Examples of wall boundary conditions

The user finds here some examples illustrating the construction of the wall boundary conditions.

- A 2D geometrical configuration is considered. So, data associated to the 3rd direction K could be removed. They are still kept in these examples even if they are useless.
- For the sake of clarity, the multi-species case is not considered (homogeneous fluid). The namelist associated to the species is therefore not present.

Heated enclosed cavity

- The domain is a square cavity (2D geometry).
- Bottom and top walls are insulated. The heat flux is null.
- The left wall is set to the upper constant and uniform temperature : T= 305K.
  The right wall is set to the lower constant and uniform "temperature : T= 295K.
- The velocity boundary conditions are no-slip and impermeability conditions.
- There is no immersed body.
- Walls of the cavity are located at the ends of the domain. This is the basic domain configuration initialized by the code if any other boundary condition is not placed at the ends (like inlet, outlet, symmetrical or periodical boundary conditions, see namelists Inlet_Boundary_Condition, Outlet_Boundary_Condition, or Border_Domain_Boundary_Conditions).
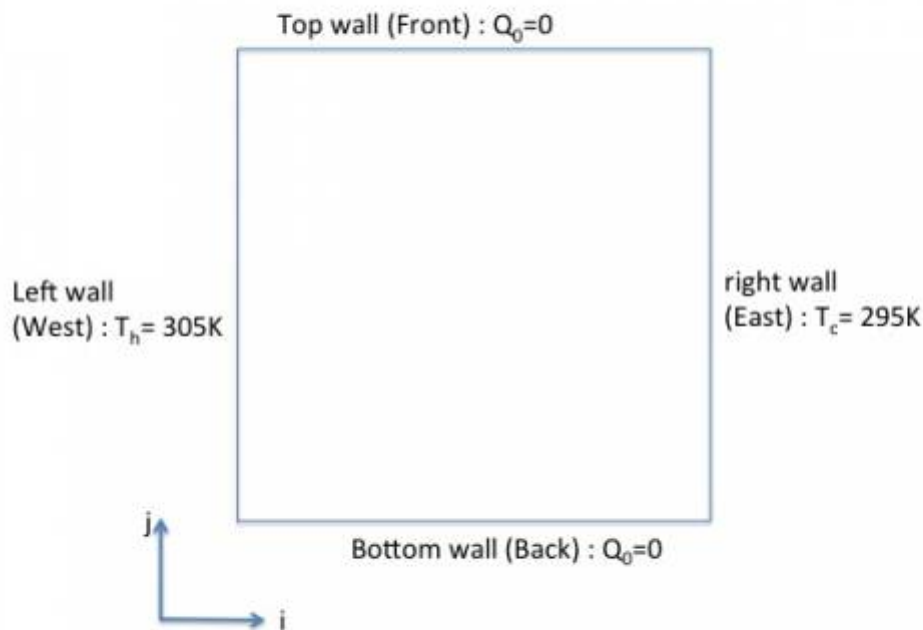
We need just to state one **WPCP**.

```
 &Heat_Wall_Boundary_Condition_Setup
    Wall_BC_DataSetName      ="Set1",
    West_Heat_BC_Option   = 0 ,  East_Heat_BC_Option    = 0 ,
Back_Heat_BC_Option    = 1 ,  Front_Heat_BC_Option    = 1 ,
    South_Heat_BC_Option    = 0 , North_Heat_BC_Option    = 0,
    West_Heat_Function_Type= 0 ,  East_Heat_Function_Type= 0 ,
Back_Heat_Function_Type= 0  ,  Front_Heat_Function_Type= 0 ,
    South_Heat_Function_Type= 0 , North_Heat_Function_Type= 0,
    West_Wall_BC_Value= 305.   ,  East_Wall_BC_Value= 295.  ,
Back_Wall_BC_Value= 0.0   ,  Front_Wall_BC_Value= 0.0    ,
    South_Wall_BC_Value= 0.0   , North_Wall_BC_Value= 0.0  /
    &Velocity_Wall_Boundary_Condition_Setup
    Wall_BC_DataSetName      ="Set1",
    West_Velocity_I_BC_Option= 0 ,  East_Velocity_I_BC_Option= 0 ,
Back_Velocity_I_BC_Option= 0 , Front_Velocity_I_BC_Option= 0,
    South_Velocity_I_BC_Option= 0 , North_Velocity_I_BC_Option= 0 ,
    West_Velocity_J_BC_Option= 0 ,  East_Velocity_J_BC_Option= 0 ,
Back_Velocity_J_BC_Option= 0 , Front_Velocity_J_BC_Option= 0,
    South_Velocity_J_BC_Option= 0 , North_Velocity_J_BC_Option= 0 ,
    West_Velocity_K_BC_Option= 0 ,  East_Velocity_K_BC_Option= 0 ,
Back_Velocity_K_BC_Option= 0 , Front_Velocity_K_BC_Option= 0,
    South_Velocity_K_BC_Option= 0 , North_Velocity_K_BC_Option= 0 ,
    West_Velocity_I_Function_Type= 0,  East_Velocity_I_Function_Type= 0,
Back_Velocity_I_Function_Type= 0,
```

```
    Front_Velocity_I_Function_Type= 0, South_Velocity_I_Function_Type= 0,
North_Velocity_I_Function_Type= 0 ,
    West_Velocity_J_Function_Type= 0,  East_Velocity_J_Function_Type= 0,
Back_Velocity_J_Function_Type= 0,
    Front_Velocity_J_Function_Type= 0, South_Velocity_J_Function_Type= 0,
North_Velocity_J_Function_Type= 0 ,
    West_Velocity_K_Function_Type= 0,  East_Velocity_K_Function_Type= 0,
Back_Velocity_K_Function_Type= 0,
    Front_Velocity_K_Function_Type= 0, South_Velocity_K_Function_Type= 0,
North_Velocity_K_Function_Type= 0 ,
    West_Wall_Velocity_I= 0.0   ,   East_Wall_Velocity_I= 0.0   ,
Back_Wall_Velocity_I= 0.0    , Front_Wall_Velocity_I= 0.0   ,
    South_Wall_Velocity_I= 0.0    , North_Wall_Velocity_I= 0.0 ,
    West_Wall_Velocity_J= 0.0   ,   East_Wall_Velocity_J= 0.0   ,
Back_Wall_Velocity_J= 0.0    , Front_Wall_Velocity_J= 0.0   ,
    South_Wall_Velocity_J= 0.0    , North_Wall_Velocity_J= 0.0 ,
    West_Wall_Velocity_K= 0.0   ,   East_Wall_Velocity_K= 0.0   ,
Back_Wall_Velocity_K= 0.0    , Front_Wall_Velocity_K= 0.0  ,
    South_Wall_Velocity_K= 0.0    , North_Wall_Velocity_K= 0.0 /
```

- There is just one WBCP. This name is "Set1". It is automatically linked with the walls belonging to the domain ends.
- The no-slip and impermeable boundary conditions are actually used by default in the code. For this reason, this kind of boundary conditions could be not explicitly set.

Enclosed cavity with two bars

- The domain is a square cavity with a length of $L= 1.0$ (2D geometry).
- Walls of the cavity are set to the constant and uniform temperature : $T= 300 K$.
- Walls of the first bar are set to the constant and uniform heat flux : $Q= 5W/m^2$. Keep in mind that :
  - heating the fluid from walls is defined with a negative heat flux
  - cooling the fluid from walls is defined with a positive heat flux
- Walls of the second bar are set to the same boundary conditions as the cavity : $T=300 K$.
- The velocity boundary conditions are no-slip and impermeability conditions for all the walls (cavity and bars). As they correspond to the default boundary conditions, they are not explicitly stated here.
- There are two immersed bodies : the couple of bars. Each bar is a rectangle with a size of 0.1x0.2. The center of the first bar is 0.3x0.3, the second one is 0.7x0.7
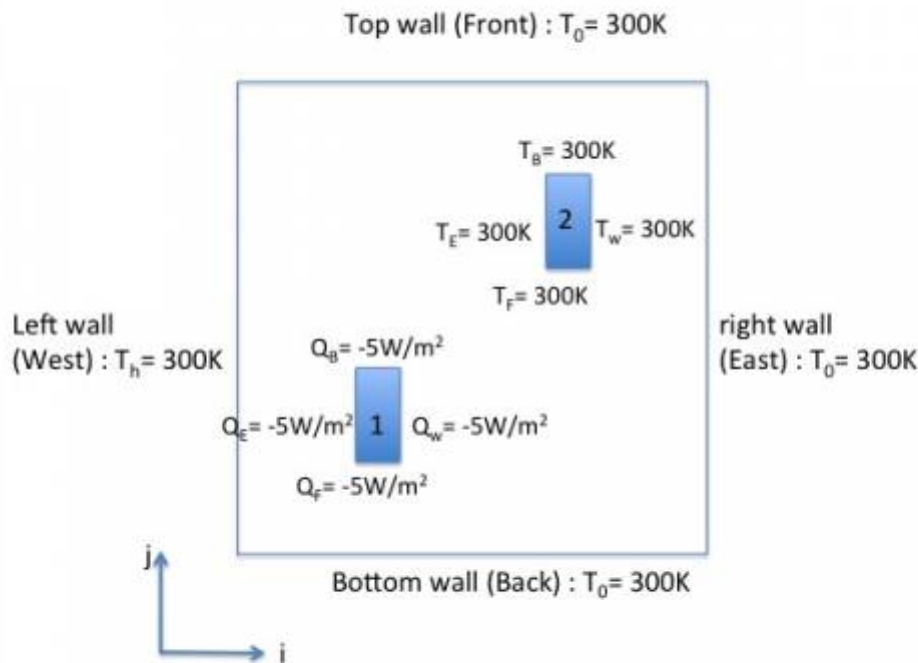
We need to two **WBCP** for setting the two different sets of wall boundary conditions, the first one for the imposed temperature, the second one for the imposed heat flux. We also need to state two **IBD** in order to define the positions of the couple of bars.

The first **WBCP**

```
  &Heat_Wall_Boundary_Condition_Setup
   Wall_BC_DataSetName     ="Set1",
    West_Heat_BC_Option    = 0 ,  East_Heat_BC_Option    = 0 ,
Back_Heat_BC_Option     = 0  ,  Front_Heat_BC_Option    = 0 ,
South_Heat_BC_Option    = 0 , North_Heat_BC_Option    = 0,
    West_Heat_Function_Type= 0 ,  East_Heat_Function_Type= 0 ,
Back_Heat_Function_Type= 0  ,  Front_Heat_Function_Type= 0 ,
South_Heat_Function_Type= 0 , North_Heat_Function_Type= 0,
    West_Wall_BC_Value= 300.   ,  East_Wall_BC_Value= 300.  ,
Back_Wall_BC_Value= 300.0   ,  Front_Wall_BC_Value= 300.0   ,
South_Wall_BC_Value= 0.0   , North_Wall_BC_Value= 0.0  /
```

The second **WBCP**

```
  &Heat_Wall_Boundary_Condition_Setup
   Wall_BC_DataSetName     ="Set2",
    West_Heat_BC_Option    = 1 ,  East_Heat_BC_Option    = 1 ,
Back_Heat_BC_Option     = 1  ,  Front_Heat_BC_Option    = 1 ,
South_Heat_BC_Option     = 0 , North_Heat_BC_Option    = 0,
    West_Heat_Function_Type= 0 ,  East_Heat_Function_Type= 0 ,
Back_Heat_Function_Type= 0  ,  Front_Heat_Function_Type= 0 ,
```

```
South_Heat_Function_Type= 0 , North_Heat_Function_Type= 0,
    West_Wall_BC_Value= -5.0   ,  East_Wall_BC_Value= -5.0  ,
Back_Wall_BC_Value= -5.0  ,  Front_Wall_BC_Value= -5.0  ,
South_Wall_BC_Value= 0.0   , North_Wall_BC_Value= 0.0  /
```

The first **IBD** (the first bar)

```
&Polyhedral_Immersed_Bodies
    Xi_1= 0.25 , Xj_1= 0.20 , Xk_1= 0.0 ,
    Xi_2= 0.35 , Xj_2= 0.20 , Xk_2= 0.0 ,
    Xi_3= 0.35 , Xj_3= 0.40 , Xk_3= 0.0 ,
    Xi_4= 0.25 , Xj_4= 0.40 , Xk_4= 0.0 ,
    Wall_BC_DataSetName    ="Set2"/
```

The second **IBD** (the second bar)

```
&Polyhedral_Immersed_Bodies
    Xi_1= 0.65 , Xj_1= 0.60 , Xk_1= 0.0 ,
    Xi_2= 0.75 , Xj_2= 0.60 , Xk_2= 0.0 ,
    Xi_3= 0.75 , Xj_3= 0.80 , Xk_3= 0.0 ,
    Xi_4= 0.65 , Xj_4= 0.80 , Xk_4= 0.0 ,
    Wall_BC_DataSetName    ="Set1"/
```
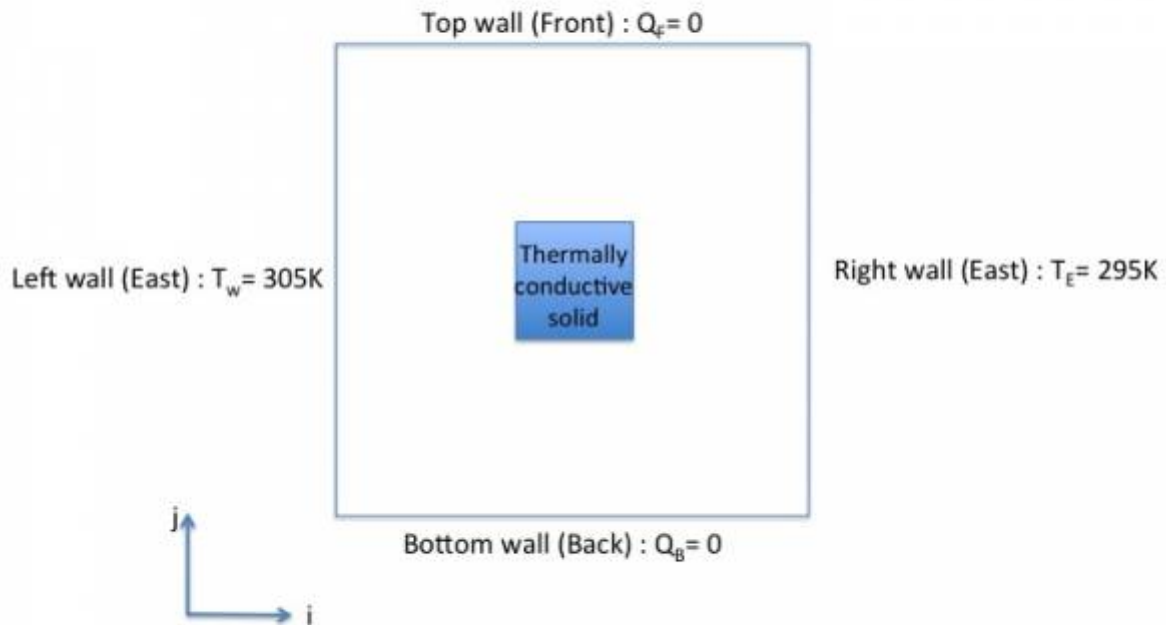
- The first immersed body is linked to the second **WBCP**(imposed heat flux) and the second body is linked to the first **WBCP** (imposed temperature) by means of the variable "Wall_BC_DataSetName".
- The **WBCP** named "Set1" is also automatically linked to the walls of the domain end's (cavity walls).
- The rank order of the boundary conditions is unimportant.

Enclosed cavity with a thermally conductive bar

- The domain is a square cavity with a length of $L= 1.0$ (2D geometry).
- Bottom and top walls of the cavity are insulated. The heat flux is null.
- The left and right walls of the cavity are set to 305K and 295K, respectively.
- The bar is thermally conductive. Its size is 0.2x0.2 and it is centered on the cavity.
- The velocity boundary conditions are no-slip and impermeable conditions for all walls.

We need to state two **WBCP** to define the two different sets of wall boundary conditions, the first one for the imposed temperature and heat flux at the walls of the cavity, the second one to define the physical properties of the bar. We also need to state one **IBD** in order to define the position of the bar.

The first **WBCP**

```
  &Heat_Wall_Boundary_Condition_Setup
    Wall_BC_DataSetName     ="Set1",
    West_Heat_BC_Option   = 0 ,  East_Heat_BC_Option   = 0 ,
Back_Heat_BC_Option    = 1 ,  Front_Heat_BC_Option    = 1 ,
South_Heat_BC_Option   = 0 , North_Heat_BC_Option    = 0,
    West_Heat_Function_Type= 0 ,  East_Heat_Function_Type= 0 ,
Back_Heat_Function_Type= 0 ,  Front_Heat_Function_Type= 0 ,
South_Heat_Function_Type= 0 , North_Heat_Function_Type= 0,
    West_Wall_BC_Value= 305.   ,  East_Wall_BC_Value= 295.  ,
Back_Wall_BC_Value= 0.0   ,  Front_Wall_BC_Value= 0.0   ,
South_Wall_BC_Value= 0.0   , North_Wall_BC_Value= 0.0  /
```

The second **WBCP**

```
  &Heat_Wall_Boundary_Condition_Setup
    Wall_BC_DataSetName     ="Set2",
    West_Heat_BC_Option   = 2 ,  East_Heat_BC_Option    = 2 ,
Back_Heat_BC_Option    = 2 ,  Front_Heat_BC_Option    = 2 ,
    South_Heat_BC_Option    = 0 , North_Heat_BC_Option    = 0,
    Material_Thermal_Conductivity= 1.00 , Material_Mass_Heat_Capacity=
3000.00 , Material_Density= 900.00 /
```

The first **IBD** (the bar)

```
&Polyhedral_Immersed_Bodies
    Xi_1= 0.40 , Xj_1= 0.40 , Xk_1= 0.0 ,
    Xi_2= 0.40 , Xj_2= 0.40 , Xk_2= 0.0 ,
    Xi_3= 0.60 , Xj_3= 0.60 , Xk_3= 0.0 ,
    Xi_4= 0.60 , Xj_4= 0.60 , Xk_4= 0.0 ,
    Wall_BC_DataSetName      ="Set2"/
```

- The **WBCP** named "Set1" is automatically linked to the walls of the domain end's (cavity walls).
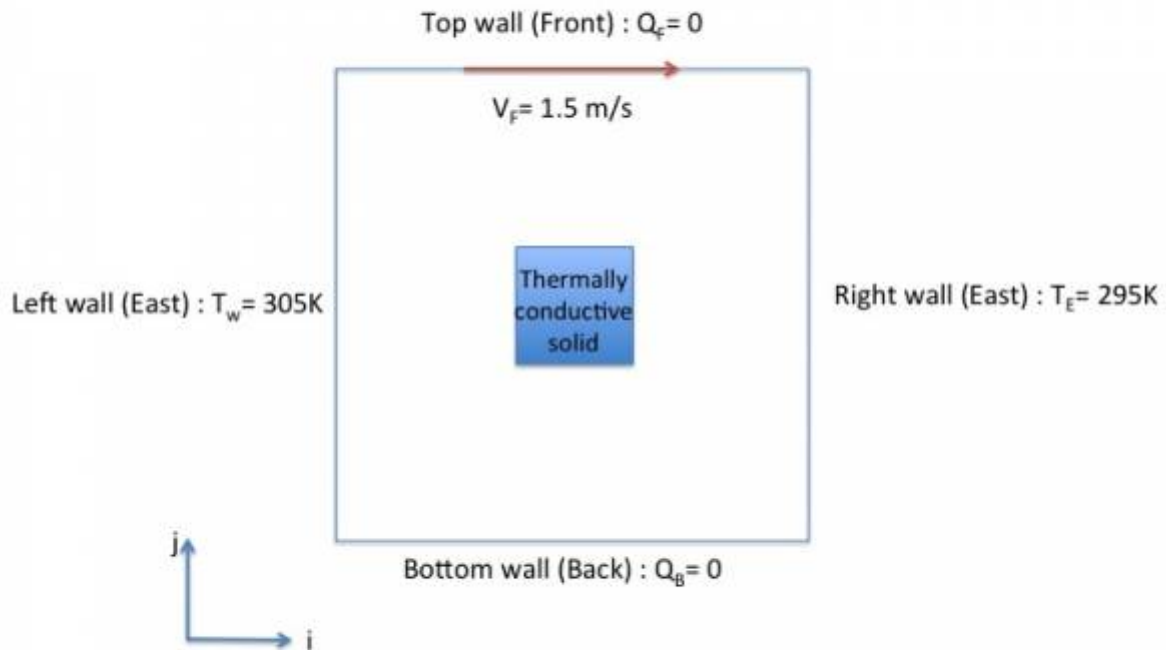- The bar (immersed body) is linked to the second **WBCP**.

Lid-driven cavity with a heated bar

The example is very similar to the previous one but the fluid is driven by the top wall of the cavity.

- The domain is a square cavity with a length of $L= 1.0$ (2D geometry).
- Bottom and top walls of the cavity are insulated. The heat flux is null.
- The left and right walls of the cavity are set to 305K and 295K, respectively.
- The bar is thermally conductive. Its size is 0.2x0.2 and it is centered on the cavity.
- The velocity boundary conditions are no-slip and impermeability conditions for all walls **except at the top of the cavity** where $V= 1.5m.s^{-1}$. For these reason, the wall boundary conditions for the velocity must be stated.

We need to state two **WBCP** to define the two different sets of wall boundary conditions, the first one for the imposed temperature and heat flux at the walls of the cavity, the second one to define the physical properties of the bar. We also need to state one **IBD** in order to define the position of the bar.

The first **WBCP**

```
  &Heat_Wall_Boundary_Condition_Setup
    West_Heat_BC_Option    = 0 ,  East_Heat_BC_Option    = 0 ,
Back_Heat_BC_Option    = 1 ,   Front_Heat_BC_Option   = 1 ,
South_Heat_BC_Option    = 0 , North_Heat_BC_Option    = 0,
    West_Heat_Function_Type= 0 ,  East_Heat_Function_Type= 0 ,
Back_Heat_Function_Type= 0 ,   Front_Heat_Function_Type= 0 ,
South_Heat_Function_Type= 0 , North_Heat_Function_Type= 0,
    West_Wall_BC_Value= 305.   ,  East_Wall_BC_Value= 295.  ,
Back_Wall_BC_Value= 0.0   ,  Front_Wall_BC_Value= 0.0   ,
South_Wall_BC_Value= 0.0   , North_Wall_BC_Value= 0.0  /
   &Velocity_Wall_Boundary_Condition_Setup
    West_Velocity_I_BC_Option= 0 ,  East_Velocity_I_BC_Option= 0 ,
Back_Velocity_I_BC_Option= 0 , Front_Velocity_I_BC_Option= 0,
    South_Velocity_I_BC_Option= 0 , North_Velocity_I_BC_Option= 0 ,
    West_Velocity_J_BC_Option= 0 ,  East_Velocity_J_BC_Option= 0 ,
Back_Velocity_J_BC_Option= 0 , Front_Velocity_J_BC_Option= 0,
    South_Velocity_J_BC_Option= 0 , North_Velocity_J_BC_Option= 0 ,
    West_Velocity_K_BC_Option= 0 ,  East_Velocity_K_BC_Option= 0 ,
Back_Velocity_K_BC_Option= 0 , Front_Velocity_K_BC_Option= 0,
    South_Velocity_K_BC_Option= 0 , North_Velocity_K_BC_Option= 0 ,
    West_Velocity_I_Function_Type= 0,  East_Velocity_I_Function_Type= 0,
Back_Velocity_I_Function_Type= 0,
    Front_Velocity_I_Function_Type= 0, South_Velocity_I_Function_Type= 0,
North_Velocity_I_Function_Type= 0 ,
```

```
    West_Velocity_J_Function_Type= 0,  East_Velocity_J_Function_Type= 0,
Back_Velocity_J_Function_Type= 0,
    Front_Velocity_J_Function_Type= 0, South_Velocity_J_Function_Type= 0,
North_Velocity_J_Function_Type= 0 ,
    West_Velocity_K_Function_Type= 0,  East_Velocity_K_Function_Type= 0,
Back_Velocity_K_Function_Type= 0,
    Front_Velocity_K_Function_Type= 0, South_Velocity_K_Function_Type= 0,
North_Velocity_K_Function_Type= 0 ,
    West_Wall_Velocity_I= 0.0   ,   East_Wall_Velocity_I= 0.0   ,
Back_Wall_Velocity_I= 0.0    , Front_Wall_Velocity_I= 1.5   ,
    South_Wall_Velocity_I= 0.0   , North_Wall_Velocity_I= 0.0 ,
    West_Wall_Velocity_J= 0.0   ,   East_Wall_Velocity_J= 0.0   ,
Back_Wall_Velocity_J= 0.0    , Front_Wall_Velocity_J= 0.0   ,
    South_Wall_Velocity_J= 0.0    , North_Wall_Velocity_J= 0.0 ,
    West_Wall_Velocity_K= 0.0   ,   East_Wall_Velocity_K= 0.0   ,
Back_Wall_Velocity_K= 0.0    , Front_Wall_Velocity_K= 0.0  ,
    South_Wall_Velocity_K= 0.0    , North_Wall_Velocity_K= 0.0 /
```

The second **WBCP**

```
  &Heat_Wall_Boundary_Condition_Setup
  West_Heat_BC_Option   = 2 ,  East_Heat_BC_Option    = 2 ,
Back_Heat_BC_Option    = 2 ,  Front_Heat_BC_Option    = 2 ,
  South_Heat_BC_Option   = 0 , North_Heat_BC_Option    = 0,
    Material_Thermal_Conductivity= 1.00 , Material_Mass_Heat_Capacity=
3000.00 , Material_Density= 900.00 /
    &Velocity_Wall_Boundary_Condition_Setup
    West_Velocity_I_BC_Option= 0 ,  East_Velocity_I_BC_Option= 0 ,
Back_Velocity_I_BC_Option= 0 , Front_Velocity_I_BC_Option= 0,
    South_Velocity_I_BC_Option= 0 , North_Velocity_I_BC_Option= 0 ,
    West_Velocity_J_BC_Option= 0 ,  East_Velocity_J_BC_Option= 0 ,
Back_Velocity_J_BC_Option= 0 , Front_Velocity_J_BC_Option= 0,
    South_Velocity_J_BC_Option= 0 , North_Velocity_J_BC_Option= 0 ,
    West_Velocity_K_BC_Option= 0 ,  East_Velocity_K_BC_Option= 0 ,
Back_Velocity_K_BC_Option= 0 , Front_Velocity_K_BC_Option= 0,
    South_Velocity_K_BC_Option= 0 , North_Velocity_K_BC_Option= 0 ,
    West_Velocity_I_Function_Type= 0,  East_Velocity_I_Function_Type= 0,
Back_Velocity_I_Function_Type= 0,
    Front_Velocity_I_Function_Type= 0, South_Velocity_I_Function_Type= 0,
North_Velocity_I_Function_Type= 0 ,
    West_Velocity_J_Function_Type= 0,  East_Velocity_J_Function_Type= 0,
Back_Velocity_J_Function_Type= 0,
    Front_Velocity_J_Function_Type= 0, South_Velocity_J_Function_Type= 0,
North_Velocity_J_Function_Type= 0 ,
    West_Velocity_K_Function_Type= 0,  East_Velocity_K_Function_Type= 0,
Back_Velocity_K_Function_Type= 0,
    Front_Velocity_K_Function_Type= 0, South_Velocity_K_Function_Type= 0,
North_Velocity_K_Function_Type= 0 ,
    West_Wall_Velocity_I= 0.0   ,   East_Wall_Velocity_I= 0.0   ,
Back_Wall_Velocity_I= 0.0    , Front_Wall_Velocity_I= 0.0   ,
    South_Wall_Velocity_I= 0.0    , North_Wall_Velocity_I= 0.0 ,
```

```
      West_Wall_Velocity_J= 0.0   ,   East_Wall_Velocity_J= 0.0   ,
Back_Wall_Velocity_J= 0.0    , Front_Wall_Velocity_J= 0.0   ,
    South_Wall_Velocity_J= 0.0    , North_Wall_Velocity_J= 0.0 ,
     West_Wall_Velocity_K= 0.0   ,   East_Wall_Velocity_K= 0.0   ,
Back_Wall_Velocity_K= 0.0    , Front_Wall_Velocity_K= 0.0   ,
    South_Wall_Velocity_K= 0.0    , North_Wall_Velocity_K= 0.0 ,
   End_of_Data_Block= .true. /
```

The first **IBD** (the bar)

```
 &Polyhedral_Immersed_Bodies
    Xi_1= 0.40 , Xj_1= 0.40 , Xk_1= 0.0 ,
    Xi_2= 0.40 , Xj_2= 0.40 , Xk_2= 0.0 ,
    Xi_3= 0.60 , Xj_3= 0.60 , Xk_3= 0.0 ,
    Xi_4= 0.60 , Xj_4= 0.60 , Xk_4= 0.0 ,
    Wall_BC_DataSetName     ="Set2"/
```

- The first **WBCP** is automatically linked to the walls of the domain end's (cavity walls). The wall temperatures are imposed as in the previous case. Moreover the I-velocity component is set to 1.5 at the top wall (Front_Wall_Velocity_I= 1.5).
- The bar (immersed body) is linked to the second **WBCP**. The usual no-slip and impermeability boundary conditions are explicitly stated here because the default values are no longer available due to the previous **WBCP**.
- When several **WBCP** are present and at least one of them contains a specific set of velocity boundary conditions, which differ from the usual ones, the namelist "Velocity_Wall_Boundary_Condition_Setup" must then be explicitly set for each **WBCP**, even for the usual velocity boundary conditions.

Click here to come back to the "Heat_Wall_Boundary_Condition_Setup"
Click here to come back to the "Velocity_Wall_Boundary_Condition_Setup"
Click here to come back to the "Species_Wall_Boundary_Condition_Setup"
Click here to come back to the "Polyhedral_Immersed_Bodies"
Click here to come back to the "Cylindrical_Immersed_Bodies"