



Department of the Navy

Modeling and Simulation Verification, Validation, and Accreditation Implementation Handbook

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1. Handbook Overview

1.1. Handbook Purpose

Secretary of the Navy Instruction (SECNAVINST) 5200.40, "Verification, Validation, and Accreditation (VV&A) of Models and Simulations (M&S)," establishes policies, procedures, and assigns responsibilities for VV&A within the Department of the Navy (DON). The information presented in the Handbook is designed to provide amplification and practical guidance for those responsible for implementing the SECNAVINST.

The DON policy and guidance is derivative from, but consistent with, Department of Defense (DoD) policy and guidance for M&S VV&A. Basic VV&A guidance presented within the Handbook can also be found within the DoD VV&A Recommended Practices Guide (RPG), and the reader is encouraged to make full use this resource when looking for authoritative information.

Where the Handbook differs from the RPG is in its DON focus. The Handbook addresses VV&A issues from a DON point of view. M&S VV&A roles and responsibilities are defined relative to DON organization, management, and use of M&S. Common formats for documenting and reporting VV&A activities within the DON are presented. Detailed examples of implementing VV&A, presented throughout the Handbook, are derived from DON programs.

To minimize confusion, the Handbook has adopted, with a few minor perturbations, the definition of M&S and VV&A terms found in the RPG glossary. Whenever a term is used in the Handbook with a meaning other than what appears in the RPG, it is directly noted within the text.

1.2. Handbook Maintenance

The responsibility for the development and maintenance of this Handbook has been assigned to the DON VV&A Program Manager.

The Handbook has been out in draft format since November 1999. Updates to this draft have been made quarterly since that time, with the last revision coming in February 2001.

Suggestions for improvement and general questions are welcomed and can be submitted by e-mail by using the contact information presented below.

vva@navmsmo.hq.navy.mil.

1.3. Handbook Organization

The contents of this VV&A Handbook have been organized to provide a simple, direct, and concise description of the DON's VV&A process. After a general description of the DON's VV&A process (Chapter 2), the Handbook looks at VV&A from the different perspectives of three key VV&A roles: the M&S Accreditation Authority (Chapter 3), the

M&S Proponent (Chapter 4), and the Verification and Validation (V&V) Agent (Chapter 5). A final chapter discusses key issues with managing and implementing M&S VV&A and provides answers to frequently asked questions (Chapter 6).

Two other roles of interest to the VV&A process are those of the M&S Developer and the Accreditation Agent. The role of the M&S Developer is discussed within the chapter on M&S Proponents and the role of the Accreditation Agent is discussed within the chapter on Accreditation Authorities.

Located in a separate document are a series of appendices to this handbook. Each appendix provides either a template for planning, reporting, and documenting a VV&A product or a detailed example implementing the DON VV&A process. The VV&A templates include: an accreditation plan (Appendix A), accreditation package (Appendix B), accreditation report template (Appendix C), accreditation decision letter (Appendix D), a verification and/or validation plan (Appendix E), and a verification and/or validation report (Appendix F).

VV&A implementation examples include a legacy model example (Appendix J), a new model example (Appendix K), a federation example (Appendix L), and a hardware-in-the-loop example (Appendix M).

1.4. How to Use This Handbook

To use this handbook, you can read the chapters in sequence or you can proceed directly to the chapter of most interest to you. Helpful links appear throughout the handbook, which allow you to obtain more detail about a given subject area. You can select these links by using your mouse to place the cursor over any text appearing in blue and then double clicking (using the left mouse button) on the text. For a complete listing of the sections and subsections of this handbook, please refer to the table of contents.

1.5. How to Get Additional Help

Although the handbook covers most of the basic responsibilities, tasks, policies, and procedures for DON M&S VV&A, you may still have unanswered questions or you may have some suggestions as to how we can improve this handbook. For answers to technical M&S questions, or for suggestions to improve the handbook, contact the DON VV&A Program Manager at vva@navmsmo.hq.navy.mil.

For general information on M&S, including information on VV&A, visit the Navy Modeling and Simulation Office (NAVMSMO) web site, <http://navmsmo.hq.navy.mil>, for access to the on-line help desk. You can also find the DON M&S Catalog, M&S resource library, M&S policies and guidance, and M&S news and events at this web site.

Links to other M&S-related web sites are included in the M&S resource library section of the NAVMSMO web site. These web sites include both general M&S sites and DON M&S Program sites.

2. M&S VV&A Basics

2.1. Why M&S VV&A?

The DON has developed general processes for verifying, validating, and accrediting models and simulations. DON policy (SECNAVINST 5200.40) requires users of M&S to implement these processes prior to making use of an M&S application. This policy applies to models and simulations used throughout these functional areas:

- Acquisition, Research, and Development
- Assessment
- Logistics
- Support to Operations
- Test and Evaluation
- Training, Training Systems, and Education
- Doctrine

Throughout the VV&A processes, models and simulations are examined from the viewpoint of the M&S user's application needs. During this examination, potential hazards to the M&S user are uncovered and documented. Once the hazards are identified, a determination is made regarding what must be done to eliminate or reduce these hazards to an acceptable level of risk to the M&S user.

M&S hazards, or risks, to the user can come in many forms. A user may make a wrong decision, or come to a wrong conclusion, based on erroneous M&S results. A user may spend too much money on preparing or modifying an M&S for their use due to non-standard M&S development and/or configuration management practices. Or, an M&S user may lack the training to properly execute the M&S or correctly interpret the M&S results.

Elimination of these hazards could involve activities such as having the developer correct M&S defects, modifying the M&S to conform to various development standards, implementing effective M&S configuration management processes, offering necessary user training courses, or modifying the scope of the M&S application to conform with known M&S limitations.

Verification is the process of determining whether a model or simulation implementation is consistent with the documented M&S requirements. Validation is the process of determining if the model or simulation correctly emulates the real-world phenomena it was designed to replicate. Accreditation is the official determination that an M&S application can adequately support a potential user's purpose. More complete definitions of these terms are in the glossary.

The DON has developed a generalized set of processes for performing the M&S examination, assessing the technical and operational impacts for the M&S user, and providing risk-mitigation feedback to the M&S user. These processes are described below.

2.2. Application Specific Accreditation Process

SECNAVINST 5200.40 identifies five steps that, together, form the DON application-specific accreditation (ASA) process. The five steps are (1) accreditation package development, (2) accreditation package review, (3) accreditation decision, (4) re-accreditation, and (5) accreditation status statement.

The Handbook provides guidance for implementing the DON VV&A processes and, as such it is consistent with the process structure presented in SECNAVINST 5200.40. However, the Handbook adds to the SECNAVINST in the case of the ASA process by including the preliminary step of developing an accreditation plan.

In addition to maintaining consistency with the SECNAVINST, the Handbook maintains consistency with the guidance put forth in the DoD VV&A Recommended Practices Guide (RPG). Figure 1 provides an illustration of the DON ASA process and shows how the DON process maps into the DoD RPG accreditation process.

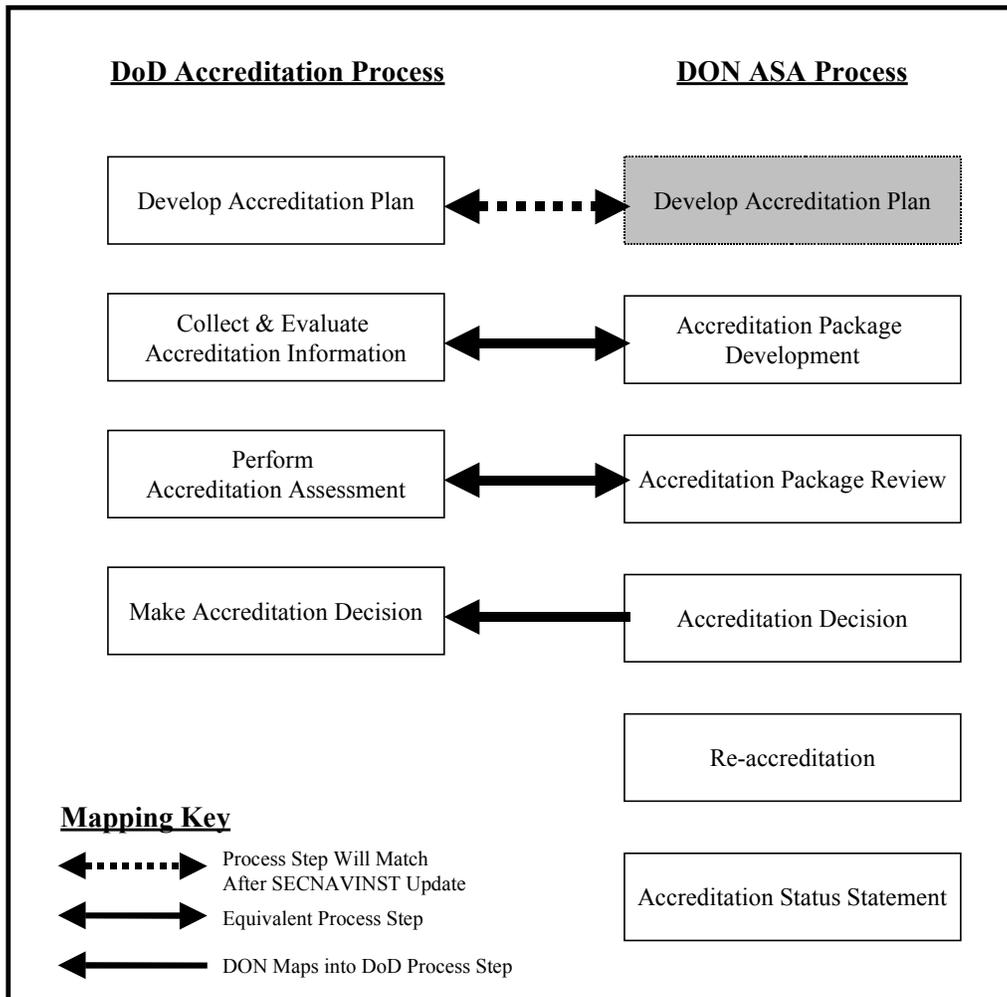


Figure 1. Overview of DON ASA Process

It is anticipated that any future update to the SECNAVINST will include the development of an accreditation plan. The accreditation planning activities and the accreditation plan format presented in this handbook are equivalent in form and function to guidance found in the DoD RPG.

The bulk of the DON ASA process lies in the accreditation package development and accreditation package review. For these two process steps, the DON guidance and the DoD guidance are equivalent. The DON accreditation package development is equivalent to the DoD collect and evaluate accreditation information step. The DON accreditation package review is equivalent to the DoD perform accreditation assessment step.

The DoD accreditation decision step offers accreditors four decision options: Full accreditation, limited accreditation, additional work is needed to accredit, or no accreditation. The DON accreditation decision does not make a distinction between full accreditation and limited accreditation. The DON accreditation decision step provides for three options: Accredit M&S for a specific application, require additional tests or information to gain accreditation, or disapprove accreditation. For all application-specific accreditations, the DON requires that any limitations on the use of the M&S be clearly stated within the accreditation letter.

The two DON ASA process steps that do not have parallel DoD steps are the re-accreditation step and the accreditation status statement step. The DON requires that each unique application, or use, of an M&S undergo a separate accreditation process. This requires previously accredited M&S to be re-accredited prior to each new M&S use. The DoD guidance also advocates re-accrediting M&S for each unique M&S application, but it does not include re-accreditation as a step in their accreditation process description.

Finally, the DON requires that all documents containing M&S results from an M&S application contain a statement as to the accreditation status of the M&S used. The status statement identifies the specific version used and if that version is accredited or has no accreditation. The inclusion of an accreditation status statement with all documented M&S results is not required at the DoD level.

The subsections below provide a summary overview of each of the DON ASA process steps. Issues regarding the practicalities of implementing each of these steps can be found in chapters 3 and 6.

2.2.1. Develop Accreditation Plan

According to SECNAVINST 5200.40, a documented version of the acceptability criteria and accreditation goals must be provided to the V&V practitioners prior to the initiation of the V&V planning phase. The Handbook is recommending this information, along with a methodology for accreditation of the M&S, be documented within an accreditation plan.

Appendix A provides a template for producing a DON M&S ASA plan. The template provides both a standardized format for documenting the plan as well as detailed guidance on developing a plan.

2.2.2. Accreditation Package Development

According to the SECNAVINST, step 1 of the DON ASA process is accreditation package development. The accreditation package should, “compile accreditation [evidence] commensurate with the purpose for which the accreditation is being sought.”

The objective of the accreditation package is to provide enough documentary material about key aspects of a model or simulation such that a clear judgment regarding the adequacy of the model or simulation to support the M&S user’s application can be made.

The DoD RPG categorizes the necessary documentary material into two basic categories: V&V information and supplemental information. V&V information includes all past and present verification and validation plans and reports. Supplemental information includes M&S user documentation, M&S development documentation (e.g. specifications), M&S configuration management plans and reports, M&S data and data sources, M&S development schedules and associated metrics, and any operational resource requirements.

Exactly how much evidence and what specific types of evidence are gathered are unique to each accreditation sought. It depends on the nature of application and how critical it is to the M&S user to establish the credibility of the M&S, the existence of available M&S documentation, and the resources the M&S sponsor has available to collect the evidence.

Appendix B provides a template for producing a DON M&S accreditation package. The template provides detailed guidance on gathering and organizing the necessary documentation.

2.2.3. Accreditation Package Review

According to the SECNAVINST, step 2 of the ASA process is a technical review of the accreditation package to “verify that it satisfies the requirements for the accreditation being sought.”

The documentation contained in the accreditation package should be reviewed and assessed according to the methodology specified within the accreditation plan. The critical M&S qualities should be measured against the M&S user’s development requirements and the M&S user-defined acceptability criteria.

All discrepancies should be identified, along with recommendations as to any work-around solutions, remaining risks to the M&S user, or M&S use limitations. The total output of the technical review of the accreditation package should be documented in an accreditation report.

Effective communication is key to successful accreditation. The ability to condense and highlight relevant information from the mounds of detailed evidence collected and contained within the accreditation package is a challenging but critical part of the task. The accreditation report should provide the necessary insights so that the accreditation authority may make a clear decision regarding the use of the M&S.

It is important to remember that insights will generally be qualitative in nature even though the methods they derive from are quantitative. M&S insights to be documented within the Accreditation Report should include:

- A summary of the overall degree to which the M&S supports the user's requirements.
- The key sources of variability and key sources of uncertainty and their impacts on the M&S user.
- The critical modeling assumptions and limitations, and their importance to the user.
- The extent to which plausible alternative assumptions or models could affect any conclusions derived from the M&S use.
- Key scientific controversies related to the M&S use and sensitivity to the importance of these issues to the user.

Appendix C provides the DON template for accreditation reports. The template provides both a standardized format for documenting the report as well as detailed guidance on developing a report.

2.2.4. Accreditation Decision

According to the SECNAVINST, step 3 of the ASA process is making the accreditation decision. The SECNAVINST specifies three decision options regarding M&S accreditation.

- The M&S under assessment satisfies the user's requirements and should be accredited.
- The M&S under assessment does not satisfy the user's requirements and should not be accredited.
- Additional information must be made available on the M&S under assessment before an accreditation decision can be made.

After reviewing the accreditation report, the accreditation authority must select one of the three decision options and then document that decision in an accreditation decision letter.

Just as important as documenting the decision, the accreditation decision letter must also clearly specify what M&S version, data, and operational limitations are attached to the accreditation decision.

Appendix D contains a template for the DON accreditation decision letter. The template provides a standard format for documenting the letter as well as guidance on making the accreditation decision.

2.2.5. Re-accreditation

SECNAVINST 5200.40 specifies that an M&S can be accredited for a specific use only. If an M&S is reused for a changed purpose, or if the M&S has undergone modification, the M&S user must re-accredit the M&S. A descriptive list of all changes made to an M&S since the last accreditation should be documented and presented to the Accreditation Authority, along with supporting evidence or rationale for why a re-accreditation should be issued.

Changes to an M&S would include modifications to the M&S, modifications to M&S input data sets, modifications to the M&S intended use, and/or modifications to M&S output data sets.

2.2.6. Accreditation Status Statement

The DON has created an M&S resource repository (MSRR) which is maintained by the DON M&S Management Office (DONMSMO). The purpose of the MSRR is to provide the DON community with a centralized resource of all M&S in use within the DON.

In 1994 and 1995, DONMSMO populated the MSRR by actively surveying the various DON organizations using or developing M&S. Since then, the DON M&S community has been responsible for voluntarily providing the DONMSMO with updated, or new, M&S application status and application accreditation status.

SECNAVINST 5200.40 specifies that documented M&S results provided to M&S using organizations include a statement as to the accreditation status of the M&S application used to generate the results. The statement should specify which version of the M&S was used to generate the results, as well as a list of all accredited versions of the M&S, along with the associated dates of each accreditation.

Additionally, the SECNAVINST requests that a description of the M&S results, along with a copy of the accreditation status statement, be provided to DONMSMO for incorporation into the DON MSRR.

2.3. V&V Process

The SECNAVINST 5200.40 identifies six process phases that, together, form the DON V&V process. The six phases are (1) preliminary activity – specify and analyze requirements, (2) conceptual model validation, (3) verification and validation plan, (4) functional design verification, (5) system verification, and (6) results validation. This segment of the Handbook provides a summary overview of each of the phases. Issues regarding the practicalities of implementing each of these phases can be found in chapters 4 and 6.

Figure 2 presents the DON V&V process and provides a mapping of each of the process phases with the process presented in the DoD RPG. As can be seen from that figure, each DON V&V process phase maps to an equivalent DoD V&V process phase. The main difference between the two processes comes in the order in which each phase is introduced within the overall V&V process. Both the DoD and DON begin the V&V process by reviewing and verifying the M&S user's M&S requirements. The DON recommends the next phase in the process be the validation of the M&S conceptual model. Comparing the model to the verified M&S user requirements validates the conceptual model. This comparison will uncover areas of greatest risk to the M&S user and will allow the V&V practitioners to then develop a highly tailored V&V plan for mitigating those risks, V&V planning being the next phase in the DON V&V process. The DoD RPG reverses this ordering, and recommends a tailored V&V plan be developed prior to validating the conceptual model.

Experience has shown that, in practice, it is likely these two process phases will be implemented more-or-less in parallel, thus the specific ordering is relatively insignificant. V&V practitioners are free to use their own judgment regarding which ordering best suits their needs.

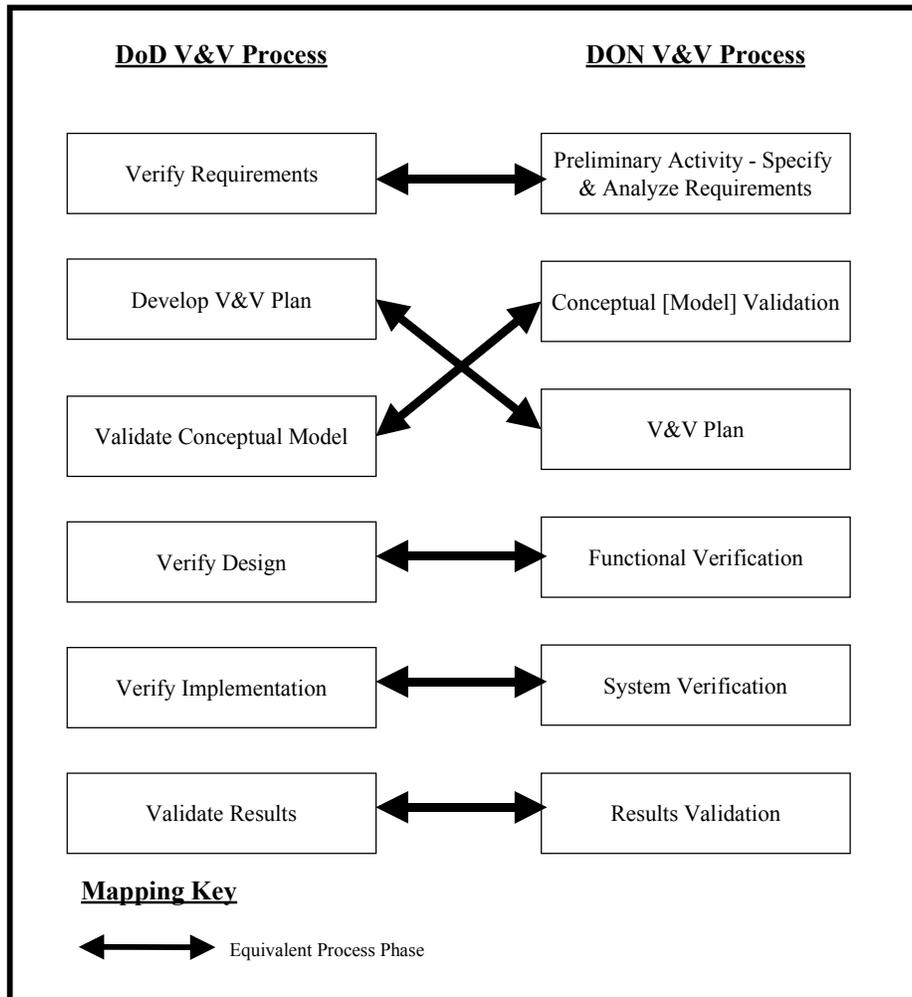


Figure 2. DON Verification and Validation (V&V) Process

2.3.1. Preliminary Activities: Specify and Analyze Requirements

According to the SECNAVINST, Phase 1 of the DON V&V process is to understand the “M&S development requirements.” The SECNAVINST describes these requirements as defining “the functionality and capability which the user requires of the model or simulation system,” and that these requirements “serve as the foundation against which the [model or] simulation will be verified and validated.” Throughout this handbook, these requirements will be referred to as either M&S development requirements or M&S user requirements.

The objective of Phase 1 is for the V&V practitioners to understand, as well as possible, what problem the M&S user is hoping to solve by using the M&S and through that understanding to verify the M&S user requirements specified will indeed solve that problem.

During this phase, the V&V practitioners interview the M&S user, review the user's requirements, and review or assist in the development of the user's M&S acceptability criteria.

The completion of this phase will produce a verified set of M&S user requirements and a refined set of acceptability criteria. While this may seem simple, this is a difficult V&V phase to perform. M&S users frequently begin by describing general problems to solve and writing general M&S development requirements. They are looking for answers to broad questions such as "How fast will the ship go?" "What is the RCS signature of the aircraft?" or "Which radar design is better?"

The answer to these questions will depend on a variety of supporting information. For example, the answer to "how fast can the ship go?" depends not only on the design parameters of the ship, but also on the ship's operational environment. Would the ship be moving in a straight line or would it be turning? Would the ship be out in the open sea or in close to shore? What would be the state of the sea, calm or turbulent? Would the ship be pulling into, or exiting, a harbor? Would the ship need to accomplish another task while it was moving, such as engaging in combat?

It will also be important to understand what is motivating the M&S user to solve the problem. Why does the M&S user want to know how fast the ship will go? Is the user trading off competing ship designs? If so, it would be important for the M&S to be capable of ascertaining what portion of the ship's overall speed was attributable to specific design features. To support the M&S user in this instance, the M&S would need to present the ship speed as a function of different design options while holding the operational environment fixed.

Conversely, if the M&S user were trying to establish the ship would meet a customer's operational speed performance specification, it would be important for the M&S to be capable of ascertaining the ship's speed as a function of varying operational conditions while holding the ship design fixed.

Asking the right questions, capturing the right level of detailed requirements, and attaching clear, testable acceptability criteria requires a good deal of persistence and skill. This is not an activity that is performed only once. Understanding of M&S user needs and refinement of M&S acceptability criteria must be iterated upon throughout the entire lifecycle of the V&V process.

2.3.2. Conceptual Model Validation

According to the SECNAVINST, a conceptual model is a statement of assumptions, algorithms, and architecture that relates the elements of the model, or simulation, to one

another. Additionally, the conceptual model describes the data that is used by, embedded in, or produced by the model or simulation.

In phase 2, the V&V practitioners first verify that that all M&S user requirements can be traced to the conceptual model. Next the V&V practitioners validate the correctness of the algorithms, assumptions, limitations, and architecture. The degree of correctness of these items is measured by how well they support the M&S user requirements.

The M&S data, described in the conceptual model as being used by or embedded into the M&S, must also be validated during this phase of the V&V process.

Data described in the conceptual model as being produced by the M&S must be examined for appropriateness. Types of, and sources for, authoritative data to be collected in order to validate the M&S outputs should be identified.

As each of the parts of the conceptual model are validated against the M&S user requirements, the V&V practitioners should identify and document any discrepancies between the M&S user requirements and the functionality described in the M&S conceptual model. The V&V practitioners should also identify any potential hazards or risks the M&S user may face in applying the M&S to solve their problem. Refer to the overview section, “Why M&S VV&A?” for a brief discussion of hazards to the M&S user.

During this phase, the V&V practitioners will produce a documented list of all uncovered discrepancies and hazards to the M&S user. These will be reviewed and prioritized as to their criticality in conjunction with the M&S user. Discrepancies needing correction will be forwarded on to the M&S developing organization in accordance with that organization’s change request process.

Plans for eliminating or mitigating potential hazards or risks to the M&S user will be developed in concert with the M&S user and documented within the V&V plan. The process of uncovering the hazards and identifying potential solutions to them is generally referred to as a risk assessment process.

The completion of this phase will produce a validated conceptual model, identification of data to be collected, authoritative sources that provide such data, and a documented risk assessment of the potential risks to the M&S user in applying the M&S to their problem.

Frequently, in the case of legacy M&S, V&V practitioners may find the M&S conceptual model has not been formally documented. The practicalities of addressing this issue are presented in chapter 4.

2.3.3. Verification and Validation Plan

According to the SECNAVINST, the V&V planning phase “identifies tasks...in a manner that matches and compliments the M&S development requirements, resources, and timelines.” The V&V plan is “adapted to address the requirements and constraints of the M&S application and covers critical issues, while allowing flexibility for adjustment and refinement.”

Appendix E presents the DON template for M&S V&V plans. The template provides both a standardized format for the plan and detailed guidance on developing the plan.

2.3.4. Functional Design Verification

According to the SECNAVINST, the V&V functional design verification phase is “based on the M&S system specification, which defines the hardware, software, and personnel that comprise the M&S. The [functional] design process has two primary components: the architectural system design, which addresses the hardware and software architecture, data structures, and interfaces; and the detailed software design, which addresses key elements of the software such as critical algorithms and data issues.”

Functional design verification ensures that all the features, functions, behaviors, algorithms, and interactions defined by the M&S user requirements and the conceptual model are correctly and completely included in the M&S design representations and documentation.

Typical types of activities performed by V&V practitioners during this phase include reviewing M&S functional design documentation, participating in M&S design walk-throughs, and demonstrating traceability of the M&S user requirements through the conceptual model and into the functional design specification.

As with the conceptual model validation phase, all discrepancies and user risks uncovered by the V&V practitioner are documented and prioritized as to criticality in concert with the M&S user. Discrepancies requiring correction are sent as change requests to the M&S developer organization.

Newly identified user risks are assessed and, if necessary, the M&S user requirements, acceptability criteria, and/or the V&V plan may be refined or revised.

Completion of this phase will result in a verified functional design, with all uncovered defects and their ramifications to the M&S user documented within the M&S verification report.

2.3.5. System Verification

According to the SECNAVINST, the V&V system verification phase is “the formal test/review process by the M&S proponent responsible for determining that the M&S accurately represents the functional design and has traceability to the conceptual model and the system requirements. System verification examines timing and protocol constraints on M&S processing, and accommodates for unanticipated input values for a model or simulation which must interact with hardware, operators, or other M&S in a distributed simulation.”

Activities commonly associated with the system verification phase include verifying requirements traceability to the implemented design, verifying hardware, verifying hardware and software interfaces, verifying M&S initialization data, verifying the overall M&S configuration, and reviewing M&S development system test plans and reports.

Completion of this phase will result in a verified system implementation, with all uncovered defects, and their ramifications to the M&S user, documented within the M&S verification report.

2.3.6. Results Validation

According to the SECNAVINST, the V&V results validation is “the formal test/review process that compares the responses of the M&S with known or expected behavior from the subject it represents, in order to ascertain that the M&S responses are sufficiently accurate for the intended uses.”

Results validation normally involves comparison of the results of a simulation to some authoritative reference data that defines what the expected results should be.

The DoD RPG defines metadata as the information describing the characteristics of data, and defines referent as the authoritative data to which the M&S results would be compared. Real-world, empirical data are preferable sources of referent, or validation, data. Examples of empirical data are telemetry data from operational systems and measurement data from test events.

When real-world data are not available, subject matter experts (SMEs) are relied upon to provide assessments as to the credibility of the M&S results. In addition, M&S results can be compared, or benchmarked, against other similar validated M&S results when no other referent resources are available.

Completion of this phase will produce validated M&S results, with all uncovered defects, and their ramifications to the M&S user, documented within the M&S validation report.

2.3.7. Tailoring the DON VV&A Processes

The DON VV&A processes described above are designed to be applicable to all types of M&S and M&S applications. It is expected that each DON program will tailor this general process to meet the specific needs of their program. Figure 3 illustrates how one DON program tailored the V&V process. The Navy program in this example had structured the rest of their program tasks into a work breakout structure (WBS). To maintain consistency with the rest of their program activities, they created a WBS for the VV&A activities. In the figure, the program’s WBS appears in black. Overlaid on top of the WBS are the generalized DON VV&A process phases and documents described in this handbook.

Notice that two of the DON Accreditation steps were not even included in their WBS. The program was not anticipating needing to re-accredit their simulation, and so omitted that process step from their WBS. The accreditation status statement step was also omitted from their process. At the time they developed their WBS, they were unaware of the requirement to include an accreditation status statement with all documented M&S results. If their program needs changed, it would be easy for them to modify their WBS to include both of these process steps.

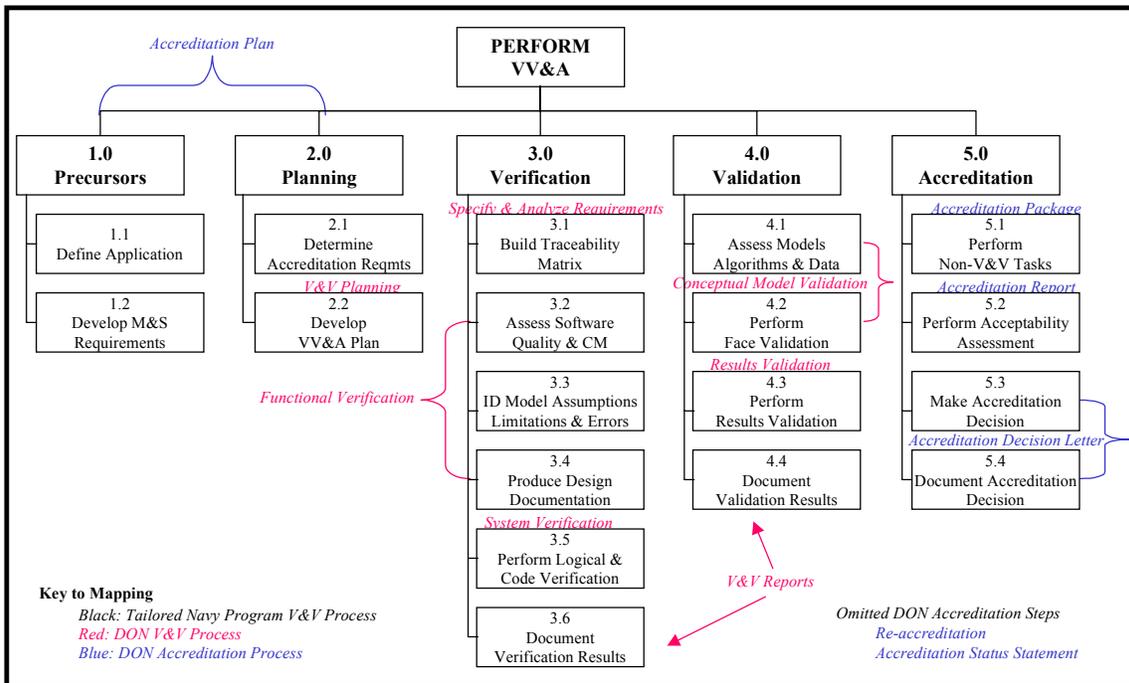


Figure 3. Tailored Navy VV&A Process with General Process Overlay

2.4. DON VV&A Roles and Responsibilities

The DON identifies seven roles within the VV&A processes. The seven roles are accreditation authority, accreditation agent, M&S user, M&S proponent, M&S developer, V&V agent, and subject matter expert (SME).

The accreditation authority is the senior management, or command-level, directly responsible to approve the use of an M&S capability for a particular application. The accreditation authority is a senior level member of the M&S user organization. Accreditation authorities can be mission sponsors, resource sponsors, program executive officers, program managers, or direct reporting program managers. Some special types of accreditation authorities are Commander, Operational Test and Evaluation (COMOPTEVFOR), Marine Corps Test and Evaluation Agency (MCTEA), and DoD M&S Executive Agents (MSEAs).

For M&S used to support DON Operational Test and Evaluation (OT&E), COMOPTEVFOR or MCTEA is the accreditation authority. MSEAs are the accreditation authority for M&S used to support certain DoD-wide functional areas. For the DON, the Oceanographer has been identified as a DoD MSEA, and is the accreditation authority for all common use M&S representations of the ocean.

What distinguishes these two cases (OT&E and MSEA) from other accreditation authorities is they are independent from the chain of command of the M&S user and they are reliant upon the M&S user to fund all necessary V&V activities for accrediting the particular M&S application.

The accreditation agent is the individual, group, or organization designated by the accreditation authority to conduct the accreditation assessment of a specific M&S application. The accreditation agent serves as the M&S user's advocate throughout the M&S accreditation assessment process.

The M&S user is the individual, group, or organization that utilizes the results or products from a specific application of a model or simulation. In a broader sense, the user is the customer, the one for whom the M&S is assembled and developed.

The M&S proponent is the individual, group, or organization that is in charge of the programmatic and managerial aspects of a simulation development. The M&S proponent directs all aspects of the development, schedule, budget, contracting, and risk management. The M&S proponent has primary responsibility for performing V&V and configuration management of a particular M&S. M&S program manager is a term that can be used interchangeably with M&S proponent.

The M&S developer is the individual, group, or organization responsible for managing or overseeing models and simulations developed by a DoD Component, contractor, or Federally Funded Research and Development Center. More specifically, the M&S developer is the group given the responsibility for building and integrating the M&S. Frequently it is a contractor organization.

The V&V agent is the organic asset, external organization, or contractor designated by the M&S accreditation agent, or proponent, to perform verification and/or validation of a model, simulation, or federation of M&S. While the verification agent and the validation agent can be separate individuals, groups, or organizations, in this handbook, "V&V agent" is used as a collective term throughout since it is seldom necessary to divide the two functions. V&V practitioner is a term that can be used interchangeably with V&V agent; however, "agent" is the more commonly used term.

The subject matter expert (SME) is an individual who, by virtue of education, training, or experience, has greater than a journeyman's expertise in a particular technical or operational discipline, system, or process and has been selected or appointed to participate in the validation of a model or simulation.

Table 1 identifies DON roles and responsibilities as a function of the DON VV&A process phases. Responsibilities are divided into six categories: lead, perform, assist, monitor, review, and approve. The definitions of each of these responsibilities have been taken directly from the DoD RPG and are provided below.

- Lead - Leads the task; normally involves active participation from others.
- Perform - Does the task; normally requires little active participation from others.
- Assist - Actively participates in the task (e.g., conducts tests, provides information).
- Review - Participation normally limited to reviewing results of the task.
- Monitor - Oversees the task to ensure it is done appropriately but does not normally participate.
- Approve - Decides when the task is satisfactorily completed and a different task can begin; determines what task should be pursued next (e.g., when a problem has been

discovered, this action decides whether to continue on to the next scheduled task or to return to a previous task).

Table 1. DON Roles and Responsibilities as a Function of VV&A Process Phase

Activities	Authority	A. Agent	User	Proponent	Developer	V&V Agent	SME
Acc. Plan		Lead/Approve	Review	Assist		Assist	
Acc. Pkg.		Lead/Approve	Monitor	Assist		Assist	Assist
Acc. Rpt.		Perform	Monitor				
Acc. Dec.	Perform						
Re-Acc.		Lead/Approve	Review	Assist		Assist	
Acc. Status			Perform	Lead	Perform		
Spec./Anal. Reqmts		Assist	Approve	Monitor	Assist	Lead	Assist
Conceptual Validation			Assist/Approve	Monitor	Assist	Lead	Assist
V&V Plan		Assist	Review	Assist	Review	Lead/Approve	Assist
Functional Verification			Approve	Monitor	Assist	Lead	
System Verification			Approve	Monitor	Assist	Lead	Assist
Results Validation							

Who participates and what management system is put in place is left to the individual program to establish according to their needs and resources. Two examples are provided in figures 2 and 3.

Figure 2 shows the VV&A Team established for the Infrared Sensor Stimulator (IRSS) program. As you can see, it is a small team. The Accreditation Authority (M&S Sponsor) delegated two accreditation agents, one for each vehicle platform simulated. The program decided to have the M&S Developers act as Verification Agents, and then selected two independent contractors to act as Validation Agents. Finally, the program selected subject matter experts for each of the sensors being simulated and each test facility being used.

Figure 3 is the accreditation process and team structure put into place for the DD21 program. This is a much larger program and one that expects to review several hundred M&S for accreditation over the program lifecycle. As can be seen in the figure, several panels of individuals and organizations, as well as an M&S screening process are used.

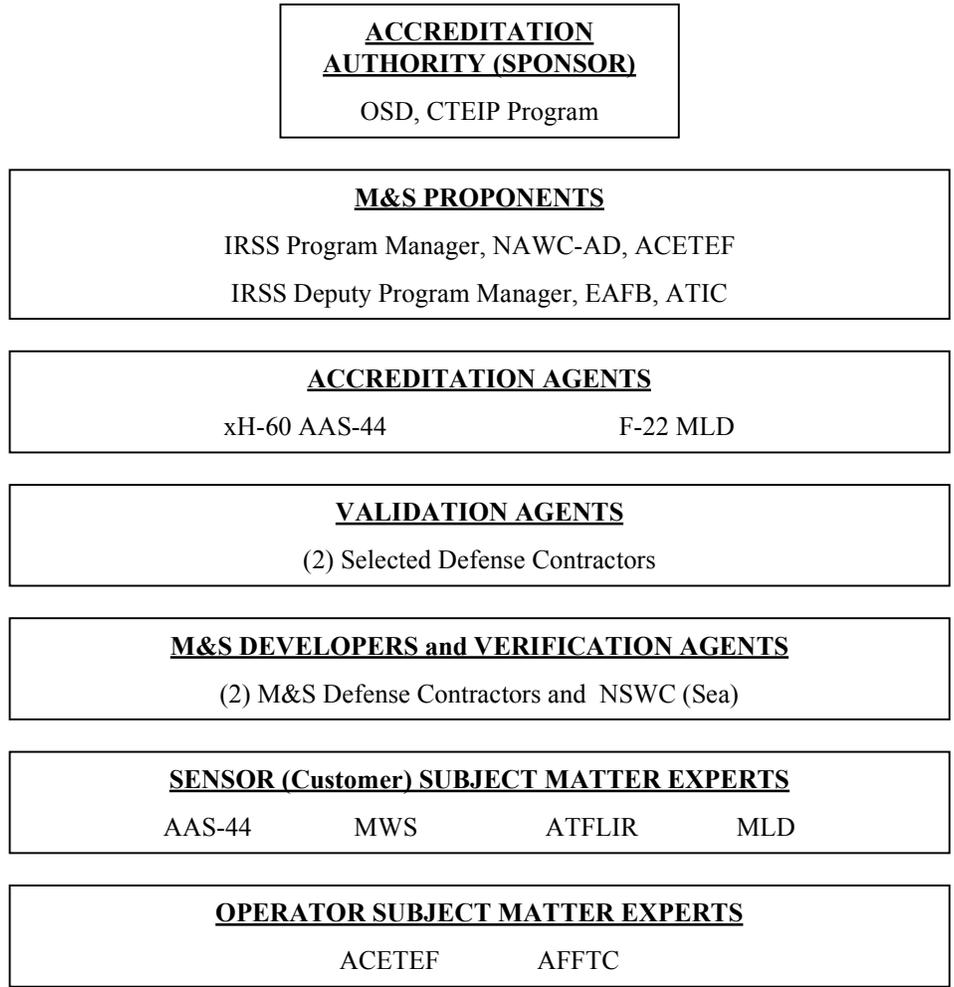


Figure 4. Example of IRSS M&S VV&A Team

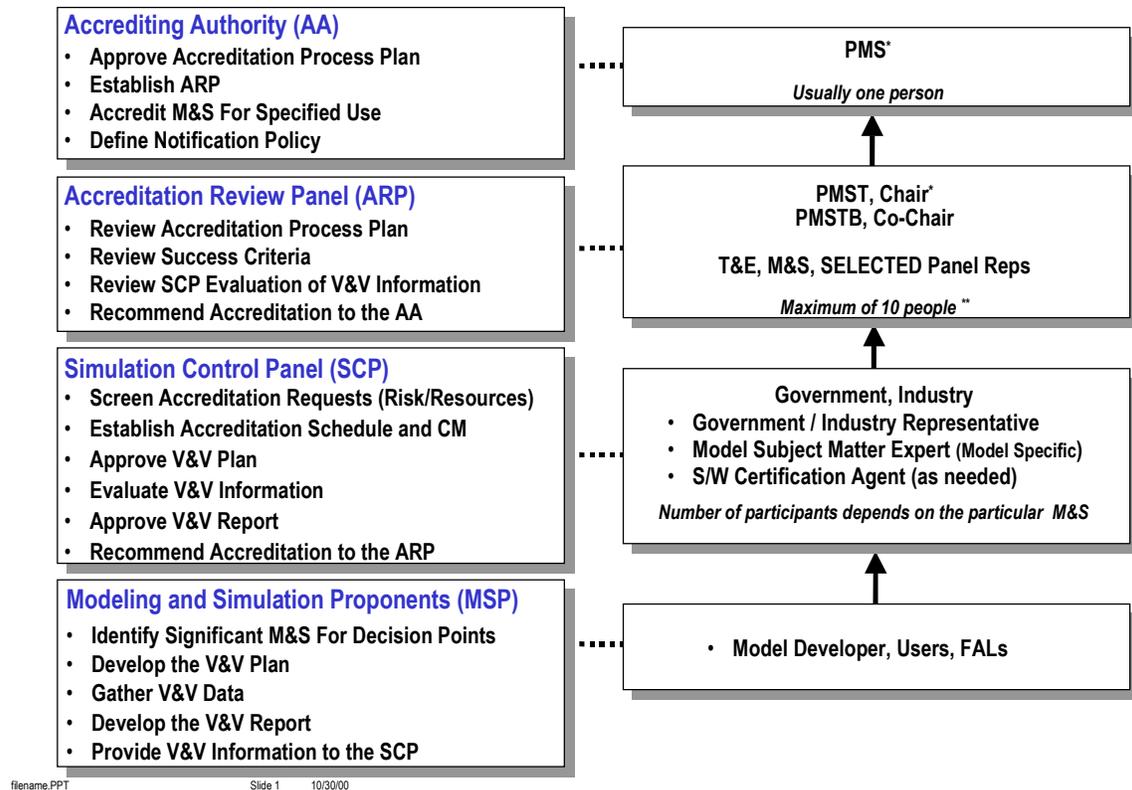


Figure 5. Example of DD21 M&S Accreditation Process and Team.

Many DON M&S programs have created web-based, collaborative scheduling, monitoring, and maintenance capabilities to track and communicate these activities. Many web sites include VV&A status and events. When establishing a VV&A team, some thought should be given to how the team members will communicate with one another, such as over a web site, should be considered.

3. Accreditation Authority

3.1. Chapter Overview

The primary function of the M&S Accreditation Authority is to decide whether or not a model or simulation can be applied to a specific user's application. Examples of M&S application include assessments, weapon system acquisition decisions, training a warfighter, developing a tactical mission plan, or supporting an exercise.

In order to make such a decision the Accreditation Authority must first develop a set of M&S user requirements and a corresponding set of user acceptability criteria. Next an appropriate M&S must be selected that most closely meets the user's requirements.

The Accreditation Authority requests the collection of evidence (the V&V process) that will allow the Accreditation Authority to assess how well the M&S meets the requirements and associated acceptability criteria for the intended use. Based upon the assessment, the accreditation authority makes the decision whether or not to accredit the M&S.

This chapter discusses the DON M&S VV&A Accreditation Authority responsibilities as defined in SECNAVINST 5200.40 and as presented in Table 2.

3.2. Preliminary Activities

3.2.1. M&S User Requirements

Once a need for M&S use is identified, the user must specify the requirements for that use. The accreditation authority, or agent, is responsible for ensuring the user's M&S requirements are clearly specified and formally documented. These requirements are the initial step in beginning an M&S VV&A process. Programs are most successful when they endeavor to provide as much specific detail in these requirements early on, but the requirements development process is usually an iterative one and will evolve over the course of the VV&A process, as well as over the course of the M&S using program.

If a program intends to reuse an M&S, they must re-accredit the M&S for each use. Therefore, when capturing the user requirements, the program should consider all uses over the lifecycle of the program in order to minimize the overall VV&A effort.

The Defense Modeling and Simulation Office (DMSO) VV&A Recommended Practices Guide³) suggests that good M&S requirements will possess the characteristics listed in Table 5.

Table 1. M&S User Requirements Characteristics

Clear and unambiguous with unique designation for each specific requirement
Expressed in a way that can be understood by the User, domain SMEs, and the Developer to mean the same thing
Even state obvious requirements (user and developer may differ about what is “obvious”)
Consistent with other requirements for the simulation
Testable or, at least, satisfaction of a requirement is demonstrable in some objective and measurable way)
Organized to facilitate requirements modification during the course of the project: Structured topically Ranked as essential (requirement) or as expected or desirable (characteristic, not a rigid requirement) according to what the simulation needs to be able to do Amenable to elaboration as requirements are translated into high level and then detailed specifications
Viable or achievable (a good requirement is not impossible to satisfy – it can be implemented)
Can accommodate tracing both forward to simulation design and implementation and back from simulation implementation to the original objectives

3.2.2. M&S Designation

SECNAVINST 5200.40 does not address how using programs designate or select an M&S for use by their program. Candidate M&S should be capable of satisfying the intended use, employ established configuration management process, and have the ability to be accredited within the resource budget and time constraints of the using program. M&S selection should be based on the coverage of M&S requirements and cost.

Each program should establish a methodology and process for reviewing candidate M&S and for making a final M&S designation. To assist programs, a central repository of DON M&S has been established and can be accessed at <http://navmsmo.hq.navy.mil/nmsiscat/>.

3.2.3. M&S Acceptability Criteria

Acceptability criteria provide a means of evaluating the M&S from the perspective of the user's application requirements. Acceptability criteria are:

- Some level of demonstrated M&S performance, for example, demonstrating that ship propulsion system model outputs equal the expected levels of power.
- The accomplishment of a process at some level of efficiency, for example, simulation of an aircraft's flight control response in real-time.
- Or some other criterion that indicates an aspect of the M&S users application requirements are satisfied, for example, establishing a web-based support site for model users.

The M&S Users requirements can be categorized into two broad classes, those that are essential to meet the user's needs and those that are desirable to the user. To effectively manage program resources, the essential and desirable requirements should be so identified and prioritized.

Similarly, the acceptance criteria for each of the M&S requirements can be categorized into essential and desired levels of performance, fidelity, or user satisfaction. These, too, should be prioritized for effective resource management. Factors affecting the priority include, but are not limited to, magnitude of the impact to the M&S user if output results are in error, degree of associated cost, or the degree of difficulty in verifying or validating its functionality.

It is the responsibility of the Accreditation Authority or Agent to develop and document the acceptance criteria for meeting an M&S User's need. They should be developed with the same level of rigor and clarity as the M&S requirements. And, as with the requirements, development will be an iterative process involving the M&S User, Proponent, V&V Agent, and SMEs.

M&S user requirements commonly fall into two main categories: M&S performance characteristics and M&S installation, operation, and maintenance characteristics.

Performance characteristics can include items such as resolution and type of numerical algorithms, resolution of force structure and force interaction, representation of physical scenarios or events, and type and resolution of data inputs.

M&S installation, operation, and maintenance characteristics can include items such as cost (to develop, install, operate, and maintain), user training, user documentation, user support services, automated user interfaces, reliability in installed environment (e.g. ability of a simulation to function aboard ship), and effectiveness of the CM policy.

The M&S User will define each specific requirement and the Accreditation Authority or Agent must select a means of quantitatively assessing the M&S on each attribute. Often, particularly for assessing M&S performance characteristics, real world data must be collected. The Accreditation Authority or Agent should specify what data are needed as part of the acceptability criteria. Included with the type of data, the Accreditation Authority or Agent should specify the data source, data collection attributes, and impact to the M&S assessment of any uncertainties associated with the data. The M&S Proponent and the V&V Agent may assist in the development of data requirements, but

the Accreditation Authority represents the users who may have very specific requirements for data.

3.2.4. Selection of M&S VV&A Agent(s)

The Accreditation Authority, as the senior management or command-level person directly responsible for decisions supported by the M&S capability, may employ assistance in the planning and oversight of the accreditation process. Depending on the size, complexity, and criticality of the use of the M&S, one or more individuals may be nominated to serve as the Accreditation Agent(s). The Accreditation Agent should have experience and general knowledge of the M&S area. The Agent must focus solely on the requirements of the user and should, therefore, be independent of the M&S Proponent and developer. The job of defining the user requirements and acceptability criteria will often be one of the Accreditation Agent's most challenging tasks. The Accreditation Agent will work closely with the M&S Proponent and the V&V Agent(s) until the entire Accreditation Package is assembled with a recommendation for the Accreditation Authority.

Usually the V&V Agent will report to the M&S Proponent (especially if the Accreditation Authority has named an Accreditation Agent, in which case the two "Agents" work closely, but their roles do not overlap). The V&V Agent should be completely familiar with all DON V&V policies and procedures. The V&V Agent should have a solid background in software engineering, systems engineering, and some experience in M&S. A V&V Agent should have excellent analytical skills, and should be able to summarize and evaluate complex technical issues, physical phenomena, and mathematical algorithms.

If the Accreditation Authority feels the risks associated with an M&S warrant an independent Agent, the Accreditation Authority can, as the customer, insist that the V&V Agent report directly to him/her rather than to the M&S Proponent. Cases that might call for complete independence (of the V&V Agent from the M&S Proponent) might include cases of extreme visibility, cost and/or risk. Some application program sponsors, who wish to employ an M&S to support an exercise or an acquisition decision, may determine that only an Agent with no vested interest can adequately assess the risk of using the M&S for the intended use.

Refer to Section 2.5, Roles and Responsibilities, for examples of delegated VV&A Agents.

3.2.5. Documenting M&S Accreditation Plan

SECNAVINST 5200.40 requires that M&S acceptability criteria and evaluation methodology be documented in both the M&S V&V plan and the M&S Accreditation Report. It is recommended that the Accreditation Authority or Agent document the acceptability criteria (and their methodology for evaluation of the M&S capability to meet those criteria) as part of the Accreditation Plan.

It is the responsibility of the Accreditation Authority or Agent to provide the M&S Proponent with a documented version of the acceptability criteria and accreditation goals prior to the initiation of the V&V planning phase.

Appendix A provides a template for planning accreditation activities. The template includes useful guidance as well as provides an outline structure for formatting the Accreditation Plan contents.

3.3. Accreditation Package Review and Report

3.3.1. Accreditation Package Review

3.3.1.1. Reviewing M&S V&V Products

The Accreditation Authority or Agent should review each report for evidence relating to the acceptability criteria and accreditation methodology specified in the Accreditation Plan. Where discrepancies are found which could affect accreditation of the M&S, the Accreditation Authority, or Agent, should document each discrepancy in accordance with the M&S CM procedures. The Accreditation Authority, or Agent, should then review these discrepancies with the M&S Proponent. The Accreditation Agent (or the V&V Agent, in cases where no Accreditation Agent was appointed) will compile the final assessment findings in the Accreditation Report. The Accreditation Report will summarize the entire process and findings and will make recommendations to the Accreditation Authority as to whether or not to accredit the M&S. This report is submitted to the Accreditation Authority and is the basis for making the accreditation decision.

In addition to reading the V&V plans and reports, it is often more informative to witness the V&V events first hand. Whenever feasible, the Accreditation Authority or Agent should be available to observe major V&V events.

3.3.1.2. Reviewing M&S Accreditation Package

In addition to the reports identified above, SECNAVINST 5200.40 specifies the following documents be included in an M&S Accreditation Package:

- M&S Software Design Document
- M&S User's Guide
- M&S Programmer's Manual
- M&S CM Plan
- M&S Data Documents
- Any prior M&S VV&A Reports

The Accreditation Authority or Agent must review each of the documents. CM is key to the conduct of V&V. The Accreditation Authority should have a good understanding of the status of not only the CM Plan, but the actual implementation of the Plan. The Accreditation Authority should make careful note of all deviations between the CM plan and its implementation. The Accreditation Authority should be convinced that CM is in place and functioning well, particularly in cases where the user will need repeatability and reliable support. CM, which includes maintenance of documentation, is key both to repeatability of simulation results and to the ability to verify and validate the M&S.

3.3.2. Accreditation Report

Appendix B contains a template for producing an M&S Accreditation Report. The template provides useful guidance and content formats.

One of the most important challenges facing the Accreditation Authority or Agent is to communicate, effectively, the M&S applicability to the user's requirements as determined within the accreditation process. It is important for the Authority or Agent to remember that insights will generally be qualitative in nature even though the methods they derive from are quantitative. M&S insights to be documented within the Accreditation Report can include:

- A summary of the overall degree to which the M&S supports the user's requirements.
- The key sources of variability and key sources of uncertainty and their impacts on the M&S user.
- The critical modeling assumptions and limitations, and their importance to the user.
- The extent to which plausible alternative assumptions or models could affect any conclusions derived from the M&S use.
- Key scientific controversies related to the M&S use and sensitivity to the importance of these issues to the user.

3.4. Making Accreditation Decision

The Accreditation Authority or Agent has three decision options available regarding M&S accreditation. After implementing the Accreditation Plan and reviewing the Accreditation Report, the Accreditation Authority can decide:

- The M&S under assessment satisfies the user's requirements and should be accredited.

- The M&S under assessment does not satisfy the user's requirements and should not be accredited.
- Additional information must be made available on the M&S under assessment before an accreditation decision can be made.

Appendix C contains a template for documenting the Accreditation decision.

3.5. Re-Accreditation

SECNAVINST 5200.40 specifies that an M&S can be accredited for a specific use only. If an M&S is reused, the M&S User must re-accredit the M&S. A descriptive list of all changes made to an M&S since the last accreditation should be documented and presented to the Accreditation Authority, along with supporting evidence or rationale for why a re-accreditation should be issued.

Changes to an M&S would include modifications to the M&S, modifications to M&S input data sets, modifications to the M&S intended use, and/or modifications to M&S output data sets.

4. M&S Proponent

4.1. Overview

According to SECNAVINST 5200.40, the M&S Proponent is responsible for developing the M&S V&V Plan, implementing the Plan, and submitting all necessary VV&A documentation to the DONMSMO. The M&S Proponent is responsible for ensuring that all related M&S processes, including CM, are established and functioning. Finally, the M&S Proponent is responsible for ensuring the M&S receives proper accreditation prior to each specific use of the M&S.

This chapter discusses the responsibilities of the DON M&S Proponent. It is organized into five sections:

The first section (M&S V&V Prerequisites) presents discussions on activities that should take place prior to the development of the V&V plan. This pre-planning is discussed in SECNAVINST 5200.40.

The second section (Conceptual Model Validation) discusses what types of activities are involved in validating the conceptual model.

The third section (Developing an M&S V&V Plan) discusses what types of activities to include in the V&V plan and links to a template for producing the plan.

The fourth section (Implementing the M&S V&V Plan) discusses the M&S Proponent's role in implementing the V&V plan.

The fifth section (Filing Documents With DONMSMO) discusses the M&S Proponent's responsibility to file the M&S Accreditation Decision Letter, Accreditation Report, and Accreditation Package with the DONMSMO.

4.2. M&S V&V Preliminary Activity

The preliminary activities for the M&S Proponent differ depending on whether the M&S is being newly developed or is a legacy system.

If the M&S is new, the M&S Proponent must work with the M&S User to fully develop the M&S requirements. The end result of this requirements development process will be a documented conceptual model, an M&S development plan, and an M&S configuration management plan.

For legacy M&S, the M&S Proponent must gather together existing M&S documentation. This documentation should include, but is not limited to, the conceptual model description, development and enhancement history, past M&S use history, and past M&S VV&A plans and reports.

For legacy M&S, the M&S Proponent must either establish a configuration management plan or demonstrate that the M&S is under adequate configuration management.

The legacy M&S documents, and configuration management information, should be made available to the Accreditation Authority or his delegated VV&A agents for inclusion in their M&S designation process (refer to section 3.2.2).

Before V&V tasks and resources can be identified and scheduled, the M&S Proponent should work closely with the user's Accreditation Authority or Agent to ensure that the intended use of the M&S is fully understood and the M&S Proponent should identify any previous V&V work which may be applicable to the current accreditation effort.

4.3. Conceptual Model Validation

Conceptual model validation examines the M&S assumptions, architecture, and algorithms in the context of the intended M&S use.

An M&S conceptual model description describes all software, hardware, and human behavior components and their associated interfaces and data sets. The conceptual model specifies all limiting assumptions and scenario specific features of the M&S. The conceptual model specifies all physical environments and systems represented within the M&S, and documents the mathematical algorithms, logic, and architectural structures employed by the M&S.

In order to properly evaluate the conceptual model with respect to the M&S User requirements, the M&S Proponent must select Validation Agent(s) and subject matter expert(s) possessing the necessary domain expertise to make detailed assessments of the basic M&S structures and functionality. Agents and experts should have strong analytical abilities and be knowledgeable in areas of mathematics, physics, computer science, and the military domain being represented by the M&S. In addition to these technical skills, the Validation Agent should possess above average technical writing skills for communicating the technical assessments and their ramifications to the M&S User.

Since the Validation Agent will implement, or lead the implementation of, the conceptual model validation process, the discussion of the validation tasks have been deferred to Section 5.3.1. Completion of the Conceptual Model Validation Phase should result in documented statements describing any discrepancies between the conceptual design of the M&S and the M&S User's Requirements. Included with these statements should be recommendations with regard to modifying the conceptual model to meet the user's needs.

4.4. Developing an M&S V&V Plan

SECNAVINST 5200.40 specifies the top-level V&V activities that must be addressed by all DON M&S V&V plans. They are M&S conceptual model validation, functional verification, system verification, and results validation. Appendix D (V&V Plan Template) contains a template that provides guidance and format structures for creating an M&S V&V Plan.

From the preliminary activities and conceptual model validation phases, the M&S Proponent should be aware of what M&S capabilities are needed by the user and what M&S capabilities are planned for development (new) or currently exist (legacy).

For new M&S, the V&V activities ensure the User's M&S requirements are properly implemented throughout the development life cycle of the M&S.

For legacy M&S, the V&V activities ensure the M&S implementation is consistent with its documented capabilities and that the M&S User requirements can be mapped into the documented M&S capabilities.

From the information gathered during the preliminary activities phase, the M&S Proponent should begin the V&V planning process by answering the following questions:

- What are the inputs that have the most effect on the outputs (sensitivity analysis)?
- What are the important outputs of the M&S, in order of importance to the user's application?
- For each of the important outputs, what part(s) of the M&S is (most) responsible for the results (where are the key associated algorithms embodied within the M&S)?
- Does the M&S have current documentation describing these parts of the M&S?
- Is there a test plan and are there test procedures that describe how the system is tested? Which of the current customer's requirements are sufficiently described in test results and which need new test items developed?
- Is CM applied to control versions and to identify what components (hardware and software) make up the M&S? Has a recent audit been conducted/requested?
- Is there a requirements traceability matrix (RTM) showing where system requirements were captured in the design, code and test phases of the M&S?
- For customer requirements that have not already been tested, what system enhancements would be needed and what would the associated costs be?
- For the key areas of the model (areas which have significant effect on the outputs deemed most important to the user's employment of the model), are the underlying algorithms and associated data credible? Available for review? Available in a form or language understandable by participating Subject Matter Experts (SMEs)? Will it be necessary to obtain review by SMEs? If so, what qualifications will be required of the SME?
- If the M&S documentation has not been maintained, will the re-work necessary (re-engineering and documentation) be worth the cost? Could another M&S serve the purpose at less cost?
- Are there time and resources to complete the needed tasks?

- Given that there is never enough time or money to inspect everything, what will be the likely consequences (restrictions on use) if some of the V&V tasks cannot be supported?

The level of effort associated with each of the V&V activities is extremely variable and must be determined on a case-by-case basis. It is a function of the complexity of the M&S, the use history of the M&S, the criticality or visibility of the M&S user's application requirements, and the capability of the M&S to support the user's specific requirements.

An example of an appropriately low level-of-effort in V&V would be the case where the Accreditation Authority may accept a recommendation to accredit a model for a given use simply because the use of the model carries little risk for that use. Another example might be a case where the M&S have been previously accredited for a very similar use. The V&V process is still conducted but fewer V&V tasks would be necessary.

Clearly, then, the tasks (and the costs) associated with the conduct of V&V are completely dependent upon the combination of the customer's (as represented by the Accreditation Authority) ability to live with risk and his confidence in the M&S system. VV&A is mandated for use of most new M&S, but the V&V will be commensurate with the importance of the use. For example, a model employed merely for demonstration may not warrant much inspection except to ensure that it doesn't crash and that the outputs will not draw uninvited attention away from the main point of the demo. At the other extreme, a model that is used to design safety features of a platform will demand very close scrutiny. The Accreditation Authority, who is usually the program sponsor using the model (but can be the Commander, Operational Test and Evaluation Force (COMOPTEVFOR) or the Marine Corps Operational Test and Evaluation Agency (MCOTEA)) is best situated to make the determination regarding what level of V&V is appropriate for the intended use.

The subsections that follow describe the V&V activities defined in SECNAVINST 5200.40, and identify the common types of tasks associated with each.

The V&V Plan should be tailored in order to be feasible and effective. The first step in preparation for V&V is the development of a solid understanding of the intended use of the M&S. Even in a new development, there is an intended use that is embodied in the requirements. The requirements for the first release in a new development would constitute the description of the intended use. For legacy systems used by sponsors other than the original developing sponsor, the requirements pertain to a unique use and thus require a separate accreditation process. The sponsor of the M&S development (for new systems) or the sponsor of the using program (the Accreditation Authority) must provide (or be assisted in the development of) requirements. A set of acceptability criteria should be established for key M&S functions. Armed with these requirements and any specific acceptability criteria, the M&S Proponent and the V&V Agent will then be able to identify which parts of the M&S are critical in supporting that use. The M&S Proponent, being the "owner" or "maintainer" of the M&S, will be able to state or to determine whether the key parts of the M&S are well documented, understood and/or trusted. If the model has undergone previous V&V for another similar use, and if the model has not

been significantly modified, some of the V&V tasks may be unnecessary to repeat, as long as the V&V plan and results are available. Some areas of the M&S will be less well documented. If these undocumented parts of the M&S are critical to the use of the model (affect the output significantly), then it may be necessary to undertake some re-work (re-engineering, model documentation, CM) before the V&V Agent can commence the process of inspection, evaluation and reporting.

4.4.1. Functional Design Verification Planning

The goal of M&S functional design verification is to establish the consistency and faithfulness of the functional design specifications to the validated conceptual model and M&S requirements.

The following tasks should be included as part of a nominal M&S functional design verification plan:

- Review M&S functional design documentation. This review ensures that the functional design supports the M&S conceptual model and that they are a complete and correct translation of the M&S requirements. This review includes software and hardware documentation, as well as data requirement documentation.
- Perform M&S design walk-throughs. Walk-throughs are a group activity and allow the M&S users and Subject Matter Experts (SMEs) direct access to the M&S functional design and direct interface with the M&S developers. All walk-throughs should include the opportunity for questions and answers regarding the M&S functional design.
- Trace M&S functional design specifications to conceptual model, top-level M&S requirements, and accreditation acceptability criteria.

4.4.2. System Verification

System verification is the formal, documented testing and review process of the M&S. It demonstrates that the M&S system accurately represents the functional design and provides traceability of each system component back to the conceptual model. System verification looks at timing and protocol constraints. It examines how the M&S system accommodates unanticipated, or out of specification, inputs. It examines how well the software components were developed in accordance with contemporary engineering and DoD standards of structure and documentation. It examines how well hardware components comply with system specifications.

For most M&S systems, it will not be possible to review every line of code or every possible permutation of parameters. In the Verification Plan, include a statement describing which sections were selected for verification and explain why that section was determined a candidate for verification. This explanation will probably highlight one or more critical user requirements that are supported by the portion of the M&S selected for verification. Describe which processes of verification will be conducted. Name key individuals or teams who will be responsible for verification.

There are many commercial software tools on the market that may automate some of the verification activities. It is recommended that these be exploited whenever and wherever possible.

The following tasks should be included as part of a nominal M&S system verification plan:

- Perform algorithm checks. These tasks verify that algorithms respond as intended.
- Assess system reliability. These tasks verify the system will perform reliably under operational environments.
- Perform measurement unit analysis. These tasks verify that parameter and variable measurement units are correct and consistent.
- Perform statistical design tests. These tasks verify stochastic processes statistically behave in a repeatable or non-repeatable manner.
- Assess rule-based functionality. These tasks verify that there are no unreachable or undefined logical branches and the correctness of the knowledge base.
- Trace M&S system components (such as software code or hardware components) to functional design, conceptual model, and accreditation acceptability criteria.

4.4.3. Results Validation

Results validation is the rigorous comparison of real world phenomena and M&S performance from the perspective of the intended M&S use.

The results validation plan should include statements detailing the process for results validation, including any scenario and data inputs. The plan should include identification of output to be measured and correlated with other data sources, identification of outside data sources and methods of collection to be used in validation. The plan should also identify any issues involved in the collection or comparison of the M&S results to collected data. It is also important to identify SMEs who participate in the development or approval of the results validation test.

The following tasks should be part of a nominal results validation plan:

- Trace M&S performance to accreditation acceptability criteria.
- Compare M&S outputs to real world data where feasible. Tasks involve defining real world data sources, defining initial input states for comparison of results with data, and quantifying differences between the real world and the M&S.
- Identify what scenarios and test data will be employed for results validation.
- Identify expected results for given test-input data (where possible).
- Identify key SMEs who assist in the design or development of the results validation process.

4.5. Accreditation Package Development

Within new M&S development, review of V&V reports should occur in step with the development process. As each development phase is completed, the V&V Agent should provide to the Accreditation Authority or Agent, the appropriate report(s) (i.e., Conceptual Model Validation Report, Functional Verification Report, Systems Verification Report, or Results Validation Report).

For legacy M&S, V&V reports will be presented to the Accreditation Authority (or, more likely, to the Accreditation Agent) as part of the Accreditation Package. As with new M&S, these reports are reviewed against the acceptability criteria and accreditation goals specified in the Accreditation Plan. And, as with new M&S, discrepancies found during the review process are provided to the M&S Proponent in accordance with established CM procedures. In legacy system VV&A as in new development VV&A, the Accreditation Agent (or the V&V Agent, if no Accreditation Agent was appointed) will compile the final assessment findings in the Assessment Report. This report is a summary of the V&V process and findings. The Accreditation Authority will make the Accreditation Decision based on a review of the assessment and recommendations and possibly a review of the substantiating V&V reports.

The M&S Proponent is responsible for the development of the V&V plan as described in the previous section. The M&S Proponent is also responsible for the implementation of the V&V plan. Implementation includes conducting planned V&V tasks, producing V&V reports, interfacing with the M&S Change Review Board (CRB), assembling the Accreditation Package, and supporting the Accreditation Authority or Agent.

The M&S Proponent is responsible for planning and implementation, but will look to the V&V Agent to take the lead in both areas. Discussion of the V&V Agent's role is covered in Chapter 5 of this handbook.

The M&S Proponent will monitor the status of the V&V progress and report the status to the Accreditation Authority, as well as to other VV&A team members. The easiest way to provide V&V progress reports is to post the plans and progress on a website. With the use of password-protection, access to these plans and reports can be limited to authorized users. Implementing an automatic e-mail notification lets authorized users know when important new information is posted to the website. Some V&V programs have already made excellent use of websites for V&V process management and reporting. Some have even used their website to support SME review of documentation, including the conceptual model and the results validation test scenarios

4.6. Filing Documents With DONMSMO

SECNAVINST 5200.40 requires the M&S Proponent to file all reports associated with M&S VV&A with the DON M&S Office. This includes all completed M&S VV&A reports, the Accreditation Package, and the Accreditation Decision Letter. NAVMSO will indicate accreditation history in the M&S Catalog on the website at: <http://navmsmo.hq.navy.mil>.

5. V&V Agent

5.1. Chapter Overview

The V&V Agent supports the M&S Proponent and Accreditation Authority and acts as the lead in seeing that VV&A activities are tailored, planned, conducted, and documented. The V&V Agent will also prepare all necessary documentation for the Accreditation Authority or Agent.

This chapter provides guidance for V&V Agents in accomplishing these tasks.

5.2. Leading the M&S V&V Planning

The V&V Agent supports the M&S Proponent by taking the lead role in accomplishing the Proponent's VV&A responsibilities. The discussion on V&V planning in Chapter 4, cover the key planning issues. The V&V Agent will assist the M&S Proponent by taking the lead in these areas. Frequently the V&V Agent is hired as contractor support to the M&S Proponent. The M&S Proponent must provide the V&V Agent access to any required M&S information to produce and implement tailored V&V plans. In addition to providing M&S information to the V&V Agent, the M&S Proponent ensures that the development team, or activity, is available to work with the V&V Agent.

5.3. Implementing the V&V Plan

5.3.1. Conceptual Model Validation

The V&V Agent will lead the task of validating the conceptual model. Conceptual model validation includes validating the completeness, correctness, and consistency of each functional element specified as necessary by the M&S user.

The objective of performing conceptual model validation is to demonstrate that the M&S functional elements accurately and completely represent the M&S User requirements, and to identify where M&S assumptions, limitations, or architectural structure impact the intended M&S use.

What specific tasks must be performed to meet this objective will vary depending on the types of functional elements to be validated and whether the M&S is a new development or if the M&S is a legacy system. However, there are a few basic tasks and methodologies that are addressed here.

5.3.1.1. Checking The M&S Conceptual Model For Completeness

To check for completeness of the conceptual model description, the validation agent should perform a mapping between the functional elements of the conceptual model and the M&S user requirements. Functional elements may include M&S software, operational

software, M&S hardware, operational hardware, human or organizational behavior, data, M&S architecture, and M&S interfaces between all hardware, software, and human functional elements.

For both new and legacy M&S, all documented user requirements should map into one or more functional elements of the documented conceptual model. Any requirements not mapping into any functional element is identified as a discrepancy between the M&S User's requirements and the M&S conceptual design.

For new M&S, all functional elements should map into one or more M&S User requirement. Any functional element not mapping into any user requirement may be extraneous should be documented as a discrepancy. The impact to the M&S User of developing and maintaining these non-required functions should be assessed.

For legacy M&S, there may well be functional elements in the existing M&S that were required by a previous user, but are not needed by the current M&S User. Those functional elements not required by the current user should be identified and a determined that the legacy functionality will not adversely impact the current M&S use should be made.

Each discrepancy and its corresponding impact-to-the-user assessment are documented as part of the validation report.

5.3.1.2. Checking The M&S Conceptual Model For Correctness.

Two common methodologies employed for checking the correctness of the conceptual model include tracing the functional elements to prerequisite references and having subject matter experts review the functional elements.

Tracing a conceptual model elements to a prerequisite references may include activities such as tracing numerical algorithms to an authoritative academic reference, relating design selections to established government or industry standards, or establishing the pedigree of collected data sets. Well-documented conceptual models should include a complete reference section that tie each of the functional elements to authoritative sources.

As mentioned in chapter 2, representation of certain types of entities comes under the purview of M&S Executive Agents. In the Department of the Navy, the Oceanographer is responsible for providing the authoritative representations of the ocean environment. The Office of Naval Intelligence or the Defense Intelligence Agency is responsible for validating all threat entity representations. M&S conceptual model elements that represent entities of these types should be referenced back to a representation approved by these Naval or DoD organizations.

SMEs are employed during the conceptual model validation phase to evaluate the correctness of model theories, algorithms and scientific assumptions. This method of validation is called Face Validation.

Face validation is particularly well suited for the early stages of new model development. The V&V Agent, or SME, looks for significant departures from expectations, unusual theories, and basic assumptions.

5.3.1.3. Checking The M&S Conceptual Model For Consistency.

Again, the methodology of tracing validation and face validation are applied to validating the consistency between functional elements of an M&S conceptual model. Here the V&V agent, assisted by the SME, determine if measurement units are consistently applied, common reference frames employed, a consistent level of detail or fidelity is applied across functional elements, and if M&S interfaces provide consistent representations of shared data.

5.3.1.4. Documenting and Reviewing Findings

All discrepancies between the conceptual model and the user requirements uncovered during the conceptual model validation phase are documented as part of the V&V Report (Appendix E). Each discrepancy should include an assessment of the impact to the M&S User and a recommendation as to how to eliminate or mitigate the impact.

The V&V Agent may recommend modifying the conceptual model, modifying the M&S User requirements, performing verification, validation, or testing activities during later stages of M&S development, or augmenting the M&S application with other program resources.

For new M&S, conceptual model validation leads to early detection and correction of errors. M&S discrepancies and assessments should be fed back to both the M&S User and Developer through the VV&A Team structure. Approval for recommended modifications, augmentations, or follow-on activities should be obtained from the M&S Sponsor or Accreditation Authority.

Uncovering and resolving discrepancies early in the M&S development process result in substantial development cost savings, as well as increasing M&S User satisfaction with the final M&S application.

For legacy M&S, conceptual model validation identifies any discrepancies between the existing M&S representation and the new M&S User requirements. This allows the M&S User, Developer, and Sponsor to accurately plan and budget for all necessary changes or enhancements to the M&S to support the intended use.

5.3.2. Functional Verification Implementation

Tasks involved in functional verification include reviewing functional design documentation for consistency with the validated conceptual model. In addition to reviews, walk-throughs of the documentation with M&S developers and the Accreditation Authority or Agent are highly recommended.

For new M&S, the V&V Agent should review the CM procedures for tracing top-level M&S requirements to functional, or detailed, design. The CM procedures will document how the requirements are tracked across development lifecycle phases and how they are measured for completeness and consistency.

For legacy M&S not supported by a comprehensive CM process, documentation is most likely very sparse. When M&S have little supporting documentation, tracking requirements and measuring them for completeness and consistency is extremely difficult. In the worst cases, where documentation has not been maintained, verification cannot be performed without re-engineering the code. Obstacles such as this should be identified in the planning phase. Functional areas of the M&S should be prioritized by the significance of their effect on the intended M&S use. In this way, costs of re-engineering can be limited to only those functional areas of greatest impact to the M&S user.

Functional verification includes tracing of the user's requirements from conceptual model to functional design and ascertaining whether the functionality has been correctly implemented at each stage. It may be possible to implement commercial software tools to automate the tracing process, but often the learning curve for the tool and the need to tailor the tool are prohibitive factors.

A common verification methodology employed during the functional verification phase is compliance testing. Compliance testing verifies that the M&S is developed in accordance with standards, procedures, and guidelines. Compliance testing is also used to establish the M&S will interoperate in distributed operating environment.

5.3.2.1. Documenting and Reviewing Findings

All discrepancies between the functional design and the user requirements uncovered during the functional verification phase are documented as part of the V&V Report (Appendix E). Each discrepancy should include an assessment of the impact to the M&S User and a recommendation as to how to eliminate or mitigate the impact.

The V&V Agent may recommend modifying the functional design, modifying the conceptual model, modifying the M&S User requirements, performing verification, validation, or testing activities during later stages of M&S development, or augmenting the M&S application with other program resources.

For new M&S, functional verification traces the detailed functional design back to the conceptual model, and establishes the accuracy of the translation from one phase of development to the next.

As with the conceptual model validation phase, early review of findings with the M&S User and M&S Developer leads to early detection and correction of errors. Approval for recommended modifications, augmentations, or follow-on activities should be obtained from the M&S Sponsor or Accreditation Authority.

For legacy M&S, functional verification may be combined with systems verification to demonstrate that the M&S has not be altered by some undocumented change.

5.3.3. System Design Verification

The V&V Agent leads the system verification steps for which the M&S Proponent is responsible. These steps are described in Chapter 4, *System Verification*. The tasks associated with system verification are designed to establish how well the M&S system represents the specified requirements. This includes verifying that deterministic and stochastic algorithms perform as expected, that functional element interfaces perform as expected, that M&S outputs are consistent with specified initial inputs, and that unanticipated, or out-of-specification, inputs are adequately dealt with by the system.

The V&V Agent should review all existing documentation of unit tests, systems tests, and system integration tests performed on the M&S. If the existing tests omit functional areas critical to the M&S user, the V&V Agent may need to request additional tests be developed and implemented. The M&S Proponent would need to step in to see that such tests are developed and implemented.

For new M&S, the V&V Agent can coordinate with the configuration manager for status on M&S problem reports, maintenance requests, and engineering change orders.

The V&V Agent should be aware of all software coding standards and hardware certification standards applicable to the M&S. An assessment of how well the M&S adheres to these standards should be included in the systems verification report. Table 6 [Balci, Nance, Arthur 2000] below lists some of the available standards.

Table 2. **Standards and Guidelines related to Software Evaluation.**

ISO/IEC Guide 25	General Requirements for the Technical Competence of Testing Laboratories
ISO/IEC Guide 28	General Rules for a Model Third-Party Certification System for Products
ISO/IEC Guide 40	General Requirements for the Acceptance of Certification Bodies
ISO 9000	Quality Management and Quality Assurance Standards
IEEE 1298	Software Quality Management System
ISO 9001	Quality Systems – Model for Quality Assurance in Design/Development, Production, Installation, and Servicing
IEEE 1061	Standard for a Software Quality Metrics Methodology
ISO/IEC 9126	Software Product Evaluation
ISO/IEC DIS 12119	Quality Requirements and Testing
ANSI/IEEE 730	Software Quality Assurance Plans
AQAP-1	NATO Requirements for an Industrial Quality Control System

The V&V Agent must keep in mind he/she is reviewing the M&S from the user's perspective. This is particularly important when looking at features that affect user operation. Are error messages descriptive enough so that a user will understand the error and be capable of correcting it? Is the user interface sufficiently automated and is it clear what inputs must be provided? Are the M&S outputs clearly defined and labeled? How difficult is it to repeat a run? How difficult is it to reconfigure for a new run? The V&V Agent should not only focus on the correctness of the software, but also on the reliability and predictability of its use.

The following sections describe some of the verification methodologies used during the system verification phase.

5.3.3.1. Interface Testing

Interface testing (also known as integration testing) tests the data, model, and user interfaces.

Data interface testing assesses the accuracy of data entered into the model or derived from the model during execution. All data interfaces are examined to substantiate that all aspects of data input and output are correct.

Model interface testing detects model representation errors created as a result of sub-model-to-sub-model or federate-to-federate interface errors or invalid assumptions about the interfaces. It is essential that each sub-model within a model or model (federate) within a federation is tested individually and found to be sufficiently accurate before model interface testing begins.

Data Interface testing is particularly important for those M&S in which the inputs are read from a database or the results are stored in a database for later analysis. The model's interface to the database is examined to ensure correct importing and exporting of data (Miller et al., 1995).

Model Interface testing deals with how sub-models (or federates) integrate with each other and is particularly useful for object-oriented and distributed simulations. Under the object-oriented paradigm, objects (a) are created with public and private interfaces, (b) interface with other objects through message passing, (c) are reused with their interfaces, and (d) inherit the interfaces and services of other objects.

Model interface testing assesses the accuracy of four types of interfaces, as identified by Sommerville (1996):

- Parameter interfaces that pass data or function references from one object to another
- Shared memory interfaces that enable objects to share a block of memory in which data are placed by one object and from which they are retrieved by other objects

- Procedural interfaces that implement the concept of encapsulation under the object-oriented paradigm—an object provides a set of services (procedures) that can be used by other objects and hides (encapsulates) the way a service is provided from the outside world
- Message-passing interfaces that enable an object to request the service of another object through message passing

This method is best suited for new M&S development when interface details are readily available. This is a costly and tedious method than ensures the interfaces within and between model components and databases are correctly implemented. It does not provide confidence on the model algorithms or outputs.

Interface misuse occurs when an object calls another and incorrectly uses its interface. For objects with parameter interfaces, a parameter may be of the wrong type or may be passed in the wrong order, or the wrong number of parameters may be passed. Interface misunderstanding occurs when object A calls object B without satisfying the underlying assumptions of object B's interface. For example, object A calls a binary search routine by passing an unordered list to be searched, when in fact the binary algorithm assumes that the list is already sorted. Timing errors occur in real-time, parallel, and distributed simulations that use a shared memory or a message-passing interface.

5.3.3.2. Sensitivity Analysis

This verification technique consists of changing a model's input and initial condition parameters to determine the effect upon the M&S and its output. Sometime referred to as "*what if*" analysis, because testing involves evaluating *what* happens *if* changes are made to various parameter. The changes can be to the initial conditions or other input affecting M&S execution. The goal is to establish a basic knowledge of M&S behavior under variation of M&S parameters and to determine the relative importance of these parameters.

Sensitivity analysis provides testing without needing extensive details of the M&S algorithms. Only input parameters or initial conditions are modified. Each input parameter can be tested over its valid range. Of particular interest are boundary conditions (minimum and maximum, or best case, likely case, and worst case for example). M&S performance is judged based on results. For example, does the M&S execute without error; does the M&S have more sensitivity to certain input parameters than other parameters?

This technique can easily be implemented using an executable version of the M&S and access to the input parameters or initial conditions. The result of each run is analyzed to determine the effect of input parameter or initial condition variable. Sensitivity analysis identifies input variables and parameters most affecting M&S behavior.

Depending on the number of input parameters and initial condition parameters this method could get computationally very large. For N parameters this method requires at least N+1 runs or more. Sometimes a Monte Carlo simulation would be required to get sufficient data to characterize the sensitivity of output to changes to the input or initial

conditions. Looking for interactions between several key parameters gets complex and requires sophisticated statistical analysis to determine the effect of the parameter set.

5.3.3.3. Documenting and Reviewing Findings

All discrepancies between the M&S system design and the user requirements uncovered during the system verification phase are documented as part of the V&V Report (Appendix E). Each discrepancy should include an assessment of the impact to the M&S User and a recommendation as to how to eliminate or mitigate the impact.

The V&V Agent may recommend modifying the system implementation, modifying the functional design, modifying the conceptual model, modifying the M&S User requirements, performing additional results validation or testing activities, or augmenting the M&S application with other program resources.

For new M&S, system verification traces the system design back to the functional design, and establishes the accuracy of the translation from one phase of development to the next.

As with the earlier V&V phases, the findings should be reviewed with the M&S User, M&S Developer, and M&S Accreditation Authority or Agent. The M&S Accreditation Authority must provide authorization for implementing any recommended modifications, augmentations, or follow-on activities as a result of the findings. All corrective action should take place prior to proceeding on to the results validation phase.

For legacy M&S, system verification may be combined with functional verification to demonstrate that the M&S has not be altered by some undocumented change.

5.3.4. Results Validation Implementation

The V&V Agent leads the results validation tasks for the M&S Proponent. Chapter 4 describes these tasks in the section entitled, *Results Validation*. Results Validation involves comparison of M&S performance with analogous real-world data and accreditation acceptability criteria.

There are many methods of data comparison. Selection of a method is a function of the type of data being compared. The sections that follow describe some of the more common validation methodologies.

5.3.4.1. Face Validation

A primary objective during initial validation is to determine if the model seems reasonable to people who are knowledgeable about the system under study. This is called Face Validation. Face Validation is based on the look and feel of the M&S results. Face Validation's informality allows for a quick initial assessment of an M&S.

Face validation is particularly well suited for the conceptual model validation phase where model theories, requirements, assumptions, and design are well-documented and easy to review. M&S results can also be informally reviewed using face validation. As

long as the results are pretty much as expected, they are considered valid on their face, but when they contradict results reported elsewhere, their validity is considered suspect.

For example, signal to noise ratio decreases with distance from the transmitting source. Any M&S results not following this simple relationship can be considered suspect.

This technique is a qualitative rather than a quantitative method. It identifies gross problems and validates only general trends and predictions.

5.3.4.2. Model Comparison

Model comparison (also known as back-to-back testing) may be used when more than one version of a model or simulation representing the same system is available for testing. For example, different simulations may have been developed by the different Services to simulate the same military combat aircraft. All simulations built to represent exactly the same system are run with the equivalent input data and the model outputs are compared. Differences in the outputs reveal problems with model accuracy. Various results are compared to results of other models.

This method provides a quick validation of an M&S when other M&S exist that provide a similar function. If such an M&S exists then executing with equivalent input parameters should yield the same results. Several statistical methods exist to establish that output from the multiple M&S are from the same distribution.

A drawback to this method is that comparison of multiple M&S would not detect common errors. If two models both were written with a unnoticed error in the code, the results might agree but would still be invalid. Another difficulty arises in matching M&S input. It is unlikely that similar M&S would have exactly the same input parameters. Proper implementation of this validation method requires the development of equivalent sets of input parameters that would provide the same processing conditions for both models.

5.3.4.3. Graphic Display Comparison

When applying the graphic display comparison validation methodology, the M&S's operational behavior is displayed graphically and compared to the same graph of the real world entity.

Graphical comparison is subjective, heuristic, and practical approach to validation. Graphs of M&S parameters are compared to analogous real system behavior. Characteristics such as periodicity, skew, number and location of inflection points, logarithmic rises, linearity, phase shifts, trend lines and slopes can be quickly observed and compared in graphical displays.

For example, if an M&S produces missile trajectories, the trajectory can be plotted versus time and be compared to the actual flight profile of the missile. The graphs of the two profiles can be superimposed on the same graph. Significant variation in the trajectories of the two plots could lead to detecting problems with the model.

5.3.4.4. Turing Test Validation

The Turing test is based upon SME knowledge about the M&S of interest. The SMEs are presented with two sets of output data, one produced by the M&S and one from the real-world entity, under the same input conditions. Without identifying the data sets, the SMEs are asked to differentiate between the two. If they succeed, they are asked to describe the differences. If they cannot differentiate between the two, confidence in the model's validity is increased (Schruben, 1980; Turing, 1963; Van Horn, 1971).

This test is suited for legacy models having limited documentation. Since the output is tested underlying design, assumption and theories can be ignored. This test is also well suited for evaluating human or organizational behavior M&S representations.

5.3.4.5. Statistical Methods Used In Comparing Data

Most statistical problems involve calculating whether M&S results match real-world system performance. This allows treating M&S output as observed results and system performance specifications as expected values. Tests that determine whether a data set matches another set fall into a general category called goodness-of-fit. These tests are generally non-parametric tests, meaning they do not assume (or require) a normal distribution. Two standard goodness-of-fit tests are the Chi-Square and Kolmogorov-Smirnov. The basic hypothesis tested in these methods is that the two result sets are from the same distribution. Using the criteria set forth by these tests, we can disprove this hypothesis.

Other statistical methods look at the relationship between a cause and an effect. In a real world system this would be the how adjustments to a system input affects a system output. For instance, how does radar input power affect electric field intensity? There are two statistical methods for determining the cause and affect relationship between two variables, and they are called regression and correlation.

As with all statistical analysis, test selection is based on many factors including experimental design, type of data, data distributions, and many other subtle circumstances. Experts knowledgeable in statistical analysis should approve both the experimental design and the selected statistic before being used to validate models.

There are many fine references on the application of statistical methods to validating data. Some general texts on the subject have been included in the References section of this handbook.

5.3.4.6. Documenting and Reviewing Findings

The results validation phase activities and outcomes should be documented as part of the validation report and should be reviewed by the VV&A Team in accordance with the established team structure. Appendix E provides a template for producing the validation report.

5.4. Supporting the M&S Accreditation Process

The V&V Agent will assist the M&S Proponent in assembling all documented evidence to support the Accreditation Authority in making the decision on the suitability of the M&S for the intended use. An Accreditation Package containing the following will be provided to the Accreditation Authority:

- V&V Plans
- Verification Reports
- Validation Reports
- M&S Development Documents (e.g., Software Design Document, User's Guide, and Programmer's Manual)
- M&S CM Plan
- Data Documents
- Accreditation Reports

The level of effort in assembling this Accreditation Package and the size of the package should be commensurate with the purpose for which the accreditation is being sought. In other words, the documentation provided should constitute sufficient supporting evidence of the suitability of the M&S to the user's requirements.

The Accreditation Package must be maintained throughout the lifecycle of the M&S. The package must be updated whenever changes and enhancements are made to the M&S. When a new version is finalized, the package must include a description of all changes and collected evidence to support re-Accreditation.

Appendix F provides a template for assembling an Accreditation Package.

6. VV&A Issues

6.1. Overview

This chapter presents M&S VV&A issues that are relevant to all individuals involved with the VV&A process. These topics include Simulation Based Acquisition (SBA), Test and Evaluation (T&E), managing VV&A costs, as well as several factors affecting VV&A implementation.

It is highly recommended that all individuals responsible for planning or performing VV&A review this chapter.

6.2. M&S VV&A Issues

6.2.1. Management Issues

6.2.1.1. SBA and Simulation Test and Evaluation Process (STEP)

SBA and Simulation, Test, and Evaluation Process (STEP) are two processes designed to improve Defense weapons acquisition by employing credible M&S to support Milestone and operational decisions. The effectiveness of these processes in reducing overall acquisition costs while increasing weapons systems performance is dependant upon the ability to credibly simulate the weapon system throughout all the weapon's lifecycle phases, beginning with conceptual design and continuing through operational deployment.

The M&S that support SBA and STEP will need to support multiple uses throughout the lifecycle of the weapons system and will undergo successive modifications to remain current with the weapon system's current state. As greater numbers of weapon systems are built, developmental and operational data from earlier versions will be fed back into the M&S, increasing the M&S ability to credibly predict and replicate the weapon system and the system's environment. Detailed information on SBA and STEP can be found at <http://www.acq-ref.navy.mil/sba>.

SBA/STEP M&S VV&A planning must account for full lifecycle uses of the M&S. VV&A must be part of a comprehensive CM plan that maintains M&S VV&A use and version control. VV&A planners must consider how to affect the weapon system design so as to be able to capture needed data from operational systems. These data will be used to further validate the M&S allowing greater reliance of the program on M&S when developing future versions of the weapon system. VV&A planners must coordinate their activities with both developmental and operational testers and provide necessary inputs to the weapon system Test and Evaluation Master Plan (TEMP).

For more information regarding the interplay between the TEMP and VV&A refer to the *VV&A and Test and Evaluation (T&E)* section of this handbook. For information

regarding M&S used for Operational Test and Evaluation (OT&E) go to <http://www.cotf.navy.mil>. Requirements to document the VV&A of M&S planned for use during test and evaluation originate from two sources, DoD 5000.2R, Change 4 and the Simulation, Test and Evaluation Process (STEP) Guidelines, Part 3.6.

A significant subset of OT&E is Live Fire Test and Evaluation (LFT&E). For information on LFT&E-related issues, see <http://www.dote.osd.mil/lfte/MODEL.HTM>.

6.2.1.2. M&S Configuration Management

M&S CM is an umbrella activity that is applied throughout the M&S life cycle. Because change can occur at any time, CM activities are developed to:

- Identify components, interfaces and documentation within each release or version
- Provide a mechanism for suggesting, adjudicating and prioritizing change requests
- Ensure that change is being properly implemented
- Report status to others that may have an interest

An M&S under solid CM will greatly reduce the effort needed to produce V&V reports, as much of the needed M&S development history can be obtained from the Configuration Manager.

During the course of the V&V process, discrepancies between the performance expected by the user and the actual performance of the M&S may be uncovered. It is the responsibility of the M&S Proponent to provide feedback to the M&S developer in the form of change requests to the M&S Change Review Board (CRB) as specified by the CM Plan. Because budgets and schedules are limited, an efficient system for categorizing these change requests must be employed. What follows are suggested change request priority criteria.

Priority 1: Unresolved problem prevents the accomplishment of an essential capability. The result would be to jeopardize safety, security, or other requirements designated "critical." An example would be a flight training simulation that negatively trained the pilot to set conditions for level flight which, if performed in the aircraft, would result in unsafe flight conditions.

Priority 2: Unresolved problem adversely affects the accomplishment of operational or mission essential capability and no work-around solution is known. Adversely affect technical, cost, or schedule risks to the project or to life cycle support of the system, and no work-around solution is known. An example of this type of problem would be a tracking radar simulation that only has a range of 5000 meters and it needs to have a range of 10000 meters.

Priority 3: Unresolved problems adversely affect the accomplishment of an operational or mission essential capability, but a work-around solution is known.

Priority 4: Unresolved problems result in user/operator inconvenience or annoyance but do not affect a required operational or mission essential capability. Problems of this type result in inconvenience or annoyance for development or support personnel, but they do not prevent the accomplishment of those responsibilities.

Priority 5: Any other effect.

6.2.1.3. Managing VV&A Costs

We all realize the importance of cost avoidance. The following paragraphs present methods for managing the cost of performing VV&A. Methods include integrating VV&A tasks with M&S development tasks, setting specific and achievable VV&A goals, performing risk assessments and risk mitigation plans, and developing an efficient VV&A team.

Integration Within M&S Development

With the multitude of existing, legacy M&S, most M&S users will not find it necessary to develop an entirely new M&S tool. However, if a new M&S capability is being developed, or if an existing M&S is undergoing major modification or enhancement, the cost of V&V can be significantly reduced through careful M&S development planning. Most, if not all, V&V activities can be embedded within the development program. If properly planned, the collection of results and preparing V&V reports should be the only additional V&V costs to the program. While this does not affect the costs associated with Accreditation, it nevertheless will result in significant overall savings.

When planning the M&S development, be sure to include a formal configuration management process that results in M&S documentation throughout all developmental phases. This includes documenting the conceptual model, the associated decision processes and rationale for selecting the design approach, documentation of all developmental and implementation tests, and test results.

Make sure requirements are defined prior to the M&S development and that development tests are designed to demonstrate compliance with those requirements.

Finally, make sure sufficient CM procedures are practiced so that traceability of the M&S design to the user's requirements is maintained and documented throughout the entire lifecycle of the M&S.

Tailoring the V&V Plan

A successful V&V plan is one that tailors the V&V tasks and schedule to prioritize inspection of the most important and highest-risk areas of the M&S. A tailored V&V plan will ensure that, given inevitable cost and schedule constraints, the V&V efforts will address the most important questions pertaining to the suitability of the M&S for a specific use. Identification of those most important questions is the process of V&V planning. The V&V report, then, will address the results of the V&V tasks. Ultimately, the Accreditation Assessment Report will summarize the findings within the V&V report and make a recommendation for, or against, Accreditation.

What is required to tailor the V&V plan? First and foremost, a clear understanding of the intended use must be established. The Accreditation Authority is responsible for identifying the user's requirements and any specific acceptability criteria. This identification process can be, and is usually, iterative.

Once the intended use is understood, the Model Proponent and the V&V Agent can work together to identify which of the user's M&S requirements are known to be supported by the M&S. Previous V&V documentation may exist, demonstrating the M&S supports some of the user's requirements. There will be a certain set of user requirements that were not previously demonstrated. Of those, which are the most important to the use of the M&S? Which are known to be problematic? Which are supported by M&S components that are highly sensitive to changes in input? Answering questions such as these will result in a prioritized list of model components or functionality that need further inspection.

Next, consider each of the items in the prioritized list. Which of them call for verification to assure that the functionality was correctly implemented in design, code and test items? Which of them call for validation of algorithms used in representation of real-world phenomena or interactions?

Once the need for verification or validation tasks is applied to each of the prioritized risk areas within the M&S, a determination can be made regarding the availability of necessary resources to conduct those tasks. Verification may be assigned to the developer who is most familiar with the design or code segments that require inspection. The V&V Agent may plan to be present during those inspections. A record of the inspection and the results are captured and later documented in the V&V Report. Validation of algorithms or data for adequate representation of the real world is normally a harder problem. The V&V Agent will work with the Model Proponent to identify how best to treat each validation question. Validation planning will involve both validations of algorithms, data and M&S output results.

In a new development of an M&S it is extremely important to conduct validation of the algorithms and data that most affect the user's M&S-based decision-making. The cost avoidance can be tremendous when mistakes are caught before the design is transformed into code. Mistakes in the algorithms might not otherwise be caught, and would end up adversely affecting the user's decision-making. In some cases, the algorithms within the M&S may have been taken from established and trusted sources.

Data validation comes from examining both the source of the data and its intended use. Empirical data sets may be identified for examination and comparison against the data used in the M&S. SMEs may be identified and tasked to review areas that cannot be readily validated.

Generalizing the above discussion, when tailoring a V&V Plan:

- Clearly understand and document the user's M&S requirements and acceptability criteria.
- Review existing M&S documentation to determine what user requirements are already demonstrated and what requirements need further investigation.

- Identify what specific V&V tasks are needed to demonstrate that the M&S supports the user's requirements.
- Assign appropriate personnel to perform each of the specific tasks.
- Finally, prioritize your goals so that they may be executed efficiently. If funding is limited, you can focus your efforts around only the most critical issues. When limited funds, time, or resources do not allow you to complete all desired tasks, clearly document what was and was not accomplished and provide a continuation plan for the remaining activities, specifying what resources must be made available to achieve them.

V&V Reuse

Whenever possible, the user should try to make use of work that has already been done. Obtain the Accreditation history for the M&S. Many of the current M&S user's requirements may already have been proven and documented. The M&S Proponent should be able to assist in identifying this information. M&S points of contact can be identified within the M&S Catalog on the NAVMSMO website, <http://navmsmo.hq.navy.mil>.

6.2.1.4. VV&A and Test and Evaluation (T&E)

If the M&S is part of a DON acquisition program and will be used to augment test planning, conduct, or analyses, the role of the M&S must be described within the program's Test and Evaluation Master Plan (TEMP). Every effort should be made to coordinate M&S VV&A activities with the TEMP.

M&S used in support of Developmental Test and Evaluation (DT&E), must be accredited by a senior official within the user's chain of command. The Accreditation Authority determines how much V&V it will take to be comfortable that s/he is using the right M&S and is using it right. S/he might determine that existing V&V is enough to show credibility for the user's needs. In other words, the responsibility lies with a senior official in the user's organization, designated by that organization, to determine what level of V&V is necessary.

COMOPTEVFOR and MCOTEAs are the Accreditation Authorities for all M&S used in support of any phase of Operational Test and Evaluation (OT&E) in the Navy and the Marine Corps, respectively. Early operational tester involvement in VV&A planning will help ensure your M&S satisfies the acceptability criteria and gains the tester's confidence that it will provide credible answers.

For combined Developmental Test (DT) and Operational Test (OT) activities, COMOPTEVFOR and MCOTEAs retain the responsibility to accredit all M&S used in support of the test event. The number of test events can be minimized if both DT and OT data collection requirements are carefully coordinated.

While COMOPTEVFOR and MCOTEAs are the accreditation authorities for M&S used to support OT&E decisions, neither COMOPTEVFOR nor MCOTEAs perform the V&V. Programs with systems under test should include COMOPTEVFOR and MCOTEAs early,

should plan V&V tasks to meet the projected requirements, and should be prepared to describe how their selected M&S will be used in the test. Furthermore, program managers need to set aside resources and schedule to adequately perform the necessary V&V activities when targeting an accreditation for OT&E. When COMOPTEVFOR or MCOTEA are the accreditors, their roles are limited to identification of test requirements and acceptability criteria; funding for the accreditation is the responsibility of the M&S Application Sponsor.

Table 7 indicates which M&S fall under the COMOPTEVFOR/MCOTEA umbrella. If case 3, 4, or 5 applies to the M&S, the VV&A plans should be coordinated with the TEMP.

Table 3. RELATIONSHIP OF VV&A PLANS TO TEMP

CASE	M&S
1 NO ACQUISITION	<ul style="list-style-type: none"> - M&S USED FOR PURPOSE OTHER THAN ACQUISITION - VV&A PLANS, NO TEMP
2 PRECEDES DEVELOPMENT	<ul style="list-style-type: none"> - M&S USED FOR CONCEPT DEFINITION OF OPERATIONAL SYSTEM - VV&A PLANS, NO OVERLAP WITH TEMP
3 SUPPORTS DEVELOPMENT	<ul style="list-style-type: none"> - M&S SUPPORTS CONCEPT DEFINITION - M&S UPDATED DURING DEVELOPMENT AND TEST - VV&A PLANS WILL INFLUENCE TEMP
4 PART OF DEVELOPMENT	<ul style="list-style-type: none"> - M&S EMBEDDED IN OPERATIONAL SYSTEM - VV&A PLANS AND TEMP DIRECTLY SUPPORT EACH OTHER
5 IS THE DEVELOPMENT	<ul style="list-style-type: none"> - M&S IS THE SYSTEM - VV&A PLANS AND TEMP CONGRUENT

While there may be overlap between T&E and VV&A, caution is recommended when attempting to apply T&E results to VV&A. M&S Accreditation must be based on an evaluation of the M&S against the user's acceptability criteria.

To assist in the coordination of the M&S and T&E planning, refer to figure 4 below. It illustrates the parallel development between the two plans.

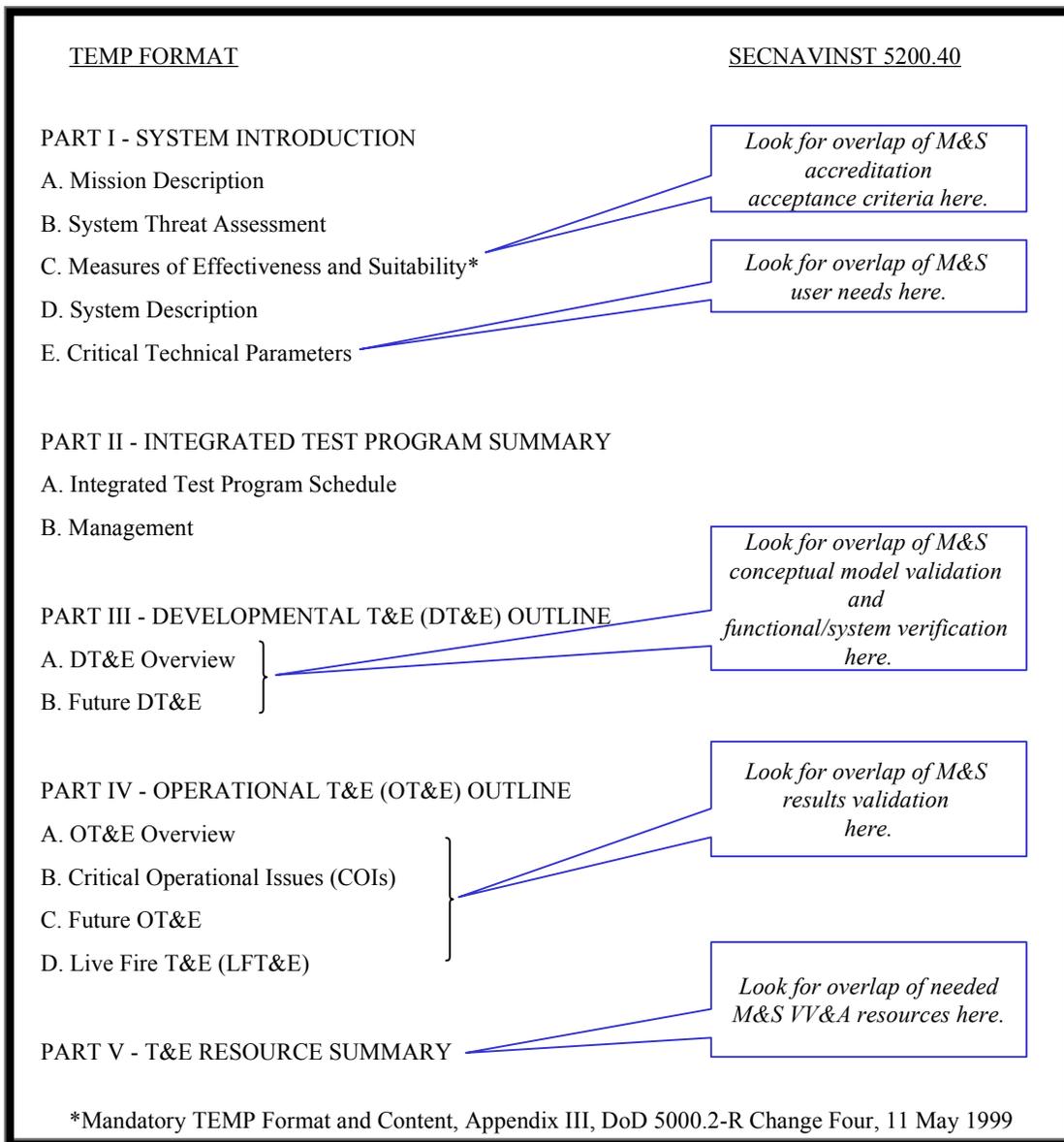


Figure 6. Parallel Development of TEMP and VV&A Plans

The TEMP identifies key test resources, including M&S, necessary to accomplish demonstration and validation testing, early operational assessment, DT&E, OT&E and Live Fire Test and Evaluation (LFT&E). As system acquisition progresses, the preliminary test resource requirements are reassessed and refined. Subsequent TEMP updates reflect changed system concepts, resource requirements, or updated threat assessment. Any resource shortfalls that introduce significant test limitations are discussed in the TEMP with the planned corrective action outlined.

The TEMP addresses the VV&A of models and simulations as follows:

PART III. DEVELOPMENTAL TEST AND EVALUATION OUTLINE. Lists all M&S to be used in DT&E, explains the rationale for their credible use and provides their source of VV&A.

PART IV. OPERATIONAL TEST AND EVALUATION OUTLINE. Identifies the M&S planned for use during OT&E and LFT&E; explains how the M&S are proposed to be used; and provides the source and methodology of the VV&A underlying their credible application for the proposed use.

PART V. TEST AND EVALUATION RESOURCE SUMMARY. Provides a summary in a table or matrix format of T&E M&S resources (target, simulator, model, simulation or virtual simulation) that will be used during the course of the acquisition program. Also identifies resources required to validate and accredit their credible usage or application.

If you have further questions regarding supporting or using an acquisition program's TEMP as part of your VV&A activities, contact vva@navmsmo.hq.navy.mil.

6.2.2. Implementation Issues

6.2.2.1. Subject Matter Experts

Why Use Them?

There are several good reasons for employing SMEs as part of your accreditation process. First of all, military art and science cannot be summarized in the totality of all the military's official, written doctrine. So much of what the military does is learned on the job, in an operational context. SMEs will have that operational experience. Secondly, there may be various M&S parameters or scenarios that due to cost, complexity, or safety, will have little or no quantitative data with which to evaluate the M&S. SMEs must be relied upon for defining what is likely and reasonable real world behavior in these cases. Thirdly, the extensive knowledge of their subject area allows SMEs to sort quickly the chaff from the wheat and focus attention on the critical aspects of the M&S with regard to the user's problem.

When to Use Them

There are two main areas where SMEs provide the greatest return: defining the accreditation acceptability criteria and supporting validation activities.

Development of the user requirements and any acceptability criteria is central to successful M&S Accreditation. SMEs will help you work with the user (through the Accreditation Agent, most likely) to work out meaningful acceptability criteria. SMEs can also support your Accreditation risk assessment by identifying, quantifying, and prioritizing areas of potential risk.

During conceptual model validation, military SMEs can evaluate and assess the completeness, consistency, assumptions, and limitations of the conceptual model as it describes the model effects, interactions, and data use.

SMEs are directly involved in every aspect of the validation of M&S results. SMEs can be used to design and evaluate test scenarios, perform comparison of M&S results with real world events, and assess the overall accuracy and applicability of the results with respect to the M&S user's requirements.

SMEs can have Fleet operational experience and/or experience in modeling.

SME Guidance

SMEs may be active duty, reservists, civilian government, or contractor personnel. They may be on staff in the organization of the M&S Proponent or the Accreditation Authority or Agent.

SMEs are human resources and, as such, are going to be highly individual. Within the same field, two SMEs may reach different conclusions when reviewing the same event. Where possible, peer review by other SMEs is always desirable. Some programs have successfully used GroupWare and web-posted materials for SME review. For example, key algorithms and data that support a particular user requirement may be posted to a web page for review by designated SMEs having the right experience, skills or knowledge.

SMEs are understandably expensive talent, so it is important to identify, during the V&V planning stage, which SME resources will be needed and when. Then an attempt can be made to obtain and schedule these resources.

Active duty SMEs are desirable resources but are in demand for many other military tasks. It is often possible to get help from qualified persons on staff or within a local Reserve unit. Planning well in advance is advised, but you may be lucky enough to have a Reserve unit who would be willing to work with you regularly. Many units have a wide range of expertise and experience.

It is also wise to consider possible rotation of personnel to different assignments or the unavailability of the same SME. Try to maintain consistency of SME guidance to software engineers under these circumstances.

If you feel it is necessary, appoint an individual to perform some of the following tasks:

- Resolve conflicts in tactically sound, but different, approaches to military operational questions and situations.
- Maintain consistent guidance to developers.
- Resolve language/glossary problems between military and engineering domains.
- Keep SME focus within the scope of the Accreditation goals.

6.2.2.2. Hardware-in-the-Loop

Do not forget to include all critical hardware M&S components in the V&V plan. M&S hardware must undergo the same V&V process steps as M&S software. There are two basic categories of hardware, operational hardware and non-operational hardware.

Operational hardware, as its name implies, is hardware taken from a real system. For example a radar sensor or a missile guidance and control unit are two types of operational hardware that might be included within an M&S.

In contrast, non-operational hardware includes physical mockups of real system components, cables, or other hardware used within an M&S. A flight simulation that includes mockups of the cockpit display units is an example of non-operational hardware.

Important aspects of M&S hardware that should be evaluated for impact to the M&S user include: hardware calibration, proper installation of cables connecting hardware to other M&S components, hardware limitations and design assumptions, and the repeatability of M&S hardware performance.

As an illustrative example, assume you're the M&S engineer working on a flight dynamics simulation of a helicopter. The simulation user requires that the simulation software interface with a replica of the helicopter flight control stick so that real-time flight control inputs are fed into the flight dynamics simulation. The Accreditation Authority has provided you with the following acceptability criteria for the flight control stick:

- Grip must be indistinguishable in feel to the Seahawk flight control stick to 3 out of 5 surveyed pilots.
- The grip slew rate must be within 0.25 cm/sec of the helicopter's flight control stick.
- The flight control stick input update rate must be at least every 1/100th of a second.
- The flight control stick must provide lateral, longitudinal, and collective control inputs in millimeters of blade displacement per second.

The M&S V&V plan should include conceptual model validation, functional verification, system verification, and results validation activities that demonstrate the ability of your flight control stick hardware to meet all the acceptability criteria. The tasks would involve qualitative assessments by pilots, and quantitative assessments of the slewing rate, input update rates, input parameters, parameter units, and so on.

When operational hardware is part of an M&S, it is generally assumed that V&V activities will be limited to establishing that the hardware has been appropriately interfaced and calibrated with the other M&S components. Internal V&V of the operational hardware component is not generally performed.

6.2.2.3. Human-in-the-Loop

Human behavior data is difficult to obtain. When M&S includes human interaction, the essential interface elements between the system and the human must be very clearly specified.

When verifying or validating the effects of human-in-the-loop to your M&S, some areas to examine are: procedures and doctrine, collective versus individual behavior, aggregation of behaviors, physical and emotional states, subject reaction time, repeatability of M&S outcomes, and isolation of specific behavioral factors.

The Turing Test discussed in section 5.4.3.4 is frequently used as a validation methodology for human behavior M&S components.

6.2.2.4. Federations and Distributed Systems

For Federated M&S and Distributed Interactive Simulations (DIS), the V&V process can be modified to support these highly complex M&S systems.

An M&S Federation is defined to be a named set of interacting federates, a common federation object model (FOM), and a supporting runtime infrastructure (RTI) that are used as a whole to achieve some specific objective. A federate can be considered to be a stand-alone M&S system. So a Federation would be a set of M&S that have been connected through the RTI and of which each adhere to the FOM.

A DIS is defined to be a set of disparate models and simulations operating in a common synthetic environment in accordance with DIS standards. Two or more M&S are considered to be DIS-compatible if their data support the realization of a common operational environment which is coherent in time and space across all systems.

As can be seen from their definitions, both Federations and DIS are sets of M&S that are interfaced together. The main difference between them comes in the structure of the interface(s) between the individual M&S systems. Figure 5 illustrates this difference.

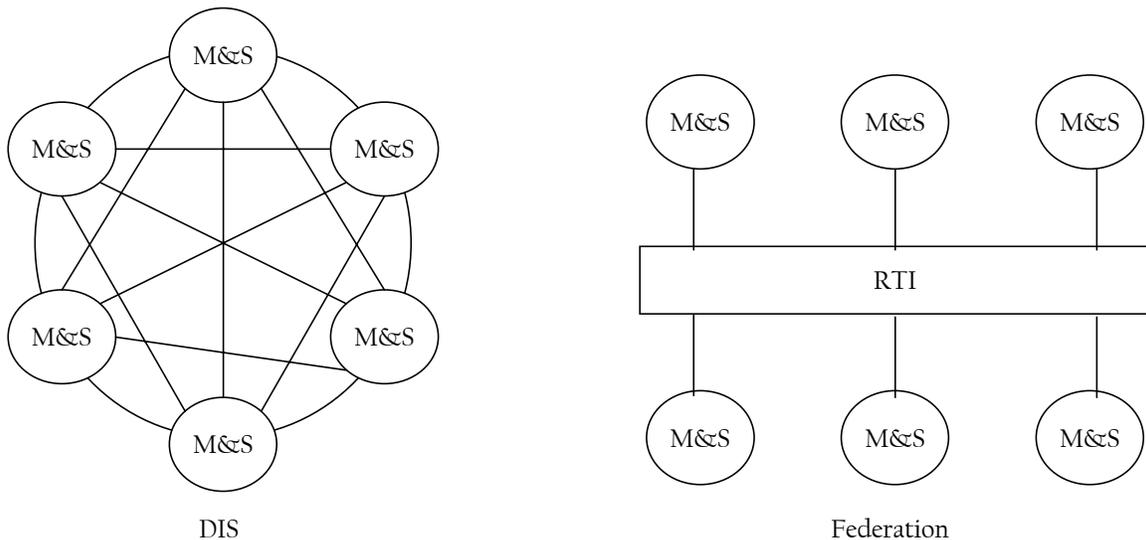


Figure 7. Differences Between Federation and DIS

When applying the DON VV&A process to a Federation or DIS, each of the individual M&S systems should undergo a stand-alone V&V process to ensure the internal integrity

of each. Next the entire Federation or DIS should undergo an overarching V&V process to ensure the system as a whole is performing as expected.

Some areas of concern for the overarching V&V process of a Federation or DIS include: interface latency, data transmission error rates, interface data verification, packet rates, bandwidth utilization, interface link availability, and time synchronization.

Another critical element to consider is the scientific assumptions and limitations made in each of the individual M&S systems. Each M&S will have a bounded region over which its outputs are valid. In a Federation or DIS, the outputs of one M&S may be used as the inputs of another. It is important to establish a mapping between the domains and ranges of each of the individual M&S to ensure each M&S receives, and produces, valid data during their combined operation.

As with stand-alone M&S, configuration management is key to successful V&V of Federations and DIS. Figure 6 provides a flow diagram of a Federation or DIS generic V&V process.

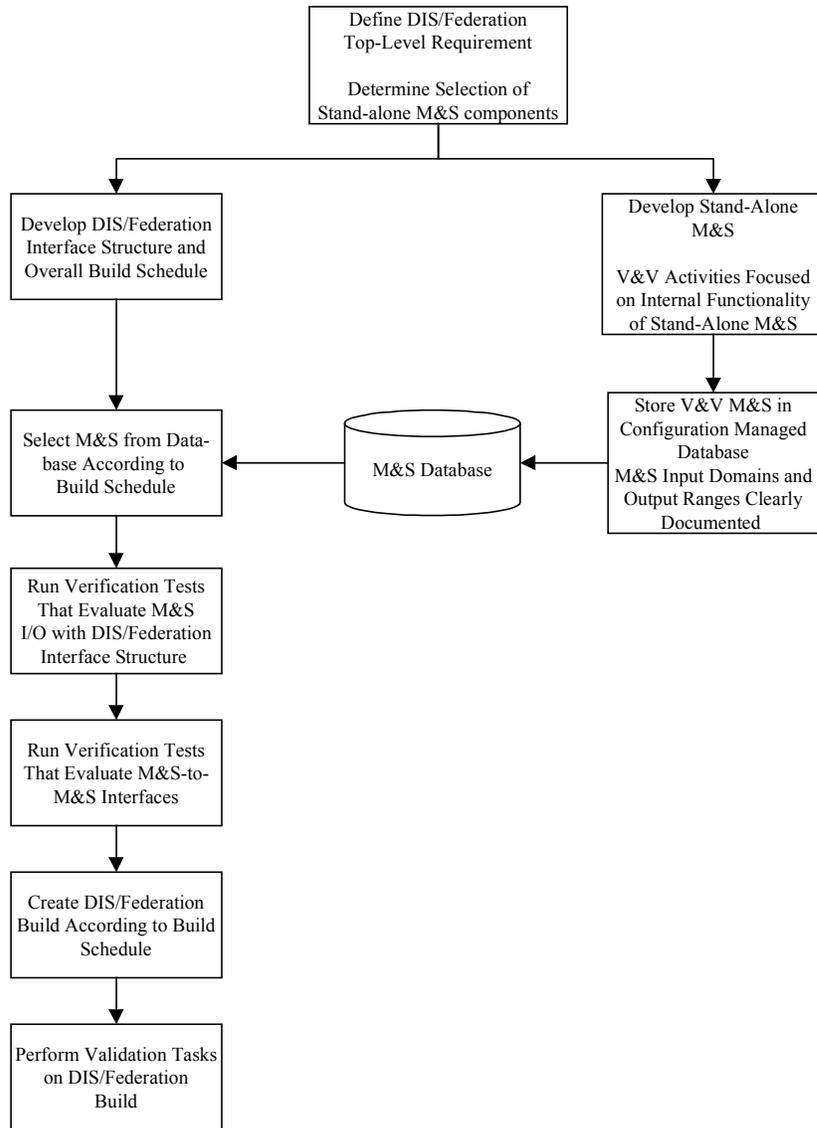


Figure 8. **Generic V&V Process for Federations and DIS.**

Figure 6 illustrates that V&V activities need to be performed along two separate paths. The first path deals with the stand-alone M&S. The internal workings of each stand-alone M&S must undergo V&V prior to its incorporation into the federated or distributed system of M&S. Secondly, a V&V process must be applied to the Federation or DIS as a whole.

6.2.2.5. **Classified or Proprietary M&S**

There may be times when the M&S may be classified or company proprietary. Both of these situations may restrict the V&V activities. Use of these M&S may require acceptance of greater uncertainty on the part of the user. Once the restrictions are fully understood, the V&V Agent should co-ordinate with the Accreditation Authority in developing acceptable work-arounds to establishing M&S credibility. These situations

generally place greater reliance upon the developer to establish the credibility of their M&S.

To be clear, this does not mean that classified or proprietary M&S are either exempt from performing VV&A or are held to a separate VV&A standard. They are not. They must provide sufficient evidence as to the ability of the M&S to meet the user's needs.

Glossary

ACCREDITATION

Accreditation is an official determination by the Accreditation Authority that an M&S is acceptable for its intended purpose(s).

ACCREDITATION AGENT

The Accreditation Agent is selected by, and reports to, the Accreditation Authority. Under the direct supervision of the Accreditation Authority, the Accreditation Agent performs any M&S VV&A function or task assigned by the authority.

ACCREDITATION AUTHORITY

The Accreditation Authority is the senior management or command-level person directly responsible for approving the use of an M&S capability for a particular application or set of applications.

ANALYSIS OF ALTERNATIVES (AOA)

An analysis of alternatives is a replacement for the “Cost and Operational Effectiveness” process associated with acquisition programs and is prepared and considered at appropriate milestone decision reviews, beginning with program initiation (usually Milestone I). These analyses are intended to:

Aid and document decision-making by illuminating the risk, uncertainty, and the relative advantages and disadvantages of the alternatives being considered. Show the sensitivity of each alternative to possible changes in key assumptions (e.g., threat) or variables (e.g., selected performance capabilities). Where appropriate, discussion of interoperability and commonality of components/systems that are similar in function to other DoD

Component programs or Allied programs are included in the analysis. The analysis shall aid decision-makers in judging whether or not any of the proposed alternatives to an existing system offer sufficient military and/or economic benefit to be worth the cost.

There shall be a clear linkage between the analysis of alternatives, system requirements, and system evaluation measures of effectiveness.

Foster joint ownership and afford a better understanding of subsequent decisions by early identification and discussion of reasonable alternatives among decision-makers and staffs at all levels. The analysis is intended to be quantitatively based, producing discussion on key assumptions and variables.

DEFENSE ACQUISITION REVIEW (DAR)

The DAR is a mandatory part of Defense Acquisition Board (DAB) and Major Automated Information System Review Council (MAISRC) information and procedures. The purpose of the DAR is to assist the Program Manager (PM) in effectively managing the program.

The information gathered in the DAR leads to Milestone Decision Authority (MDA) decisions by the Defense Acquisition Executive (DAE) for DAB and by the Assistant Secretary of Defense (ASD) Command, Control, Communications & Intelligence (C3I) for MAISRC decisions. It also describes the process leading to a signed and documented

MDA decision. The DAR assists the MDA in determining the program's readiness to proceed into the next phase.

DOMAIN

The set of all possible values a given model or simulation input parameter can take on.

INDEPENDENT VERIFICATION AND/OR VALIDATION

Within the context of DoD M&S Accreditation, Independent V&V (IV&V) is the process of performing V&V by an Agent who is independent of the M&S developer. The advantage in having the M&S evaluated independently from the developer is the increased objectivity of the resulting V&V reports. The disadvantage is it is usually very expensive.

The Accreditation Authority determines what degree of independence is warranted based on the level of risk and/or visibility of the intended M&S use.

Outside the context of DoD M&S Accreditation, IV&V has a slightly different interpretation than the one presented here.

INDEPENDENT VERIFICATION AND/OR VALIDATION AGENT

Within the context of DoD M&S Accreditation, an independent verification and/or validation Agent performs the identical function as a regular verification and/or validation Agent. The difference is the independent Agent must be independent of the M&S developer. The M&S Proponent, the Accreditation Authority, or any other appropriate authority may sponsor the independent Agent.

LEGACY MODELS OR SIMULATIONS

For purposes of this Handbook, legacy M&S are defined to be M&S which were developed and implemented prior to the issuance of SECNAVINST 5200.40 (issued 19 April 1999).

M&S DATA VERIFICATION, VALIDATION, AND CERTIFICATION

The term "Data Verification, Validation, and Certification (VV&C)" is no longer used in the context of M&S data. For purposes of M&S VV&A, data associated with, or used in, a model or simulation are verified, validated, and accredited along with the other elements of the M&S.

M&S EXECUTIVE AGENT

The M&S executive Agent is the DoD-assigned management individual or group with the responsibility and authority for the development and maintenance of a specific area of M&S application, including relevant standards and databases, used by, or common to, many M&S capabilities. M&S executive Agents have been designated for Terrain, Atmospheric and Space, Intelligence, and Oceanographic Environments.

M&S PROPONENT

The M&S Proponent is a representative of an agency or organization, e.g. program manager, laboratory commander, or systems commander. The proponent has the primary responsibility for the development, V&V, and CM of a particular M&S capability, as well as its application in specific areas of interest.

PROGRAM OBJECTIVES MEMORANDUM (POM)

The POM is an annual memorandum, in prescribed format, submitted to the Secretary of Defense (SECDEF) by the DoD component heads. The POM recommends the total resource requirements and programs within the parameters of SECDEF's fiscal guidance. The POM is a major document in the planning, programming, and budgeting system (PPBS) and is the basis for the component budget estimates. The POM is the principal programming document which details how a component proposes to respond to assignments in the defense planning guidance (DPG) and satisfy its assigned functions of the future years defense program (FYDP). The POM shows programmed needs for six years hence, and includes manpower, force levels, procurement, facilities, and research and development (R&D).

RANGE

1. The set of all possible values a given model or simulation output variable can take on.
2. The maximum extent of values limiting the operation, action, or effectiveness of a model or simulation.

SOFTWARE V&V

This term is often confused, or substituted for, M&S V&V. The term "Software V&V" is often used outside the DoD accreditation process to mean commercial software testing. Within the DON, a greater emphasis is placed on validation of the M&S against real world, or operational, conditions within the context of a specific M&S use. Commercial V&V are oriented more towards tasks DoD identifies as verification. This difference between commercial and defense M&S results from the fact that commercial software is not replicating real-world behavior. For example, software for a bank's automated teller machine, or software which performs text editing, would not have any existing real-world counterpart to validate.

SUBJECT MATTER EXPERTS

SMEs are individuals who are recognized experts in a field or area of specialty relevant to the M&S. SMEs provide expert insight and understanding of M&S conceptual principles and M&S performance outputs. In addition they play a major role in designing validation tests to ensure that critical aspects of the M&S are evaluated.

VALIDATION

Validation is the process of determining the extent to which a model or simulation accurately represents the real world from the perspective of its intended use. Validation involves the comparison of the M&S behavior to data collected from real world experiments, events, or through subjective evaluation by SMEs.

For the DON, validation is applied in two areas: validation of the conceptual model and validation of the results of the M&S.

Conceptual model validation is an examination of the key assumptions, algorithms, data, and limitations of the M&S as described by the conceptual model. Its purpose is to determine whether the conceptual model supports the resolution and accuracy required by the M&S user.

Results validation answers questions on how well the M&S results compare to empirical data. In the absence of empirical data, SMEs will compare the M&S results to

expectations and, if available, to results from other similar models and/or simulations which are considered credible.

VERIFICATION

Verification is the process of determining that a model or simulation implementation accurately represents the developer's conceptual description and specifications. Verification is applied at each M&S lifecycle stage between the conceptual model development and implementation. Verification ensures that the products of each subsequent M&S development stage accurately reflect the output from the previous development stage. The DON defines two basic types of verification: functional design verification and systems verification.

- Functional design verification is a comparison of the M&S functional design with the validated conceptual model to ensure that it accurately reflects the validated concept. It addresses both the architectural system design, which includes the hardware and software architecture, and the detailed software design, which addresses key software elements such as critical algorithms and data issues.
- System verification is the formal, documented test or review process performed by the M&S Proponent. It determines that the M&S accurately represents the verified functional design and has traceability back to the conceptual model.

VERIFICATION AND/OR VALIDATION AGENT

The M&S Proponent normally designates the verification and/or validation Agent. The Accreditation Authority may deem it necessary to call for complete independence of the V&V Agent from the M&S Proponent for reasons including high visibility of the program, high risk or known limitations of the Proponent's resources. The V&V Agent plans, leads and reports status of verification and/or validation of an M&S. Verification tasks may be conducted by various individuals. M&S developers, maintainers, and/or testers may participate while the V&V Agent will monitor and ensure that results are documented for later summarization within the V&V reports. The skills and backgrounds required for verification are significantly different from those required for validation. Thus the V&V tasks may be assigned to one or several persons based on their availability and capability. Verification involves considerable knowledge of requirements engineering, CM, and testing. The Validation Agent is probably not going to be the Subject Matter Expert in areas of the model, but rather the person who plans, organizes, monitors and reports the progress of the SMEs in reviewing their respective parts of the conceptual model and the M&S results. In addition, the Validation Agent may support the design of test scenarios and data generation.

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Acronyms

AOA	Analysis of Alternatives
ASD	Assistant Secretary of Defense
C3I	Command, Control, Communications and Intelligence
CM	Configuration Management
COMOPTEVFOR	Commander, Operational Test and Evaluation Force
CRB	Change Review Board
DAB	Defense Acquisition Board
DAE	Defense Acquisition Executive
DAR	Defense Acquisition Review
DIS	Distributed Interactive Simulation
DMSO	Defense Modeling and Simulation Office
DON	Department of the Navy
DONMSMO	DON Modeling and Simulation Management Office
DPG	Defense Planning Guide
DT	Developmental Test
DT&E	Developmental Test and Evaluation
FOM	Federation Object Model
FYDP	Future Years Defense Program
IRSS	Infrared Sensor Simulation
IV&V	Independent Verification and Validation
LFT&E	Live Fire Test and Evaluation
M&S	Model & Simulation; Modeling and Simulation
MAISRC	Major Automated Information System Review Council
MCTEA	Marine Corps Test and Evaluation Agency
MDA	Milestone Decision Authority

MSEA	Modeling and Simulation Executive Agent
NAVMSMO	Navy Modeling and Simulation Management Office
OT	Operational Test
OT&E	Operational Test and Evaluation
PEO	Program Executive Office
PM	Program Manager
POM	Program Objectives Memorandum
PPBS	Planning, Programming, and Budgeting System
R&D	Research and Development
RTI	Runtime Infrastructure
RTM	Requirements Traceability Matrix
SBA	Simulation Based Acquisition
SECDEF	Secretary of Defense
SECNAVINST	Secretary of the Navy Instruction
SME	Subject Matter Expert
STEP	Simulation Test and Evaluation Process
T&E	Test and Evaluation
TEMP	Test and Evaluation Master Plan
TSG	Technical Support Group
V&V	Verification and Validation
VV&A	Verification, Validation, and Accreditation
WBS	Work Breakdown Structure



Department of the Navy

Modeling and Simulation Verification, Validation, and Accreditation Implementation Handbook Appendices

February 2001

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Appendix A. Accreditation Plan Template

This template provides guidance for preparing a Department of the Navy (DON) Modeling and Simulation (M&S) Accreditation Plan. It supplements information found in Secretary of the Navy Instruction (SECNAVINST) 5200.40. Text of the template that is italicized is intended to guide preparation of the plan. Non-italicized text defines the format and structure of the document (title page, table of contents, section head and numbers, tables and titles).



Department of the Navy

Accreditation Plan

(M&S Name)

(M&S Version Identifier)

(Date of this Plan)

1 BACKGROUND

1.1 User Requirements.

Identify the M&S user requirements. Briefly characterize the primary objectives of the M&S use (e.g., is the M&S intended to support acquisition of a weapons system? Train warfighters? Support advance concept development or decisions?).

1.2 M&S Overview.

Identify and describe briefly the key elements of the M&S for the intended use (e.g., major software, hardware, and human components; functional interfaces; key physical parameters; and installation or support services).

1.3 Status.

State whether this is the initial accreditation plan for this M&S or a revision. If this is a revision, summarize briefly the reason for the change. Cite any change in M&S use or top-level management direction since the last accreditation. Summarize aspects of past accreditation and/or past M&S use that impact this accreditation effort.

2 ACCREDITATION PROGRAM MANAGEMENT

2.1 M&S Accreditation Scope.

Briefly describe accreditation level of effort and methodology. Include a discussion of any limitations or restrictions associated with this accreditation effort. Any modification or work-around to the standard format or contents of the accreditation process should be noted here.

2.2 Points of Contact.

Identify key accreditation program individuals or groups. Include name, title, organization, business address, phone, fax, and e-mail for:

*M&S User(s)
Accreditation Authority
Accreditation Agent
M&S Proponent
V&V Agent
Subject Matter Experts (SMEs)*

2.3 Program Control.

Explain how accreditation activity will be planned, measured, reported, evaluated, and conducted. Identify any performance metrics that will be used.

2.3 Risk Management.

Identify primary cost, schedule, and technical risks. Describe the risk management strategy, including how risks will be identified, tracked, analyzed, reported, and mitigated.

3 FUNDING

Use the format of Table 1 to display costs associated with accreditation. If this is a jointly funded program, show all agency funding. Use whatever time reporting interval (RI) best makes sense for your accreditation program. This may be weeks, months, quarters, or years.

Table 1. Accreditation Costs
((\$K))

Cost Element	Appropriation	RI 1	RI 2	RI 3	RI 4	RI 5	RI 6	RI 7	RI 8	RI 9	RI 10	RI "n"	Cost at Completion
Accreditation Plan													
Acceptance Criteria													
Verification Review													
Validation Review													
Accreditation Assessment Report development													
Accreditation Package review													
Total Accreditation Cost													

4 SCHEDULE

Provide the schedule for primary accreditation events. Primary events include, but are not limited to, development of accreditation acceptance criteria, identification of needed data resources, review of M&S conceptual model validation report, review of M&S system verification report, review of M&S functional verification report, review of M&S results validation report, review of accreditation package, and completion of accreditation report. The schedule should associate the names of qualified individuals or activities with each task. The schedule should be made available to all concerned to ensure that conflicts in tasking are identified early so that appropriate substitutions can be identified where necessary.

5 PERFORMANCE

5.1 Development of Acceptance Criteria.

Define each specific, testable acceptance criteria and any associated methodology for weighting and combining individual criteria into an overall assessment of the M&S suitability. Correlate criteria with user M&S requirements.

5.2 Review Conceptual Model Validation Report(s).

Describe the overall approach for reviewing the conceptual model validation report. Describe how problems/deficiencies will be reported to M&S Proponent.

5.3 Review Functional and System Verification Report(s).

Describe the overall approach for reviewing the M&S functional and system verification reports. Describe how problems/deficiencies will be reported to M&S Proponent.

5.4 Review M&S Results Validation Report(s).

Describe the overall approach for reviewing the M&S results validation reports. Describe acceptance criteria and how it will be applied. Describe how problems/deficiencies will be reported to M&S Proponent.

5.5 Review Accreditation Package.

Describe the overall approach for reviewing the accreditation package. Describe acceptance criteria and how it will be applied. Describe how user interfaces, user training, and user support services will be evaluated. Describe how problems/deficiencies will be reported to M&S Proponent.

5.6 Generate Accreditation Report.

Describe the overall M&S insights to be obtained from the accreditation report.

Appendix B. Accreditation Report Template

This template provides guidance for preparing a Department of the Navy (DON) Modeling and Simulation (M&S) Accreditation Report. It supplements information found in Secretary of the Navy Instruction (SECNAVINST) 5200.40. Text of the template that is italicized is intended to guide preparation of the report. Non-italicized text defines the format and structure of the document (title page, table of contents, section head and numbers, tables and titles).



Department of the Navy

Accreditation Report

(M&S Name)

(M&S Version Identifier)

(Date of this Report)

1 BACKGROUND

1.1 User Need.

Identify the M&S user requirements. Briefly characterize the primary objectives of the M&S use (e.g., is the M&S intended to support acquisition of a weapons system? Train warfighters? Support advance concept development or decisions?).

1.2 M&S Methodology.

Identify and describe briefly all key elements of this M&S (e.g., major software, hardware, and human components; functional interfaces; key physical parameters; and installation or support services).

2 OVERVIEW

2.1 M&S Accreditation Scope.

Briefly describe accreditation level of effort and methodology. Include a discussion of any limitations or restrictions associated with this accreditation effort. Describe the information that was collected or developed based on the Accreditation plan. Any modification or work-around to the standard format, or contents of the accreditation process should be noted here.

2.2 Points of Contact.

Identify key accreditation program individuals or groups. Include name, title, organization, business address, phone, fax, and e-mail for:

*M&S User(s)
Accreditation Authority
Accreditation Agent
M&S Proponent
V&V Agent
Subject Matter Experts (SMEs)*

3 ACCREDITATION METHODOLOGY

Describe the overall approach for accrediting the M&S for the specified use. Define each specific, testable acceptance criteria as well as methodology for weighting and combining individual criteria into an overall assessment of the M&S suitability. Correlate criteria with user requirements and M&S requirements.

4 ACCREDITATION PACKAGE EVALUTION

Summarize the comparisons of the application M&S V&V results to acceptance criteria.

5 ACCREDITATION RECOMMENDATIONS AND CONCLUSIONS

Provide recommendations for changes to the model or simulation to use it for the application or to reduce application risk. Summarize conclusions about model or simulation suitability for intended use.

Appendix C. Accreditation Decision Template

This template provides guidance for preparing a Department of the Navy (DON) Modeling and Simulation (M&S) Accreditation Decision Letter. It supplements information found in Secretary of the Navy Instruction (SECNAVINST) 5200.40. Text of the template that is italicized is intended to guide preparation of the decision letter. Non-italicized text defines the format and structure of the document (title page, table of contents, section head and numbers, tables and titles).



Department of the Navy

Accreditation Decision Letter

(M&S Name)

(M&S Version Identifier)

(Date of this Letter)

1 ACCREDITATION DECISION

1.1 M&S Description.

Identify the M&S name and version number and the date of the accreditation package upon which the accreditation decision was based.

1.2 M&S Use.

Identify the using Activity(s) and Program. Describe how the M&S will be used to support the program.

1.3 Accreditation Decision.

State what accreditation decision was made (accredited, not accredited, or further evaluation needed). Summarize the major reasons for making the decision. Identify any special considerations or conditions of the accreditation decision.

1.4 Points of Contact.

Identify key accreditation program individuals or groups. Include name, title, organization, business address, phone, fax, and e-mail for:

M&S User(s)

Accreditation Authority

Accreditation Agent

M&S Proponent

V&V Agent

Subject Matter Experts (SMEs)

2 SIGNATURES

2.1 Accreditation Authority

2.2 M&S Proponent

2.3 NAVMSMO VV&A Program Manager

Appendix D. V&V Plan Template

This template provides guidance for preparing a Department of the Navy (DON) Modeling and Simulation (M&S) Verification and Validation (V&V) Plan. It supplements information found in Secretary of the Navy Instruction (SECNAVINST) 5200.40. Text of the template that is italicized is intended to guide preparation of the plan. Non-italicized text defines the format and structure of the document (title page, table of contents, section head and numbers, tables and titles).



Department of the Navy

Verification and/or Validation Plan

(M&S Name)

(M&S Version Identifier)

(Date of this Plan)

1 BACKGROUND

1.1 User Need.

Identify the M&S user requirements. Briefly characterize the primary objectives of the M&S use or uses. Some examples of M&S uses include supporting a DAB decision for an acquisition program, support the training of warfighters, and supporting an advance concept decision. Figure 1 is an example of a User Need Statement.

1.1 User Need.

The SH-60B Program is modifying its weapons payload configuration and composition to include Hellfire missiles. Under Title 10, modifications of this type require the Program to perform Live Fire Test and Evaluation (LFT&E) of the modified SH-60B. The Program is seeking a waiver that releases them from performing the LFT&E. As part of the waiver package, the Program needs to demonstrate the modified system has not increased its operational vulnerability to an established set of kinetic-energy threats. In addition to some component-level testing, the Program will use credible M&S predictions of the modified SH-60B's operational vulnerability to the threats.

FIGURE 1. EXAMPLE USER NEEDS STATEMENT.

1.2 M&S Description.

Provide the full name of the M&S and, if applicable, its corresponding acronym. Provide version control numbers or identifiers for all M&S components, including software, hardware, and/or human or organizational components. Identify and describe briefly all key components, interfaces, and architecture of the M&S. Provide illustrative figures whenever possible. Describe installation and support services of the M&S. Provide references to detailed descriptions of the M&S development and design, such as conceptual model documents, M&S design documents, and M&S Analyst's Manuals. Figure 2 illustration of how figures can be used to provide overview descriptions of M&S features. Shown in the figure is the system architecture overview of the Infrared Sensor Simulator (IRSS).

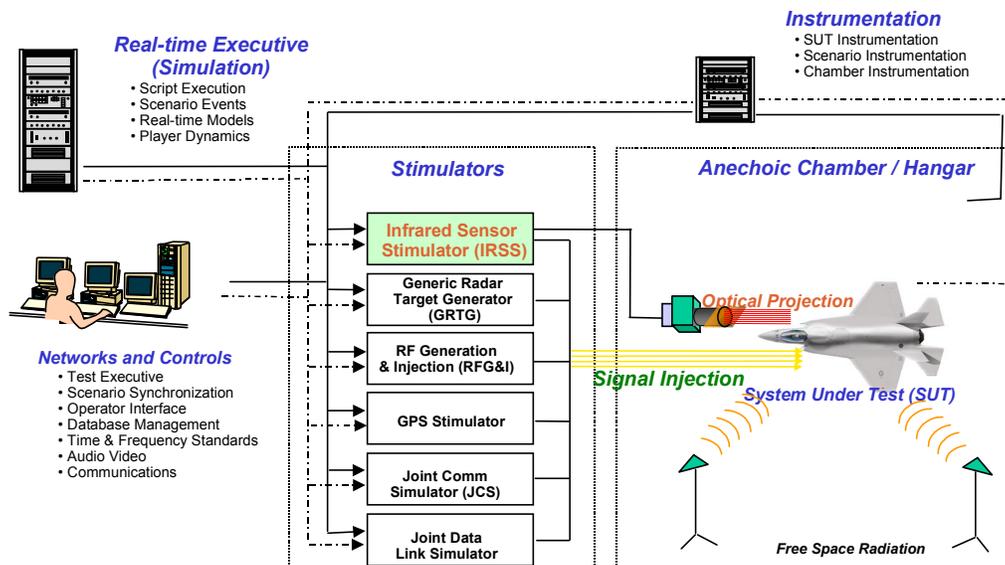


FIGURE 2. EXAMPLE OF M&S DESCRIPTIVE FIGURE (SYSTEM ARCHITECTURE)

1.3 M&S Background Status.

State whether this is the initial verification and validation (V&V) plan for this M&S or a revision. If this is a revision, summarize briefly the reason for the change. Cite any change in M&S use or top-level management direction since the last V&V. Summarize aspects of past V&V and/or past M&S use that impact this V&V effort.

2 V&V MANAGEMENT STRATEGY

2.1 M&S V&V Scope.

Summarize all aspects of the V&V effort. Include a brief description of V&V level of effort and methodology. Include a discussion of any limitations or restrictions associated with this V&V effort. Any modification or work-around to the standard format or contents of the V&V process should be noted here.

2.2 Points of Contact.

Identify key V&V program individuals or groups. Include name, title, organization, business address, phone, fax, and e-mail for:

*M&S Using Agencies
M&S Sponsor(s)
Accreditation Authority
Accreditation Agent(s)
M&S Proponent
V&V Agent(s)
Subject Matter Experts (SMEs)*

2.3 V&V Program Control.

Explain how V&V activity will be planned, measured, reported, evaluated, and acted on. Identify what performance metrics will be used. Identify the mechanisms that will be used to coordinate and report activity (e.g., monthly status reviews, quarterly regional reviews, and semiannual reviews).

2.4 V&V Risk Management.

Identify primary cost, schedule, and technical risks associated with the use of the M&S. Describe the process by which the identified risks will be mitigated through V&V activities.

3 FUNDING

Use the format of Table 1 to display program funding. Use the same cost breakout elements. If this is a jointly funded program, show all agency funding. Use whatever time reporting interval (RI) best makes sense for your V&V program. This could be weeks, months, quarterly, or yearly.

**Table 1. V&V Funding
(\$K)**

Cost Element	Appropriation	RI 1	RI 2	RI 3	RI 4	RI 5	RI 6	RI 7	RI 8	RI 9	RI 10	RI "n"	Cost at Completion
<i>Preliminary V&V Activities</i>													
<i>Conceptual Model Validation</i>													
<i>V&V Planning</i>													
<i>Functional Verification</i>													
<i>System Verification</i>													
<i>Results Validation</i>													
<i>V&V Report</i>													
Total V&V Cost													

4 SCHEDULE

Provide the schedule for primary V&V events. Primary events include, but are not limited to, preliminary V&V activities, conceptual model validation activities, functional verification activities, system verification activities, results validation activities, development of data and data sources, and documentation of V&V results. Include when the user(s) intend to apply the M&S results.

5 APPROACH

5.1 Conceptual Model Validation.

Describe the overall approach for validating the M&S conceptual model. Correlate specific segments of the conceptual model to the accreditation acceptance criteria. Identify which authoritative resources will be used to establish the validity, including subject matter experts, reference documents, and reference data. For subject matter experts, describe the specialized skills or knowledge that is needed.

5.2 Functional Verification.

Describe the overall approach for verifying the M&S functional design. Correlate specific segments of the functional design to the conceptual model and to the accreditation acceptance criteria. State how completeness and accuracy of functional requirements will be measured.

5.3 System Verification.

Describe the overall approach for verifying the M&S system. Correlate specific segments of the system to the functional design, conceptual model, and accreditation acceptance criteria. Site all applicable design standards, codes, regulations, or law to which the design must adhere. State how the adherence to these standards will be evaluated.

Describe how the M&S configuration management process is to be reviewed and evaluated. Describe how the M&S system documentation (installation guide, user's manual, and so on) will be reviewed and evaluated.

5.4 Results Validation.

Describe the overall approach for validating the M&S results. Correlate M&S results with accreditation acceptance criteria. Identify all authoritative resources to be used in evaluating the M&S results. Include subject matter experts, mathematical or statistical techniques, and data resources. State how the resources are to be applied and how the results are to be evaluated. For subject matter experts, describe the specialized skills or knowledge that is needed.

5.5 Accreditation Package.

Identify all verification and validation documents, reports, and results that are to be included in the accreditation package. This includes documentation from 5.1 through 5.4 above, historical verification and validation documents, M&S development and user documents, and other applicable test results.

5.6 Accreditation Review Support.

Specify how and how often accreditation reviews, walk-throughs, and inspections will be held.

5.7 Filing Accreditation Status.

Identify how, electronically or via mailed hardcopy reports, and when the M&S accreditation status will be filed with the Navy Modeling and Simulation Management Office.

Appendix E. V&V Report Template

This template provides guidance for preparing a Department of the Navy (DON) Modeling and Simulation (M&S) Verification and Validation (V&V) Report. It supplements information found in Secretary of the Navy Instruction (SECNAVINST) 5200.40. Text of the template that is italicized is intended to guide preparation of the plan. Non-italicized text defines the format and structure of the document (title page, table of contents, section head and numbers, tables and titles).



Department of the Navy

Verification and/or Validation Report

(M&S Name)

(M&S Version Identifier)

(Date of this Report)

1 BACKGROUND

1.1 User Need.

Identify the M&S user requirements. Briefly characterize the primary objectives of the M&S use (e.g., is the M&S intended to support acquisition of a weapons system? Train warfighters? Support advance concept development or decisions?).

1.2 M&S Methodology.

Identify and describe briefly all key elements of this M&S (e.g., major software, hardware, and human components; functional interfaces; key physical parameters; and installation or support services).

1.3 V&V Activity Summary.

Summarize the V&V activities documented in this report.

2 PERFORMANCE

2.1 Conceptual Model Validation.

Describe the overall approach for validating the M&S conceptual model. Correlate specific segments of the conceptual model to the accreditation acceptance criteria. Identify which authoritative resources were used to establish the validity, including subject matter experts, reference documents, and reference data. For subject matter experts, describe the specialized skills or knowledge that is needed.

2.2 Functional Verification.

Describe overall approach for verifying the M&S functional design. Correlate specific segments of the functional design to the conceptual model and to the accreditation acceptance criteria. State how completeness and accuracy of functional requirements was measured.

2.3 System Verification.

Describe overall approach for verifying the M&S system. Correlate specific segments of the system to the functional design, conceptual model, and accreditation acceptance criteria. Site all applicable design standards, codes, regulations, or law to which the design must adhere. State how the adherence to these standards was evaluated. Describe how the M&S configuration management process was reviewed and evaluated. Describe how the M&S system documentation (installation guide, user manual, and so on) was reviewed and evaluated.

2.4 Results Validation.

Describe overall approach for validating the M&S results. Correlate M&S results with accreditation acceptance criteria. Identify all authoritative resources that were used in evaluating the M&S results. Include subject matter experts, mathematical or statistical techniques, and data resources. State how the resources were applied and how the results

were evaluated. For subject matter experts, describe the specialized skills or knowledge that were utilized.

3 RESULTS.

Summarize the results of the V&V activities.

4 CONCLUSIONS

Describe any conclusions or recommendations resulting from the V&V activities.

Appendix F. Accreditation Package Template

This template provides guidance for preparing a Department of the Navy (DON) Modeling and Simulation (M&S) Accreditation Package. It supplements information found in Secretary of the Navy Instruction (SECNAVINST) 5200.40. Text of the template that is italicized is intended to guide preparation of the decision letter. Non-italicized text defines the format and structure of the document (title page, table of contents, section head and numbers, tables and titles).



Department of the Navy

Accreditation Support Report

(M&S Name)

(M&S Version Identifier)

(Date of this Package)

1 INTRODUCTION

1.1 M&S Description.

Identify the M&S name and version number and the date of the accreditation package upon which the accreditation decision was based.

1.2 M&S Use.

Identify the using Activity(s) and Program. Describe how the M&S will be used to support the program.

1.3 Accreditation Support Documentation.

State what M&S documentation is included in the accreditation package. At a minimum, the package should include all current V&V plans and reports, M&S development documents (including the Requirements Document, Specification Document), and user support documents (including Installation Guide, User's Guide, Analyst's Guide).

1.4 Points of Contact.

Identify key accreditation program individuals or groups. Include name, title, organization, business address, phone, fax, and e-mail for:

M&S User(s)

Accreditation Authority

Accreditation Agent

M&S Proponent

V&V Agent

Subject Matter Experts (SMEs)

2 ATTACHED DOCUMENTS

Either attaches documents or sites documentation reference location.