CFD WORKSHOP GOTHENBURG 2010

Questionnaire

Code identifier: (insert the same identifier as in the computed results)

Except when stated otherwise, please reply to each question by filling the appropriate alternative(s) (key letters) into the attached answer sheet (quest-answer.xls). Note that more than one alternative may be applicable! Upload the completed questionnaire together with your results.

If answers differ between the computed cases, please duplicate relevant parts inside the same cell of the answer sheet!

The coordinate system is the same as in the computed results.

A. OVERALL STRATEGY

1. Domain of simulation?
   a. Complete hull (H)
   b. Only the stern and wake flow (S)
   c. Other (O, specify)

2. In your domain, which approach is used?
   a. Global (single method is used for entire flow)(G)
   b. Zonal (separate methods are used in different regions) (Z)

3. If zonal, complete the remainder for each viscous-flow region, carefully denoting the region to which the description applies. If a viscous/inviscid interaction method is used, indicate the interaction method used:
   a. Displacement thickness (D)
   b. Surface and wake blowing or suction (S)
   c. Matching along a specified boundary outside the viscous layer (M)
   d. Other (O, specify)

B. EQUATIONS SOLVED

1. Which best describes the equations solved?
   a. Direct Numerical Simulation (DNS): Fully resolved Navier-Stokes (NS) equations with no models (N)
   b. Large Eddy Simulation (LES): NS equations with sub-grid model (L)
   c. Hybrid LES/RANS (e.g. DES): NS equations with hybrid model of LES and RANS (D)
   d. Reynolds-averaged Navier-Stokes (RANS) equations(R)
   e. RANS with grid related approximations (Ra)
   f. Partially-parabolic RANS (P)
   g. Thin-Layer RANS (T)
   h. Boundary-layer equations (B: differential; I: integral)
   i. Other (O, specify)

2. Which base coordinate system are the equations formulated in?
   a. Cartesian (Ca)
   b. Cylindrical (Cy)
   c. Other (O, specify)

3. Describe the coordinate transformation used:

   a. Partial transformation (independent variables only) (P)
   b. Full transformation (independent and dependent variables)
      i. Covariant(C)
      ii. Contravariant(Cn)
      iii. Physical (Ph)
      iv. None (N)
   c. Other (O, specify)

4. What formulation is used for the dependent variables?
   a. Velocity and Pressure (VP)
   b. Velocity and vorticity (VV)
   c. Stream function and vorticity (SV)
   d. Other (O, specify)

C. BOUNDARY AND INITIAL CONDITIONS

1. Initial conditions (give letter in brackets, followed by a colon and the quantities determined, i.e. P: **V**, p and U: k, ε)
   a. From rest (R)
   b. Uniform distribution (U)
   c. Potential flow for (P)
   d. Boundary layer solutions (B)
   e. Other (O, specify)

2. Upstream boundary (give location (x/L), letter in brackets: quantities determined, i.e. -1.5, P:**V**, p and U:k, ε)
   a. Uniform distribution (U)
   b. Potential flow for (P)
   c. Boundary layer solutions (B)
   d. Other (O, specify)

3. Downstream boundary (give location (x/L), letter in brackets: quantities determined, i.e. 1.5, 1D: **V**, k,ε and 0D: p)
   a. Value of quantity specified (0D)
   b. Zero derivative along longitudinal grid lines (1D)
   c. Zero second derivative along longitudinal grid lines (2D)
   d. No condition (N)
   e. Other (O, specify)

4. Wall boundary (give max and min value of y+ for first grid point, followed by letter in brackets, i.e. 2.3-0.5, N)
   a. No-slip (N)
   b. Wall functions
      i. With pressure gradient (W)
      ii. Without pressure gradient (WO)
   c. Other (O, specify)

5. Far field boundary (give location (R/L or y/L and z/L), letter in brackets: quantities determined, i.e. 1.0, l D: **V**, p and Z: k, ε)
   a. Value of quantity specified
      i. Zero(Z)
      ii. From uniform flow (U)
      iii. From potential flow (P)
   b. Zero derivative along normal grid lines (1D)
   c. Zero second derivative along normal grid lines (2D)
   d. Free boundary (F)
   e. Other (O, specify)

D. TURBULENCE TREATMENT

1. Type of model
   a. None (N)
   b. Large Eddy Simulation (LES, specify)
   c. Hybrid LES/RANS (RANS/LES, specify)
   d. Algebraic eddy-viscosity or mixing-Length, (AL, specify)
   e. One-equation (e.g. k, specify)
   f. Two-equation, (e.g. k, ε, specify)
   g. Algebraic stress equations (AS, specify)
   h. Reynolds stress equations (RS, specify)
   i. Other (O, specify)

2. Transition point
   a. Forced transition (F, specify location of transition, x/L)
   b. Natural transition (N, specify model)
   c. Fully turbulent (T)
   d. Other (O, specify)

3. Wall treatment
   a. Wall resolved (WR)
   b. Wall model, log law-type (WM)
   c. Other (O, specify)

E. PROPELLER TREATMENT

1. Propeller model
   a. Actual Propeller (A)
   b. Body force model
      i. Prescribed (BP)
      ii. Lifting line (BL)
      iii. Lifting surface (BS)
      iv. Lifting body (BB)
      v. Vortex lattice (BV)
      vi. Other (BX, specify)
   c. Pressure jump (P)
   d. Other (O, specify)

2. Parameters given to propeller model
   a. Propeller rotation rate
      i. Prescribed (RP)
      ii. Balanced with ship's resistance (RB)
   b. Advance coefficient
      i. Prescribed (JP)
      ii. Balanced with ship's resistance (JB)
   c. Thrust
      i. Prescribed (TP)
      ii. Balanced with ship's resistance (TB)
   d. Torque
      i. Prescribed (QP)
      ii. Balanced with ship's resistance (QB)
   e. Other (O, specify)

3. How do you evaluate propeller open water performance (POT) ?
   a. Use measured data (M)
   b. Compute with propeller model (C)
   c. Other (O, specify)

F. FREE-SURFACE TREATMENT

1. Describe your free-surface treatment
   a. Linearized free surface (L)
   b. Nonlinear free-surface tracking (T)
   c. Free-surface capturing
      i. MAC (M)
      ii. VOF (V)
      iii. Level set (LS)
   d. Other (O, specify)

2. Please explain the following, concerning your treatment of the kinematic free-surface boundary condition (KFSBC).
   a. Discretization and solution scheme is similar with an underlying flow solver (R)
   b. Addition of filtering (F) and/or artificial viscosity (A) is required
   c. Separate grids are used for flow solver and KFSB (S)
   d. Special treatment of solid/free-surface contact line (SF, explain)
   e. No explicit enforcement KFSBC (N)
   f. Other (O, specify)

3. What approximations to the dynamic free-surface boundary conditions (DFSBC) are made?
   a. Small slope and vertical velocity gradient approximation (S)
   b. Surface tension neglected (T)
   c. Viscous effects neglected (V)
   d. No approximation made (NA)
   e. No explicit enforcement of DFSBC (N)

4. For given DFSBC formulation, specify what conditions are applied to the dependent variables (give letter in brackets, followed by a colon and the quantities determined, i.e. 1G:V, k, ε and 0D:p)
   a. Value of quantity specified (0D)
   b. Zero derivative in the direction normal to free surface (1N)
   c. Zero derivative along the grid lines (1G)
   d. Zero derivative in the vertical direction (1Z)
   e. No explicit enforcement of DFSBC (N)
   f. Other (O, specify)

5. For diffraction problem, how do you generate incident waves?
   a. Simulated wave maker (WM)
   b. Oscillatory velocity (OV)
   c. Oscillatory pressure (OP)
   d. Oscillatory velocity and pressure (OVP)
   e. Other (O, specify)

G. SHIP MOTIONS TREATMENT

1. What are the degrees of freedom (DOF) of ship motions?
   a. 6 DOF (surge, sway, heave, roll, pitch and yaw) (6)
   b. 4 DOF (surge, sway, roll and yaw) (4)
   c. 3 DOF (surge, sway and yaw) (3)
   d. Other (O, specify)

2. What is the frame of reference for 6DoF calculations?
   a. Ship-fixed: CFD in non-inertial frame (S)
   b. Earth-fixed: CFD in inertial frame, ship motions added as boundary conditions (E)

3. How is force integration performed?
   a. Based on solid-surface cell (C)
   b. Based on fluid momentum balance (Mb)

4. Type of formulation:
   a. Euler angles (E)
   b. Quaternions (Q)

5. How is moment of inertia treated? (mark all that apply)
   a. Full tensor (Ft)
   b. Diagonal tensor (D)
   c. Variable (changes with moving appengades) (V)
   d. Fixed (Fi)

6. How are the rigid body equations integrated?
   a. Euler explicit (E)
   b. Euler implicit (I)
   c. Runge-Kutta (R)
   d. Adams-Bashforth (A)
   e. Multi-stage explicit (M)
   f. Three point backward implicit (B)
   g. Other (O, specify)

7. What is the formal order of accuracy of the integration?
   a. First (1)
   b. Second (2)
   c. Third (3)
   d. Fourth (4)
   e. Other (O, specify)

8. Method to handle ship motions in the grid
   a. Moving grid (Overall grid) (Mo)
   b. Moving grid (Chimera or Overset grid)) (Mc)
   c. Immersed boundary (Ib)
   d. Deforming grid (Dg)
   e. Regridding (Rg)
   f. Other (O, specify)

9. What is the non-dimensional time step size ($t^*=\Delta t^*U/L$)?

10. What type of controller is used?

H. GRID CHARACTERISTICS

1. What software did you use to generate your grids?
   a. Commercial software (C, list name and version):
   b. In-house software (I)

2. For your simulation, which geometry format did you use?
   a. Offsets (O)
   b. Surface grid (G)
   c. IGES file (I)

3. Type of grid (For multiblock grid systems, multiple answers may be needed)
   a. Single block structured (S)
   b. Multiblock structured (MS)
   c. Overlapping structured (OS)
   d. Unstructured (U)

  e. Multiblock unstructured (MU)
  f. Other (O, specify)

4. Orthogonality
  a. Non-orthogonal everywhere (NE)
  b. Orthogonal in planes (OP)
  c. Orthogonal at some boundaries(OB)
  d. Orthogonal everywhere (OE)

5. Generation method
  a. Analytic (A)
  b. Numerical (N)
  c. Algebraic (L)
  d. Elliptic (E)
  e. Hyperbolic (H)
  f. Parabolic (P)
  g. Transfinite (T)
  h. Conformal (C)
  i. Geometrical (G)
  j. 3D(3)
  k. 2D plane by plane (2)
  l. Other (O, specify))
  m. Post generation smoothing? (PS)

6. Control
  a. Adaptive (A)
  b. Control from boundaries (B)
  c. Control from inside the domain (D)

I. NUMERICAL METHOD

(The answers to some of the questions of this paragraph may differ between the equations solved (i.e. RANS, turbulence and free surface). If so, give answer for all)

1. General classification by discretization scheme
  a. Finite element (FE)
  b. Finite difference (FD)
  c. Finite volume (FV)
  d. Finite analytic (FA)
  e. Spectral (S)
  f. Integral (I)
  g. Mixed (M)
  h. Other (O, specify)

2. What kind of CELL or ELEMENT is the formulation based on?
  a. Hexahedra (H)
  b. Tetrahedra (T)
  c. General polyhedra (P)
  d. Other (O, specify)

3. Spatial discretization
  a. Finite difference, regular or collocated grid (R)
  b. Finite difference, staggered grid (T)
  c. Finite volume, regular grid (V)
  d. Finite volume, staggered grid (S)
  e. Finite element (L)
  f. Hybrid (H)
  g. Other (O, specify)

4. For FINITE ELEMENT METHODS, specify the appropriate basis function for velocity and pressure (e.g. V: dG1, P: dG0)
   a. Piecewise constant, discontinuous (dG0)
   b. Piecewise linear, discontinuous (dG1)
   c. Piecewise linear, continuous (cG1)
   d. Mixed (M, specify)
   e. Spectral (S)
   f. Other (O, specify)

5. For FINITE ELEMENT METHODS, how is stability ensured
   a. Streamline diffusion (S)
   b. Through choice of basis functions (B)
   c. Through choice of scheme (Sc)
   d. Other, (O, specify)

6. How are the convective terms discretized?
   a. Centered (C)
   b. Upwind, standard (U)
   c. Upwind, skewed (K)
   d. Rotated (R)
   e. Explicit artificial viscosity (E)
   f. Hybrid, (H, specify)
   g. Other, (O, specify)

7. What is the formal order of accuracy of the convective term discretization?
   a. First (1)
   b. Second (2)
   c. Third (3)
   d. Fourth (4)
   e. Mixed (M)
   f. Other (O, specify)

8. In your scheme, what quantities are formally conserved?
   a. Mass (Q)
   b. Mass and momentum (M)
   c. Mass, momentum, kinetic energy (J)
   d. Mass, momentum, total energy (W)
   e. Other (O, specify)

9. What kind of linearization scheme is used?
   a. Picard (P)
   b. Newton (N)
   c. Quasi-Newton (Q)
   d. Explicit scheme (E)
   e. Other (O, specify)

10. What scheme is used to couple pressure and velocity fields?
    a. Fully-coupled solutions
       i. Direct method (D)
       ii. Penalty method (P)
       iii. Compressible-flow code used at low Mach number (C)
       iv. Artificial compressibility (A)
       v. Other (OF, specify)
    b. Segregated
       i. Pressure-correction technique, e.g., Fractional step, MAC, SIMPLE, SIMPLER, SIMPLEC, PISO, etc. (PR, specify)
       ii. Other (OS, specify)

11. For each iterative solver in your scheme, please specify the method used
    a. Point substitution (P)
    b. Line substitution (L)
    c. Direct matrix inversion (M)
    d. Split (ADI-like)(A)
    e. Incomplete LU decomposition (I)
    f. Krylov methods, e.g., conjugate gradient methods (C)
    g. Other (O, specify)

12. Specify any pre-conditioning or acceleration techniques which are used
    a. Under-relaxation (U)
    b. Over-relaxation (R)
    c. Grid sequencing (G)
    d. Multi-grid (M)
    e. Additive terms (e.g., quasi-time dependent, fixed or variable time step)(A)
    f. Other (O, specify)

13. How are the temporal terms discretized?
    a. Euler explicit (E)
    b. Euler implicit (I)
    c. Runge-Kutta (R)
    d. Adams-Bashforth (A)
    e. Multi-stage explicit (M)
    f. Three point backward implicit (B)
    g. Other (O, specify)

14. What is the formal order of accuracy of the temporal terms discretization ?
    a. First (1)
    b. Second (2)
    c. Third (3)
    d. Fourth (4)
    e. Other (O, specify)

J. COMPUTER PERFORMANCE

1. What computer system architecture was used for the simulation?
    a. Distributed memory scalable parallel processing system (D)
    b. Shared memory scalable parallel processing system (S)
    c. Vector processing system (V)
    d. Desktop workstation (W)

2. Processor
    a. Manufacturer:
    b. Model:
    c. Number of CPUs:
    d. Number of cores/CPU:
    e. Core speed:
    f. Total memory:

3. For distributed memory systems, what kind of interconnect was used?
    a. Infiniband (I)
    b. Gigabit Ethernet (E)
    c. Myrinet (M)
    d. Other (O, specify)

4. What is the theoretical speed of this computer?
    a. In GFLOPS:

   b. Spec CPU2000 (CFP2000):

5. If parallel computing was used, specify approach
   a. Message-passing interface (MPI), single-program multiple data, and distributed memory (M)
   b. OpenMP, threads, and shared memory (OM)
   c. High-performance Fortran (HPF) (H)
   d. Vendor constructs (e.g., SGI doacross) (V)
   e. Other (O, specify)

6. Grid specification, finest grid
   a. Total number of cells/elements:
   b. Number of blocks:
   c. Number of cells/elements in the smallest block:
   d. Number of cells/elements in the largest block:

7. What algorithm was used to partioning the grid
   a. Metis (M)
   b. Split along grid axis (S)
   c. Other (O, specify)

8. Memory requirements, finest grid
   a. Total memory
      i. In gigabytes, GB:
      ii. or in megawords, MW:
   b. For parallel computations,
      i. Number of processors:
      ii. Required memory per processor:

9. Time, finest grid
   a. CPUtime (seconds) for the complete simulation:
   b. CPUtime (seconds) per iteration per grid point:
   c. Wall-clock time (seconds) for the complete simulation:

10. Convergence, finest grid
   a. Number of iterations or time steps for convergence:
   b. Convergence criterion:

K. UNCERTAINTY ASSESSMENT

1. Case for which you performed your uncertainty assessment:

2. What sources of error were you able to evaluate?
   a. Spatial discretization (S)
   b. Lack of iterative convergence (I)
   c. Computer round-off (R)
   d. Other (O, specify)

3. How did you determine the error due to lack of iterative convergence?
   a. Residuals(R)
   b. Iterative history of integral quantity (e.g., resistance)(I)
   c. Iterative history of point quantity (e.g., velocity or pressure at a specific point in the flow field)(P)
   d. Other, (O, specify)

4. How did you determine the spatial discretization error/uncertainty?
   a. Richardson extrapolation via systematic grid studies(R)
      i. Number of grids used:

ii. Refinement ratio used:

b. Single-grid error methods (S, describe)

c. Previous experience (E)

d. Other (O, specify)

5. List any references used in your uncertainty assessment:

L. CODE REFERENCES

References to the method and previous results must be included in the paper

M. COMMENTS

Use this section to provide additional information.

Indicate appropriate sections (A through M, above).