality or accuracy identified and explained. The discussions should focus on the impact of these shortcomings on the outcome of the application, and its associated risks. The discussions should also address related issues, such as the quality of the software, the fidelity of the input data, the validity or realism of simulation outputs, and the capabilities of the analysts running the simulation and interpreting the results.

One hazard is the tendency for the discussion to drift into a critique of the simulation itself, evaluating simulation performance or design, and discussing its weak features and how it can be improved without regard for the essential needs of the intended application. This type of discussion does little to support an accreditation decision. Focus must be maintained on the critical issues that relate to the simulation's usability in the particular application being considered, and how well the simulation compares to the acceptance criteria for credible, low risk use in this application. Discussions about how to improve the simulation are of little value unless they are focused on how to modify the simulation for use in this application.

The assessment team should reach some preliminary decisions about simulation fitness to purpose and the feasibility of potential work-arounds for any deficiencies and limitations that were identified. For deficiencies that have no acceptable work-arounds, the discussion should lead to some assessment of whether the risk of using the simulation with the known deficiency is tolerable. In some cases, team members may view a deficiency as being intolerable only because they know of a better modeling technique or some modification that can correct the deficiency. The question then becomes, "Why live with this problem when it can be resolved?" Such discussions can derail the accreditation assessment by introducing alternatives that cannot be effectively addressed within the resources available.

A structured approach should be followed to really assess how a deficiency will impact the intended use. This approach should

- analyze the deficiency's impact on model outputs
- determine if the outputs will be biased high or low (or if the expected variation is unknown)
- address the validity of these expected biases for some or all conditions of the application and instance data values
- assess the utility of the model outputs considering all the risks and restrictions placed on its use

Any actions or steps that can be taken to mitigate the impact of model weaknesses should be examined as well, such as

- manual adjustments of input or output values
- changes to parameters within the model
- modifying the scenarios to exclude problem areas
- limiting the model's use to certain scenarios where the outputs are known to be acceptable

## ***Building Consensus***

The goal of any assessment process is to achieve consensus of the participants on the issues. Participant involvement in decision-making is essential for building consensus. Assessment team members should be encouraged to participate in all aspects of the assessment including developing the review objectives, criteria, and procedures; determining how the review will be conducted; and selecting the questionnaires and scoring techniques to be used. They should also be encouraged to contribute to development of the agenda.

Consensus is best achieved through frequent communication. In some cases it is a good idea to have a pre-review video teleconference so that coordination items can be presented and discussed in a structured fashion.

## ***Complete, Accurate Reporting***

The last key to a successful review is accurate, complete, well organized, and timely reporting. When the discussions are complete, the findings should be assembled and an overall assessment made about model fitness to purpose and the risks of using the model as it is. Any recommendations for model changes or additional V&V work should be prioritized. A summary of the results should be drafted and reviewed prior to team dispersal.

To ensure accurate and complete recording of each discussion, a person with expertise in the simulated operations and knowledge of the application should be designated to take the minutes and be the principal report author. Ideally this recorder should not be someone who is relied upon for major contributions to the discussions, since the recorder duties will preclude any significant inputs. The recorder should have the ability to recognize significant points in the discussions and be able to construct a draft report that will require minimal changes by the team members.

The designated recorder should keep a set of minutes that are reviewed and approved by the team during the review sessions. These minutes will be valuable to the team in preparing its summary findings, and to the recorder in drafting the final report. If possible, a running draft of the final report should be developed in parallel with the minutes, either as the discussion progresses or at the end of each day's session. A comprehensive outline that was drafted during the planning stage will prove invaluable in this regard.

Review of the draft minutes and draft report is an essential part of the reporting process. Minutes of each session should be reviewed and corrected at the beginning of the next session. When the draft report is prepared, (ideally within 7 to 10 working days after the review) it should be circulated to team members for comments and concurrence. Planning should include provisions for these reviews, and team members must commit to providing timely responses.

In most cases, the report reviews can be done through the exchange of documents (either paper or electronic). However, if consensus was not reached during the assessment or where significant disagreements develop over the content of the draft report, it may be necessary to reconvene the team (either in person or via video teleconference) to iron out the disagreements. If consensus cannot be obtained, an appendix or a separate report containing strong minority opinions should be included in the final report.

*In the web-based version of this document, the appendix below appears as a hot link in the **Develop Accreditation Plan (SME Selection), Perform Accreditation Assessment, and VV&A Cost Controls** sections.*

## **Appendix E: Selecting Appropriate Team Members**

There are two general reasons for including someone on the assessment team: technical or organizational expertise. The team, as a whole, needs knowledge and capability in the four areas listed below. However, no team member need have expertise in more than one area:

- operations being simulated
- key systems represented within the simulation
- technology or physical science underlying the problem
- problem domain

Although representatives of the original Developer, or anyone with a vested interest in the simulation itself, should be available to answer questions about details of the simulation, they should not normally be considered part of the “assessment team” per se because of the possible conflict of interest. Similarly, experts with an alternative agenda (e.g., a competing simulation developer) should be excluded.

Other major considerations to consider are availability and political considerations.

- **Availability** -- Availability involves not only having the time available to participate but also the willingness to commit to serve for the entire effort, including preliminary study and preparation for all meetings, attendance at all meetings, and participation through the documentation phase.
- **Political considerations** -- Although technical expertise should be the primary factor in selecting team members, political considerations must also be accommodated in the practical world. In many cases, the assessment team must include members who represent the organizations having some responsibility related to the problem. Although these members should be technically capable, in some cases they may lack the technical proficiency needed to avoid time-consuming basic explanations. Therefore, it is essential to have a perceptive facilitator to mitigate any potentially disruptive effects.

Determination of the necessary qualifications for team membership depends on the nature of the assessment being done. Additional information is contained in the special topic on Subject Matter Experts and VV&A.

In the web-based version of this document, the appendix below appears as a hot link in the **Support Functions** (*Legacy Simulation Selection*) section.

## Appendix F: Selecting a Legacy Simulation

The User may decide to use a particular legacy simulation because they have prior successful experience with that tool. This experience builds the credibility of the simulation as well as reducing the training overhead associated with using a simulation with which the user is unfamiliar. If the User only wants to use their existing simulation to address a new problem then no selection function need be performed.

If, on the other hand, the User sees several legacy simulations as viable candidates to provide the information they need then they must execute some selection function. This function should involve the Accreditation Agent and the Program Manager if they have been selected. The project may not need a Program Manager if the User does not anticipate expending sufficient resources for the discovery or modification activities to warrant the management overhead. However, if the User wishes to explore a new problem area with an existing simulation then they should appoint someone to fill the Accreditation Agent role to insure that they sufficiently understand the simulation's mapping into their problem space.

Choosing a legacy simulation from a set of candidates involves a cost-benefit analysis, either formal or informal. The primary benefits that using an existing simulation brings include

- demonstrated capabilities of the existing simulation
- credibility gained from the direct experience of the user successfully applying an existing simulation to related problems
- credibility gained from the direct experience of others trusted by the user in their successfully applying the legacy simulation to related problems
- support investment minimized by an existing maintenance, control and help desk infrastructure
- discovery and training investment minimized by an existing documentation package describing simulation capabilities and use history
- support and discovery investment minimized by the available resources of an existing trusted user community
- training investment minimized by the existing direct experience from using a familiar simulation
- development investment and schedule minimized by the use of an existing simulation

Each of these benefits can also be expressed in terms of the financial and schedule savings that they offer. For example, a simulation with a well-documented pedigree minimizes the effort required to assess that simulation's capabilities and hastens the accreditation effort. Documentation that permits direct accreditation assessment can completely eliminate the burden of the entire discovery effort.

The primary costs associated with using a legacy simulation come in the form of actual financial costs and schedule impact. The sources of these impacts are associated with the efforts to

- discover an unfamiliar simulation's capabilities if not sufficiently documented or available from the existing user or developer community
- change or add capabilities to an existing simulation to suit the new purpose
- validate the modified legacy simulation
- train users to effectively operate an unfamiliar simulation or unfamiliar parts of a familiar simulation
- provide local maintenance and support for an unsupported or modified simulation

The User will always need to make some investment and allocate some time in their schedule to accredit and prepare a legacy simulation for a new purpose. Those costs remain constant in the legacy use process and could serve as a measure of the minimal costs to compute relative magnitude of the other investments if desired.

The Accreditation Agent should assist the User with this analysis. If the need for modification or a significant discovery effort becomes a heavily weighted factor then the Program Manager should also assist in the selection process since they will be responsible for managing the execution of that effort.

Above all, the selection process must carefully analyze the balance of the costs and benefits, even if they are only estimates. For example, a simulation with a well-documented pedigree may seem an attractive selection if the pedigree is considered alone but any costs of modifying it may far exceed the costs of discovering the capabilities of a simulation that may need less modification. The selection process should also weight the impacts of financial and schedule costs appropriately. A User pressed for quick answers to critical questions may defer financial costs for reduced schedule. Likely, both factors will play some part in the selection but have different weights for different situations.

The selection analysis should also consider the flexibility of the purpose in the decision. One simulation may enable the User to achieve eighty percent of their objectives with no modification whereas another simulation may permit achieving ninety five percent of the User's objectives but require a huge financial and schedule investment to add the needed capabilities. When dealing with an unfamiliar simulation, encouraging the User

to explore a very small sample of their questions through the capabilities of the unmodified legacy simulation will provide valuable information at a minimal cost. This exercise will familiarize the User with the tool and give some information about where the simulation may require added representational capabilities. It will also give the User the opportunity to tailor their requirements to better suit the available tools.

The credibility of an existing simulation to the User and their customers may carry the most weight in its use. The strongest credibility comes from direct use by the User with the next strongest weight coming from the successful experiences of others that the User trusts as good sources of that information. However, care should be exercised when evaluating the applicability of prior experience to a new problem. The experience should come from problems whose examination requires simulation representations closely related to the new problem. While this advice seems obvious, many subtleties lie in using simulated representations. For example, a credible simulation of nuclear effects may provide very poor information of the dispersion of contamination if it models the weather and terrain poorly.

The value of an existing support infrastructure associated with a legacy simulation is often overlooked and discovered long after making a selection decision. The support for a legacy simulation comes first from the current proponent of that simulation. The proponent's support is very important as they will likely serve as the source of much of the simulation's documentation and experiential base. The simulation's developer can also play an important role if they are still available. Finally, the support from an existing user base can serve many purposes including as the sources of capabilities, training, usage, and maintenance information. Further, a broad user base and an active proponent can help to minimize execution and representation faults through an ongoing feedback and response process.

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