Mastercourse 7LY4M0
Part: Fire Safety Engineering (FSE)

Assignment FSE

Code	**7LY4M0 – course 2025-2026**	
Lecturer FSE	Ir. Ruud van Herpen FIFireE.	
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 and heat extraction ventilation SHEV (smoke outlet system)

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

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

In case of questions:

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Case

Building conditions:
Compartment (supermarket): W x D x H [m]

External separation constructions:

1. Thermal thick — $C_c = \infty$ J/m²K
2. Thermal thin, well insulated — $C_c = 0$ J/m²K — $R_c = 6.0$ m²K/W
3. Thermal thin, non-insulated — $C_c = 0$ J/m²K — $R_c = 0$ m²K/W

Windows in façade 2 and 4: daylight-openings from h=+1.0 until h=+0.8 x H [m] over the total width of the façade. The windows are considered to be partly open after flashover, due to glass fall out.

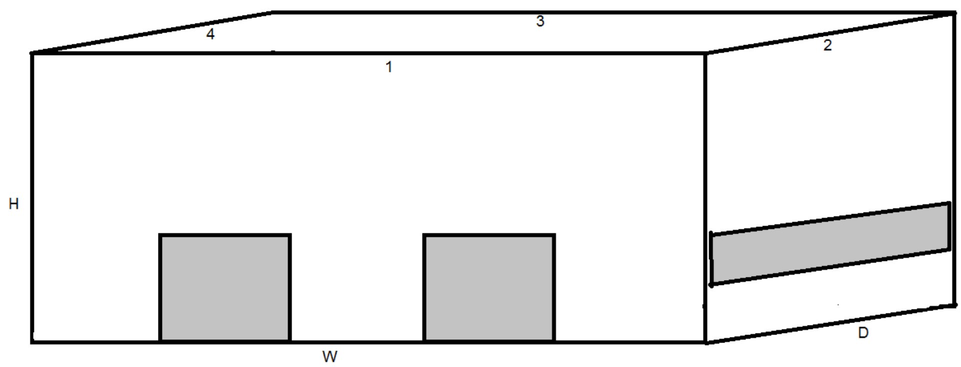
Entrances in façade 1: 2 exits permanently open, per exit: w x h = 3 x 4 [m]. In case of fire assume that one exit is blocked by the local fire and can't be used.

Building users conditions (average conditions):

- Building users density: 0.25 [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 H_c = 17.5 MJ/kg
- Average fire load density: 1050 [MJ/m^2]
- RHR density: 500 [kW/m^2]
- Fire development: $RHR(t) = (t / t_c)^2$ [MW]



Exploration:

0.1. Pre flashover fire:

Model the fire development until the fashover conditions are reached. Assume fully airtight external separation constructions with all openings (including the entrances) in the external separation constructions closed. What is the maximum overpressure in the compartment, compared to the ambient airpressure? Why is there an overpressure in the compartment and what happens at the peak value of the overpressure?

Passive fire safety:

For the next questions make sure that you apply the right boundary conditions for external separation constructions and openings.

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. 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), deterministic assessment:

The compartment in question 1.2 is an enclosed fire compartment. When there is no flasover to a compartment fire the compartment is considered as an open fire compartment. Remove the facades to check whether or not flashover occurs. Since you removed the external separation constructions it is not possible to use a 2-zone model. You have to apply a 1-zone model.
What is the thermal load in minutes SFC in this open compartment? Compare the thermal load to the answer of question 1.2 and explain the difference.

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

Go back to the enclosed compartment (question 1.2) with the boundary conditions of your case.
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 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 and heat extraction ventilation (SHEV):

Create natural openings in the roof with a total open area of 10% of the roof surface. This natural SHEV 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 SHEV?
What is the difference in (ASET-RSET) when you compare the active SHEV 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 SHEV system, in minutes SFC (RST). Compare the thermal load with the thermal load without SHEV. Is (AST-RST) more reliable with a SHEV system than without a SHEV system?

Active fire suppression system:

Create a sprinkler system in a sprinkler grid of 3 x 4 meter, with an 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 of the sprinkler protection according to the Detact-algorithm?
What is the expected sprinklered fire scenario?

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

What is the natural fire concept based of 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.

3.3. Risk subsystem *Safe Compartmentation*, probabilistic assessment:

Which stochastic boundary condition do you expect to have the most significant influence in case of an active fire suppression system?
PS: Only an expectation and a motivation. It is not necessary to perform a probabilistic analysis on all stochastic boundary conditions.

Combination of active fire suppression and active SHEV:

Combine the SHEV system of question 2 and the sprinkler system of question 3. Create a new fire scenario, taking into account both sprinkler and SHEV system.

4.1. Compare the combined scenario with the SHEV scenario. What is the reduction in thermal load?

4.2. Compare the combined scenario with the sprinklered scenario. What is the reduction in thermal load?

4.3. What is your conclusion about the combination of sprinkler and SHEV, from a thermal load perspective?

Rubric assessment criteria

Assessment criteria Assignment Fire Safety Engineering

Criterion	Ratings		Pts
Comprehensive report Report, divided into chapters, corresponding to the assignment, with answers on the questions in the assignment. Figures and graphs, needed for explanation or motivation added. Calculations in appendix	**10 to >0.0 Pts Full marks**	**0 Pts No marks**	10 pts
Readable appendices Appendices in pdf (if possible), divided into sections corresponding with the chapters in the report.	**10 to >0.0 Pts Full marks**	**0 Pts No marks**	10 pts
Q.0 – Exploration Results 50% - Explanation/motivation 50%	**10 to >0.0 Pts Full marks**	**0 Pts No marks**	10 pts
Q.1 - Passive fire safety Results 50% - Explanation/motivation 50%	**25 to >0.0 Pts Full marks**	**0 Pts No marks**	25 pts
Q.2 - Active fire safety: SHEV Results 50% - Explanation/motivation 50%	**15 to >0.0 Pts Full marks**	**0 Pts No marks**	15 pts
Q.3 - Active fire safety: Sprinkler Results 50% - Explanation/motivation 50%	**15 to >0.0 Pts Full marks**	**0 Pts No marks**	15 pts
Q.4 - Combination SHEV + Sprinkler Results 50% - Explanation/motivation 50%	**15 to >0.0 Pts Full marks**	**0 Pts No marks**	15 pts
Total points: 100			

Software and Literature

Recommended literature:

- R.A.P. van Herpen – *7LY4M0 Reader FSE* – 2026, TUE, NL (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)
- Spreadsheet equivalent fire duration
- Spreadsheet probabilistic assessment
- Detact worksheet (Mowrer spreadsheet)