

Innovative Fire Protection for Concert Halls

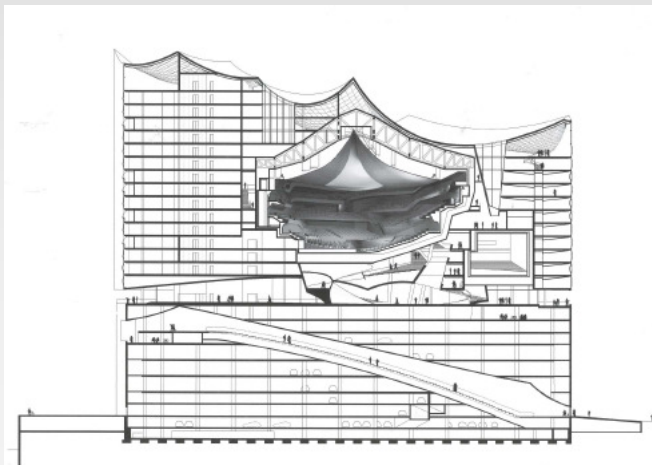
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Case Study Elbphilharmonie in Hamburg



- City of Hamburg aimed to build one of the world's best concert houses
- Outstanding location at the Elbe river in the harbour of Hamburg
- New landmark of the city
- Extraordinary design by architects Herzog & de Meuron combining a brick stone building with glass facades
- Project is a PPP project by an investor, the city of Hamburg and donations by citizens of Hamburg

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- Overall building floor area is 120.000 m² with an overall height of 110 m
 - Beside the philharmonic concert hall the building houses a 5-star hotel, restaurants, bars, a plaza, residential apartments and parking areas
 - Concert hall has 2200 seats and an overall height of 25 m
 - Hotel, restaurants, bars, plaza, residential apartments and parking areas are protected by a conventional sprinkler system
- ➔ Concert hall was a fire protection challenge

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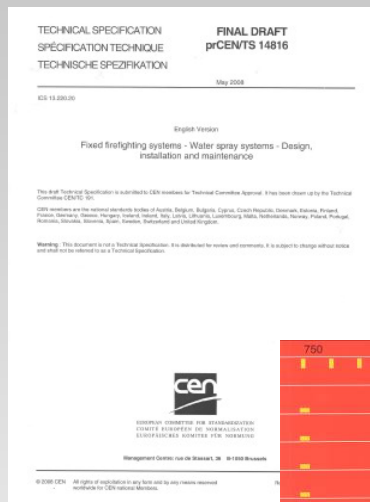
Protection of the concert hall

- A conventional sprinkler system could not be used due to the height of the area and due to the potential water damage when the system is activated
 - A gas fire fighting system could also not be used due to evacuation time of the audience
- ➔ **Development of an innovative fire protection concept based on high pressure water mist technology**

Fire Protection Concept

- Since the fire load is concentrated to the floor and seating area the fire fighting agent preferably shall be present in this area
 - Instead of overcoming the concert hall height of 25 m, a floor mounted system would be advantageous
 - An rapid activation of the system after fire detection would increase the safety level
 - Fire detection and fire fighting system must be jointly evaluated
- ➔ Development of a protection concept in conjunction with fire consultants (HHP and DEKRA)

System Acceptance and Approval Process



- Full scale fire test scenario was developed by the fire consultants based on NFPA 750 and prCEN/TS 14972 standards
- Fire tests were defined as close to reality as possible including
 - Fire load
 - Arrangement of fire load
 - Ventilation conditions
 - Fire detection

Fire Tests for Concert Hall

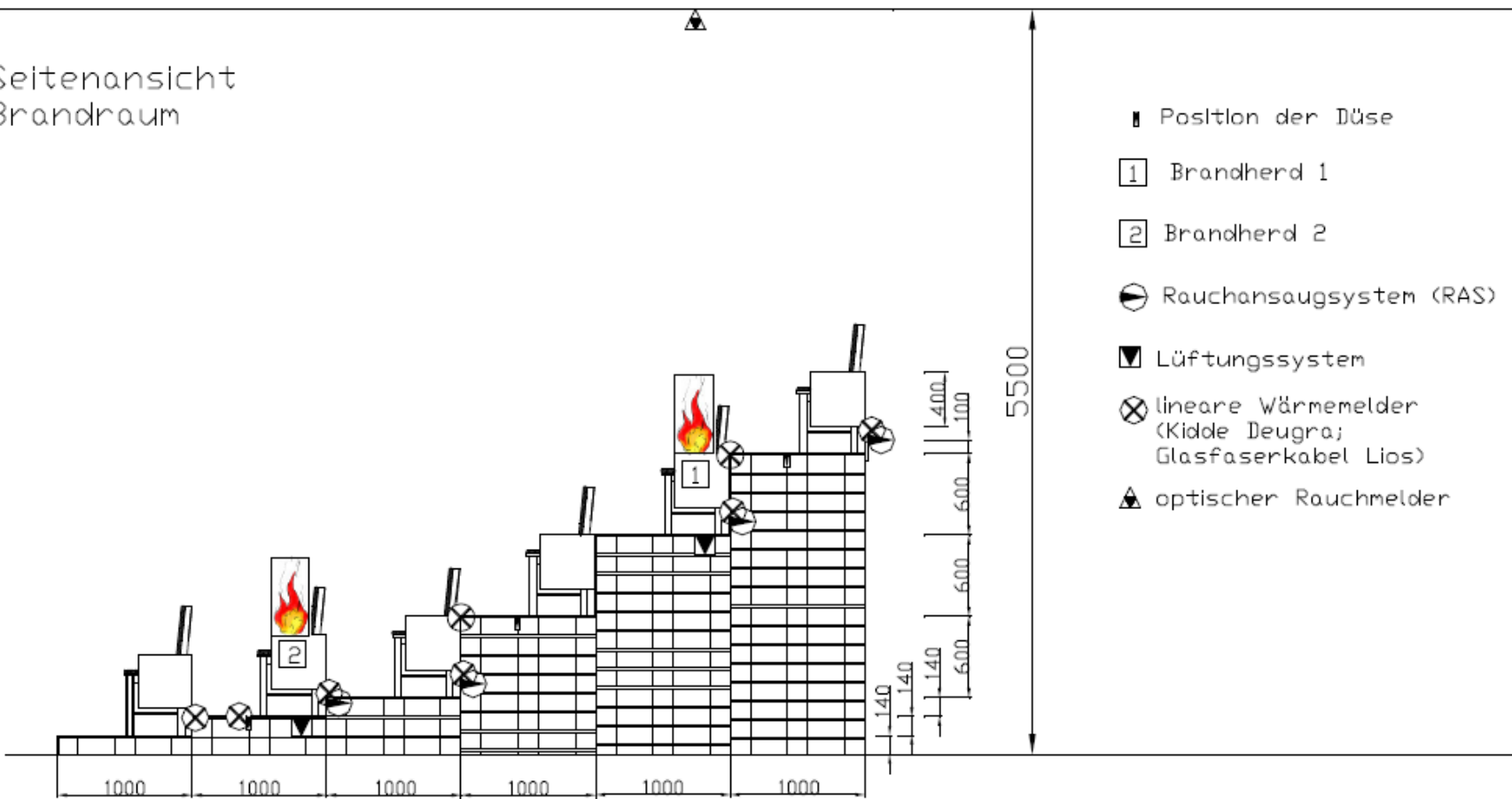
Fire Test Arrangement



- Test field of 6 m x 6 m (6 rows of each 8 seats) in a test hall of 10 m x 15 m floor area
- Steps between 14 cm and 60 cm height / stage height of 2,4 m
- Ceiling at 5,5 m height with 1 m distance to wall
- Original ventilation conditions (6 ventilation openings with 60 m³/h)
- Two fire scenarios (low and high level) each between 4 nozzles

Fire Tests for Concert Hall

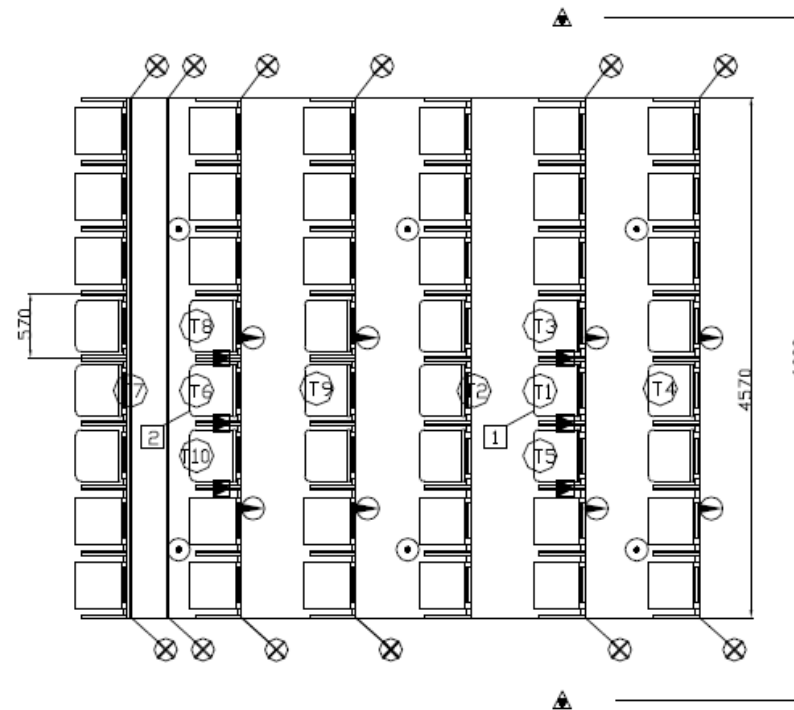
Seitenansicht
Brandraum



Fire Tests for Concert Hall

Grundriss
Brandraum

Anordnung der Thermoelemente



- Position der Düse
- 1 Brandherd 1
- 2 Brandherd 2
- ☉ Rauchansaugsystem (RAS)
- ▣ Lüftungssystem
- ⊗ lineare Wärmemelder (Kilde Deugra; Glasfaserkabel Llos)
- ▲ optischer Rauchmelder

Thermoelemente am Brandherd 1

- ⊙ T1 Thermoelement am Entstehungsbrand
- ⊙ T2 Thermoelement zur Überwachung der unteren Stuhreihe
- ⊙ T3 Thermoelement zur Überwachung der linken Stuhreihe
- ⊙ T4 Thermoelement zur Überwachung der oberen Stuhreihe
- ⊙ T5 Thermoelement zur Überwachung der rechten Stuhreihe

Thermoelemente am Brandherd 2

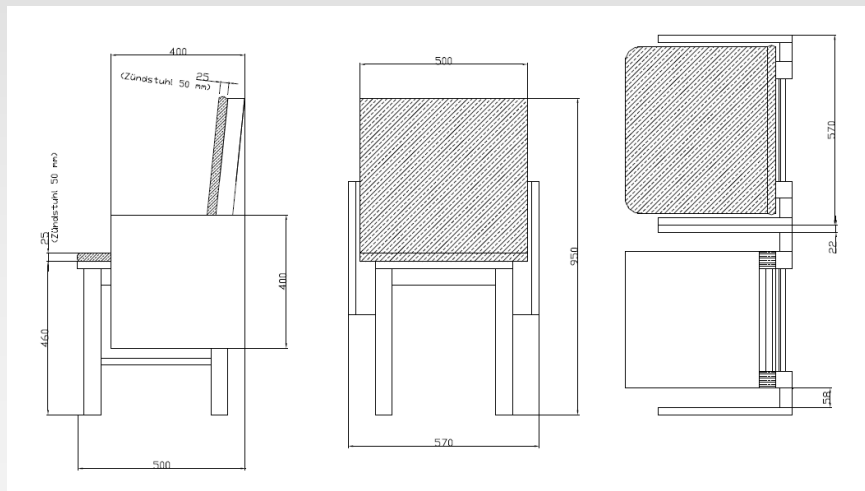
- ⊙ T6 Thermoelement am Entstehungsbrand
- ⊙ T7 Thermoelement zur Überwachung der unteren Stuhreihe
- ⊙ T8 Thermoelement zur Überwachung der linken Stuhreihe
- ⊙ T9 Thermoelement zur Überwachung der oberen Stuhreihe
- ⊙ T11 Thermoelement zur Überwachung der rechten Stuhreihe

Fire Tests for Concert Hall



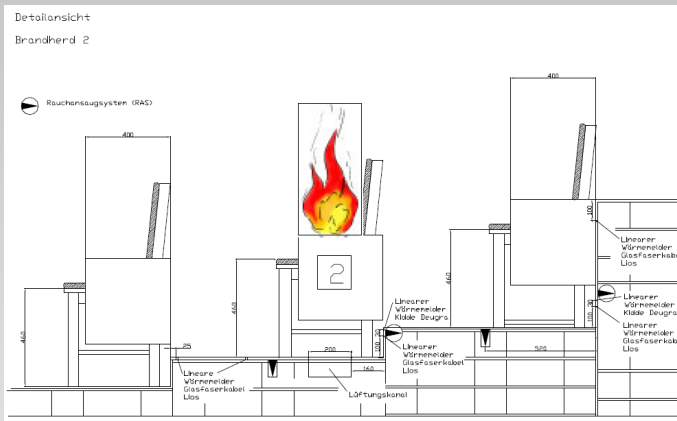
Fire Load

- Seat as specified in prCEN/TS 14972 for office areas, but modified to represent the original seat of the concert hall
- Paper cushion as specified in DIN 5510-2 lying on the seat, lighted in all four corners as igniter



Seat	Material	Size [mm]	Weight [kg]	HRR MJ/ material	HRR MJ total
Original Seat	PU - Mattress 55 kg/m ³	1000*400*60	1,3	60,0	60,0
Test Seat	Pine wood	950*570*50	6,0	97,2	136,2
	PU - Mattress 33 kg/m ³	1000*500*50	0,8	22,3	
	Cotton - cover (140 g/m ²)		1,064	16,7	

Fire Tests for Concert Hall



Detection System Fire Test

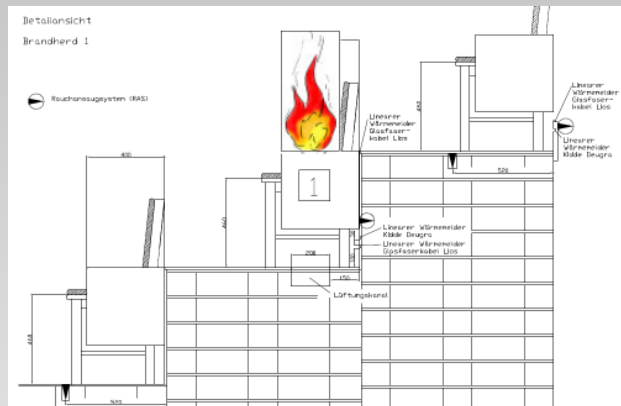
- Three different detection systems were tested at the low scenario [2], being more difficult to detect
- Smoke Aspirating System (pipe above each step)
- Linear Heat Detection System (cable above each step)
- Optical Smoke Detection System (detectors at ceiling / original ceiling is 20 m higher)

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Detection System Fire Test Results

- Smoke Aspirating System: Fire detection 5:30 min after ignition**
 - Linear Heat Detection System: Fire detection 1:51 min after ignition**
 - Optical Smoke Detector: Fire detection 1:31 min after ignition**
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- Decision was made for the Linear Heat Detection System, since it was fast and can localise the fire precisely**
 - Fire consultants defined the pre-burn time for all water mist fire tests to 3 min to ensure sufficient safety margin**

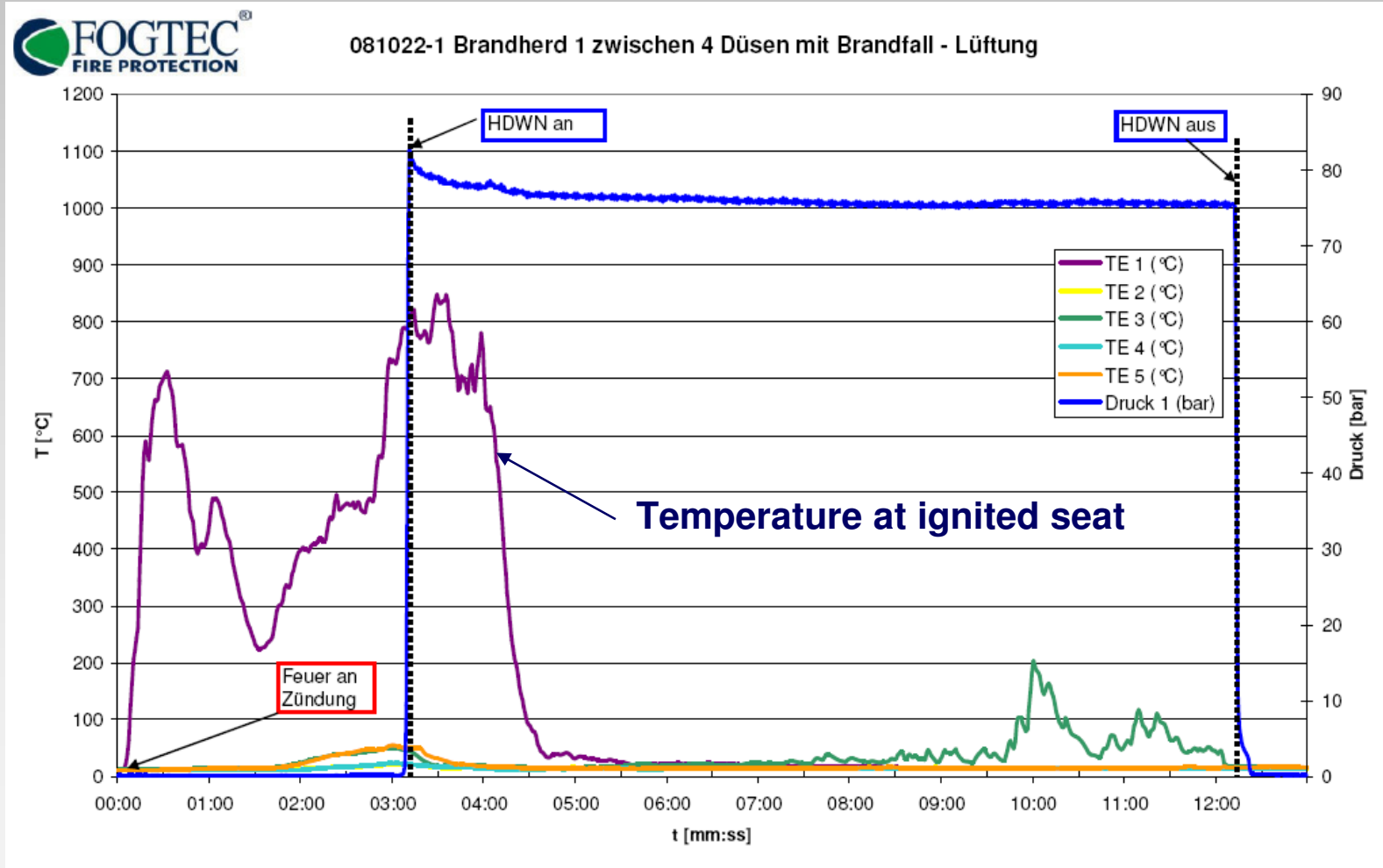
Fire Tests for Concert Hall



Water Mist System Fire Test

- Fire tests were carried out at low and high scenario / high scenario [1] turned out to be more difficult
- Fire between 4 nozzles as most difficult scenario
- Additional test with one disabled nozzle
- Aim was fire control until manual intervention by the fire brigade
- Fire test duration 10 min
- Fire damage was evaluated after fire test

Fire Tests for Concert Hall



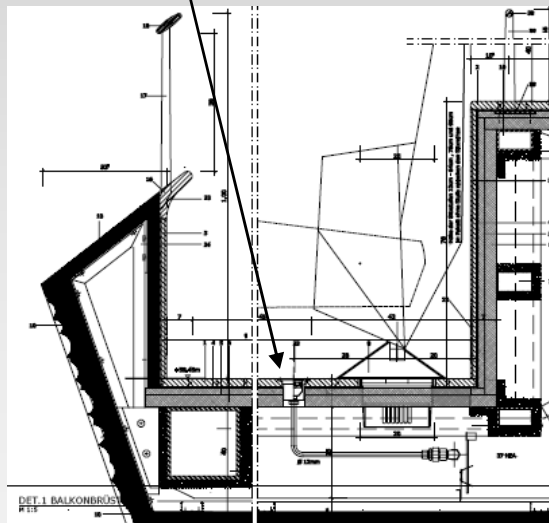
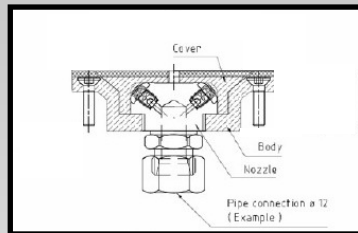
Fire Tests for Concert Hall



Water Mist System Fire Test Results

- Temperatures in direct vicinity of the fire were effectively controlled
- Fire spread was limited
- Ventilation system had minimal influence on the effectiveness of the system
- Fire damage was concentrated on the ignition area

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- Fire tests have determined the position of nozzles and the flow rate (1,2 l/min/m²)
- Nozzle installation in the floor with a cover, having the same appearance as the floor
- Nozzles will be zoned in sections
- Pump capacity is designed to operate 3 adjacent sections
- Small bore pipework for installation
- ➔ Minimal disturbance of the architecture

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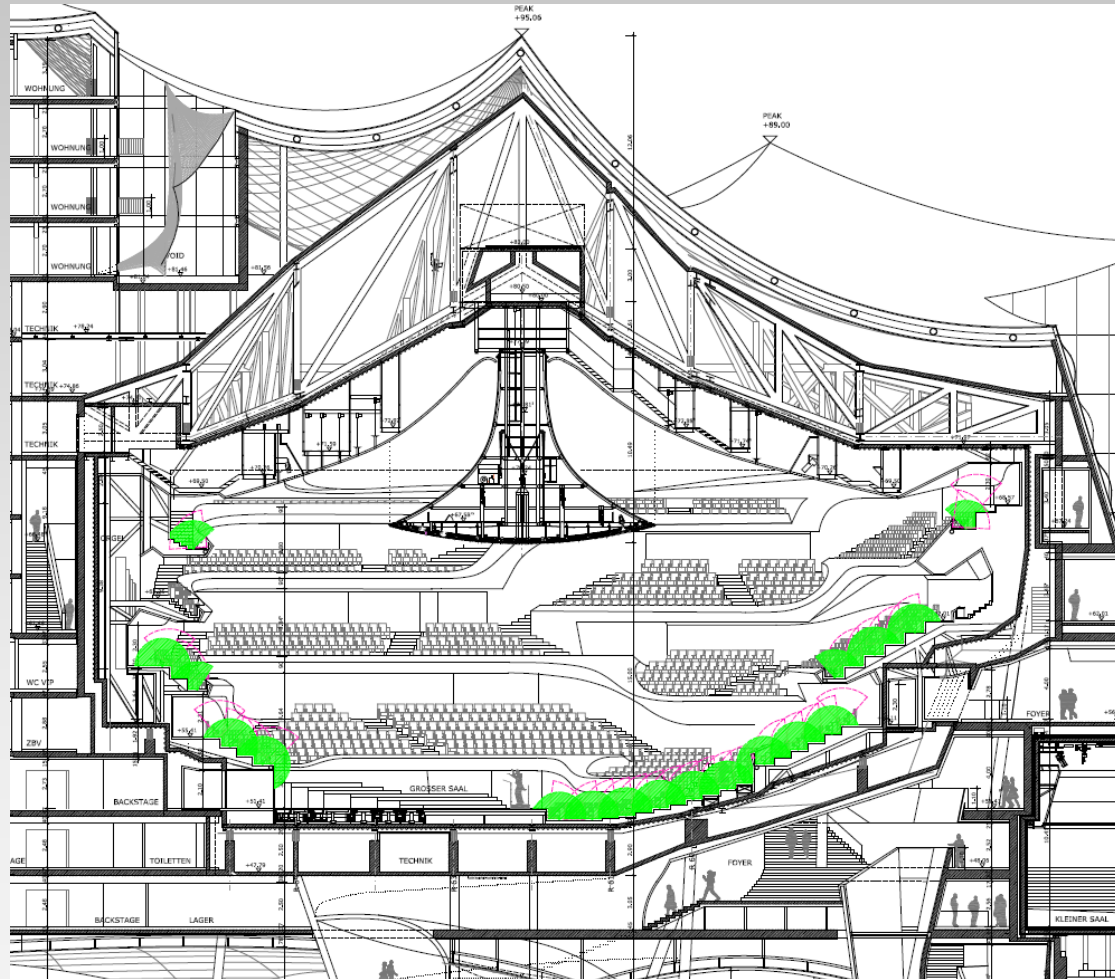


Reliability Tests for Nozzles

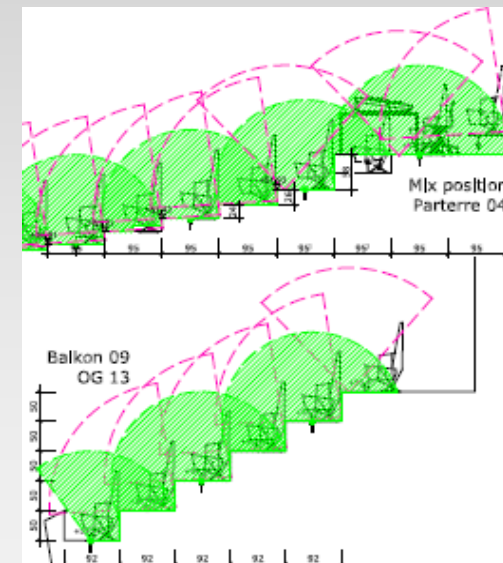
- Reliability of the lift-off of the cover was analysed
- ➔ No danger for audience by the cover
- ➔ Cover removes even if obstructed by an object, e.g. a bag



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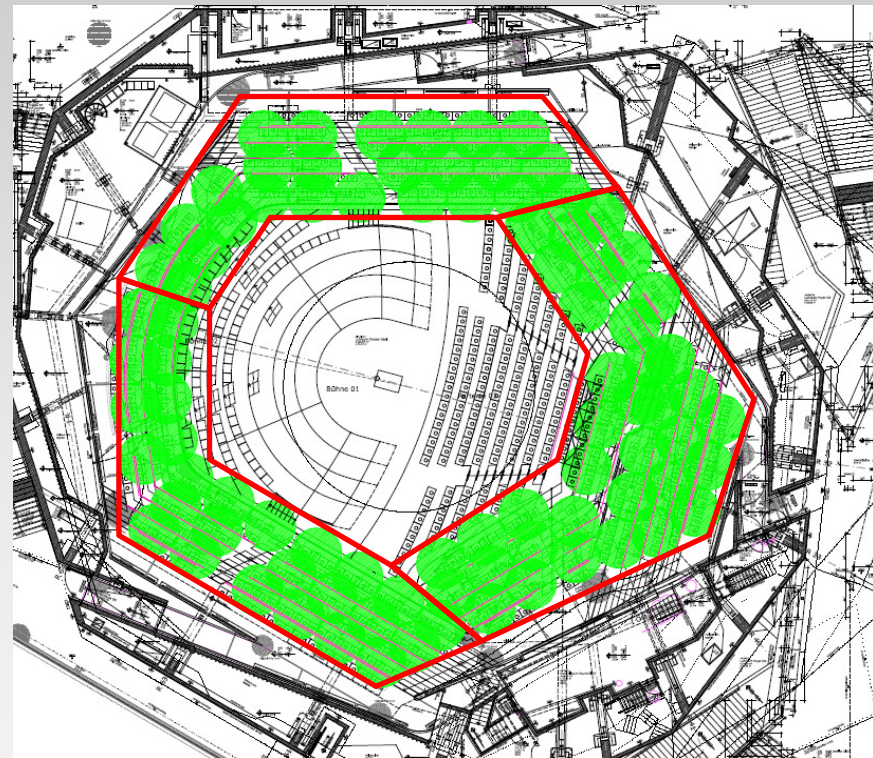
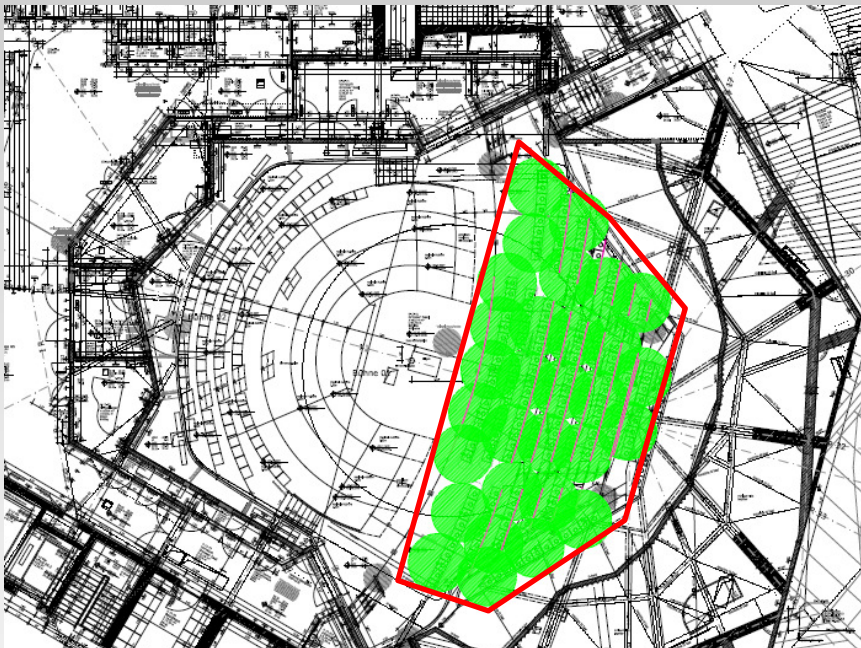


Nozzle Arrangement



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Different Activation Zones



Innovative Fire Protection for Concert Halls

The presented protection concept for concert halls allows a safe and architecturally pleasant solution for this special environment

System design must be integrated in the overall fire safety concept of a building and be evaluated by authorities having jurisdiction

**Thank you for your
attention**