GROBDESIGN

Tutorial 2

FIRE DYNAMICS SIMULATION USING FDS (FIRE DYNAMICS SIMULATOR) TOOL IN OFFICE ROOM

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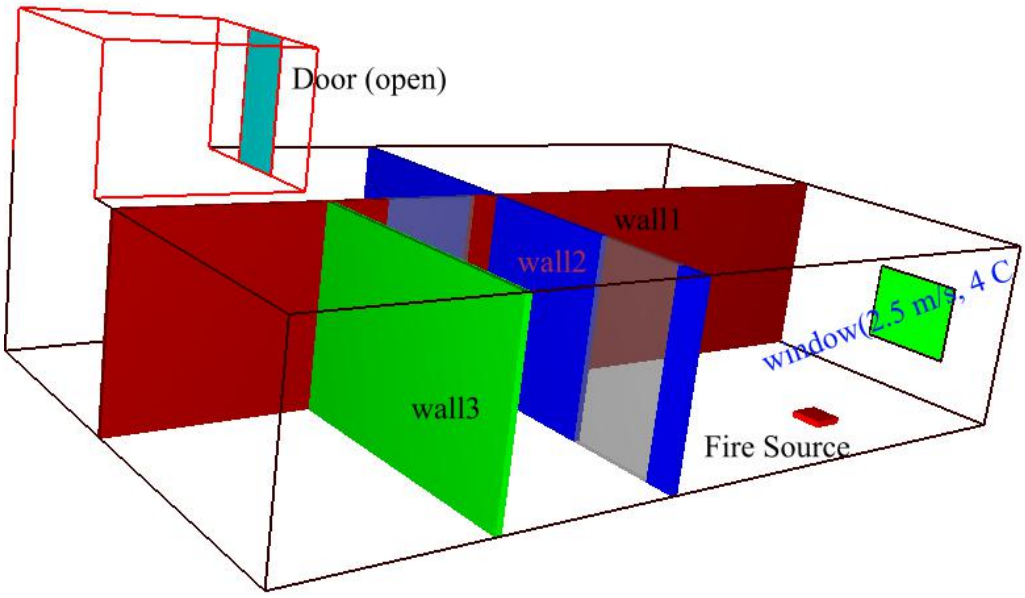
Tutorial 2 Fire dynamics simulation using FDS (fire Dynamics Simulator) tool in office room

In this tutorial a window is created which is treated as inflow of air with velocity of **2.5 m/s** having temperature of **5 C**. The outflow conditions is treated at top of the office, and the boundary condition is set as **open to atmosphere.** One fire point is created from which Methane is continue burning using **HRR equal to 1000 unit**.



The steps are followed in this tutorial are listed below::

Step I: create header syntax file to start program in FDS software.

```
&HEAD CHID='fire'/
```

Note: fire is user defined name of FDS function/ file.

Step II: create syntax for simulation flow time.

```
&TIME T_END=20.0
```

Note: 20 sec is simulation flow time, which is solved in FDS software.

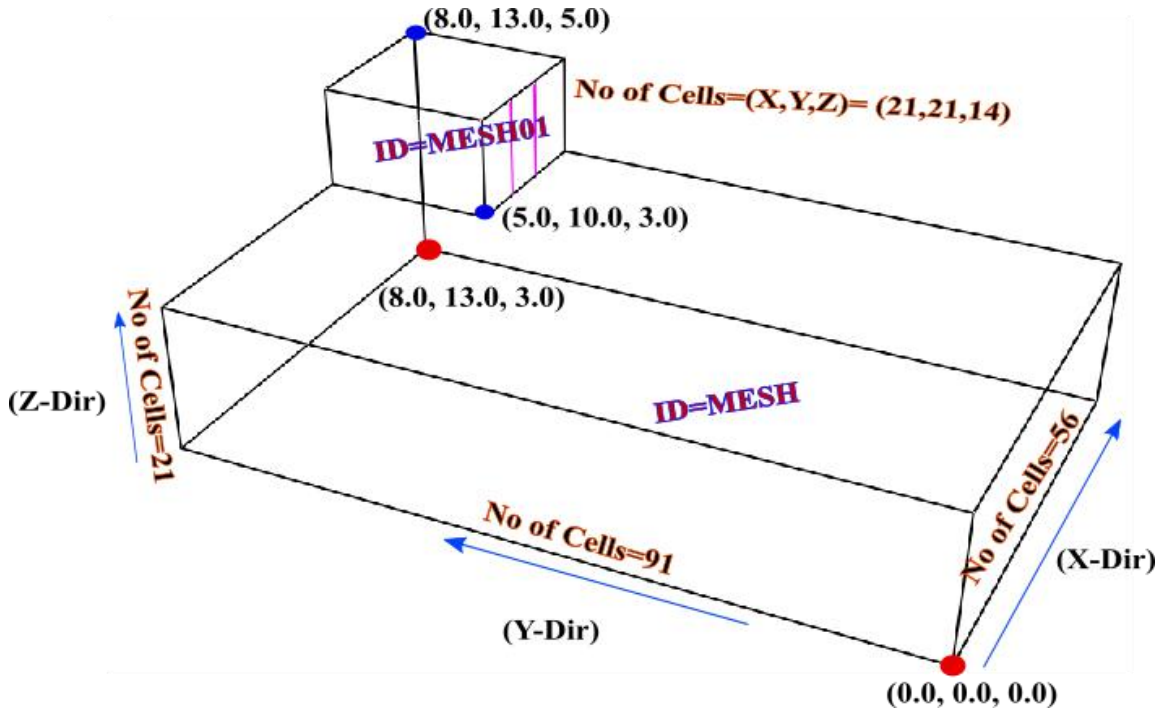
Step III: create syntax for initial temperature of domain.

```
&MISC TMPA=45.0/
```

Note: 45 C is initial room temperature, which is provided in this tutorial. Following three syntax is must for every FDS function.

Step IV: Create syntax for geometry making of fluid domain

```
&MESH ID='MESH', RGB=51,0,0, IJK=56,91,21, XB=0.0,8.0,0.0,13.0,0.0,3.0/
&MESH ID='MESH01', COLOR='RED', IJK=21,21,14, XB=5.0,8.0,10.0,13.0,3.0,5.0/
```



Note: **MESH ID** represent user name of mesh created in FDS. **IJK** represent cell created in domain in X-dir, Y-dir and Z-dir respectively. Like in current problem, 56 cells are created in X-direction, 91 cells are created in Y-direction and 21 cells are created in Z-direction. **XB** represent start and END point of rectangular domain in following syntax

XB=X1,X2,Y1,Y2,Z1,Z2/

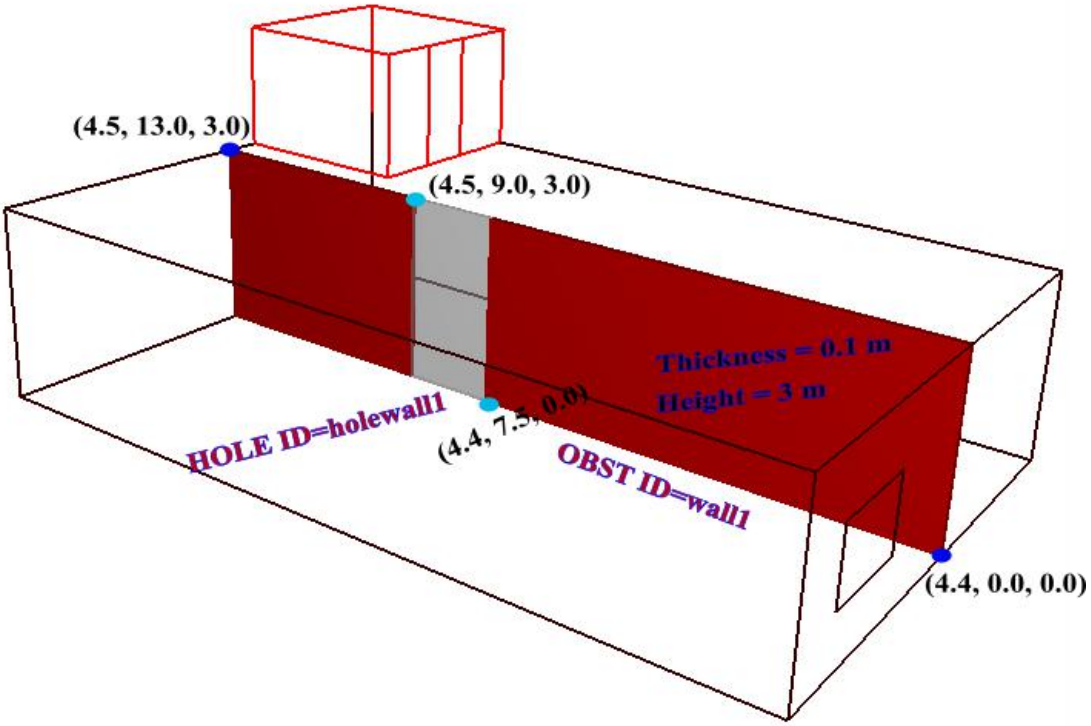
Here 1 represent starting point and 2 represent end point. XB is always start from origin.

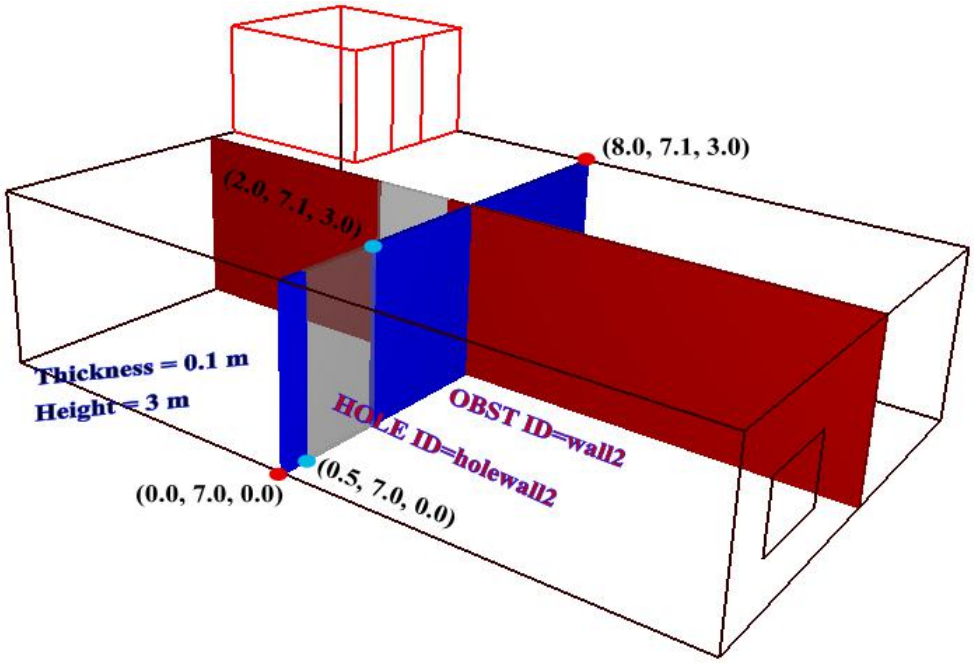
Step V: create walls and holes in walls using OBST command in syntax

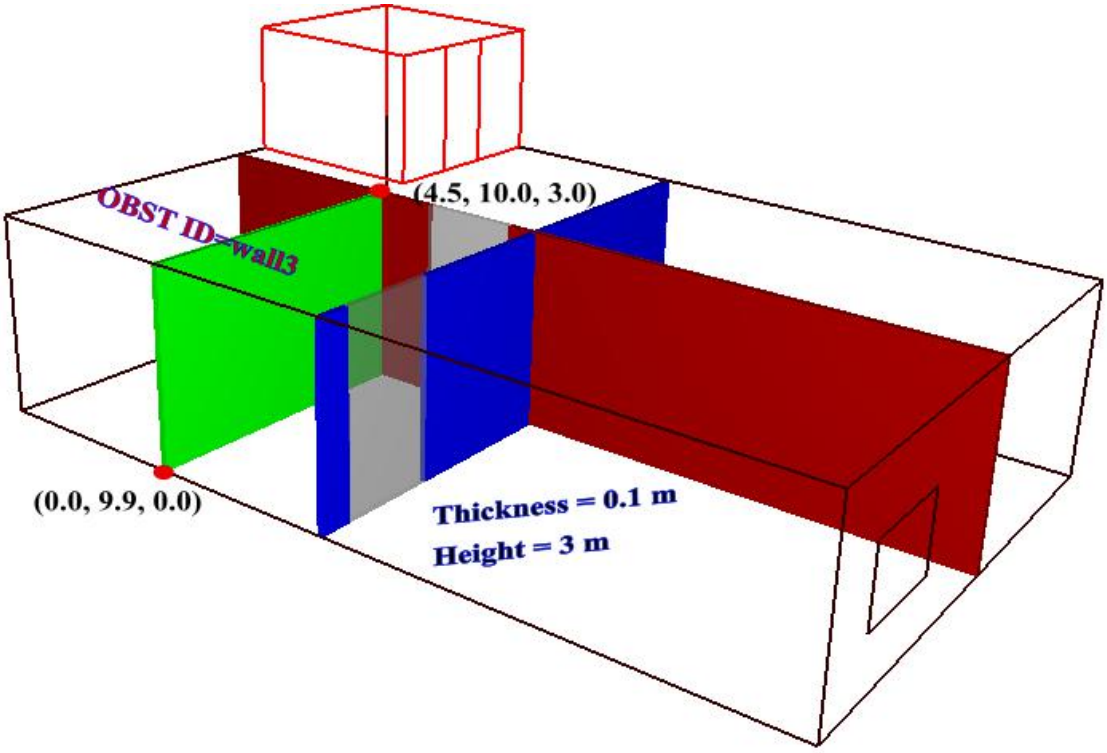
```
&OBST ID='wall1', XB=4.4,4.5,0.0,13.0,0.0,3.0, RGB=152,0,0,
SURF_ID='INERT'/
&HOLE ID='Holewall1', XB=4.4,4.5,7.5,9.0,0.0,3.0/
&OBST ID='wall2', XB=0.0,8.0,7.0,7.1,0.0,3.0, COLOR='BLUE',
SURF_ID='INERT'/
&HOLE ID='Holewall2', XB=0.5,2.0,7.0,7.1,0.0,3.0/
&OBST ID='wall3', XB=0.0,4.5,9.9,10.0,0.0,3.0, COLOR='GREEN',
SURF_ID='INERT'/
&OBST ID='methane_source', XB=1.0,1.5,2.5,3.0,0.0,0.1,
SURF_ID='methane_burner'/
```

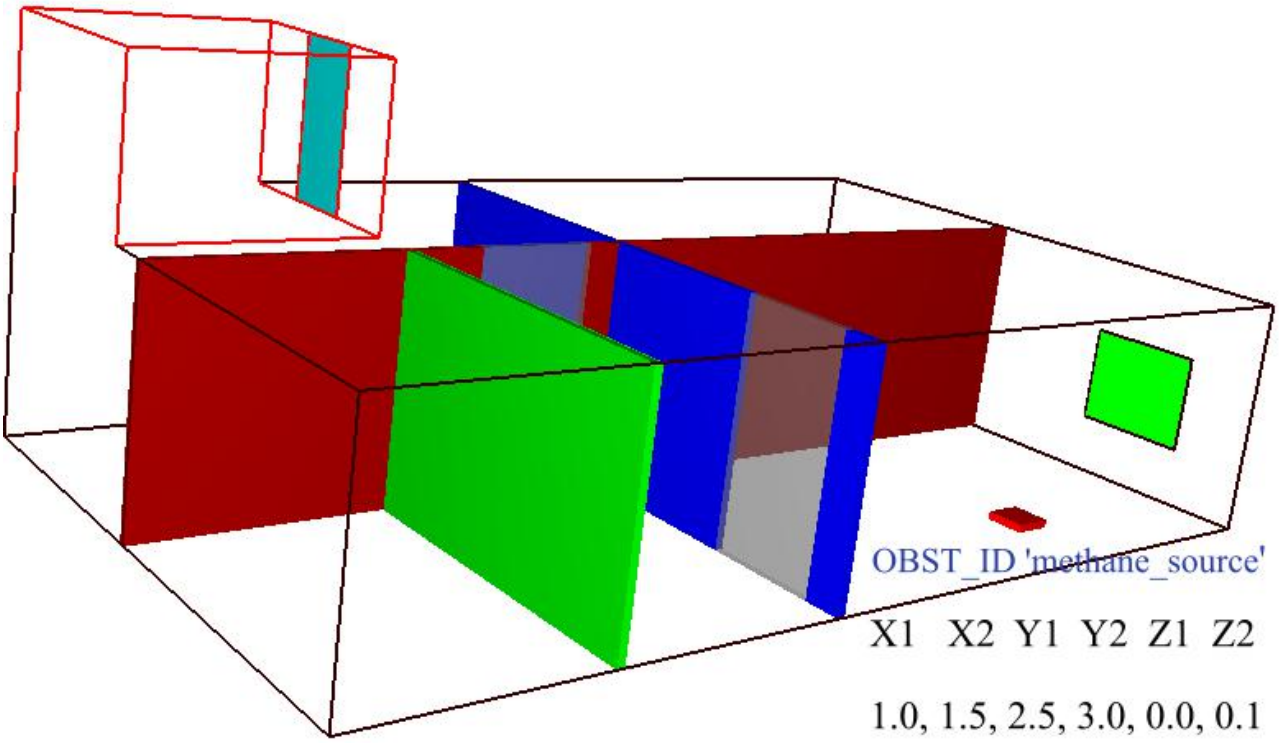
Note: **OBST** is obstacle created in FDS and it can be 3D or 2D depend on fluid problem. Wall1, wall2 and wall3 represent user name of **OBST,** created in current problem. **XB** represent the geometrical presentation in syntax of FDS software. These OBSts are created at different location of domain (see figure). **SURF ID**

represent fluid boundary conditions in FDS software. In this case software generated surf-id named “inert” is created inert has no CFD interference in simulation. **HOLE ID** is used to create hole in **OBST ID** in FDS software. Methane source is used to set as burner which create fire in room. SURF ID methane burner is user created reaction boundary condition which create chemical reaction between CH4 and air.





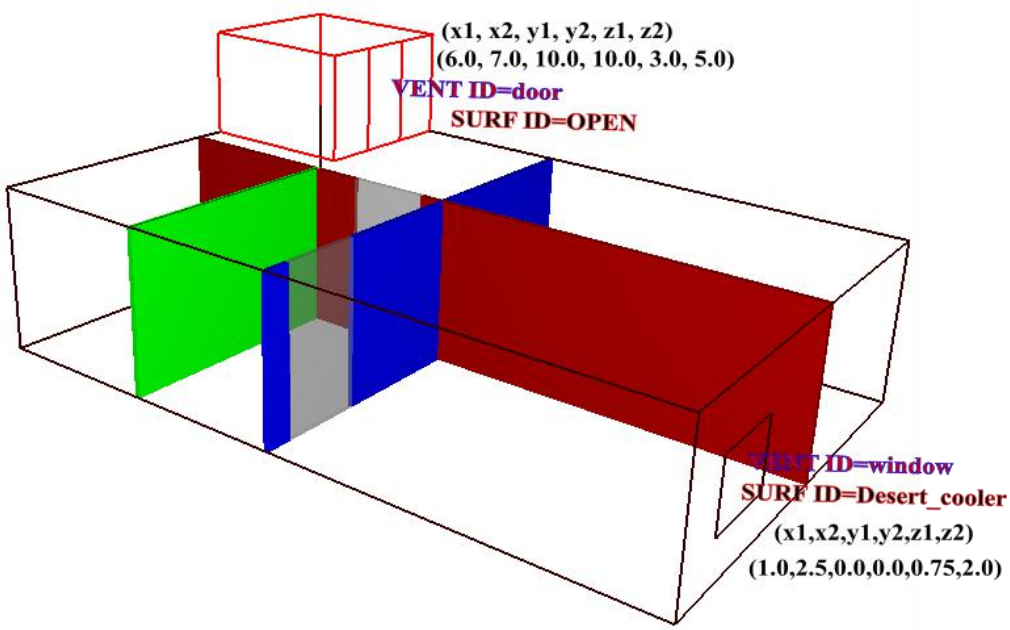




Step VI: create door and window at wall surface using VENT ID syntax

```
&VENT ID='door', SURF_ID='OPEN', XB=6.0,7.0,10.0,10.0,3.0,5.0/
```

```
&VENT ID='window', SURF_ID='Desert_cooler',
XB=1.0,2.5,0.0,0.0,0.75,2.0, COLOR='GREEN'/
```



Note: **VENT ID** is special type of CFD boundary conditions, which are applied on surface of mesh/ **OBST**. In this problem one door and one window is created using these **VENT ID** syntax. Door has software created **SURF ID "OPEN"**, where as window has user created **SURF ID "Desert Cooler"**. **COLOR** represent grren color to window surface.

Step VII: create surf ID syntax

```
&SURF ID='Desert_cooler',
      RGB=26,204,26,
      TMP_FRONT=5.0,
      VEL=-2.5/

&SURF ID='methane_burner',
      COLOR='RED',
```

```
        HRRPUA=1000.0/
```

Note: As discussed in previous step, Desert Cooler is CFD boundary condition applied on **VENT ID** window. **RGB** represent color provided to selected **VENT ID. TMP_FRONT** represent 5 C temperature at window with 2.5 m/s velocity at window. The default fluid medium is AIR in FDS software. Methane burner is use HRR (heat release rate) equal to 1000 SI unit.

Step VIII: create reaction using syntax (syntax for chemical reaction in FDS)

```
&REAC ID='METHANE',
        FYI='AFT NIST Multi-Floor FDS5 Validation',
        FUEL='REAC_FUEL',
        FORMULA='C1H4',
        CO_YIELD=0.01,
        SOOT_YIELD=0.05/
```

Step IX: create surface contour for field variable (velocity and temperature)

```
&SLCF QUANTITY='TEMPERATURE', VECTOR=.TRUE., PBZ=1.5/
&SLCF QUANTITY='VELOCITY', VECTOR=.TRUE., PBX=6.5/
```

Note: **SLCF** syntax represent surface contour. **QUANTITY** represent type of field variable and **PBY/ PBZ/ PBX** represent user defined plane for virtual surface creation. VECTOR TRUE means vector is also present in contour in smoke-view PBZ=1.5 represent 1.5 m distance from Z-direction. The measurement is stared from origin.

Step X: end the function by using syntax

&TAIL /

Final FDS code for current problem

```
&HEAD CHID='office'/
&TIME T_END=15.0/

&MISC TMPA=45.0/

&MESH ID='MESH', RGB=51,0,0, IJK=56,91,21, XB=0.0,8.0,0.0,13.0,0.0,3.0/
&MESH ID='MESH01', COLOR='RED', IJK=21,21,14,
XB=5.0,8.0,10.0,13.0,3.0,5.0/

&OBST ID='wall1', XB=4.4,4.5,0.0,13.0,0.0,3.0, RGB=152,0,0,
SURF_ID='INERT'/
&HOLE ID='Holewall1', XB=4.4,4.5,7.5,9.0,0.0,3.0/

&OBST ID='wall2', XB=0.0,8.0,7.0,7.1,0.0,3.0, COLOR='BLUE',
SURF_ID='INERT'/
&HOLE ID='Holewall2', XB=0.5,2.0,7.0,7.1,0.0,3.0/

&OBST ID='wall3', XB=0.0,4.5,9.9,10.0,0.0,3.0, COLOR='GREEN',
SURF_ID='INERT'/

&VENT ID='door', SURF_ID='OPEN', XB=6.0,7.0,10.0,10.0,3.0,5.0/
```

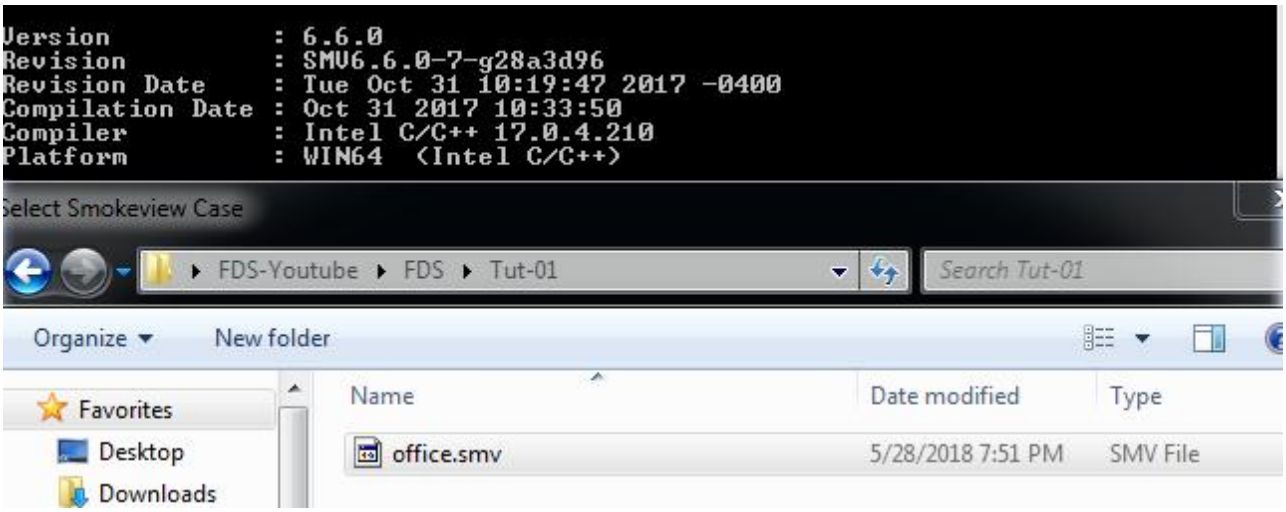
```
&VENT ID='window', SURF_ID='Desert_cooler', XB=1.0,2.5,0.0,0.0,0.75,2.0,
COLOR='GREEN'/

&SURF ID='Desert_cooler',
      RGB=26,204,26,
      TMP_FRONT=5.0,
      VEL=-2.5/

&OBST ID='methane_source', XB=1.0,1.5,2.5,3.0,0.0,0.1,
SURF_ID='methane_burner'/

&SURF ID='methane_burner',
      COLOR='RED',
      HRRPUA=1000.0/

&REAC ID='METHANE',
      FYI='AFT NIST Multi-Floor FDS5 Validation',
      FUEL='REAC_FUEL',
      FORMULA='C1H4',
      CO_YIELD=0.01,
      SOOT_YIELD=0.05/
&SLCF QUANTITY='TEMPERATURE', VECTOR=.TRUE., PBZ=1.5/
&SLCF QUANTITY='VELOCITY', VECTOR=.TRUE., PBX=6.5/


&TAIL /
```

Note: save this function in notepad and save with exe format of *.fds

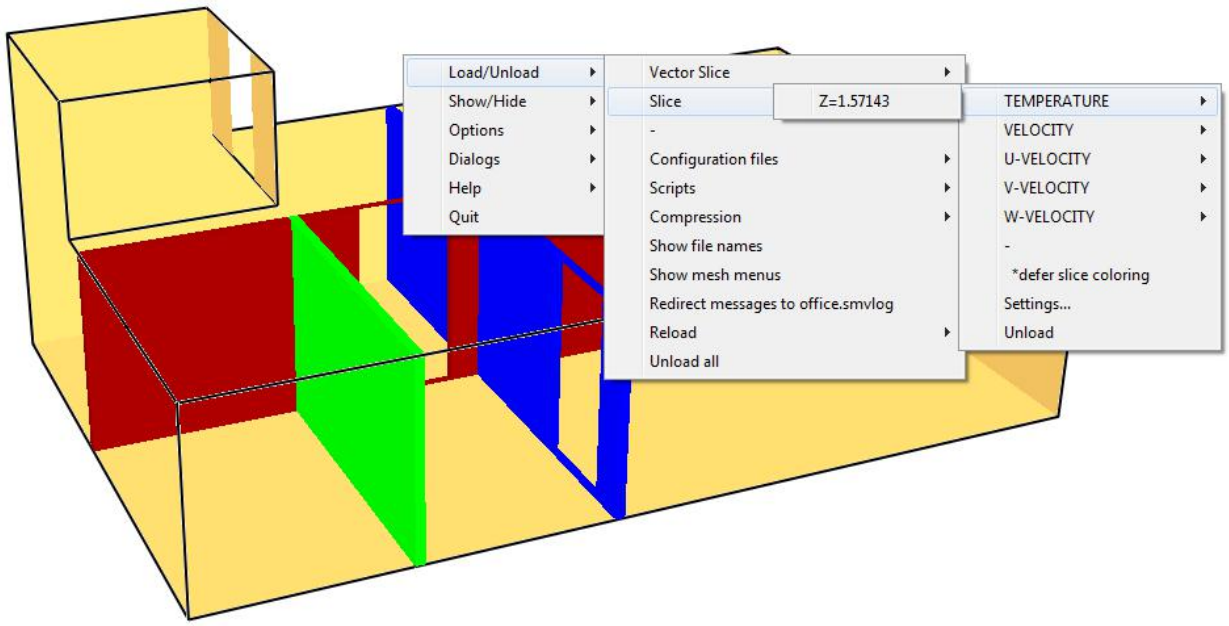
Step XI: run the code by using CMD command prompt in window platform.

Go to folder using CD command and then type **fds office.fds.**

Step XII: run smoke view after run the FDS file by using CMD command prompt



Step XIII: run surface contour using Load/unload in smoke-view



END