Test Problem #1

Simulation of the 2D experiment

The main purpose of this problem is to compare the results obtained from calculations and experimental data. This problem is intended for simulation on techniques with half-empirical 2D turbulence models and probably for direct 2D and 3D simulation. This test problem is based on shock-tube experiments by Meshkov et al. The experiments use Air-Helium interface with 2D perturbation. The experiments were presented at the previous workshop.

Shock-tube dimensions

The initial geometry is shown in a fig. 1.

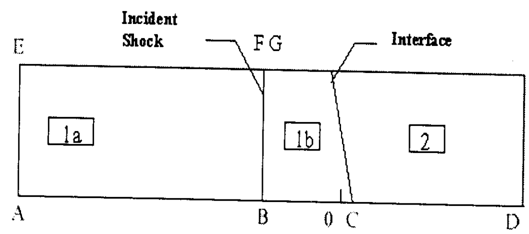

Figure 1. Schematic of problem geometry

AB=38cm, BC=3.2cm, 0D=20cm, AE=12cm, FG=0.8cm. Initially the average position of the interface is x=0 (point 0). Regions 1a,b contain Air (1a - shocked air, 1b - unshocked air), region 2 contains He. The incident shock moves from left to right, i.e. from Air to He. (For 3D calculation - transverse size of region in experiment was 12cm).

Perturbation

The full width of the tube is 12cm.

Full perturbation amplitude: 2.4cm .

The perturbation shape is shown in the fig.1.

Initial conditions

	Shocked Air	Unshocked Air	Unshocked He
Density ($\times 10^{-4}$ g/cm^3)	18.2641	12.05	1.67
Pressure (bar)	1.804997	1	1

Mass velocity (km/sec)	0.15076	0	0
γ	1.4	1.4	1.63

The initial conditions are such that the interface will be almost stationary after shocking. The shock should be initiated at x=-2cm.

Equation of state

If a compressible simulation is being used then the equation of state for both fluids is

$$P = (\gamma - 1)\rho e$$

where ρ = density,
e = specific internal energy.

Boundary conditions

The inflow condition of air with parameters behind shock is set on the left boundary. Other boundaries are rigid walls.

Mesh

The mesh is square for x>-2cm. Zone size is 0.2cm corresponding to 60 zones per region width.

Suggested diagnostics.

The following charts should be drawn on the moments of time t = 0.34, 0.64, 0.94, 1.24, 1.54, 1.84msec for the region x>5.2 (suggested size of each graph - 7.4 6 cm): ×

- 5% and 95% volume fraction isolines;
- velocity field;
- Total mass of each material in mixing zone (from 5% to 95% of volume fraction).