ASME VVUQ 60.1-2025

Considerations and Questionnaire for Selecting Computational Physics Simulation Software: An ASME Guideline

AN AMERICAN NATIONAL STANDARD

The American Society of Mechanical Engineers

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FOREWORD

Results from computational analyses and simulations of physical systems are major factors in engineering decision making. These results are determined by

(a) the skills of the end user in setting up the computational models

(b) the approach the end user takes

(c) the assumptions and decisions the end user makes

(d) the capabilities of the computational analysis and physics simulation software used

It is critical to consider the capabilities of the selected software tools from the outset to ensure the reliability of engineering decisions based on simulations and verification and validation (V&V) procedures. This Guideline has been created to provide guidance to end users for evaluating and selecting computational physics simulation software appropriate for the intended application of interest. While this Guideline does not provide explicit guidance for V&V, it does offer guidance for assessing the accuracy and credibility of computational models and simulations. The end user's objective in using simulation software is to obtain accurate and reliable simulation results. Commercial software providers are interested in supplying the simulation software used for that purpose. However, the end user and the potential provider need a transparent exchange of information to ensure that the end user selects simulation software that is indeed appropriate for their intended use.

Before selecting a particular simulation software, the end user should understand the software's theoretical basis, dependability, and limitations relevant to one or more of the end user's specific applications of interest. This Guideline provides a list of pertinent questions to help the end user select appropriate simulation software. These questions have been selected based on the experience of the members of the ASME VVUQ 60 Subcommittee on Verification, Validation, and Uncertainty Quantification of Modeling and Simulation in Energy Systems. Answers to these questions can be found in software user manuals and theory guides or obtained directly from the software provider.

This Guideline has been specifically created for the benefit of the computational simulation community. It has been kept short and concise toward this end, and it can be expanded and extended in future versions.

ASME VVUQ 60.1 was approved by the American National Standards Institute on February 12, 2025.

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Verification, Validation, and Uncertainty Quantification in Computational Modeling and Simulation

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Revisions and Errata. The committee processes revisions to this Guideline on a periodic basis to incorporate changes that appear necessary or desirable as demonstrated by the experience gained from the application of the Guideline. Approved revisions will be published in the next edition of the Guideline.

In addition, the committee may post errata on the committee web page. Errata become effective on the date posted. Users can register on the committee web page to receive email notifications of posted errata.

This Guideline is always open for comment, and the committee welcomes proposals for revisions. Such proposals should be as specific as possible, citing the paragraph number, the proposed wording, and a detailed description of the reasons for the proposal, including any pertinent background information and supporting documentation.

Cases

(a) The most common applications for cases are

(1) to permit early implementation of a revision based on an urgent need

(2) to provide alternative requirements

(3) to allow users to gain experience with alternative or potential additional requirements prior to incorporation directly into the Guideline

(4) to permit the use of a new material or process

(b) Users are cautioned that not all jurisdictions or owners automatically accept cases. Cases are not to be considered as approving, recommending, certifying, or endorsing any proprietary or specific design, or as limiting in any way the freedom of manufacturers, constructors, or owners to choose any method of design or any form of construction that conforms to the Guideline.

(c) A proposed case shall be written as a question and reply in the same format as existing cases. The proposal shall also include the following information:

(1) a statement of need and background information

(2) the urgency of the case (e.g., the case concerns a project that is underway or imminent)

(3) the Guideline and the paragraph, figure, or table number

(4) the editions of the Guideline to which the proposed case applies

(d) A case is effective for use when the public review process has been completed and it is approved by the cognizant supervisory board. Approved cases are posted on the committee web page.

Interpretations. Upon request, the committee will issue an interpretation of any requirement of this Guideline. An interpretation can be issued only in response to a request submitted through the online Inquiry Submittal Form at https://go.asme.org/InterpretationRequest. Upon submitting the form, the inquirer will receive an automatic email confirming receipt.

ASME does not act as a consultant for specific engineering problems or for the general application or understanding of the Guideline requirements. If, based on the information submitted, it is the opinion of the committee that the inquirer should seek assistance, the request will be returned with the recommendation that such assistance be obtained. Inquirers can track the status of their requests at https://go.asme.org/Interpretations.

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Interpretations are published in the ASME Interpretations Database at https://go.asme.org/Interpretations as they are issued.

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CONSIDERATIONS AND QUESTIONNAIRE FOR SELECTING COMPUTATIONAL PHYSICS SIMULATION SOFTWARE: AN ASME GUIDELINE

1 SCOPE

ASME VVUQ 60.1 provides guidance to computational physics simulation software end users for evaluating and selecting simulation software appropriate for their intended application of interest. The selection should be guided by the level of risk associated with the application of interest. The software can be based on theoretical formulations or empirical data.

Before selecting a particular simulation software (either commercial, open-source, or developed in-house), the end user must know its theoretical basis, dependability, and limitations relevant to the end user's application of interest. This Guideline outlines some matters that the end user can take into consideration during the software selection process. A series of questions are also included to help the end user assess the suitability of the simulation software by weighing responses based on the risk associated with their application of interest.

The scope of this Guideline is limited to computational physics simulation software. It does not offer guidance on other software. ASME VVUQ 60.1 has been developed to provide guidance to end users to evaluate simulation software based on its functionality. Other aspects such as cost are not considered. This Guideline is not limited to any physics or any specific engineering application. It assumes the end user is technically skilled to understand the physics underlying the phenomena being simulated, is capable of setting up appropriate computational models, and is appropriately qualified or certified.

2 REFERENCES

The following is a list of publications referenced in this Guideline.

ASME VVUQ 1-2022. Verification, Validation, and Uncertainty Quantification in Computational Modeling and Simulation Terminology. The American Society of Mechanical Engineers.

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Baguley, D., and Hose, D. (1994). NAFEMS HT02: How to Choose a Finite Element Analysis System. National Agency for Finite Element Methods and Standards.

IEEE Std 1062-2015. IEEE Recommended Practice for Software Acquisition. Institute of Electrical and Electronics Engineers.

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3 CONSIDERATIONS FOR SOFTWARE SELECTION

The end user is responsible for

(a) defining the problem statement with an understanding of the physical phenomena and the risk inherent in the application of interest