ASME VVUQ

Standards Portfolio

Verification, Validation, and Uncertainty Quantification

About ASME VVUQ

ASME's Verification, Validation, and Uncertainty Quantification (VVUQ) Standards portfolio is a comprehensive suite enabling credibility, efficiency, and regulatory confidence in simulation-driven engineering. Adopted across industries — from advanced manufacturing and medical devices to aerospace, energy, and national research labs, this portfolio empowers organizations to trust their computational models, streamline development, and deliver high-quality, compliant products.

Purpose of VVUQ

The ASME VVUQ (Verification, Validation, and Uncertainty Quantification) portfolio of Standards exists to establish a unified, cross-disciplinary framework for building, assessing, and maintaining computational models. Its purpose is to support simulation results used in engineering, design, and regulatory decision-making that are trustworthy, reproducible, and defensible. By providing structured guidance across diverse domains—ranging from foundational (solid mechanics, fluid dynamics, and heat transfer) to industry-specific (medical devices, advanced manufacturing)—the VVUQ portfolio empowers innovation, helps reduce development risk, and can drive confidence in model-based engineering throughout the product and system lifecycle.

VVUQ
VERIFICATION
VALIDATION
AND
UNCERTAINTY
QUANTIFICATION

History of VVUQ

ASME's VVUQ (Verification, Validation, and Uncertainty Quantification) Standards portfolio was born from the growing need to establish credibility in computational modeling and simulation across critical industries. What started as a single guide for solid mechanics (VVUQ 10, formerly V&V 10) has grown into a robust, multi-standard framework that helps model-based engineering across healthcare, aerospace, energy, manufacturing, and beyond.

Overview of the ASME VVUQ Standards Portfolio

The ASME VVUQ Standards portfolio is a comprehensive, cross-industry suite of guidance documents that define best practices for Verification, Validation, and Uncertainty Quantification (VVUQ) in computational modeling. Each Standard in the portfolio focuses on a distinct technical or application domain, enabling professionals to apply VVUQ principles within specific modeling contexts while aligning to a shared framework of credibility.

ASME VVUQ
Standards Portfolio

Verification, Validation, and Uncertainty Quantification

Who Will Benefit From ASME VVUQ?

The ASME VVUQ Standards portfolio supports professionals and organizations that rely on computational modeling to inform design, regulatory, and operational decisions. Whether you build, use, validate, or approve simulation models, VVUQ empowers users and organizations to make better, faster, and more reliable decisions through credible simulation.

Top Job Roles

Model Developers & Analysts	Provides technical criteria for code and calculation verification, validation test design, and UQ integration (e.g., VVUQ 10, 20, 30.1).
Simulation Engineers & Systems Engineers	Helps instill confidence in multi-domain simulations, guiding end-to-end credibility workflows (e.g., VVUQ 40, 50.1, 60.1).
Project Managers & Technical Leads	Offers a structured framework to assess modeling quality and manage risk across the model lifecycle (e.g., VVUQ 40, 50.1).
Regulatory Affairs & Quality Professionals	Enables the use of simulation in compliance submissions by aligning to accepted credibility standards (e.g., VVUQ 40, 40.1).
Tool & Software Evaluation Teams	Provides evaluation criteria for selecting credible simulation software (e.g., VVUQ 60.1).
R&D and Innovation Leaders	Supports model-based innovation with trusted guidance on model reuse, efficiency, and lifecycle planning (e.g., VVUQ 50.1).
Regulators & Reviewers	Offers a shared credibility language to assess submissions involving modeling (e.g., VVUQ 30.1, 40, 40.1).

ASME VVUQ

Standards Portfolio

Verification, Validation, and Uncertainty Quantification

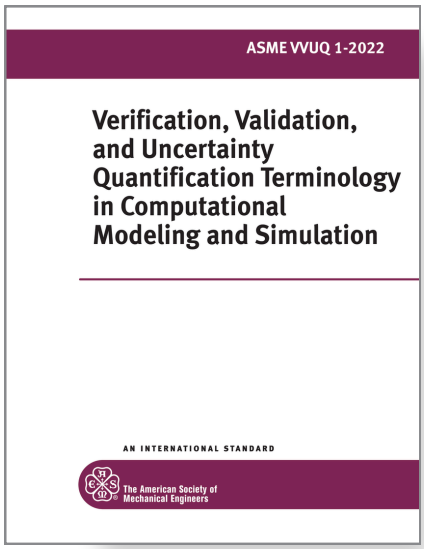
Top Industries & Standard Alignment

Aerospace & Defense	VVUQ 10, 20, 50.1	Can improve structural and fluid simulation reliability; supports advanced manufacturing and system qualification.
Medical Devices & Healthcare	VVUQ 40, 40.1	Provides a regulator-aligned framework for assessing model credibility in support of FDA submissions.
Automotive & Transportation	VVUQ 10, 20, 40, 50.1	Enhances model assurance in structural/crashworthiness simulations and supports digital factory transitions.
Energy & Nuclear Power	VVUQ 20, 30.1, 60.1	Enables high-confidence thermal-fluid and safety-critical models; guides tool selection for simulation-driven operations.
Advanced Manufacturing & Industry 4.0	VVUQ 40, 50.1, 60.1	Offers model lifecycle guidance for production systems and ensures the right tools are chosen for digital twins or automation.
Pharmaceuticals & Biotech	VVUQ 40, 60.1	Supports model use in drug delivery devices and simulation validation for regulatory processes.
Academia & National Labs	All (esp. VVUQ 10, 20, 30.1, 50.1)	Serves as a research foundation for model development, validation studies, and training the next generation of engineers.

ASME VVUQ

Standards Portfolio

Verification, Validation, and Uncertainty Quantification

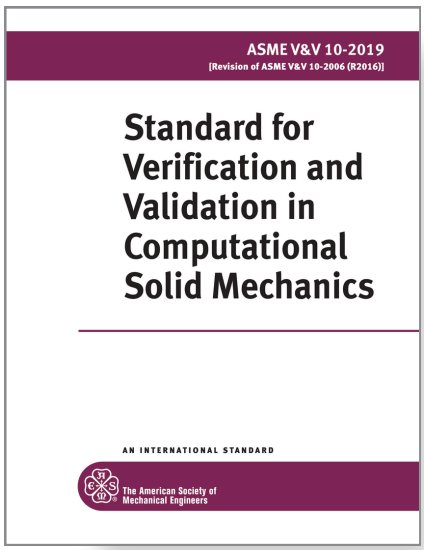


ASME VVUQ 1

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

VVUQ 1 establishes terminology and summarizes key concepts for verification, validation, and uncertainty quantification (VVUQ) to assist the developers and users of computational models to better communicate the evidence that justifies application of their models for the context of use.

AVAILABLE FREE OF CHARGE



ASME VVUQ 10

Standard for Verification and Validation in Computational Solid Mechanics

VVUQ 10 is a foundational guide for implementing verification and validation practices in computational solid mechanics. This Standard covers model development processes, code and calculation verification techniques, validation principles, experimental design and uncertainty quantification, as well as an emphasis on establishing model credibility in simulations of structural and mechanical systems.

ASME VVUQ

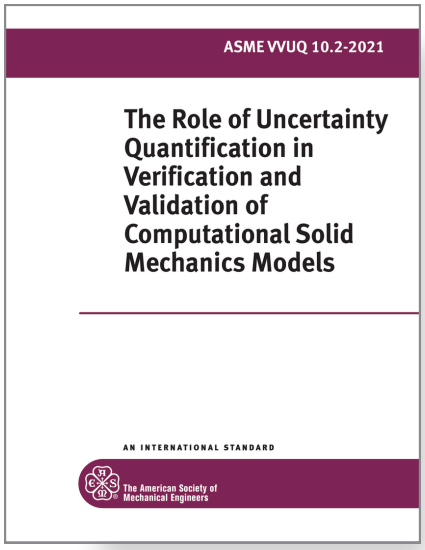
Standards Portfolio

Verification, Validation, and Uncertainty Quantification

ASME VVUQ 10.1

An Illustration of the Concepts of Verification and Validation in Computational Solid Mechanics

VVUQ 10.1 illustrates, by detailed example, the most important aspects of verification and validation to provide a common language, a conceptual framework, and general guidance for implementing the process of computational modeling.



ASME VVUQ 10.2

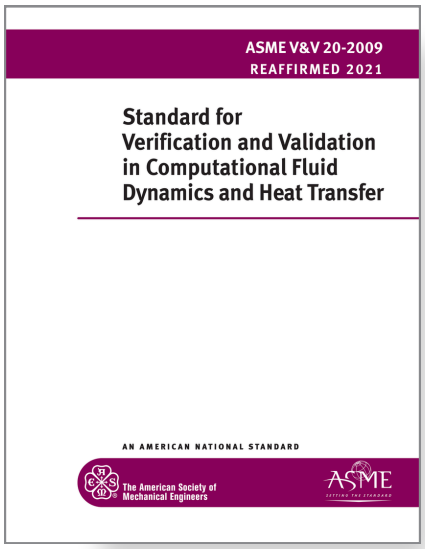
The Role of Uncertainty Quantification in Verification and Validation of Computational Solid Mechanics Models

This Standard expands upon the important role of uncertainty quantification (UQ) in verification, validation, and uncertainty quantification (VVUQ) and provides a common language for developers to perform UQ, and communicate results, conclusions, and recommendations to a decision maker.

ASME VVUQ

Standards Portfolio

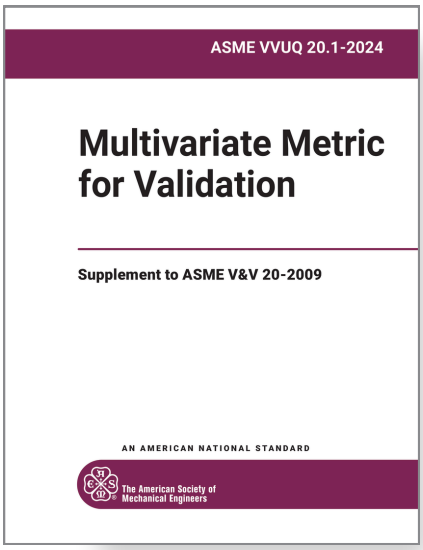
Verification, Validation, and Uncertainty Quantification



ASME VVUQ 20

Standard for Verification and Validation in Computational Fluid Dynamics and Heat Transfer

VVUQ 20 is the specification of a verification and validation approach that quantifies the degree of accuracy inferred from the comparison of solution and data for a specified variable at a specified validation point. The approach uses the concepts from experimental uncertainty analysis to consider the errors and uncertainties in both the solution and the data.



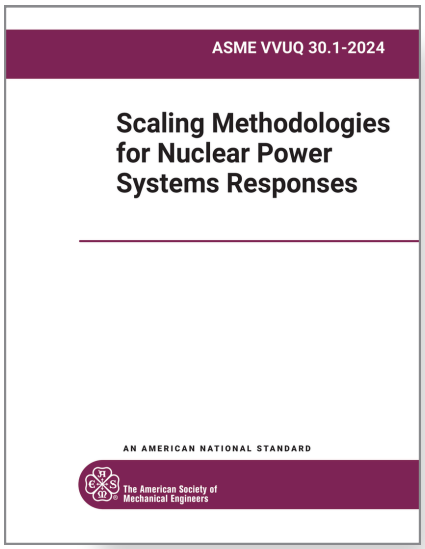
ASME VVUQ 20.1

Multivariate Metric for Validation

VVUQ 20.1 presents a technique that builds on the pointwise technique of ASME VVUQ 20 to make a global assessment of the discrepancies between multiple validation variables obtained from experiments and simulations. The metric can be applied to the same validation variable at different locations in space and/or at different time instants, or to different validation variables at the same location and time instant, or even to a combination of both. Furthermore, the multivariate metric can work with experimental, numerical, and input parameter uncertainties that are independent or shared by the multiple validation set point.

ASME VVUQ
Standards Portfolio

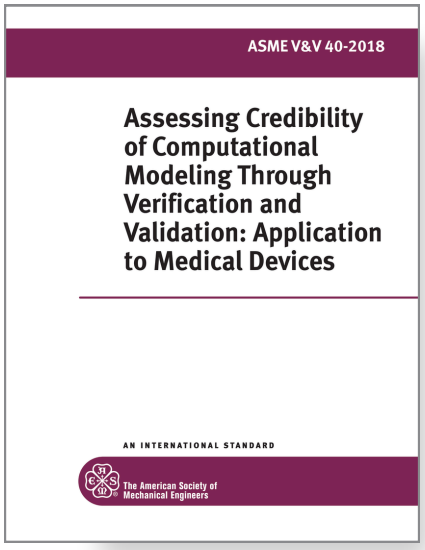
Verification, Validation, and Uncertainty Quantification



ASME VVUQ 30.1

Scaling Methodologies for Nuclear Power Systems Responses

VVUQ 30.1 is focused on the scaling analysis that is used to evaluate the effects of differences in the phenomenological behavior of experimental facilities compared to the real-world systems. This Standard covers common nomenclature in scaling analysis practices, creation of the adequacy and validation matrix using scaled experimental facilities, as well as provides an overvieew and comparison of H2TS and FSA system decomposition and hierarchy.



ASME VVUQ 40

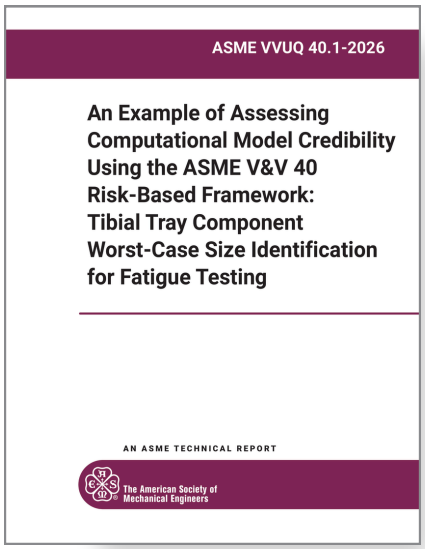
Assessing Credibility of Computational Modeling Through Verification and Validation: Application to Medical Devices

VVUQ 40 provides a framework for medical devices assessing the relevance and adequacy of completed VVUQ activities that establish credibility of a computational model. The credibility should be commensurate with the degree to which the computational model is relied on as evidence of device performance, functional characteristic, and/or safety to support a decision, and the consequences of that decision being incorrect. It also augments other standards that present VVUQ methodologies, such as ASME VVUQ 10 and ASME VVUQ 20. This Standard presents a framework for the practitioner to make assessments using sound engineering judgment.

ASME VVUQ

Standards Portfolio

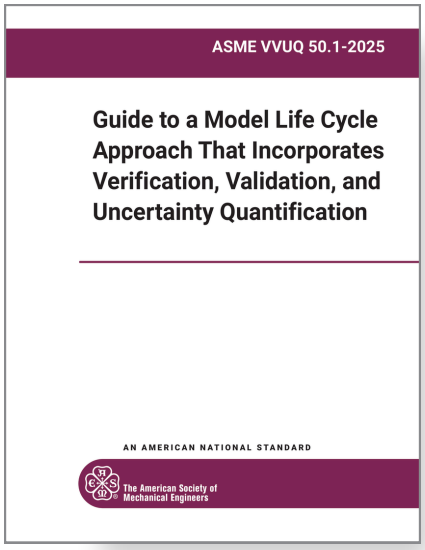
Verification, Validation, and Uncertainty Quantification



ASME VVUQ 40.1

An Example of Assessing Computational Model Credibility Using the ASME VVUQ 40 Risk-Based Framework: Tibial Tray Component Worst-Case Size Identification for Fatigue Testing

VVUQ 40.1 is a technical report that summarizes the application of the ASME VVUQ 40 to a computational model that simulates a mechanical test based on the ISO 14879-1 Standard, which evaluates the fatigue performance of an orthopedic tibial tray component. Section 2 provides background on the credibility assessment framework and guidance on using this technical report. Section 3 provides a general overview of tibial tray design and evaluation, including a description of the mechanical test method. Sections 4 through 8 follow the ASME VVUQ 40 credibility assessment framework up to documentation and evidence.



ASME VVUQ 50.1

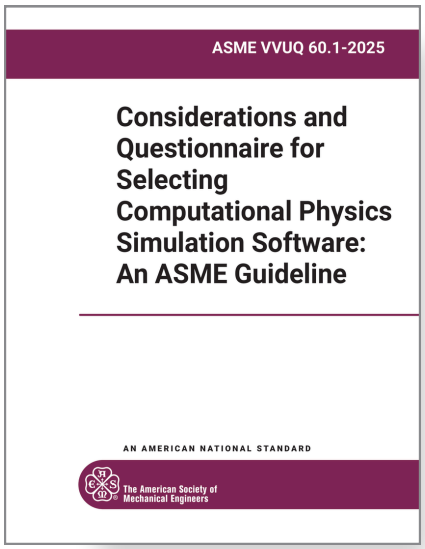
Guide to a Model Life Cycle Approach That Incorporates Verification, Validation, and Uncertainty Quantification

VVUQ 50.1 provides a guide to the life cycle of a computational model from an engineering perspective, with particular reference to the associated verification and validation processes. The material is presented in the application context of advanced manufacturing, demonstrating how verification and validation processes are incorporated across the modeling lifecycle stages: establish model requirements, develop the model, deploy the model, use and maintain the model, and retire the model.

ASME VVUQ

Standards Portfolio

Verification, Validation, and Uncertainty Quantification



ASME VVUQ 60.1

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

VVUQ 60.1 helps end users evaluate and select computational physics simulation software for their intended application. It provides guidance for assessing whether a software tool is appropriate for a specific use case based on functionality and fitness for purpose, regardless of whether the software is built on theoretical formulations or empirical data. Applicable across physics domains and engineering applications, the guideline is focused specifically on computational physics simulation software and does not address non-simulation software or commercial considerations such as cost.

Learn more about ASME VVUQ Standards and related solutions:

go.asme.org/vvuq