

NHM UNLOCKED TVSP - READING

MACE
CONSTRUCT



Flue support structures
Supplementary notes
Version 1.0

Introduction

The NHM Unlocked project consists of storage facilities for the world-unique collections of the Natural History Museum of the UK. The facilities include extensive laboratories to maintain the specimens stored in the building in their optimal conditions. The building services design included conducting extensive simulation work to guarantee adequate indoor conditions within the stores and the laboratories.

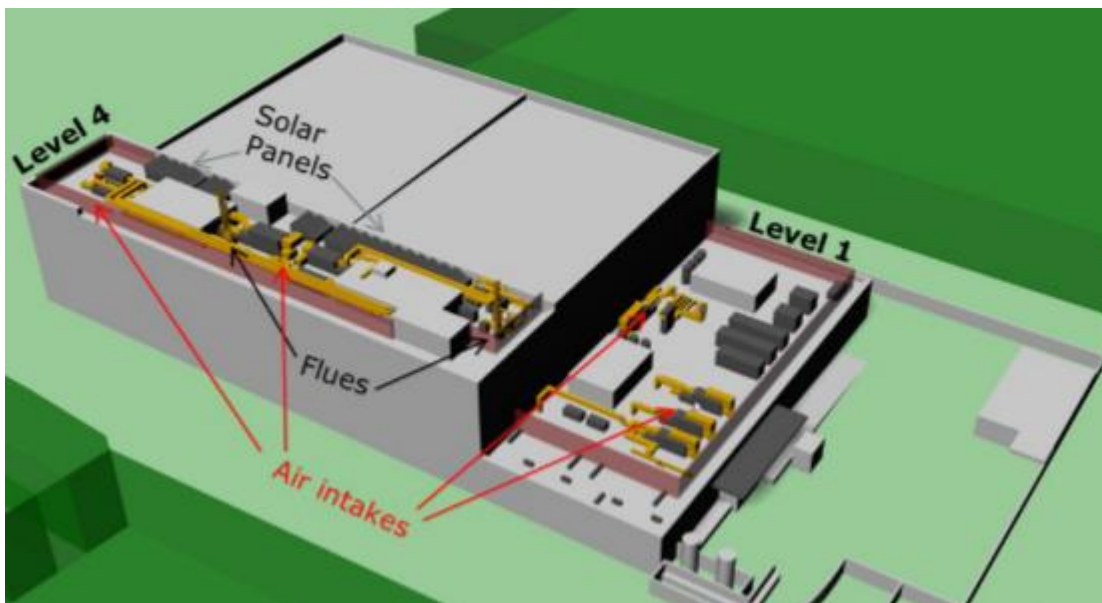
The laboratory equipment includes fume cupboards with multiple cupboards connected to a total of five fume stacks positioned on the rooftop at level 4 of the building. BS EN 14175-2:2003 indicates a typical height for the wake of a building, identifying 125% of the total height of the building as the top extent of the wake. This is analogous to 11.55 m above the Level 4 roof surface.

The British Standard also refers to a suitable dilution ratio (5000:1) for highly toxic pollutants, which are the kind of pollutants taken as reference for the building's flue design. A CFD assessment was undertaken to establish an optimal stack height and subsequent flue dispersal and if, under different wind conditions, the removed contaminated laboratory fume extract away from the building as well as ensuring no cross contamination occurred between the office air handling systems.

Based on the CFD analysis, a flue height of 11.55m was recommended, ensuring sufficient flue dispersal, avoiding building air intake contamination and providing margin of error to account for gravity effects and buoyancy influencing dispersal behaviour.

Roof-mounted flue locations

The flue stacks are arranged in two separate clusters. Their positioning upon the roof was dictated by the internal layout of building and the positions of laboratories and risers within the building, and the relative locations of the building's air intakes.



Flue construction

The expected nature of the contaminated laboratory fumes exhausted from the building is a primary factor determining the material of flue construction. Glass reinforced plastic (GRP) flues are proposed for the building, with flue heights constructed from connected flue pipe sections of diameters up to 450mm.

GRP flues of this height and diameter are unable to self-support and be able to resist applied wind loadings, and a maximum support bracket spacing of two metres is recommended for the vertical height of each flue pipe.

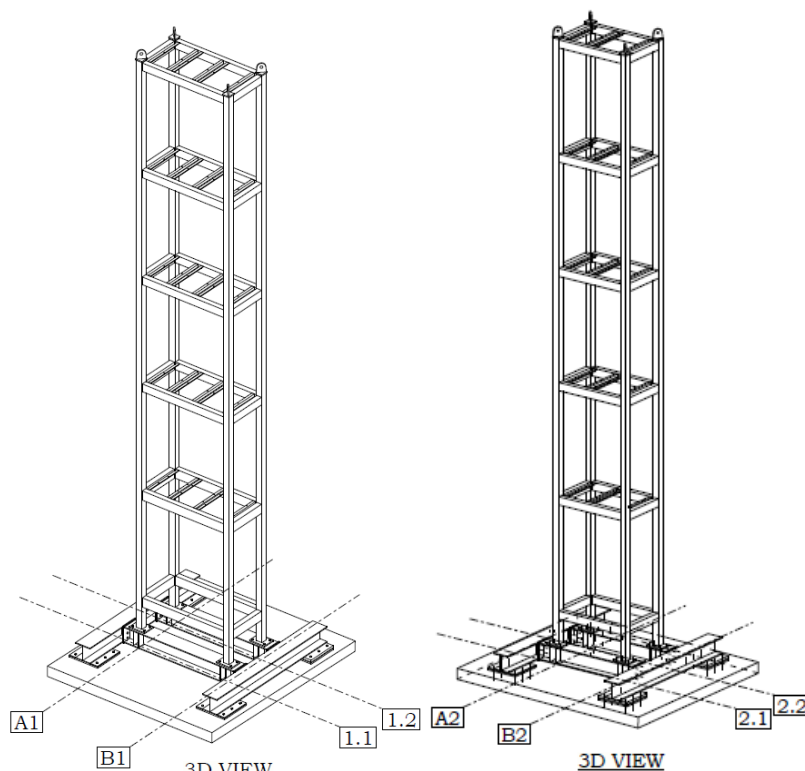
Reason for the introduction of supports

A dedicated structure is required for supporting flue stacks of 11.5m height above roof level with brackets at two metre vertical centres.

The structural engineer has advised a lightweight frame structure is required instead of one, central column, to transfer the horizontal wind loads acting on each flue cluster in a suitable manner into the concrete roof slab using post-fixed steel-to-concrete connections. Thus, a rectangular Vierendeel frame around each flue cluster is intended with regularly spaced horizontal cross members for attaching flue support brackets.

The resulting loads at the base of each frame structure require an additional, horizontal load-spreading grillage structure to adequately distribute forces across a wider area of the roof slab at each flue cluster location. Each grillage structure is approximately 3m x 3m plan area and can be accommodated within the thickness of the roof insulation and paving.

Details of each structure are presented on drawings 48-211125 - GA-01, Rev P02 and 48-211125 - GA-01 Rev P02 respectively.



Alternatives considered

The use of guy wires was considered, both on their own, and in conjunction with an external frame structure, to provide stability for each flue cluster. Whilst possibly a more cost-effective alternative, guy wires were considered unsuitable because:

- i) The flue pipes require supporting at two metre vertical centres, which would result in numerous levels of guy wires being needed when used on their own and a high number of guy wire anchor points being needed.
- ii) The proximities of the flue clusters to the edges of the building did not provide sufficient horizontal distance for effective anchoring of guy wires.
- iii) The amount of other plant and equipment at roof level prevented clear, straight-line paths being available for anchoring the guy wires to an appropriate structure.
- iv) When used in conjunction with an external frame structure, whilst the introduction of guy wires helped reduce the loads being transferred into the slab, guy wires did not reduce support structure height, and difficulties routing guy wires to suitable anchor points (points ii) and iii) above) would still need overcoming.

Flue cluster locations

The flues are arranged in two clusters of three and two flues respectively. Locations at roof level are predominantly determined by riser positions of the floor levels below, allowing for some horizontal pipe distances at roof level to include in-line fan assemblies.

Each cluster is positioned within the roof-level screened plant area along the western side of the building, where the roof structure comprises traditionally reinforced concrete and overlies the administrative rooms of the building on the floor levels below. Elsewhere, the majority of the building's roof area shall be occupied by photo-voltaic panels providing solar energy electrical supply for the building, installed upon a lighter, post-tensioned concrete roof slab overlying the Collection stores of the building below housing the numerous specimens of the Natural History Museum. The passage of services through roof above the Collection stores is avoided to mitigate the risk of water ingress in these sensitive locations, and the arrangement of post-tensioned cables within the roof slab places considerable constraints on any post-fixing of connectors, effectively prohibiting those needed for supporting and restraining flue clusters.

The roof-level screened plant area along the western side of the building provides limited scope for altering positions of equipment. The requirement to incorporate additional steel grillages beneath each flue cluster to aid the distribution of loads into the reinforced concrete roof slab has required some adjustment of the flue clusters from their originally intended locations. Both cluster positions have been adjusted by approximately three metres, generally southwards in the case of the triple flue cluster and generally eastwards in the case of the dual flue cluster.

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