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**4.1. BOUNDARY CONDITION LIST**

You will probably want the table of boundary conditions below available. When processing your grid, use either the indices in the first column or the second column. When you get your results back, the forces that are summarized in the `[project].forces` file will be labeled using the notation in the second column. This is done so that existing boundary condition flags may be used, while still allowing for 4-digit boundary conditions in the solver, which enable room for future growth. *\_Note that if you want to change a boundary condition, you must pre-process the grid over again. The BC indices are hardwired into the partition files.\_* This is on our to-do list to change.

Grid Index	FUN3D Index	Description	Notes
6661	6661	Symmetry Plane	x plane only: enforces zero crossflow velocity
6662	6662	Symmetry Plane	y plane only: enforces zero crossflow velocity
6663	6663	Symmetry Plane	z plane only: enforces zero crossflow velocity
3	5000	Farfield	Riemann invariant node based
4	4000	Viscous	strong enforcement of no-slip condition
5	3000	Tangency	weak enforcement of zero normal velocity through fluxes
6100	6100	Periodicity	Discrete periodicity, limited to nominally 2D grids extruded across n planes in a third dimension

Element Based Boundary Conditions ( Version 10.5 )— Values ( where required ) set up in `&boundary_conditions` namelist in `namelist.input` (`fun3d.nml` for versions 10.9.0 and later)

Grid Index	FUN3D Index	Description	Notes
5025	5025	Farfield	Riemann invariants
5026	5026	Extrapolate	Supersonic outflow
5050	5050	Farfield	Freestream
5051	5051	Back pressure	Specified static pressure (allows supersonic flow)
5052	5052	Back pressure2	Static pressure set by specified Mach number ( $M < 1$ )
7011	7011	Subsonic inflow	Subsonic inflow (pt,Tt) for nozzle plenum
7012	7012	Subsonic outflow	Subsonic outflow (p0) for inlet duct
7031	7031	Mass flow out	Specification of massflow out of the control volume
7036	7036	Mass flow in	Specification of massflow in to the control volume
7100	7100	Fixed inflow	Fixed primitive variables in to control volume

**TRAINING WORKSHOPS**

- I. March 2010 Workshop
  - 1. Overview
  - 2. Agenda
  - 3. Images
- II. April 2010 Workshop

- 1 Overview
- 2 Agenda and Training Materials
- 3 Images
- III. July 2010 Workshop
  - 1 Overview
  - 2 Agenda and Training Materials
- IV. March 2014 Workshop
  - 1 Overview
  - 2 Agenda and Training Materials
- V. Future Workshops
  - 1 Overview

#### TUTORIALS

- I. Introduction
  - 1 See also
- II. Flow Solver
  - 1 Inviscid flow solve
  - 2 Turbulent flow solve
  - 3 Merge VGRID mesh into mixed elements and run solution
- III. Grid Motion
  - 1 Overset Moving Grids
- IV. Design Optimization
  - 1 Max L/D for steady flow
  - 2 Max L/D for steady flow at two different Mach numbers
  - 3 Lift-constrained drag minimization for DPW wing
  - 4 Max L/D over a pitching cycle for a wing
  - 5 Max L/D for steady flow over a wing-body-tail using Sculptor
- V. Geometry Parameterization
  - 1 MASSOUD
  - 2 Bandaids

#### APPLICATIONS

- 1. Updated scaling study on ORNL Cray XK7 system
- 2. Forward and adjoint solutions for wind turbine
- 3. Forward and adjoint solutions for aeroelastic F-15
- 4. Simulation of biologically-inspired flapping wing
- 5. Notional unducted engine with counter-rotating blades
- 6. More applications posters
- 7. Animation of Landing Gear Simulations
- 8. Computational Schlierens for Supersonic Retro-Propulsion
- 9. Time-dependent discrete adjoint solution for UH60 helicopter in forward flight
- 10. Fuselage effects for UH60 helicopter
- 11. Mesh adaptation for RANS simulation of supersonic business jet
- 12. More applications posters
- 13. Horizontal axis wind turbine
- 14. BMI's Mike Henderson describes the role of CFD and HPC in tractor-trailer analysis and design
- 15. Computational Schlieren for Unsteady Simulation of Launch Abort System
- 16. Computational vs Experimental Schlieren for Supersonic Retro-Propulsion
- 17. More Smart Truck Simulations at BMI Corporation
- 18. More recent applications at AMRDEC
- 19. Hypersonic Winnebago Simulation
- 20. Flight Trajectories for Various Rocket Geometries
- 21. Supersonic Retro-Propulsion
- 22. Smart Truck Simulations at BMI Corporation
- 23. Ongoing Improvements in Computational Performance
- 24. Long-duration Landing Gear Simulations
- 25. Design of Tiltrotor Configuration
- 26. Design of F-15 with Simulated Aeroelastic Effects
- 27. FUN3D and LAURA v5 STS-2 heating comparisons
- 28. Recent applications at AMRDEC
- 29. DES ground wind simulation on ARES configuration
- 30. Modified F-15 with Propulsion Effects
- 31. Mars Science Laboratory
- 32. Propulsion-Related Test Cases

## 4.2. VALUE INPUT FORMAT (VERSION 11.0)

For code released at 10.8.0 or later, a change in the boundary condition input format has been made. The patch number associated with a boundary condition now used to directly index the physical conditions. `bc_count` and `bc_patch(n)` are no longer used.

Please report any problems, inconsistencies, issues, etc. with the new `boundary_conditions` input to [FUN3D Support](#).

```

! This file contains namelists used for specifying inputs to
! FUN3D. For versions 10.8 and later, the following namelists
! apply (if a namelist is not present, its variables take on
! their default values):
!   boundary_conditions
!
&boundary_conditions
  grid_units = 'meters'
                                ! options: meters, inches, millimeters
                                ! DEFAULT=meters
                                | Used in dimensional unit conversion
  massflow_dimensions = 'nondim'
                                ! options: metric (kg/s), nondim (mesh units squared)
                                ! DEFAULT=metric
                                | Used in dimensional unit conversion
  total_pressure_ratio(n) = 1
                                ! Input for BC 7011 associated with bc patch number -n-
                                ! DEFAULT=1
  total_temperature_ratio(n) = 1
                                ! Input for BC 7011 associated with bc patch number -n-
                                ! DEFAULT=1
  subsonic_inflow_velocity(n) = 'normal'
                                ! Direction of inflow velocities for BC 7011
                                ! associated with bc patch number -n-
                                ! options: 'normal', 'alpha,beta'
                                ! DEFAULT='normal'
  alpha_bc(n) = 0.0
                                ! Input for BC 7011 associated with bc patch number -n-
                                ! DEFAULT=0.0
  beta_bc(n) = 0.0
                                ! Input for BC 7011 associated with bc patch number -n-
                                ! DEFAULT=0.0
  static_pressure_ratio(n) = 1
                                ! Input for BC 7012, 5051 associated with bc patch number -n-
                                ! DEFAULT=1
  mach_bc(n) = 0
                                ! Input for BC 5025 patch number associated with bc patch number -n-
                                ! DEFAULT=0
  q_set(n,5) = 0
                                ! Input for BC 7100, 7105 associated with bc patch number -n-
                                ! DEFAULT=(0.,0.,0.,0.,0.)
  massflow(n) = 0
                                ! Input for BC 7031, 7036 associated with bc patch number -n-
                                ! DEFAULT=0
  wall_temperature(n) = 1
                                ! Input for BC associated with patch number -n-
                                ! Sets Twall/Tref value. (Note that corresponding
                                ! wall_temp_flag(n) must be set to .true.)
                                ! DEFAULT=1
  wall_temp_flag(n) = .false.
                                ! Input for BC associated with patch number -n- to activate
                                ! use of wall temperature input
                                ! DEFAULT=.false.
!
!-----
!-----
/

```

Note that the above namelist file contains many input variables, but in general it is not necessary to list them all. One can instead rely on the fact that most of the defaults are often desired, and only those variables that are **different** from the defaults need to be given. The following might be an example of a typical namelist file for a calorically-perfect FUN3D run:

- 33 Recent Applications at BMI Corporation
- 34 Applications Posters
- 35 Mars Phoenix Lander
- 36 CLV Analysis
- 37 Robin Helicopter
- 38 Dynamic Overset Grid Demonstration Using A Simple Rotor/Fuselage Model
- 39 Hypersonic Tethered Ballute Simulation
- 40 Time-Dependent Oscillating Flap Demonstration
- 41 Adjoint-Based Adaptation Applied to AIAA DPW II Wing-Body
- 42 Adjoint-Based Adaptation Applied to High-Lift Airfoil
- 43 Trapezoidal High-Lift Wing
- 44 Adjoint-Based Adaptation Applied to Supersonic Double-Airfoil
- 45 Partial-Span Flap
- 46 Mach 24 Temperature-Based Adaptation of Space Shuttle Configuration in Chemical Nonequilibrium
- 47 Line Construction for Line-Implicit Relaxation
- 48 Biologically-Inspired Morphing Aircraft
- 49 Mars Flyer
- 50 Support for QFF Tunnel Experiment
- 51 Combined FUN3D/CFL3D F-18
- 52 Adjoint-Based Adaptation for 3D Sonic Boom
- 53 Unsteady Space Shuttle Cable Tray Analysis
- 54 Adjoint-Based Design of Indy Car Wing
- 55 3D Domain Decomposition
- 56 Mesh Movement Strategies
- 57 High-Lift Computations vs Experiment
- 58 Various 2D Adjoint-Based Airfoil Designs

#### SOURCE CODE ACTIVITY

- Subversion Commits

### SAMPLE BOUNDARY CONDITION NAMELISTS

#### SUBSONIC INFLOW / NOZZLE BC – BC 7011

This is an example of a mesh in inches, one total pressure-total temperature boundary condition associated with patch 3, with the inflow velocity set normal to the patch (default setting) for a pressure ratio of 1.6 ( inflow total pressure normalized by reference static pressure ) and a temperature ratio of 1.0 ( inflow total temperature normalized by reference static temperature).

The non-dimensional freestream static pressure in FUN3D is 1/g and is the same as the reference static pressure.. Total\_pressure\_ratio is the same as nozzle pressure ratio for propulsion simulations.

```
&boundary_conditions
  total_pressure_ratio(3)    = 1.6,
  total_temperature_ratio(3) = 1.0,
/
```

#### INLET BC EXAMPLE 1 – BC 7031

This is a sample for an inlet with one mass flow out of the control volume boundary associated with patch 1, with a mass flow rate of 0.25 in units of mesh units squared. The desired massflow in this example is ramped from 0 to the set condition of 0.25 over 500 iterations as set by flow\_mflux\_ramp.

```
&boundary_conditions
  massflow(1)                = 0.25,
  inlet_solution_method      = 'massflux',
/
&component_parameters
  flow_mflux_ramp=500,
/
```

#### INLET BC EXAMPLE 2 – BC 7012

This is a sample for an inlet mesh with a specified static pressure ratio of 0.9 associated with patch 5. This is the static pressure required at the outflow boundary normalized by the reference static pressure.

```
&boundary_conditions
  static_pressure_ratio(5) = 0.9,
/
```

#### FIXED INFLOW/OUTFLOW – BC 7100/7105

Patch 8 is a fixed inflow or outflow boundary setting the normalized density to 1, the normalized velocities of u, v, and w to 0.5, 0.0, and 0.0 respectively and the pressure to 0.714.

```
&boundary_conditions
  q_set(8,:) = 1.0, 0.5, 0.0, 0.0, 0.714,
/
```

#### TOTAL PRESSURE INFLOW/STATIC PRESSURE OUTFLOW – BC 7011-7012

Patch 5 is a total pressure—total temperature boundary condition associated assuming alpha=0 and beta=0 with the total pressure ratio of 1.984 and a total temperature ratio of 1.201. The total pressure ratio is ramped from 1.0 to 1.984 over 100 iterations via the parameter inflow\_pt\_ramp. The second boundary condition patch is 6 and is a static pressure ratio and static temperature ratio boundary set to the conditions of 1.364 and 1.0 respectively.

```
&boundary_conditions
  total_pressure_ratio(5) = 1.984
  total_temperature_ratio(5) = 1.201
  static_pressure_ratio(6) = 1.364
/
&component_parameters
  inflow_pt_ramp=100
/
```

### SPECIFIED MACH NUMBER – BC 5052

The Mach number of 0.5 is specified for patch 5.

```
&boundary_conditions
  mach_bc(5) = 0.5
/
```

### STATIC PRESSURE FOR FLOW OUT OF CONTROL VOLUME – BC 5051

The static pressure ratio of 0.25 is specified for patch 2.

```
&boundary_conditions
  static_pressure_ratio(2) = 0.25
/
```

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