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INTERIM RECOMMENDED PROCEDURE
PREPARED BY RESISTANCE COMMITTEE OF 22nd ITTC

Edited	Approved
Date	Date

Uncertainty Analysis in CFD, Guidelines for RANS Codes

1. PURPOSE OF PROCEDURE

To provide guidelines for implementation of QM procedure 4.9-04-01-01, "Uncertainty Analysis in CFD, Uncertainty Assessment Methodology."

2. GUIDELINES FOR RANS CODES

The overall CFD verification and validation procedures can be conveniently grouped in four consecutive steps: (1) preparation; (2) verification; (3) validation; and (4) documentation. The section references are to QM procedure 4.9-04-01-01.

Preparation. The 1st step is preparation, which involves selection of the CFD code and specification of objectives, geometry, conditions, and available benchmark information. The objectives might be prediction of certain variables at certain levels of validation (e.g., programmatic validation requirements U_{reqd}). The variables can either be integral (e.g., resistance) or point (e.g., mean velocities and turbulent Reynolds stresses) values and the levels of validation may be different for each variable.

Verification. The 2nd step is verification, which is defined as a process for assessing simulation numerical uncertainty U_{SN} and, when conditions permit, estimating the sign and magnitude of the simulation numerical error d^*_{SN} itself and the uncertainty in its error referred to as the corrected simulation numerical uncertainty $U_{S_C N}$. Iterative and input parameter convergence studies are conducted using multiple solutions with systematic parameter, as described in Section 3.2.

Validation. The 3rd step is validation, which is defined as a process for assessing simulation modeling uncertainty U_{SM} by using benchmark experimental data and, when conditions permit, estimating the sign and magnitude of the simulation modeling error δ_{SM} itself. The comparison error E (difference between data D and simulation S values) and validation uncertainty U_V (combination of uncertainties in data and portion of simulation uncertainties that can be estimated) are used, as described in Section 3.3.

Documentation. The 4th step is documentation, which is detailed presentation of the CFD code (equations, initial and boundary conditions, modeling, and numerical methods), objectives, geometry, conditions, verification, validation, and analysis.