HI-FOG®
water mist fire protection

Water Mist and Heritage Buildings Case - St. Mark's Dome, Venice

By
Nino Frisina
Sales Director
Marioff Italy

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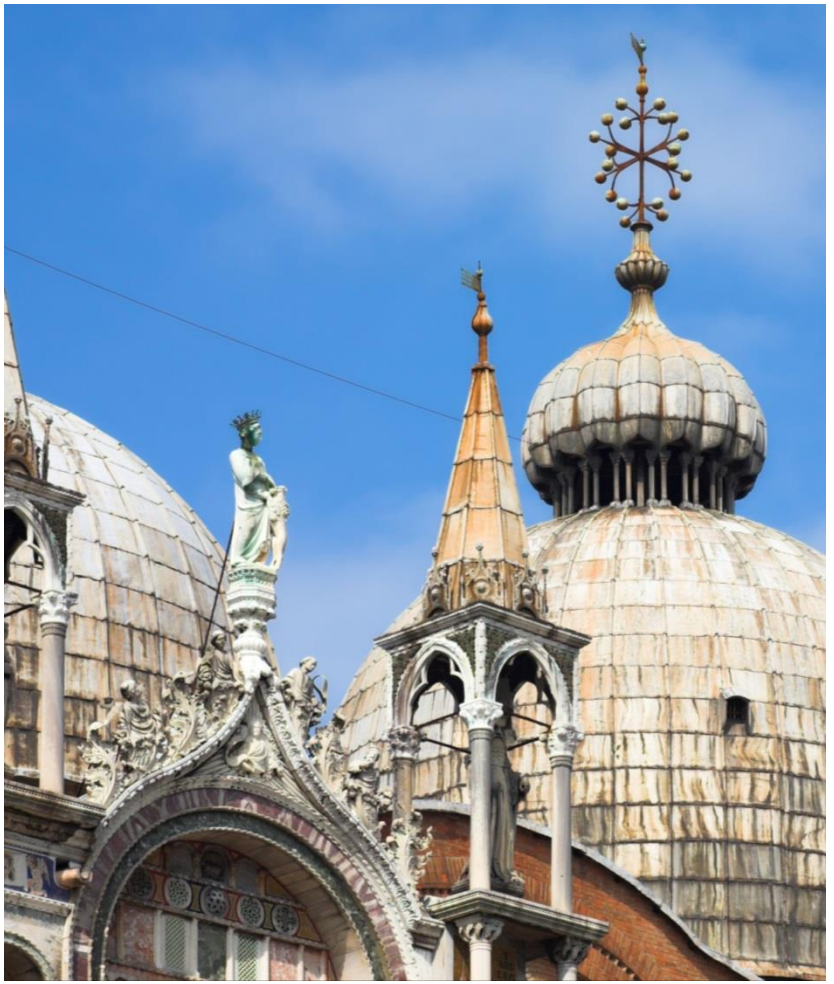
AGENDA

Background

Case - St. Mark’s Basilica

HI-FOG® solution

Conclusion



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BACKGROUND

HERITAGE BUILDING - DEFINITION

UNESCO: ”Heritage is our legacy from the past, what we live today and what we pass on to the future generations. Our cultural and natural heritage comprise irreplaceable sources of life and inspiration”.

References of heritage buildings protected by water mist

Hotel Gabrielli, Venice, Italy

Tudor House Museum, Southampton, UK

Duchess Anna Amalia Library,
a UNESCO World Heritage Site

HERITAGE BUILDINGS

Typical Firefihgting Challenges

Each historical building is unique and requires unique and creative fire protection solutions

Buildings of cultural heritage were built in other times, under different rules and with no standards of safety

Lack of proper building standards, documentation, drawings etc

Various types of spaces, e.g. atriums, cupols, stairs, heights

Historic buildings usually don’t have proper fire compartmentation

Fire protection should be of high standard without destroying the historical value or high value assets

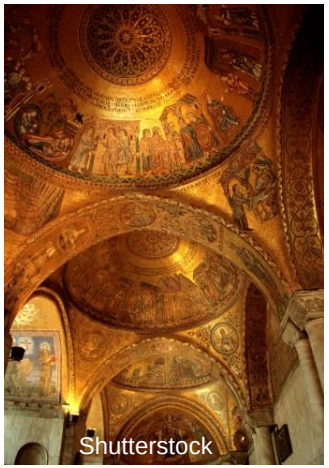
The building might be strictly controlled by museum authorities

CASE - ST. MARK'S BASILICA

ST. MARK’S BASILICA

The St. Marks Basilica is the cathedral church of the Roman Catholic Archdiocese of Venice, Italy. It is the most famous of the city's churches and one of the best known examples of Italo-Byzantine architecture. It lies at the eastern end of the Piazza San Marco.

For its opulent design, gold ground mosaics, and its status as a symbol of Venetian wealth and power, from the 11th century on the building has been known by the nickname Chiesa d'Oro - Church of gold.



CUSTOMER CHALLENGE

The customer's main objective was to define the scope of a efficient fire protection system that would provide adequate fire protection for the unique heritage building and its irreplaceable assets. Naturally, this would be based on a proper risk assessment of the building and it's usage.

While fires might be considered as rare occurrance…

... they might happend and lead to damage that no insurance can cover, loss of lives and the loss of unique buildings and irreplaceable assets.

Trinity Cathedral, St. Petersburg, fire incident 25 August 2006 during reconstruction work

WHY FIRE PROTECTION

According to CFPA-E* Guideline No 30:2013F the most common causes of fires in historic buildings are arson, electrical faults, open fires, smoking, candles, heating equipment, lightning, hot works such as welding, cutting, and similar uses during works of renovation, etc.

Additionally to the most common causes and risk areas, specially in Venice, fire can be ignited by fireworks during annual festives

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*CFPA-E: Confederation of Fire Protection Associations in Europe

WOODEN CUPOLES

Wooden made cupoles are quite common among heritage churches and domes.

Usually, a wooden structure supports the outer cupole and the waterproofing. There might also be a wooden structure that supports the inner cupole.

Also, if not frequent, a fire may develop between the inner and the outer cupole, making it very challenging to reach.

The main challenge would be for the fire brigade to reach the cupole and to extinguish the flames in the event of a fire.

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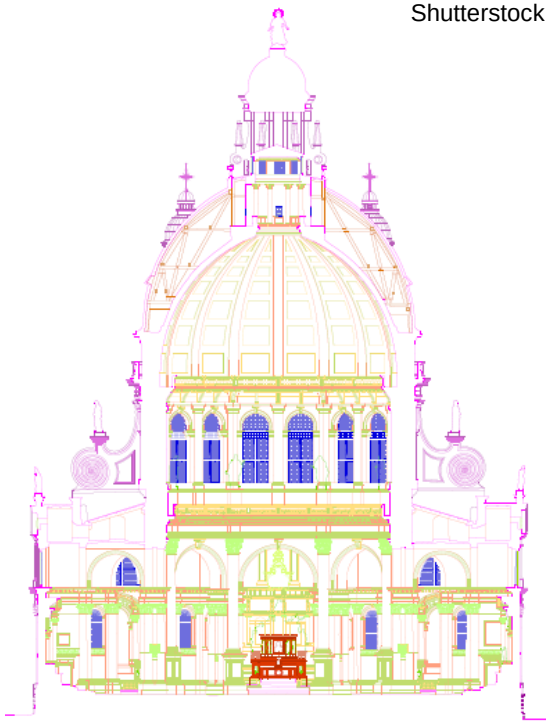

FIRE SUPPRESSION FOR HERITAGE BUILDINGS

In St. Mark's Basilica case, the difficulty of carrying out efficiant manual intervention of a fire, makes the installation of a fixed fire fighting system the most attractive solution for the wooden cupolas as well as for the wooden attics.

Nevertheless, the system design and installation might not always be straight-forward.

Naturally, the fixed fire suppression system must be safe also for interior decorations and high value assets.

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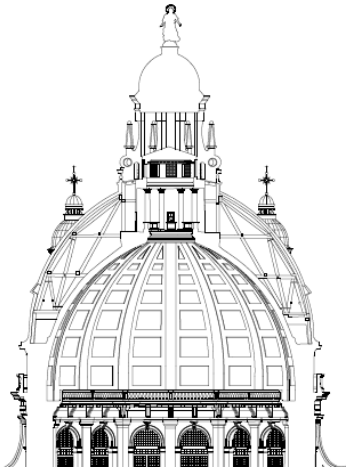

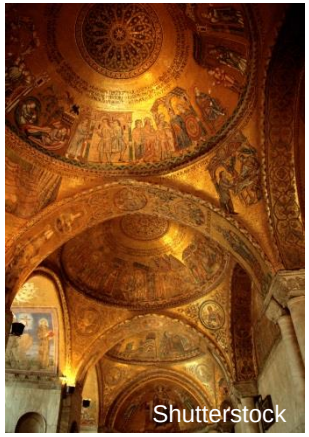

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FIRE SUPPRESSION FOR HERITAGE BUILDINGS

Comparison of different suppression technologies considered for the project

Agent	Challenges
Gaseous Agents	• Integrity issues • Sufficient cooling effect • Cylinder bank extremely bulky • High cost for large volumes • Risk of accidental activation from detection systems
Traditional Sprinkler	• Pipe size too large from installation and esthetical point of view • High water consumption, risk of flooding • Large water damages in case of fire or accidental discharge • Potential need for massive water tank and pump stations
Water mist	• Performance based system solution • Initial installation cost

HI-FOG® WATER MIST SOLUTION

MARIOFF DESIGN APPROACH

HI-FOG® water mist systems are always performance based suppression systems. The effectiveness has been validated and confirmed through thousands of full-scale fire tests representing a very wide range of applications and fire hazards.

St. Mark's Basilica – Fire Protection Schemes

Occupancy	Standards	Hazard	HI-FOG solution
Attics	FM, VdS	LH1 / OH1	GPU-LH
Cupolas	Project specific full scale fire testing	Vertical wooden construction	Performance based solution

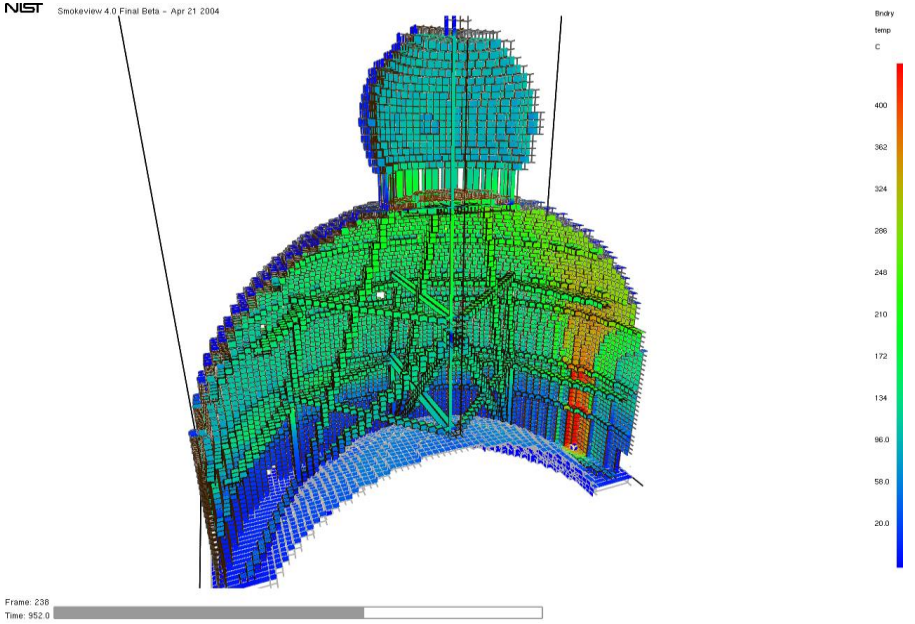
Wooden Cupolas

The shape and format of the combustible surfaces of the cupolas, results in a one-of-a-kind fire hazard scenario. The design criteria for a water mist system needed to be verified through full scale fire testing.

FIRE DYNAMICS SIMULATION

Prior to full scale fire testing, FDS (Fire Dynamics Simulation) simulation was used as an additional help, to find the right conditions and assess the fire propagation of the construction

The target of performing numerical simulations was to predict how the sprinkler nozzle location impacted on system activation and final fire fighting performance



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FULL SCALE FIRE TEST

FULL SCALE FIRE TEST

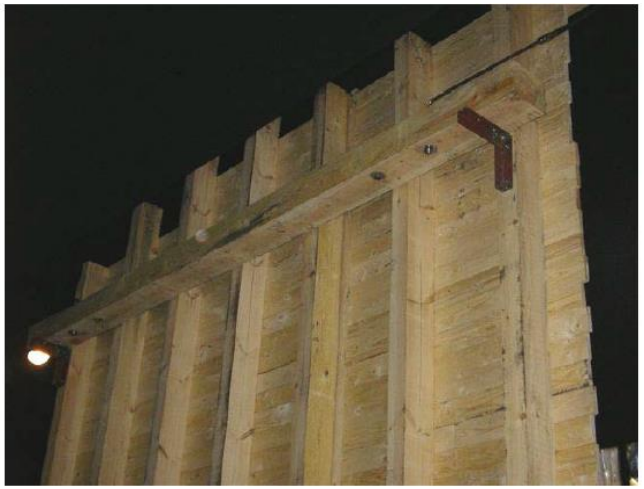
Based on the results of the mathematical model, a good understanding of the fire propagation and optimized configuration of the sprinklers within the wooden structure was reached.

Based on the configuration adopted, real-life tests were performed at the VTT fire testing laboratory, exactly replicating the structure of a section of the cupola.

The fire tests verified the system design, specifically the sprinkler nozzle configuration as well as time of activation.

TEST ARRANGEMENT

The Cupola Wall Mock-Up



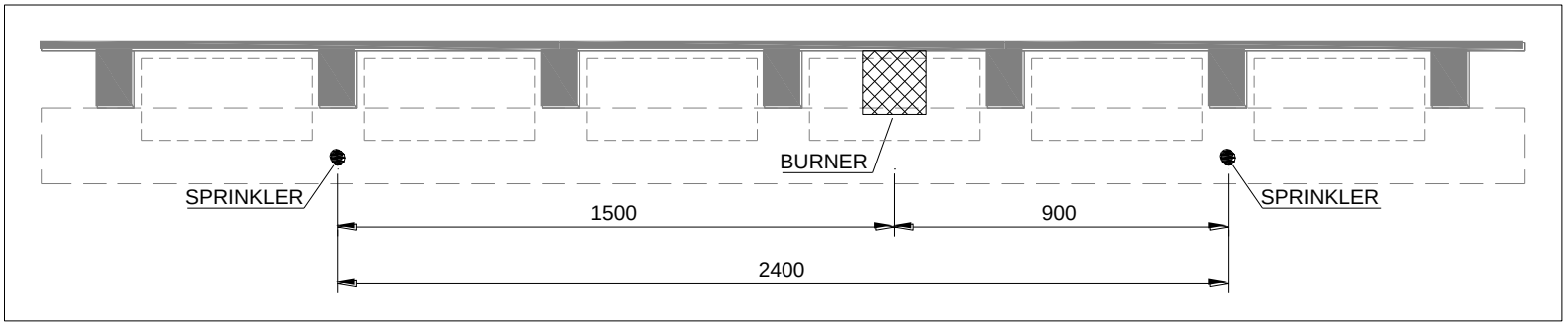
TEST ARRANGEMENT

Detail of the plates installed to partially close the channel gaps

Gas burner set to generate 100kW

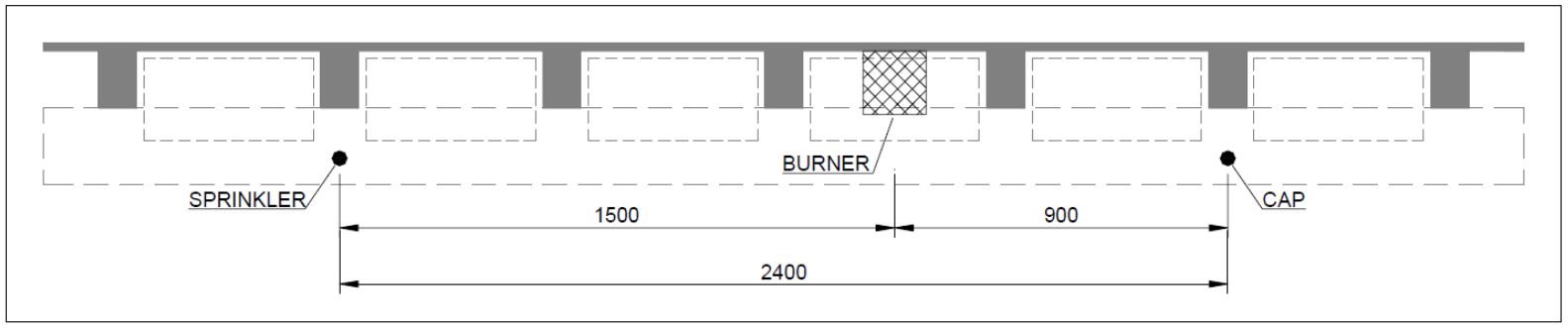
TEST ARRANGEMENT

#14



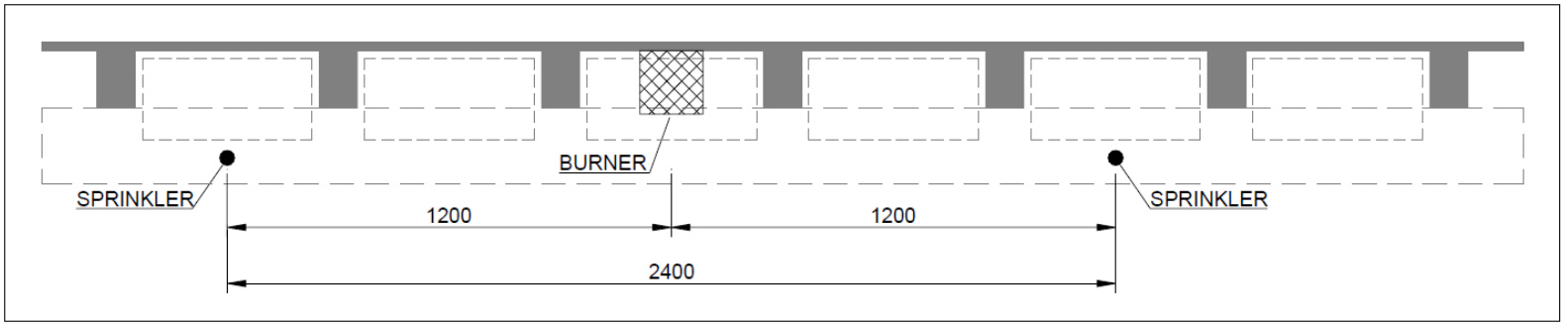
Pass

#15



Fail

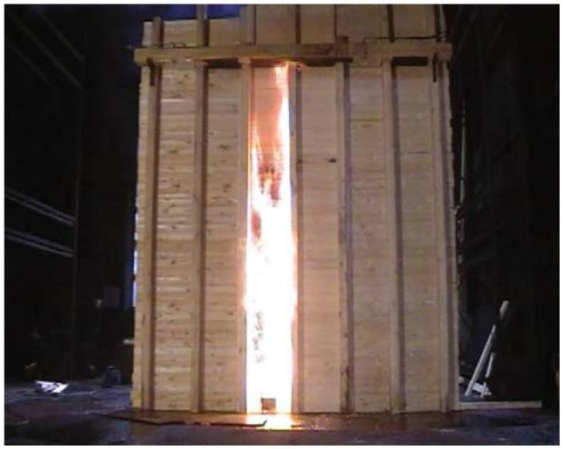
#16



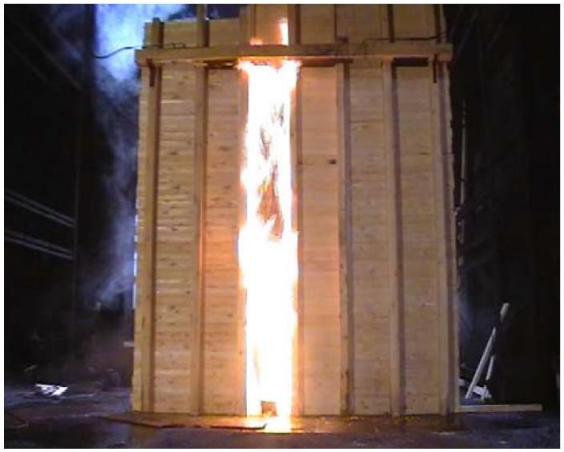
Pass

FULL-SCALE FIRE TEST

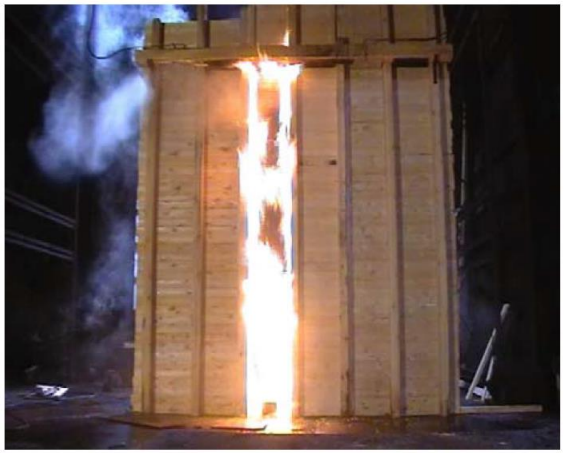
0’



2’



3’05”



3’06” (left sprk activated)

Before burner shut off

After burner shut off

WATER MIST SYSTEM

HI-FOG® GPU (**G**as driven **P**ump **U**nit)

A "self-contained" system that does not require any external power

The water supply line was kept at 30 bar standby pressure and after the sprinkler activation, the GPU started operation providing a pressure of approx. 90 bar, gradually decreasing.

NOZZLE TYPE

Two types of nozzles were used, in various spacing ignition-location configuration:

Marioff HI-FOG Type *1N 1ME 6MF 10RC*
(Nominal water flow rate=12.5 lpm)

Marioff HI-FOG Type *1B 1MC 6MC 10RC*
(Nominal water flow rate=7.5 lpm)

Nozzles were installed projecting downward (pendent), beneath the horizontal beam located a 4 m from ground, 7 cm from the hedge and approximately 30 cm from the wall.

The nozzles were thermally activated and were rated 79 °C (bulb color: yellow).

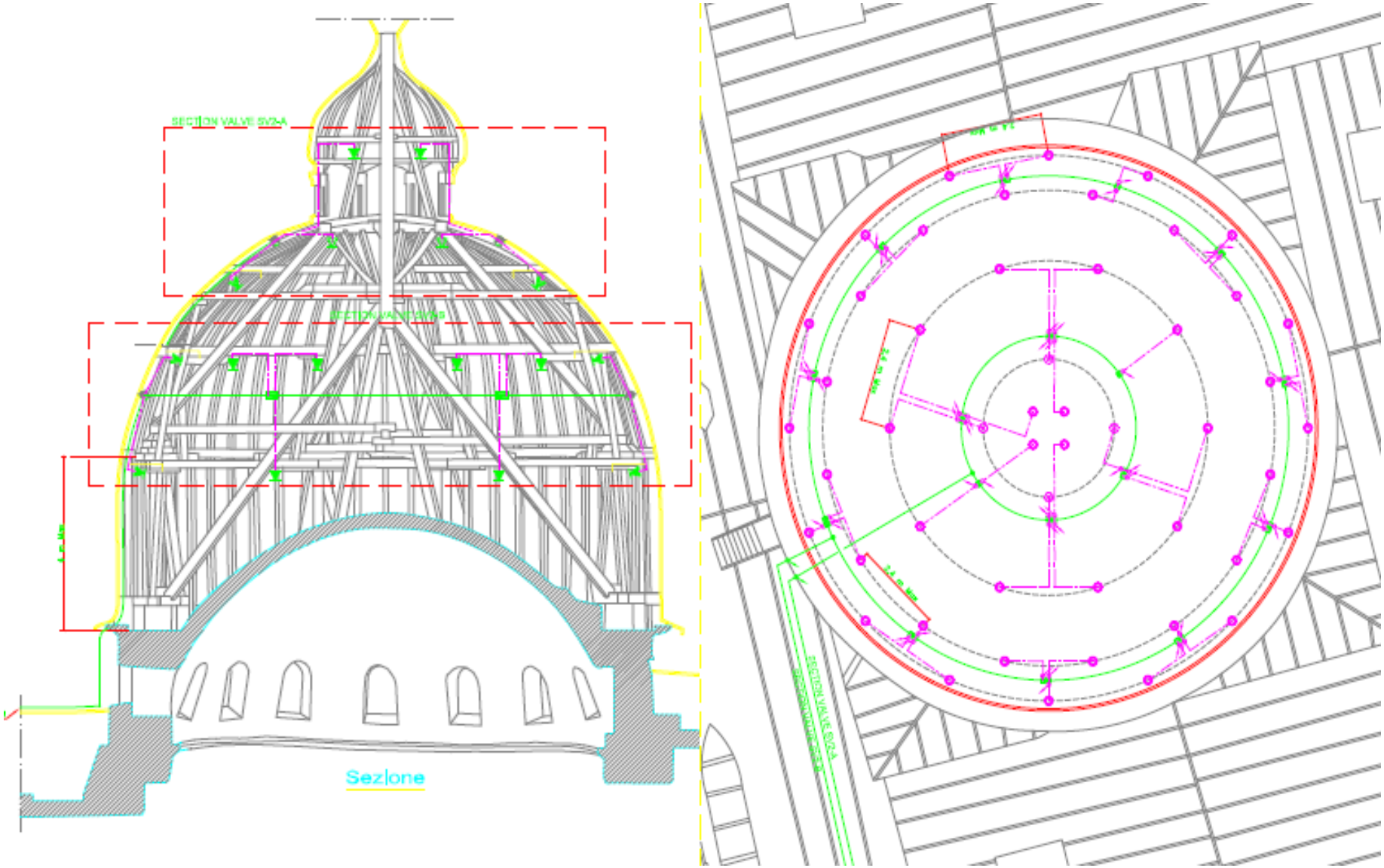
DESIGN PARAMETERS

The following design criteria was defined:

Number of operating sprinklers	9
Duration	Minimum 30 min
Sprinkler type	Marioff 1N 1MC 6MC 10 RC (k= 2.5; 7.5 lpm) or Marioff 1N 1ME 6MF 10 RC (k = 6.4; 12.5 lpm)
Pump	Gas Driven Pump for Light Hazard Occupancies
Type and Number of cylinders of air	According to HI-FOG GPU design manual
Sprinkler installation	Projecting downward
	In front of a vertical column
	Underneath a horizontal solid beam with plates closing channel gaps or underneath a horizontal heat collecting curtain 35 cm wide from wall
	Approx 30 cm from wall, at least 7 cm from the edge of the beam or the heat collecting curtain
Sprinkler temperature rating	79 °C
Horizontal Spacing	up to 2.4 m
Vertical spacing	up to 4 m
Nominal pressure	90 bar

FINAL SYSTEM LAY OUT

FINAL SYSTEM LAY OUT



FIRE TESTING - CONCLUSION

The full scale fire tests verified the performance of the HI-FOG® water mist system to control and suppress the fire spread on a specific wooden wall structure typcal for historical buildings having cupolas.

Suppression of the fire spread on the wall was achieved in all the 2.4 m spacing tests, with different configurations / ignition. The system in most cases was also able to extinguish the fire on the wall after the burner was shut off.

The cooling effect was very evident, when considering that the wooden wall was installed in a large test hall without relevant enclosure or obstacles that could help to contain the water mist.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THANK YOU
QUESTIONS