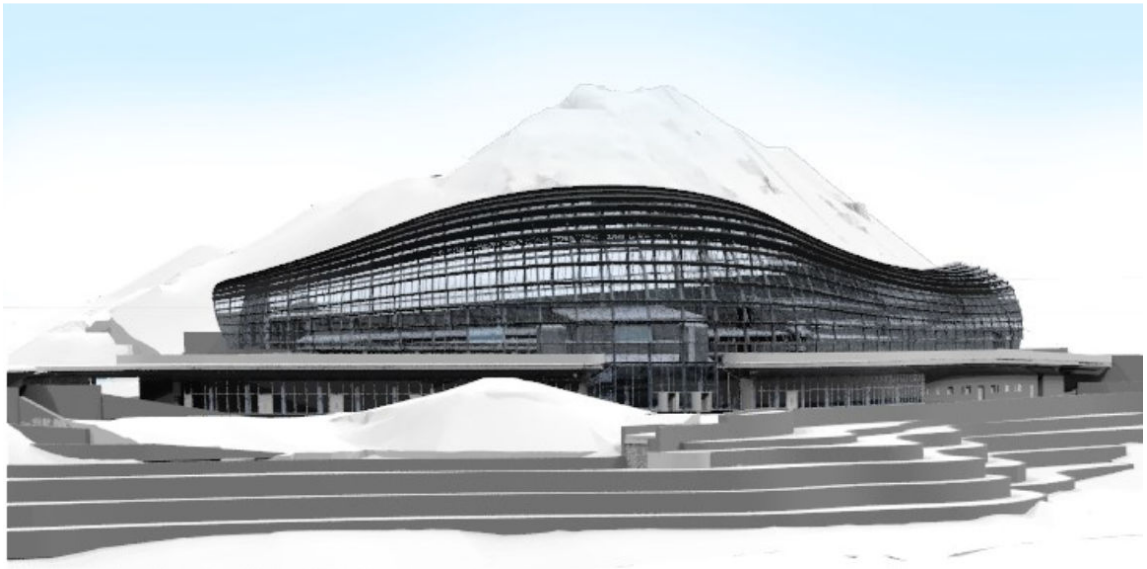
## Case Study

## Specific Fire Engineering design for the Oman Botanic Gardens Biome Spaces

Cowi Gulf A/S in collaboration with FireNZE worked in conjunction with other stakeholders to complete a specific fire engineering design for the Oman Botanic Gardens Northern and Southern Biomes.



These unique buildings are impressive structures with very large open spaces that present a number of fire engineering design challenges not readily addressed by prescriptive design solutions.

Like many fire engineering designs, the selection of an credible worst case design fire was crucial. The botanical areas were challenging due to a lack of fire data and the biomes have extensive retail and exhibition spaces.

A critical consideration in our scoping of the project was the assessment of project timelines. The complex geometry and large volume of the biomes dictates CFD. Completing the modelling to meet project deadlines was going to be a challenge. Through preliminary sensitivity analysis the modelling burden was reduced from months to weeks.

Established prescriptive tenability criteria for egress and fire fighting were applied to the design.

Fire Safety Systems

The biome garden spaces could not be provided with effective automatic fire sprinkler detection and control due to the height and profile of the domes. This dictated a smoke control design approach.

Early design proposals included VESDA detection and HVAC smoke control. Analysis of these systems in the Biome large open spaces with a credible worst case design fire and extreme ambient environmental conditions identified a number of potential issues.

Detection could be significantly delayed by stratification and aspirating transport delays, and the HVAC volume transport requirement for effective smoke control was prohibitive.

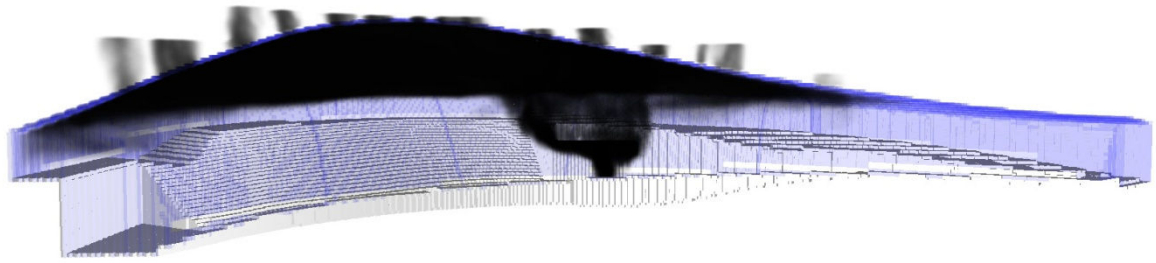
We developed an alternative detection strategy and reverted to a naturally buoyant smoke control system which could be integrated with environmental management systems.

A key consideration in the development of fire safety systems was ensuring that all systems had sufficient redundancy. This was achieved through zoning so that failure of any zone on any system would not compromise life safety. This had additional benefits for biome occupancy during fire safety system maintenance.

In completing the design we modelled the effects of extreme ambient temperature and wind events in combination with a credible worst case design fire to ensure fire safety system resilience.

The biome structural columns were subjected to specific fire engineering design to determine an appropriate fire resistance rating and the extent of column protection. This resulted in significant reductions to the column protection requirement reducing construction and maintenance costs. The analysis also considered fire spread and glazing failure.

Modelling the biomes for CFD presented its own challenges due to the complex terrain topology and the curved biome envelopes which needed to be represented in a rectilinear computational domain with an appropriate degree of accuracy. In an ideal world the key elements from the architectural design package would be directly imported into the fire model, ensuring accurate geometrical and material representation, and facilitating rapid assimilation of design changes. However appropriate file formats were not available resulting in a separate model development exercise.



While computer modelling can be an effective tool for some aspects of fire engineering we like to use hand calculations to estimate our model output prior to detailed modelling. This reality check was applied to throughout our design process.

The design was completed through a comprehensive serries of fire scenarios for each biome examining both maximum and minimum plume height and the potential for spill plumes under adverse environmental conditions and with fire safety system zone failure. This was followed by ASET/RSET analysis and the calculation of Fire Safety Level which also considered Civil Defence search and rescue and firefighting operations.

Although the biomes presented a number of design challenges we have been able to provide a robust, resilient and economic fire safety design for the life of the building through application of specific fire engineering design.