Mastercourse 7LY4M0
Part: Fire Safety Engineering (FSE)

Assignment FSE

Code	**7LY4M0 – course 2020-2021**	
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Coursename	*Nederlands*: **Gebouwinstallaties en brandveiligheid**	*English*: **Building services and fire safety**
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Introduction

The assignment concerns a large fire compartment with different levels of fire protection:

- Passive fire and smoke control only by buffering in the compartment volume
- Active fire control (sprinkler)
- Active smoke control (smoke outlet system)

This assignment focuses on two risk subsystems: personal safety and fire compartmentation.
Please use a zonemodel for this assignment.

Each student has his own personal boundary conditions for this case. You can find your personal boundary conditions in the assignment boundary list; This is a separately uploaded document.

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Case

Building conditions:
Large compartment with retail function (supermarket): W x D x H [m]

External separation constructions:

1. Thermal thick — Cc = ∞ J/m^{2}K
2. Thermal thin, well insulated — Cc = 0 J/m^{2}K — Rc = 6.0 m^{2}K/W
3. Thermal thin, non-insulated — Cc = 0 J/m^{2}K — Rc = 0 m^{2}K/W

Windows in façade 2 and 4: daylight-openings from h=+0.5 until h=+0.8 x H [m] over the total width of the façade. The windows may considered to be open for 50% after flashover.

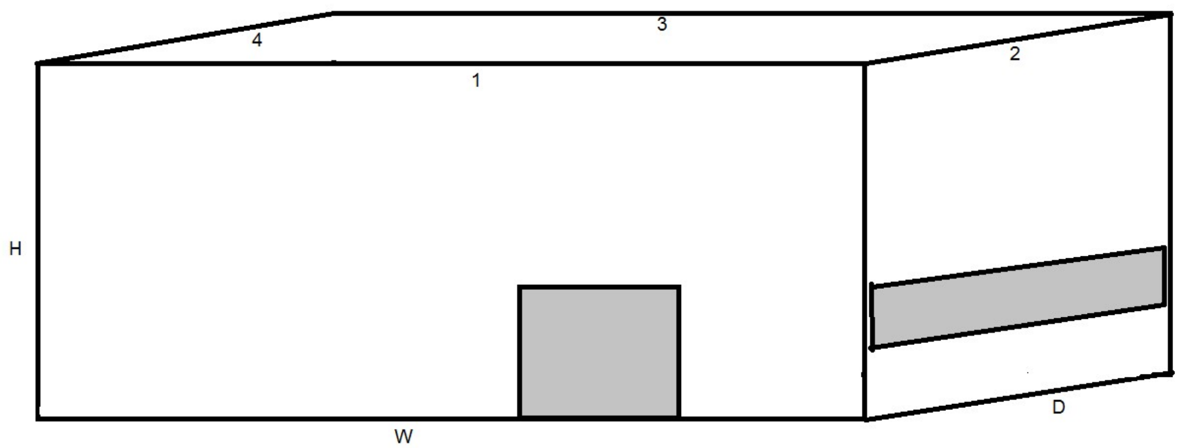
Entrances in façade 1: all exits together permanently open w x h = 4 x 2.5 [m]

Building users conditions (average conditions):

- Building users density: 0.3 [m^{-2}]
- Evacuation, pre movement time: 2 [min]
- Evacuation, movement time: t = 1 + N / (45 x w) [min],
  with N = number of building users
  and w = total width of the entrance openings (exits) in [m].

Fuel an fire conditions (average conditions):

- Fire elevation: 0,2 x H [m]
- Fuel height: 0,5 x H [m]
- Cellulose fuel with r = 1.27 kg/kg and Hc = 17.5 MJ/kg
- Average fire load density: 900 [MJ/m^2]
- RHR density: 500 [kW/m^2]
- Fire development: RHR(t) = (t / t_c)^2 [MW]



Passive fire safety:

1.1. Risk subsystem *Safe Evacuation*, deterministic assessment:

What is the RSET in [min.] for evacuating all building users?
What are acceptable assessment conditions for the ASET, and what is the ASET in [min.], based on a natural fire concept? Apply the most realistic combustion model in your case.
Is safe evacuation possible? (ASET > RSET)

1.2. Risk subsystem *Safe compartmentation* (limiting spread of fire), deterministic assessment:

When the walls are 60 minutes fire resistant (EI 60, SFC), the expectation is that the compartmentation is safe enough (AST > RST). What is the basis for this expectation?
Determine the thermal load, caused by a natural fire in minutes SFC (RST). Assume that 50% of glass in windows will fall out after flashover. Is safe compartmentation possible? (AST > RST)

1.3. Risk subsystem *Safe compartmentation* (limiting spread of fire), probabilistic assessment:

Apply the variation coefficient VAR(f) on all mentioned fuel and fire conditions, except on the fire load density. Use a variation coefficient of 0.2 for the fire load density.
Apply the variation coefficient VAR(o) on mentioned conditions of the windows.
Determine by a sensitivity analysis on all fuel and fire conditions and on the daylightopenings the failure probabilility p((AST-RST) < 0).
Which stochastic boundary condition has the most significant influence on the standard deviation of p(AST-RST)?

Active smoke outlet system:

Create a smoke outlet system with natural openings in the roof of 5% of the roof surface. This system is activated 2 minutes after the fire starts. The air inlet system (entrance openings) is activated at the same time.

2.1. Risk subsystem *Safe Evacuation*, deterministic assessment:

What is the ASET, based on a natural fire concept, using the smoke outlet system?
What is the difference between (ASET-RSET) when you compare the active smoke outlet system with passive smoke buffering?
What does the difference in (ASET-RSET) mean in reliability?

2.2. Risk subsystem *Safe Compartmentation*, deterministic assessment:

Determine the thermal load, caused by a natural fire with an active smoke control system, in minutes SFC (RST). Compare the thermal load with the thermal load without smoke outlet system.
Is (AST-RST) more reliable with a smoke outlet system than without a smoke outlet system?

Active fire suppression system:

Create a sprinkler system in a sprinkler grid of 3 x 4 meter, with actuation temperature of Ta [^{o}C] and a response time index of RTI [s].

3.1. Risk subsystem *Safe Compartmentation*, deterministic assessment:

What is the activation time according to the Detact-algorithm?
What is the expected sprinklered fire scenario?
What is the natural fire concept based on the expected sprinklered scenario?
What is the thermal load (RST), based on this sprinklered fire scenario? Assume that 50% of glass in windows will fall out after flashover.

3.2. Risk subsystem *Safe compartmentation* (limiting spread of fire), probabilistic assessment:

Which stochastic boundary condition do you expect to have the most significant influence in case of an active fire suppression system?

3.3. If the reliability of the sprinkler installation is 0.98, how should you combine the results of 1.3 and 3.2?

Software and Literature

Recommended literature:

- R. Hagen, L. Witloks, (modification: R.A.P. van Herpen) – *The basis for fire safety (part A)* – 2014, IFV Arnhem Netherlands (available in pdf)
- M. Kealy et al. – *Cibse Guide E – Fire safety engineering* - 2003, CIBSE London UK (available in pdf)
- IFEG - International fire engineering guidelines - 2005, ICC, USA. (data, available in pdf)

Recommended software:

- Ozone V.3.0.2 (University of Liege) or newer
- Spreadsheet equivalent fire duration
- Spreadsheet probabilistic assessment
- Detact worksheet (Mowrer spreadsheet)