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PART 1 – CONTROLLED TEST SETUP

Test case : **CIB W14 Round Robin Test – 2000/2/4**
Document Version 1.2

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Case: **CIB W14 Round Robin Test – 2000/2/4**

User details

Run by: Date: Phone no: email:	Address:

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 case arises from the CIB round robin tests* of which subscenario B1 is the case of interest. The fire compartment measured 14.4 m × 7.2 m in plan and 3.53 m in height and contained a doorway of dimensions 2.97 m × 2.13 m. The walls of the compartment were made of aerated concrete blocks (with siporex mortar) with thickness 0.3 m and the following material properties: specific heat 1.05 kJ/kg.K, thermal conductivity 0.12 W/m.K and density 500 kg/m^3. The initial air temperature was measured as 20.0 ^{o}C.

The fire was located on the floor in the centre of the room. The fire fuel consisted of softwood (Pinea ecelsa) timber cribs nailed into 40mm x 40mm battens. The crib measured 2.4m in length, 2.4 m in width and 1.4 m in height.

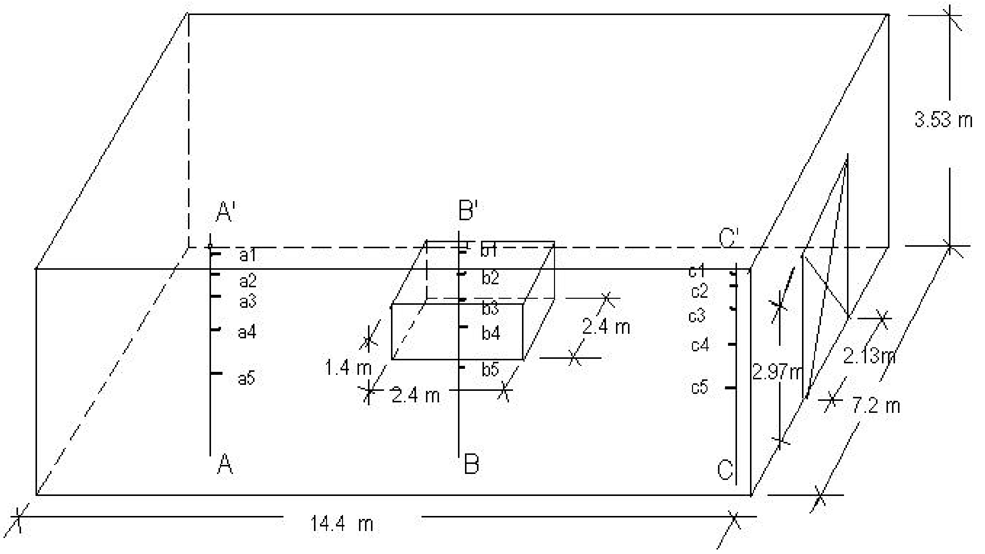

Figure 1 – Depiction of fire compartment geometry showing location of fire source.

The heat release rate ($\dot{Q}$) is given by the following calculation :-

$$\dot{Q} = c \cdot \Delta H_c \cdot \dot{m}$$

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. A maximum heat release rate of approximately 11 MW was produced. It is assumed that the fuel molecule is $CH_{1.7}O_{0.83}$.

*Hostikka S and Keski-Rahkonen O., Results of CIB W14 Round Robin for Code Assessment Scenario B. Draft 31/08/98, VTT Technical Research Centre of Finland.

Time (s)	0	60	120	180	240	300	360	420	480	540	600
Mass loss rate(kg/s)	0	0.005	0.004	0.009	0.013	0.014	0.019	0.033	0.052	0.08	0.207

Required Results:

Temperature histories locations (Ta, Tb and Tc) illustrated in Figure 2 which is a plan view of the compartment with the doorway at the right hand side of the compartment. In the vertical direction spot values are needed at 20cm, 50cm, 100cm, 180cm and 250cm below the ceiling. These spot values should be produced at the end of every timestep.

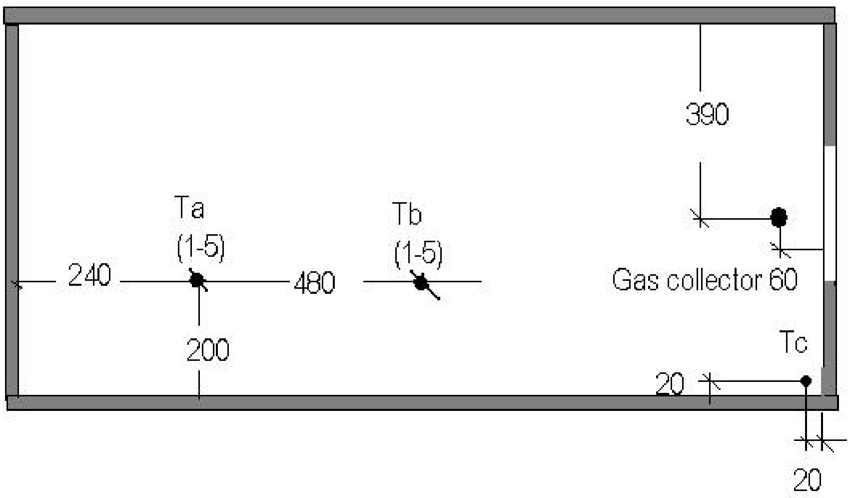

Figure 2 - location of the three thermocouple trees in the fire compartment

CFD set up

1D	2D	3D

Transient	Steady State

The case needs to be run for 10 minutes using 5 s timesteps.

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:

For the first phase validation process the standard k- ε turbulence model with the standard buoyancy modification, $C_3 = 1.0$ (see ε-equation below) must be used with the parameters below.

$$\frac{\partial re}{\partial t} + \nabla.(rUe) - \nabla\left(\left(m_L + \frac{C_m r \frac{k^2}{e}}{s_e}\right)\nabla e\right) = C_1 \frac{e}{k}\left(P + C_3 \max(G,0)\right) - C_2 r \frac{e^2}{k}$$

Turbulence Parameters*:

C_μ	σ_k	σ_ε	$C_{1\varepsilon}$	$C_{2\varepsilon}$	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
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. $S_{m_f} = -r \frac{e}{k} C_R \min\left(m_f, \frac{m_o}{i} \right),$ where S_{mf} 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 -> (1+i) kg products

Compressibility

Incompressible	Boussinesq	Weakly compressible	Fully compressible

Compressibility Parameters:

External Pressure 1.013e+05 Pa

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 (dynamic)	Laminar 1.798e-005kg/m.s + Value determined from turbulence model
Conductivity	0.02622 W/m.K
Specific heat capacity	1007.0 J/kg.K

The fuel and combustion products are assumed to have the same physical properties of air for the first phase of validation.

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 doorway measures 2.97 m high × 2.13 m wide and is centrally located in one of the small walls. This wall is constructed as a solid non-conducting obstruction with a thickness 0.3m An extended region for this door is required to ensure that the airflow in the door is correctly modelled.

On the extended region all the boundary patches are fixed pressure (outlet) boundaries set to 0.0 Pa apart from the floor which is an adiabatic floor.

The fire is modelled as a volumetric source of fuel with the same location, position and using the mass fuel rate as the wood crib in the case description.

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

The mesh consists of 42775 (i.e. 59 x 25 x 29) computational cells.

59 25 29

```
X 0.0 0.119432 0.315183 0.556021 0.831774 1.136787 1.467348 1.820784
2.195064 2.588575 3.0 3.511529 3.994572 4.44635 4.863213 5.240085
5.569238 5.836772 6.0 6.3 6.6 6.9 7.2 7.5 7.8 8.1 8.4 8.563228 8.830762
9.159915 9.536787 9.95365 10.405428 10.888471 11.4 11.774744 12.134776
12.479132 12.806659 13.115946 13.405214 13.672127 13.913434 14.124187
14.295486 14.4 14.5 14.599999 14.7 14.797048 14.994193 15.262831
15.591825 15.974489 16.406185 16.883438 17.403511 17.964167 18.56353
19.200001
Y 0.0 0.2 0.4 0.6 0.8 1.0 1.2 1.4 1.482473 1.617647 1.783956 1.974375
2.185 2.337378 2.479893 2.611395 2.730281 2.834114 2.918509 2.97
3.030143 3.12872 3.25 3.37128 3.469857 3.53
```

```
Z 0.0 0.126073 0.332710 0.586939 0.878026 1.2 1.597829 1.945285
2.227695 2.4 2.535 2.724465 2.970275 3.243066 3.535 3.665 3.956934
4.229725 4.475535 4.665 4.8 4.972305 5.254715 5.602171 6.0 6.321974
6.613061 6.86729 7.073927 7.2
```

Input files

Convergence

All variable residuals should be converged to 0.1%. The mass source tolerance is set to 0.0001.

Runtime

Results files/Archiving:

Document cross-reference:

Comments