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4. Boundary Conditions

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

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 numb
                            ! DEFAULT=1
   mach_bc(n) = 0
                            ! Input for BC 5025 patch number associated with bc pat
                            ! DEFAULT=0
   q_set(n,5) = 0
                            ! Input for BC 7100, 7105 associated with bc patch numb
                            ! DEFAULT=(0.,0.,0.,0.,0.)
   massflow(n) = 0
                            ! Input for BC 7031, 7036 associated with bc patch numb
                            ! 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 acti
                            ! 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:

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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