FluSol

Problem: Mach 2.0 flows past ogiv-cylinder-wings missile at 5^o, 10^o, 15^o and 20^o angle of attacks.

* 2D mesh consists of 22,332 elements and 22,346 nodes
* 25 minutes to generate the 2D mesh
* Assign 4 wing surfaces
* Sweep 2D mesh around axis to generate 3D mesh
* 3D mesh includes 1,576,872 cells and 1,595,110 nodes.
* 144 pyramids, 14,400 prisms and 1,562,328 hexahedrons
* Wall clock : 59317 seconds
* Hardware: AMD64 3500+ CPU 2.19GHz,2.87 GB of RAM

Flusol calculations	Mach number	Aplha (Degrees)	CN	Xcp/D
Inviscid	2.0	5.00	0.8235	11.4469
Inviscid	2.0	10.00	1.8229	10.983
Inviscid	2.0	15.0	3.2539	10.1854
Inviscid	2.0	20.0	5.3285	9.6227

Oktay E., Alemdaroglu N., Tarhan E., Champigny P.1, d'Espiney P. “Unstructured Euler solutions for missile aerodynamics”, Aerospace Science and Technology, Volume 4, Number 7, October 2000 , pp. 453-461.

Break down of pressure forces acted on all boundary surfaces for 20 degrees angle of attack. Reference point locates at nose tip [x,y]=[0.0,0.0].Diameter = 1.0

Part Name	CDX	CDY	CDZ	CMX	CMY	CMZ
Nose	0.06171	0.61766	0.9686E-06	0.2482E-08	-0.3018E-05	1.26002
Cylinder	0.0	2.2508	0.9067E-04	0.1832E-09	-0.4954E-03	18.7214
Cylinder among-Wings	0.2459E-04	0.2227	-0.1645E-03	-0.1514E-07	0.2422E-02	3.424
Base Area	0.08143	0.0	0.0	0.0	0.1720E-04	0.3345E-02
Wings	0.5425E-01	1.093	0.1766E-03	-0.2365E-03	-0.2804E-02	16.86
Summation	0.1974	4.18506	0.1037E-03	-0.2365E-03	-0.8628E-03	40.2718

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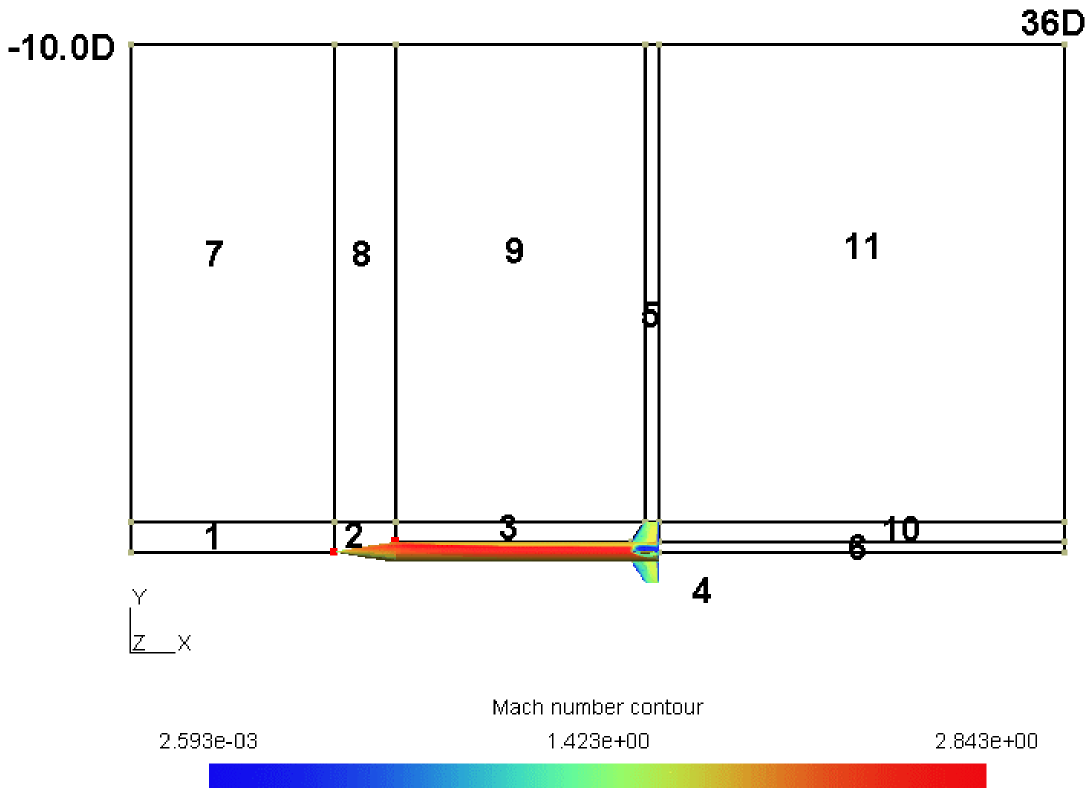

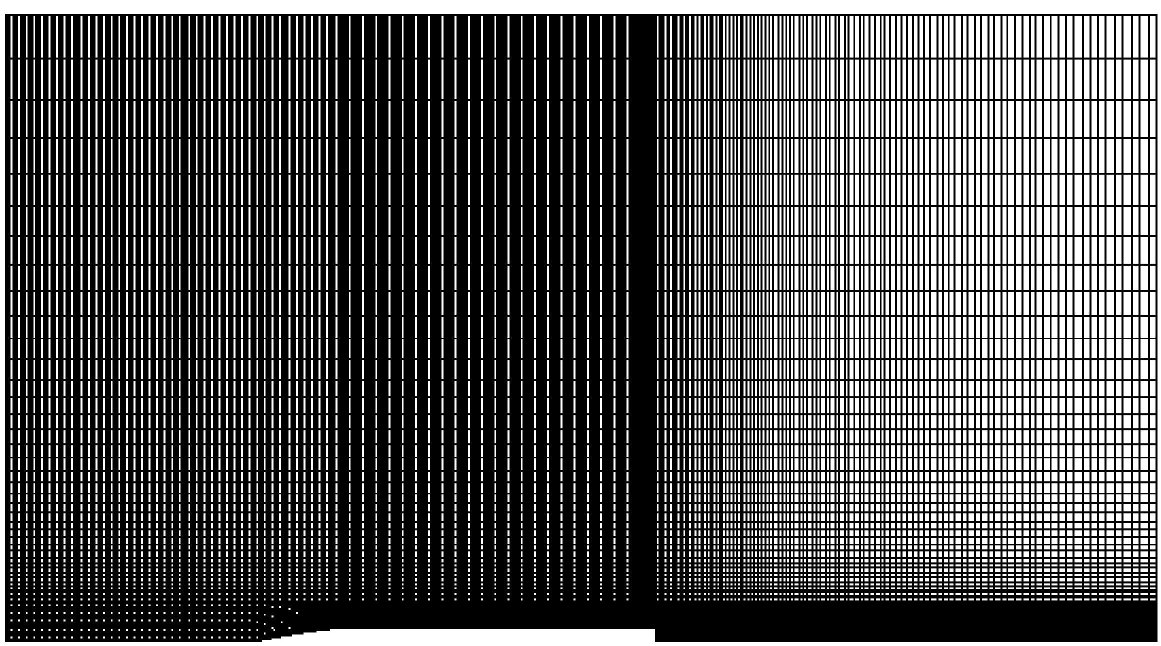

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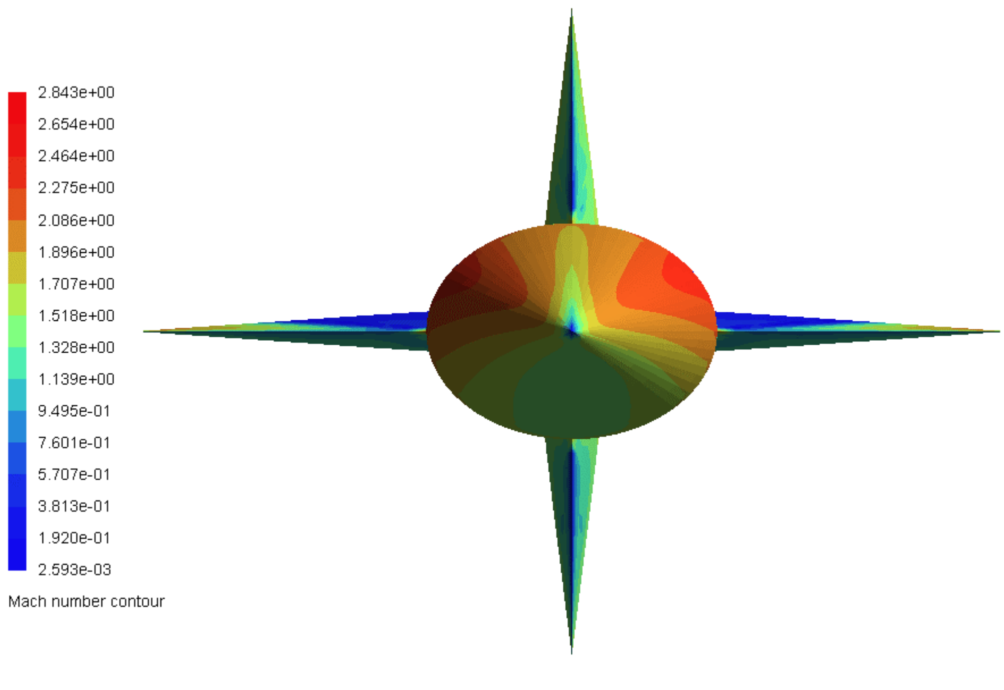
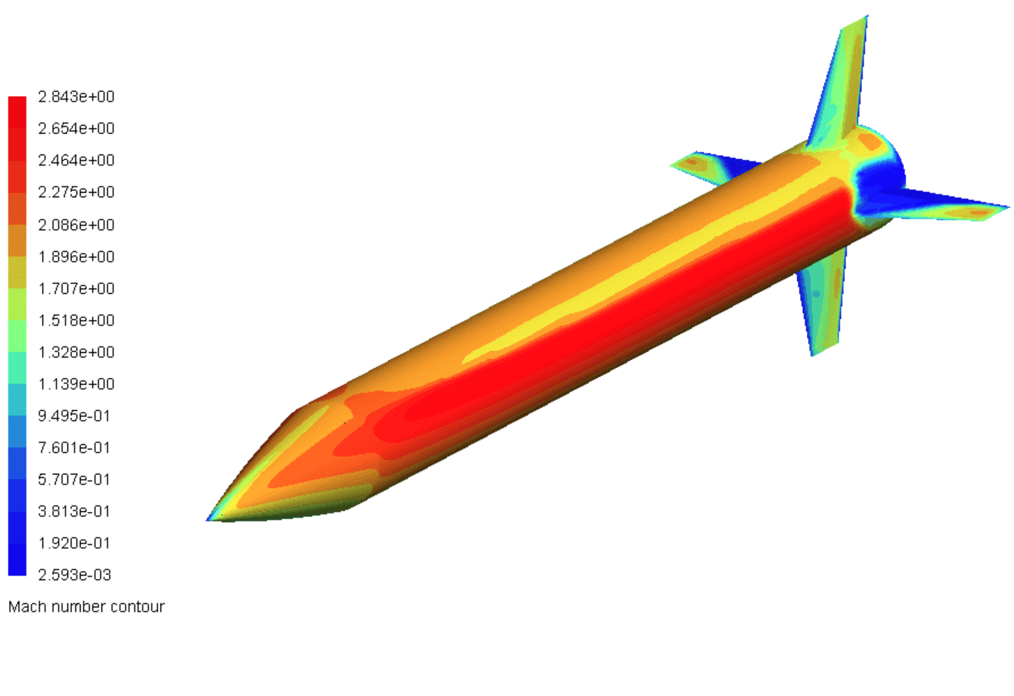
Mach number contour for flow past an ogiv-cylinder-wings missile at 20 degrees angle of attack.





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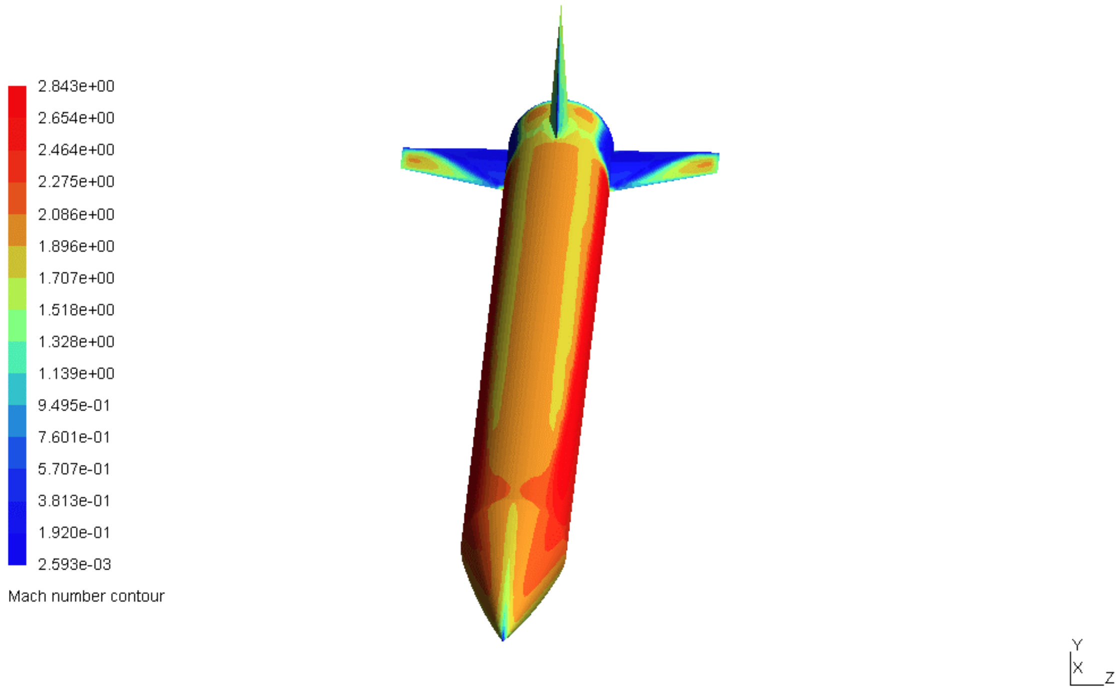

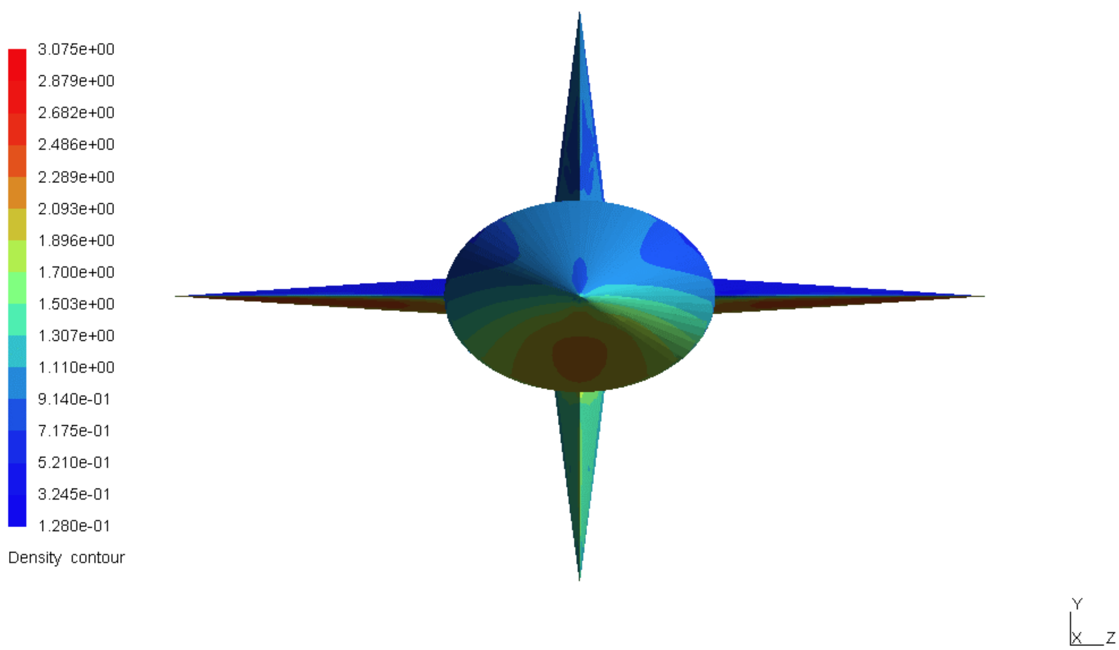

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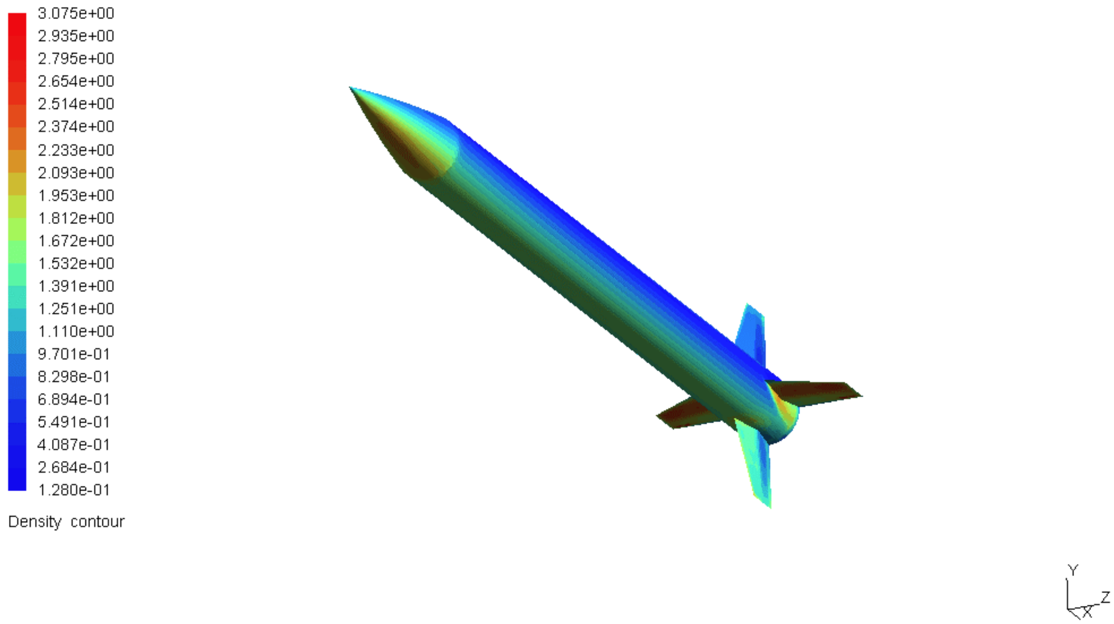

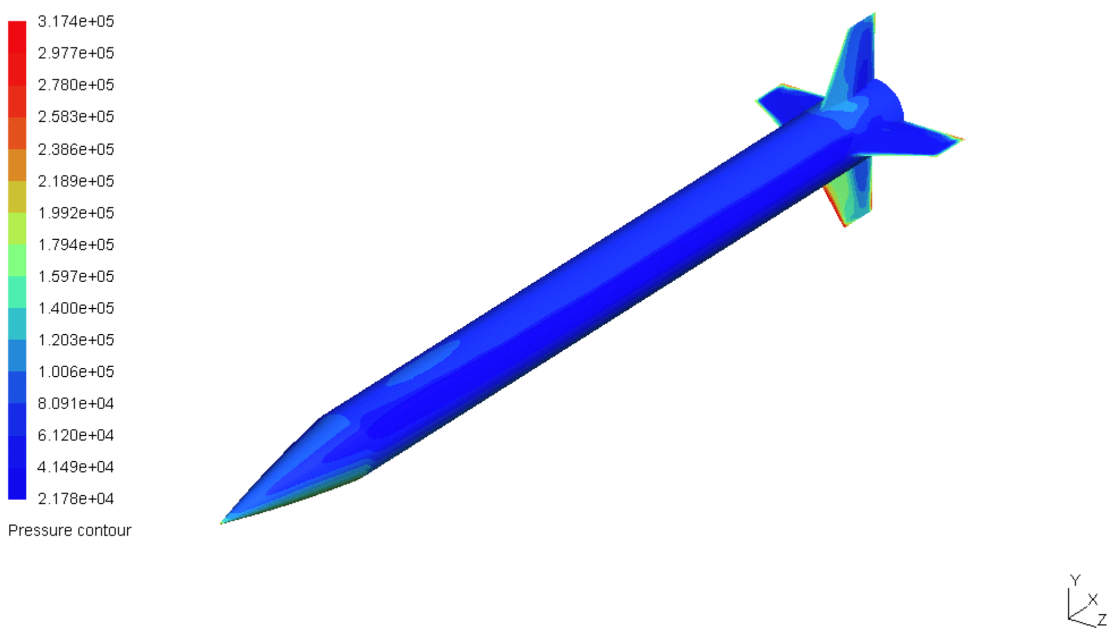

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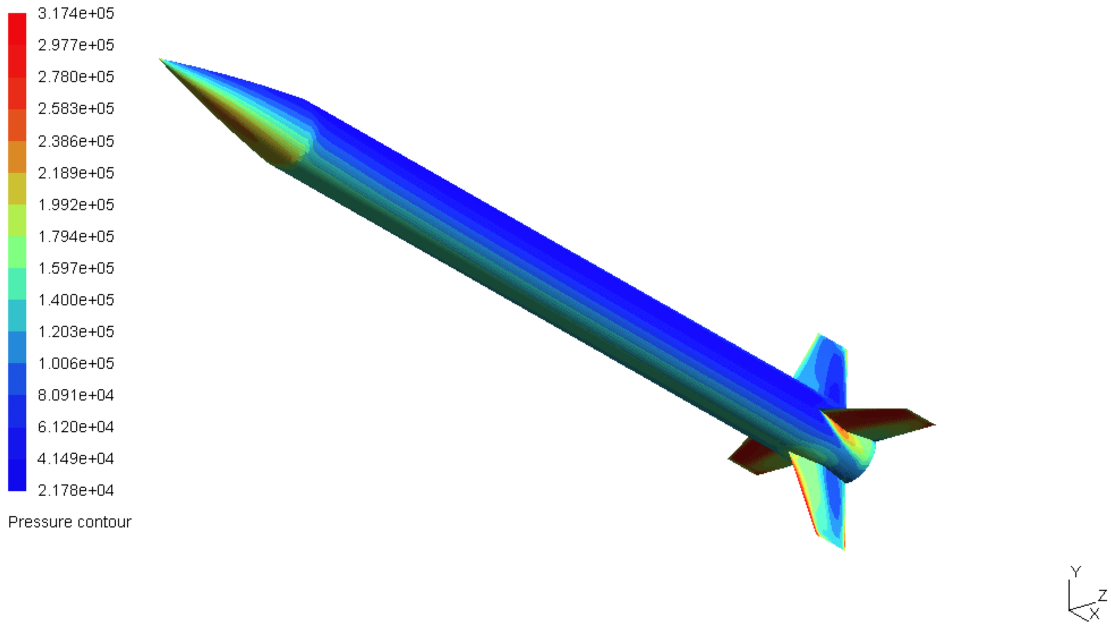

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****
********* Mesh generation file for : f20-ogiv-cylinder-wings *********
****

```
**begin
solver = mesh
dimension = ax
adapt = on
file = f20
restart = 0
convert = 3d
wall = on
wing = on
*title
mach 2.0 flow past a ogiv-cylinder-4wings missile at 20 deg. angle of
attack
*sweep
circle = full
elem = 72
**  Generating full or half circle       , IHALF = ',I2
**  Total degree in theta direction      , KDGRE = ',I3
**  Total element in theta direction     , NTH   = ',I3
**  Ratio of radius in x-z to x-y planes , RATIO = ',E12.6
**  Set parameter value on wing surface  , NPARAM= ',I3
**  2nd and 3rd wing location is +- locations from'
**  The symmetric plane                  , MLOC  = ',I3
**  Total number of elements in the theta direction, elem = 72
*mesh
** Region 1
** ahead nose : grid size is 100x15
** Domain: x=[-10.0:0.0],  y=[0.0:1.5]
** Missile diameter is : D = 1.0
** DX = (10.0-0.0)/100= 0.01
** DY = (1.5-0.0)/15  = 0.01
**
set = 1
type = patch
elex = 100
eley = 15
x1 = -10.0
y1 =  0.0
x2 =  0.0
y2 =  0.0
x3 =  0.0
y3 =  1.5
x4 =  -10.0
y4 =  1.5
farfield = 4
boundary = 1 vy 0.0
end
** Region 2
** ogiv nose: grid size is 30x15
** Domain: x=[0.0:3.0], y=[0.0:1.5]
** DX = (3.0-0.0)/30 = 0.01
** DY = (1.5-0.0)/15 = 0.01
**
```

```
set = 2
type = patch
elex = 30
eley = 15
x1 = 0.0
y1 = 0.0
x2 = 3.0
y2 = 0.5
x3 = 3.0
y3 = 1.5
x4 = 0.0
y4 = 1.5
ityb = 1
slopb = 37.25
solid = 1
end
** Region 3
** cylinder: grid size is 140x15
** Domain: x=[3.0: 15.326], y=[0.5:1.5]
** DX = (15.326-3.0)/140= 0.08804
** DY = (1.5-0.5)/15    = 0.01
set = 3
type = patch
elex = 140
eley = 15
x1 = 3.0
y1 = 0.5
x2 = 14.66
y2 = 0.5
x3 = 15.326
y3 = 1.5
x4 = 3.0
y4 = 1.5
solid = 1
lift = 1
end
** Region 4
** wings: grid size is 10x15
** Domain: x=[14.66: 16.0], y=[0.5:1.5]
** DX = (16.0-14.66)/10= 0.134
** DY = (1.5-0.5)/15    = 0.01
set = 4
type = patch
elex = 10
eley = 15
thick = 0.07
wing = 4
nwing = 2
**
** nwing = 1, double circular arc (biconvex)
** nwing = 2, 3, 4  for double wedge, PENT= 0.5, 1/3, or general
** nwing = 5, for airfoil
** nwing = 6, given (x1,y1),(x2,y2) and thickness ratio : thick
**             find radius = slp and circle center : (xcent,ycent)
x1 = 14.66
y1 = 0.5
x2 = 16.0
```

```
y2 = 0.5
x3 = 16.0
y3 = 1.5
x4 = 15.326
y4 = 1.5
solid = 1
end
set = 5
** Region 5
** above wings: grid size is 10x40
** Domain: x=[15.326: 16.0], y=[1.5:25.0]
** DX = (16.0-15.326)/10= 0.0674
** DYMIN = 0.1, stretch in y-direction
type = patch
elex = 10
eley = 40
x1 = 15.326
y1 = 1.5
x2 = 16.0
y2 = 1.5
x3 = 16.0
y3 = 25.0
x4 = 15.326
y4 = 25.0
farfield = 3
stretch = 1
dymin = 0.1
end
set = 6
** Region 6
** Base area: grid size is 100x10
** Domain: x=[16: 36.0], y=[0.0:0.5]
** DXMIN = 0.1, stretch in x-direction
** DY = (0.5-0.0)/10 = 0.05, constant
type = patch
elex = 100
eley = 10
x1 = 16.0
y1 = 0.0
x2 = 36.0
y2 = 0.0
x3 = 36.0
y3 = 0.5
x4 = 16.0
y4 = 0.5
farfield = 2
solid = 4
boundary = 1 vy 0.0
strlx = 1
dxlmin = 0.1
dxumin = 0.1
strux = 1
end
** Region 7
** Incoming top area: grid size is 100x40
** Domain: x=[-10.0: 0.0], y=[1.5:25]
** DX    = (10.0-0.0)/100 = 0.1
```

```
** DYMIN = 0.1, stretch in y-direction
** income top
set = 7
type = patch
elex = 100
eley = 40
x1 = -10.0
y1 =  1.5
x2 =  0.0
y2 =  1.5
x3 =  0.0
y3 =  25.0
x4 =  -10.0
y4 =  25.0
farfield = 3  4
stretch = 1
dymin = 0.1
end
** ogiv top
set = 8
type = patch
elex = 30
eley = 40
x1 = 0.0
y1 = 1.5
x2 = 3.0
y2 = 1.5
x3 = 3.0
y3 = 25.0
x4 = 0.0
y4 = 25.0
farfield = 3
stretch = 1
dymin = 0.1
end
** after nose
set = 9
type = patch
elex = 140
eley = 40
x1 = 3.0
y1 = 1.5
x2 = 15.326
y2 = 1.5
x3 = 15.326
y3 = 25.0
x4 = 3.0
y4 = 25.0
farfield = 3
stretch = 1
dymin = 0.1
end
** base top top
set = 10
type = patch
elex = 100
eley = 40
```

```
x1 = 16.0
y1 = 1.5
x2 = 36.0
y2 = 1.5
x3 = 36.0
y3 = 25.0
x4 = 16.0
y4 = 25.0
farfield = 2 3
stretch = 1
dymin = 0.1
strlx = 1
dxlmin = 0.1
dxumin = 0.1
strux = 1
end
set = 11
** after wing middle
type = patch
elex = 100
eley = 15
x1 = 16.0
y1 = 0.5
x2 = 36.0
y2 = 0.5
x3 = 36.0
y3 = 1.5
x4 = 16.0
y4 = 1.5
farfield = 2
strlx = 1
dxlmin = 0.1
dxumin = 0.1
strux = 1
end
*property
cfl, 0.95
*cntrl
iter = 1500
nprint = 1500
fmach = 2.0
refl = 1.0
redn = 1.25
repr =1.0133e5
nfar = 2
*initial condition
1,  1,1,0.12500E+01,633.136,230.44,0.0,0.10133E+06
*last
```