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Test case : **LPC-007 – 2000/2/5**
Document Version 1.1

PART 1 – CONTROLLED TEST SETUP

Case: **LPC-007 – 2000/2/5**

User details

Run by:

Address:

Date:

Phone no:

email:

Fire modelling Software

| | | | |
|-----------|-----|----------|--|
| SMARTFIRE | CFX | PHOENICS | |
|-----------|-----|----------|--|

Version/build number _____

Date of release _____

Operating System

| | | | |
|--------------------|------------|------|-----|
| Windows 95/98/2000 | Windows NT | Unix | Dos |
|--------------------|------------|------|-----|

Version/build number _____

Machine

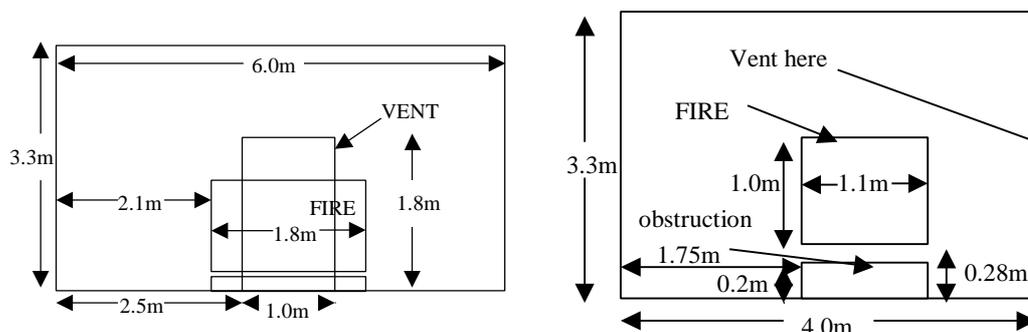
| | | |
|----|------------------|--|
| PC | Unix Workstation | |
|----|------------------|--|

CPU:

Memory:

Case description

This test case arises from a fire test conducted by the Loss Prevention Council (LPC)*. The test is a burning wood crib within an enclosure with a single opening. The test compartment is illustrated below and had a floor area of 6m x 4m and a 3.3m high ceiling. The compartment contained a doorway (vent) measuring 1.0m x 1.8m located on the rear 6m x 3.3m wall. The walls and ceiling of the compartment were made of fire resistant board (Asbestos) which were 0.1m thick. The floor was made of concrete.



y-z view

x-y view

The heat release rate (\dot{Q}) is given by the following calculation (see equation 1).

$$\dot{Q} = c \cdot \Delta H_c \cdot \dot{m} \quad (1)$$

The efficiency factor (c) and heat of combustion (ΔH_c) were given as $c=0.7$ and ΔH_c is 17.8 MJ/kg for burning wood with a 10% moisture content and the mass loss rate (\dot{m}) (kg/s) for the wood crib is presented in the table below. It is assumed that the fuel molecule is $\text{CH}_{1.7}\text{O}_{0.83}$.

| | | | | | |
|------------------|---|---------|---------|--------|--------|
| Time(s) | 0 | 150 | 450 | 460 | 1650 |
| \dot{m} (kg/s) | 0 | 0.01835 | 0.18636 | 0.1978 | 0.1978 |

* Glocking, J.L.D, Annable, K., Campbell, S.C. "Fire Spread in multi-storey buildings – 'Fire break out from heavyweight unglazed curtain wall system – Run 007' "; LPC Laboratories rep. TE 88932-43, 25 Feb 1997.

Required Results

The results should be supplied as graphs and as Excel97 worksheets

The results from this case will be compared against experimental results and between the codes.

The required results are the temperature history curves for the first 900 seconds for the following locations:-

For the corner thermocouple stack located at 0.57m away from the side wall and 0.5m away from the front wall containing the vent.

The thermocouples within this stack are located at 1.5m, 2.0m, 2.5m and 3.0m above the floor.

The plume temperature measurements were taken at 3.0m away from the side wall and 2.392m away from the back wall of the compartment with the low measurement 1.5m above the floor and the high measurement at 3.0m above the floor.

CFD set up

| | | |
|----|----|----|
| 1D | 2D | 3D |
|----|----|----|

| | |
|-----------|--------------|
| Transient | Steady State |
|-----------|--------------|

180 * 5s time steps (900s total)

Differencing Schemes

Temporal:

| | | | | |
|----------------|----------------|----------|-------------|--|
| Fully Implicit | Crank-Nicolson | Explicit | Exponential | |
|----------------|----------------|----------|-------------|--|

Spatial:

| | | | | |
|--------|--------------------|--------|--|--|
| Hybrid | Central Difference | Upwind | | |
|--------|--------------------|--------|--|--|

Notes:

Physical Models

Radiation Model (*if not listed please specify in the space provided*)

| | | | | | |
|------|----------|-------------------|-------------|-----------|--|
| None | Six flux | Discrete Transfer | Monte Carlo | Radiosity | |
|------|----------|-------------------|-------------|-----------|--|

Notes:

(1) If the fire modelling software does not possess the six-flux model, a discrete transfer model may be used in place of the six-flux model. If the discrete transfer model must be used instead of a six flux model then the discrete model must be made to emulate the behaviour of the six-flux model. This can be achieved by using 6 rays in the co-ordinate directions. If a radiation mesh needs to be specified, this should be identical to the flow mesh. If this is not possible, then at least the same number of cells in each direction must be specified. The details of the mesh must also be provided with your results.

Parameters

The absorption coefficient (a) assumed the following form:

$$a = 0.315$$

It is assumed there is no scattering so $s = 0.0$.

Turbulence model (*if not listed please specify in the space provided*)

| | | | | |
|---------|---------------|---------------------------------|-----|--|
| Laminar | k- ϵ | Buoyancy modified k- ϵ | RNG | |
|---------|---------------|---------------------------------|-----|--|

Notes:

| |
|--|
| |
|--|

Turbulence Parameters* :

| | | | | | |
|-----------|------------|---------------------|-----------------|-----------------|-------|
| C_{μ} | σ_k | σ_{ϵ} | $C_{1\epsilon}$ | $C_{2\epsilon}$ | C_3 |
| 0.09 | 1.0 | 1.3 | 1.44 | 1.92 | 1.0 |
| | | | | | |

*If different parameters are being used please specify in the table above.

Combustion Model (if not listed please specify in the space provided)

| | | | |
|----------------------|------------------------|----------------|---------------|
| none | Volumetric heat source | Mixed is burnt | Eddy break up |
| Magnussen soot model | | | |

Combustion Parameters:

For phase-1 testing the Eddy Break up model must be used with the collision mixing model and infinite rate chemistry.

$$S_{m_f} = -\mathbf{r} \frac{\mathbf{e}}{k} C_R \min\left(m_f, \frac{m_o}{i}\right),$$

where S_{m_f} is the source term for the fuel mass fraction equation,

$C_R = 4.0$ (rate constant for collision mixing model),

m_f is the mass fraction of fuel

m_o is the mass fraction of oxident.

i is the amount of oxygen used for combustion every unit fuel, i.e

1kg Fuel + ikg \rightarrow (1+i) kg products

Compressibility

| | | | |
|----------------|------------|---------------------|--------------------|
| Incompressible | Boussinesq | Weakly compressible | Fully compressible |
|----------------|------------|---------------------|--------------------|

Compressibility Parameters:

| |
|-------------------------------|
| External Pressure 1.01325e+05 |
|-------------------------------|

Buoyancy

| | |
|-----|----|
| Yes | No |
|-----|----|

| | |
|---------|---------------------------------------|
| Gravity | -9.81m/s in the v-velocity direction. |
|---------|---------------------------------------|

Material Properties

| | |
|------------------------|--|
| Material Name | Air |
| Density | Determined by compressibility (Ideal Gas Law) Molecular Weight of air is 29.35 |
| Viscosity | Laminar 1.798e-005 + Value determined from turbulence model |
| Conductivity | 0.02622 |
| Specific heat capacity | 1007.0 |

| | |
|--|--|
| | |
|--|--|

Initial Values

| | |
|------------------|--------|
| | |
| U-VELOCITY | 0.0 |
| V-VELOCITY | 0.0 |
| W-VELOCITY | 0.0 |
| PRESSURE | 0.0 |
| TEMPERATURE | 293.75 |
| KINETIC ENERGY | 0.01 |
| DISSIPATION RATE | 0.01 |

Boundary conditions

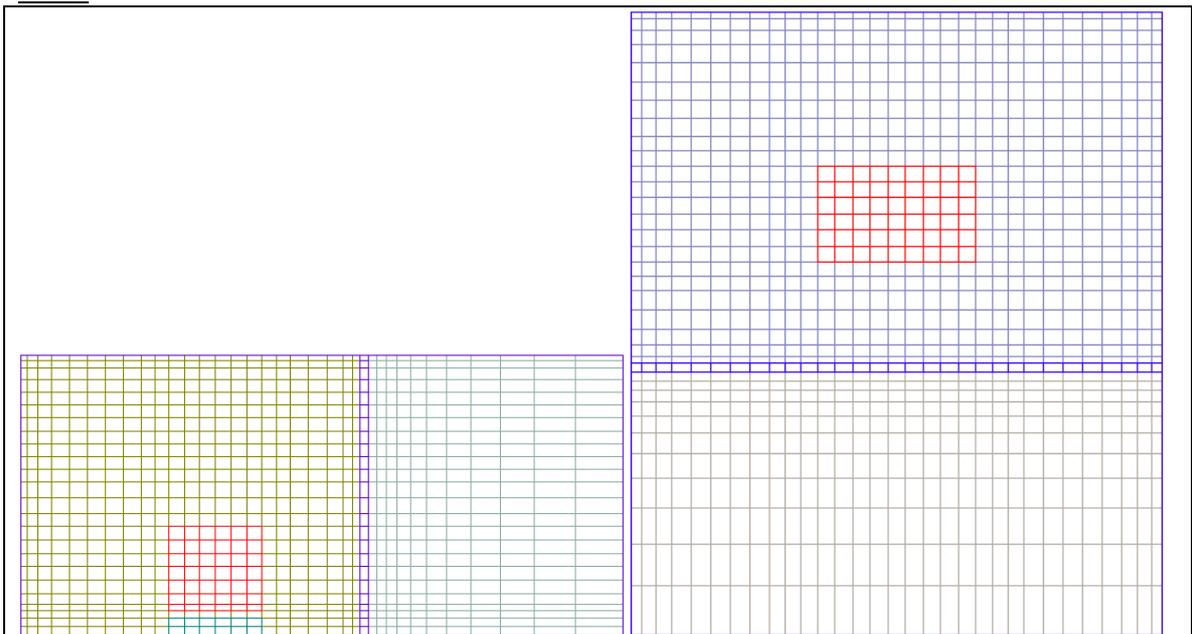
All walls are assumed to be adiabatic for the first phase of the validation process. In the first phase of validation the walls are perfect reflectors of radiation, i.e. the emissivity of the walls is 0. The default log-law turbulent wall functions should be used.

The door measures 1.0m wide and 1.8m high and is centrally located in the front wall. An extended region for this door is required to ensure that the airflow in the doorway is correctly modelled.

On the extended region all the boundary patches are fixed pressure (outlet) boundaries set to 0.0 Pa.

The fire needs to be modelled as a volumetric source of fuel with the same dimensions as the crib illustrated above using the fuel mass source specified above.

Mesh



Side view

Top view

31 24 35

X 0.0 0.12 0.28 0.46 0.68 0.9 1.12 1.34 1.56 1.74 1.92 2.1 2.3 2.5 2.7
2.9 3.1 3.3 3.5 3.7 3.9 4.08 4.26 4.44 4.66 4.88 5.1 5.32 5.54 5.72
5.88 6.0

Y 0.0 0.1 0.2 0.28 0.36 0.49 0.648 0.806 0.964 1.122 1.28 1.43 1.62 1.8
1.952 2.104 2.256 2.408 2.56 2.712 2.864 3.016 3.145 3.234 3.3

Z 0.0 0.08 0.21 0.37 0.58 0.79 1.0 1.21 1.42 1.585 1.75 1.9333 2.1167
2.3 2.4833 2.6667 2.85 3.015 3.18 3.4 3.62 3.8 3.92 4.0 4.1 4.2 4.312
4.4435 4.6021 4.7951 5.0303 5.315 5.6568 6.0633 6.5418 7.1

Model Definition files

Convergence

Please specify your convergence criteria including type of error estimator and tolerance value for each variable

Runtime

Results files/Archiving:

Document cross-reference:

User Guides, etc

Comments