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Water Mist in preformance-based Buildings

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Brandrådgiver

Aarhus Universitetshospital

New Buildings: 240.000m2

Rebuilding: 80.000m2

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Odense Universitetshospital

New Buildings: 200.000m2 (Hospital)

New Buildings: 47.000m2 (Universitet)

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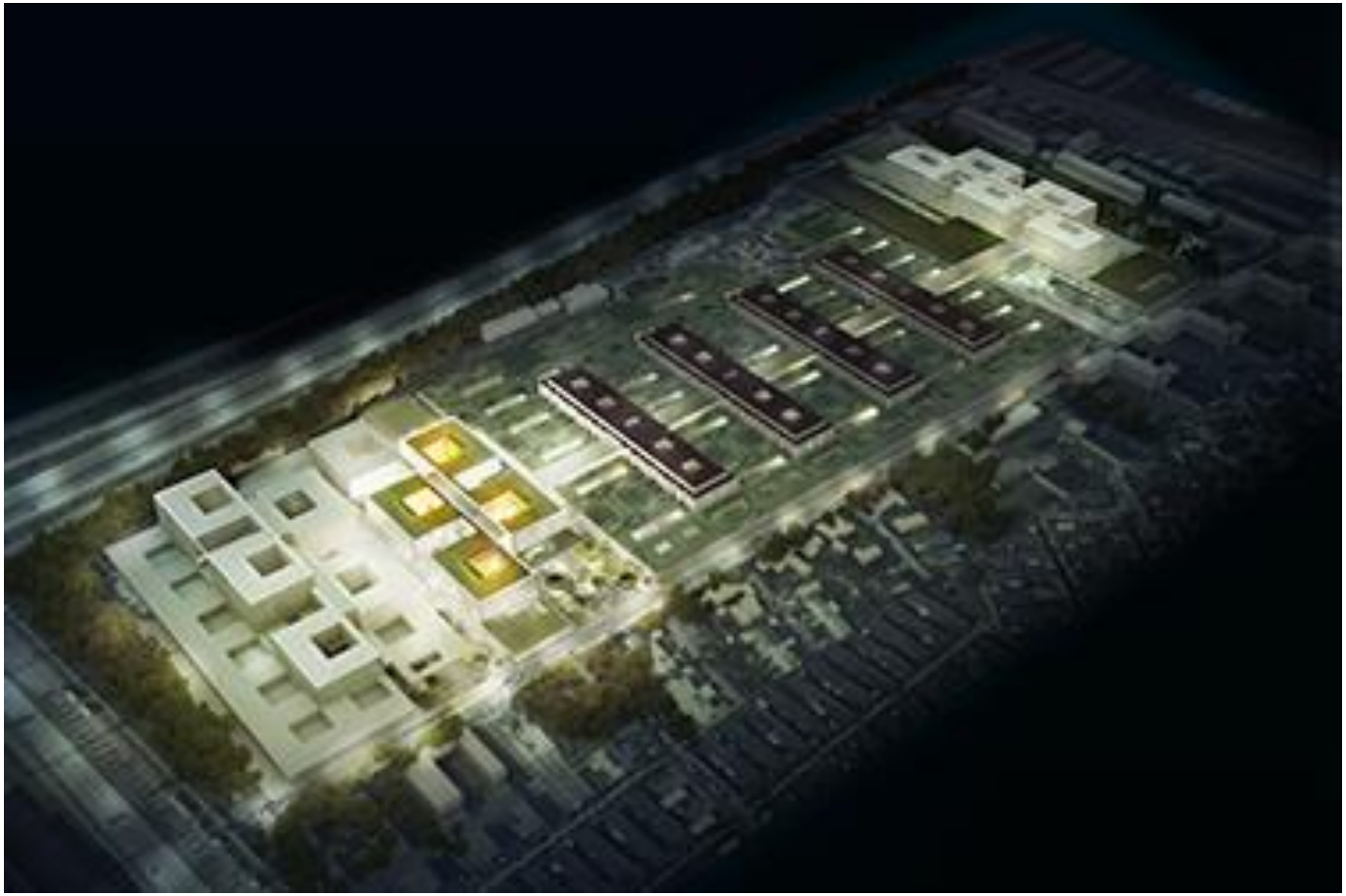
Hvidovre Universitetshospital



New Buildings: 40.000m2 (Etape 1)

New Buildings: 100.000m2 (Etape 2)

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Køge Universitetshospital

New Buildings: 125.000m2

Rebuilding: 65.000m2

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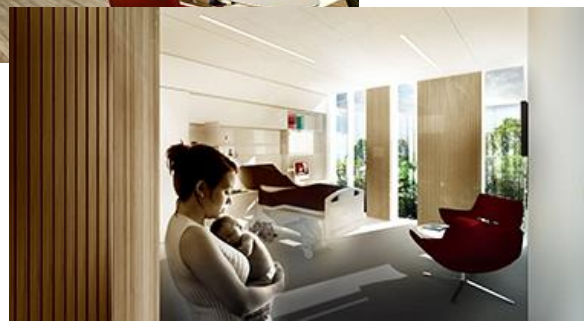
The Builders requirements:

Create a:

- Modern
- Professional
- Urban
- Homely

- inviroment



and a maximum fire safety level

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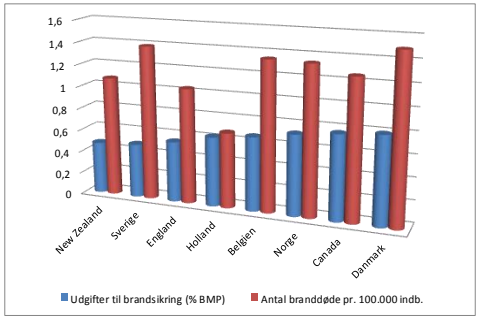
The starting point for the fire safety strategy

- The total cost for building the new hospital correspond with the total running costs for a period of only 6 years.
- The running costs of ineffective working processes counted over a 50 years period would exceed the total building cost of the fire safety initiatives.
- Fire safety initiatives should support instead of restrict the hospitals processes and flows.
- The Danish building regulations requirements to fire safety is performance based.
- Ordinary noncomplex building can be built after a preaccepted collection for fire safety initiatives.



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Practical experiences with water mist

- Water mist is in common use to protect buildings and other objects from heat exposure from fires.
- Water mist is in common use as self-protection by firefighters.
- Water mist is in common use for controlling smoke and chemical clouds.
- Water mist is in common use for fire extinguishing in enclosures.
- - etc.

Water mist in not a new technology

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Acceptan criteria – fire safety

Critical conditions for persons:

Visibility:

Rooms < 150m^2 Optical density > 2,0 dB/m (visibility < 5 meter)

Rooms > 150m^2 Optical density > 1,0 dB/m (visibility < 10 meter)

Radiation:

A short intensity of radiation > 10 kW/m^2 in up to 4 seconds or

A continuing intensity of radiation > 2,5 kW/m^2 or

A connected intensity of radiation > 60kJ/m^2 in addition to the energy from the radiation on 1 kW/m^2

Temperature:

Temperature under the smoke layer > 80^{o}C in escape routs

If a smoke layer hasn't been established, the temperature can be measured at a height of 2 meters over the floor.

The height to the underside of the smoke layer:

The height from floor to the smoke layer < 1,6 meters + 0,1 x the height of the room.

Critical conditions for the firefighters:

Criteria for flash over:

Temperature in the smoke layer > 500^{o}C

Intensity of radiation from the smoke layer > 20kW/m^2

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Acceptan criteria – fire safety

The acceptan criteria correspond with:

The characteristic of water mist:

Radiation

Water mist is characteristic by an effective absorption of radiation

Temperature

Water mist is characteristic by an effective cooling of the smoke gasses

Smoke

Water mist is characteristic by effective controlling smoke and by cleaning the air from soot and other particles from the fire.

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The first choice of fire safety installations:

Due to the acceptance criteria and the characteristic of water mist, it was natural to base the strategy for the fire safety on water mist applications.

It was easy to convince both the builders and the architects, that the water mist applications where the right way to reach the overall modern environment requirements for the projects.

Another story was to convince the local authorities about our choices……!

Documentation of the water mist system

Working with performance-based fire safety, requires precise, analytical and particular documentation in all aspects.

Working with performance-based fire safety and water mist is quit challenging, because the theoretical part isn't common knowledge, and often very complicated to explain for the local authorities.

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Documentation of the water mist system

The approval of water mist systems are related to one or several standards.

These standards are focused on controlling or suppress a fire like traditional sprinkler systems.

Only the equivalency with sprinkler systems are documented.

The important characteristic cooling and radiation are only indirectly included in the test standards.

The ability to control smoke and gasses from the fire are not included at all.

If we just use the approval documents for a water mist system as documentation, we just get a modern fire suppression system. The only differences from the traditional sprinkler system is lower requirements of water, smaller droplets, smaller pipes and increased costs.

It´s like buying a new Mercedes Benz – whit out an engine

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Documentation of the water mist system

One way to create the documentation:

- The base function of the water mist system can be documented by the approval certificate from a chosen test standard.
- The absorption of radiation can be calculated and verified by CFD-simulations.
- The droplets absorption of heat from the gas layer and/or the plume can be calculated and verified by CFD-simulations.
- The droplets capability to control smoke and gasses can be estimated by CFD-simulations.

Documentation of the water mist system

Radiation through water mist

Radiation is the transfer of heat from a fire caused by electromagnetic waves.

Many scientific studies are made, and the function of electromagnetic waves is well documented.

The radiation through a water mist barrier is depending on the droplet size, the wavelengths and naturally by the amount of droplets the radiation interact with.

The wavelength of the radiation from a fire typically can be set between 0,3 and 80µm, and peaks near the lower scale around 0,5-8µm. That means, that the smallest droplets are the most effetely to absorb the radiation.

The droplet size and the amount of droplets depend of the chosen water mist application.

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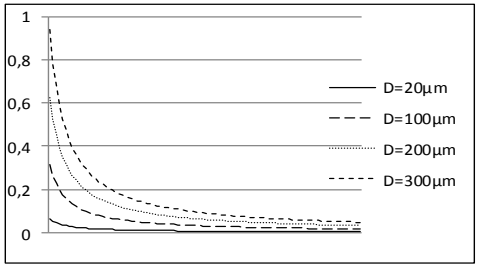
Documentation of the water mist system

Example:

We are investigating for the acceptance criteria for a short intensity of radiation
= max. 10 kW/m^2 (escaping people).

Our water mist application work with droplets in the area of 200µm

We calculate the radiation to 35 kW/m^2.



Our transmitted fraction must be max. 10 kW/m^2.

Our water mist has to absorb at least 25 kW/m^2.

The requirement of water in our water mist curtain can then be calculated to at least

200 g/m^3

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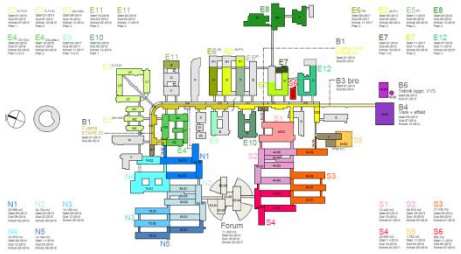
Examples from our documentation



The main logistic corridor is almost 875 meters long.

The corridor are separated in several smoke sections with water mist barrier – and no doors.

1

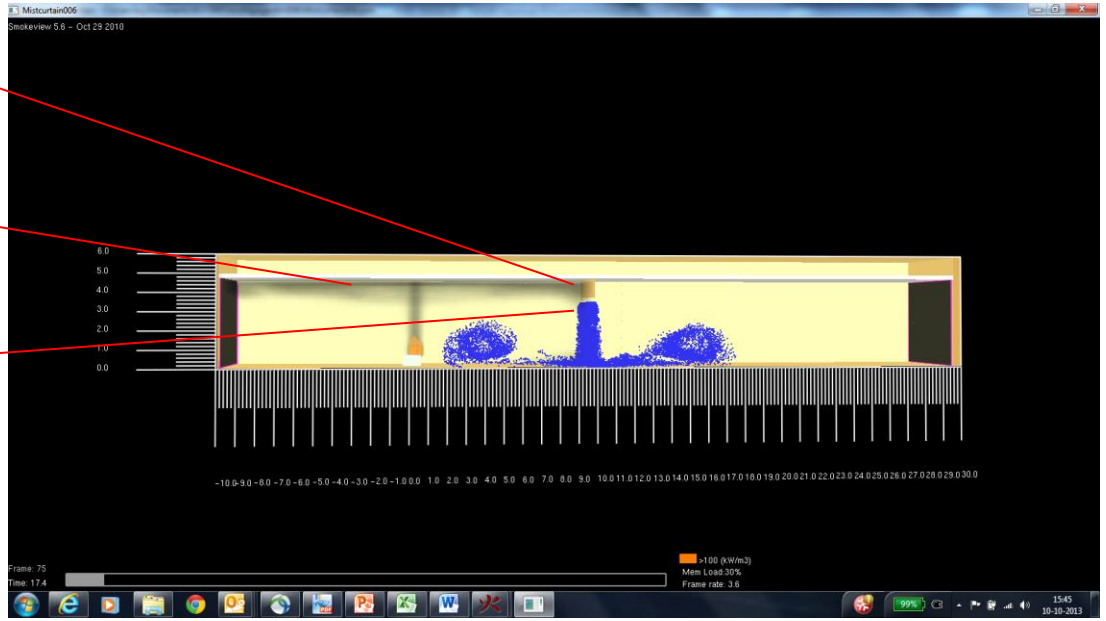
Smokebarrier whit integrated water mist nozzles.

2

Water mist nozzles activated by temperature (57ºC)

3

The nozzles activates by smoke detectors.



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Examples from our documentation

Fig. 01 Temperature

Temperature is max. 135ºC. Only the water mist barrier is activated.

The nozzles under the sealing is not activate after 600 sec.

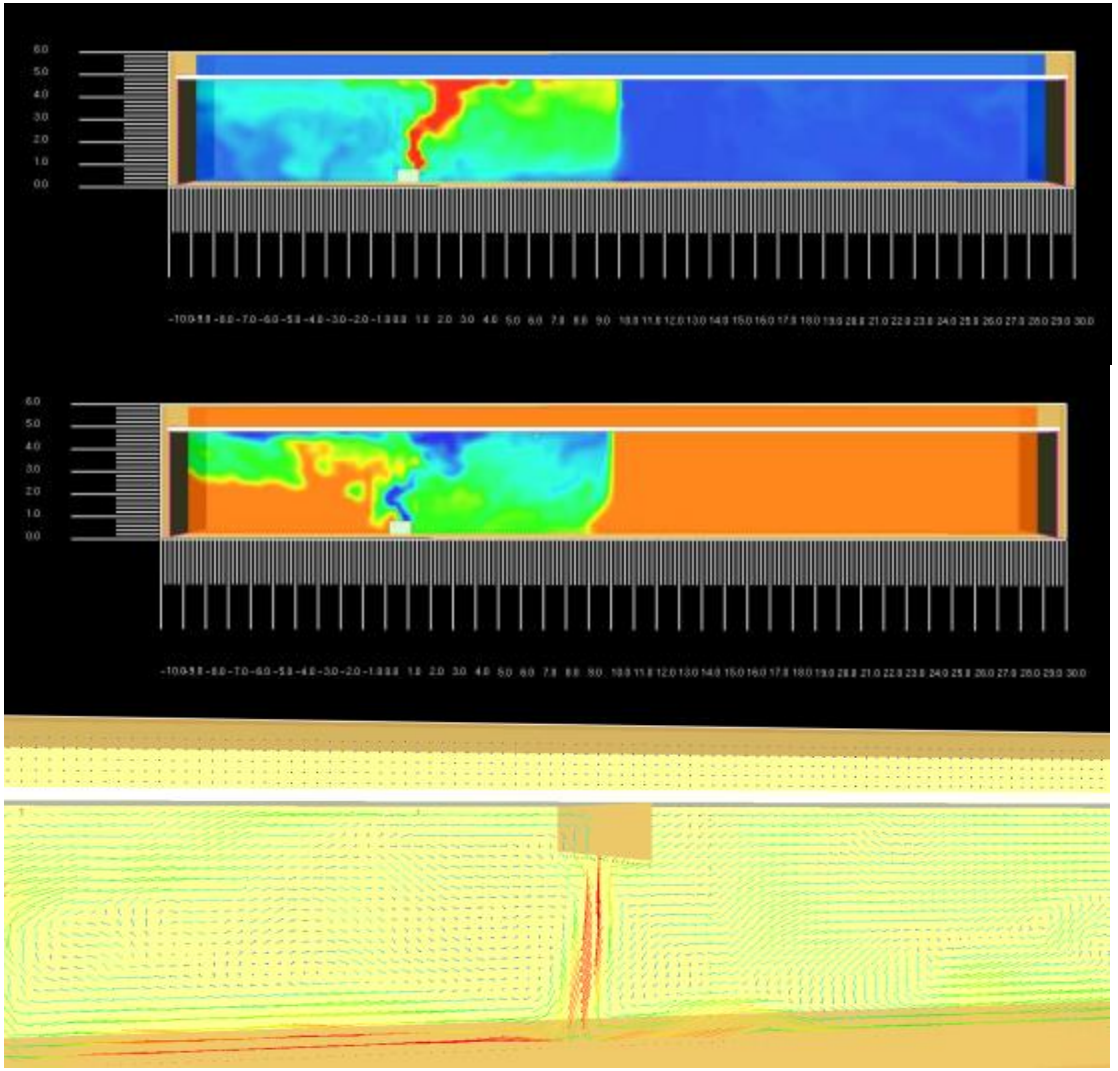
Temperature on the other side of the water mist is under ambient start temp.

Fig. 02 Visibility

Visibility behind the water mist curtain is not effected

Fig. 03 Velocity (vector)

Velocity vectors shows the airflow created by the water mist curtain



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Examples from our documentation

Calculation in FDS showing that temperature from a fire not will affect steel beams under the roof of glass, and that radiation through windows not will occur a new fire in the room behind.

The pyrolysis, smoke, temperatures and airflows are quit validated in FDS. Hand calculations are only used to verify in data for the scenario.

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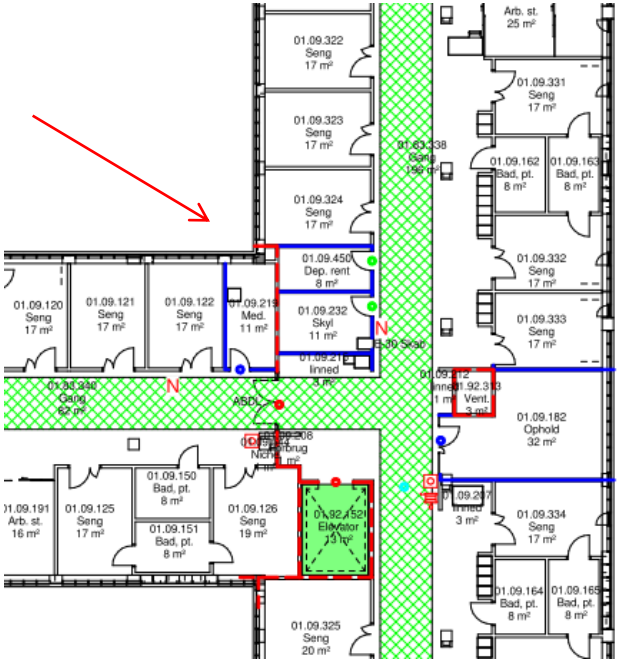
Examples from our documentation

The fire spread over the angle (< 135º) will not occur because the radiation is only 1,8 – 2,1kW/m^2

Accepten criteria: < 20kW/m^2

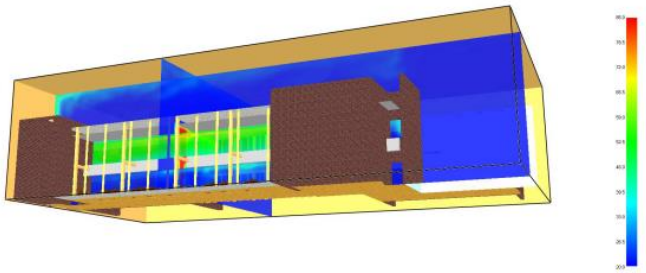


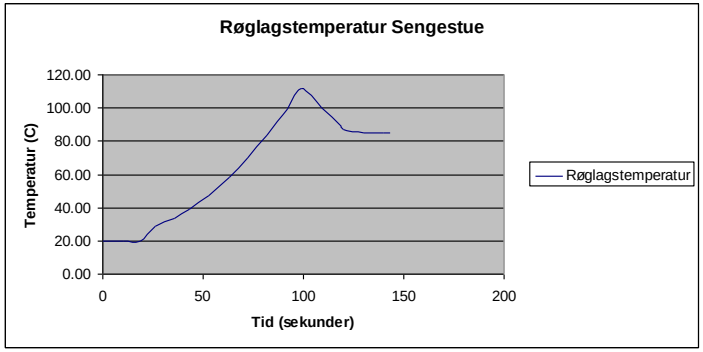
Method:

Calculations in FDS

Calculations in Argos

Hand calculations





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Examples from our documentation

When the temperature under the sealing in the fire compartment is below 130°C, the resulting air temperature in the main ventilation duct will be under 40°C.

No fire insulation is needed.

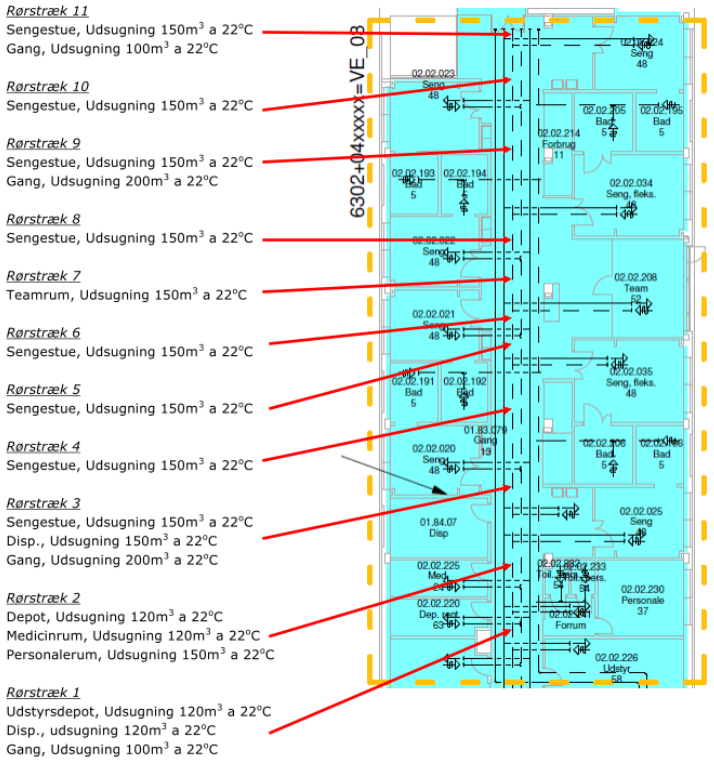
The ventilation fans can operate with air temperatures up to 63°C.

There for, the air flow out of the room continues under a fire.

The intake of fresh air will be reduced to 80% of the out taken air and create a under pressure.

For the complete primary fire compartment the under pressure will be able to remove the smoke from a 5,7 MW fire.

Smoke will not be spread out of the primary fire compartment.



Method:

Hand calculations

Calculation in FDS

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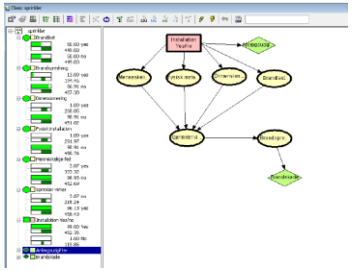
Fire Risk Management in fire safety

A fire safety initiative should not be implemented because we use to do so, or because it is required in a standard.

The fire safety initiative should be implemented if it make sense to do it.

Fire safety initiatives should be taken as a result of fire risk analyses.

By using Bayesian networks we manage to locate risk and calculate consequences.



The use of a radical different strategy for fire safety like this, is not a risk in it self.

Just you know what you do.

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Water mist can be used for increasing the fire safety level in modern buildings, but we have to focus om radiation and smoke to get the total functionality.

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Thank you

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