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Power Hall and
Decarbonisation

Science and Industry
Museum

20th August 2021
Lightning Protection Strategy

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This document is intended to be read in conjunction with the Max Fordham's Services Strategy Report which forms part of the submission.

Introduction

This document has been prepared by Carmody Groarke, with input from the design team, to support the application for Planning and Listed Building Consent for works required in relation to the Power Hall restoration project. It should be read in conjunction with the Design and Access Statement, Max Fordham's Services Strategy Report, Vision document submitted as part of the application.

- This document sets out the following:
- a description of the proposed lightning protection system
 - the implications of lightning strike damages
 - the risk assessment that guides the design of a lightning protection system
 - the Power Hall proposal and conclusion
 - an initial proposal prepared by a specialist lightning company and a revised proposal by a different specialist lightning company

Lightning Protection System

Buildings with prominent roofs are often targets for lightning strikes. This phenomenon should be considered carefully for historic buildings as it involves an additional risk of cultural heritage loss. Although lightning protection is not a legal requirement, insurance companies and Public Trustees may require these buildings to have lightning protection.

Lightning Strike Damage

Although thunderstorms are more likely in the south of England, climate change studies indicate that the number and power of lightning storms is likely to increase over this century across the country. As a result, lightning strikes are likely to become more common in the future.

The most typical damage occurs to roof structures, with limited risk of fire, however lightning strikes can create voltage surges which in turn can cause an electrical system to shut down, malfunction, or even a complete burn out of wiring and equipment. The more vulnerable items are alarms, controls, sound reproduction systems, computers, telephones, and electronic components.

About 60% of insurance claims for lightning damage to historic buildings are for damage to electrical wiring and equipment. While indirect damages are more common than structural damage, it is important to note that it is far less costly. Repairing structural damage is on average three times more expensive. A recent incident at the National Railway Museum in York, one of the Science Museum's assets, has brought the approach to lightning protection to the Science Museum Group's current attention.

Risk Assessment

The design of a lightning protection system is guided by BS EN 62305 Protection against Lightning. Physical damage to structures and life hazard, for which a risk assessment shall be carried out to assess the need of installing a new system.

The BS EN 62305 risk assessment is concerned with both possible risks to people, damage to the structure and its contents, and protection against electrical surges which can also cause damage through sparking and fire. The complex calculations are based on the BS EN 62305

three-way matrix of sources of damage, types of damage, and types of risks. BS EN 62305 defines four classes of protection (I, II, III and IV for minimum and maximum values of lightning currents).

An important part of the standard risk assessment is the loss of cultural heritage: the architectural and historic importance of the building and its contents needs to be included in the risk assessment.

Power Hall Proposal

The Power Hall building does not have a lightning protection system in place now, however significant refurbishment works are due to be carried out both for the super-structure and for the electrical building infrastructure.

A new transformer/main distribution room is under construction within the Power Hall, as part of the Work Package 1A. The new electrical infrastructure is part of the wider Decarbonisation strategy that targets to reduce the carbon footprint via the site electrification.

This infrastructure, together with the other electrical systems proposed to be installed as part of this application (fire alarm, general lighting, LV distribution) are sensible to protect from the risk of lightning as the entire new operations of the building (steam for historic working machines, heating via heat pumps, etc) will depend on the electrical system.

Two independent risk assessments have been carried out to evaluate the advice to provide lightning protection. The risk assessments took into consideration several aspects, including:

- Dimensions and use of building
- Types and characteristics of the equipment to be protected
- Construction details such as floor surfaces, roof types and wall materials
- Infrastructure for power, telecommunications and data
- Earthing systems
- Risk of fire and the current fire protection
- Risk of people injury
- Risk of loss of public services
- Risk of loss of economic values
- Details of the historic significance of the building and its contents and their value ('Loss of Cultural Heritage')

In parallel the assessment considered:

- The installation and visual implications for installing this system on a Grade II listed building
- The additional installation and maintenance costs related with it.

Conclusion

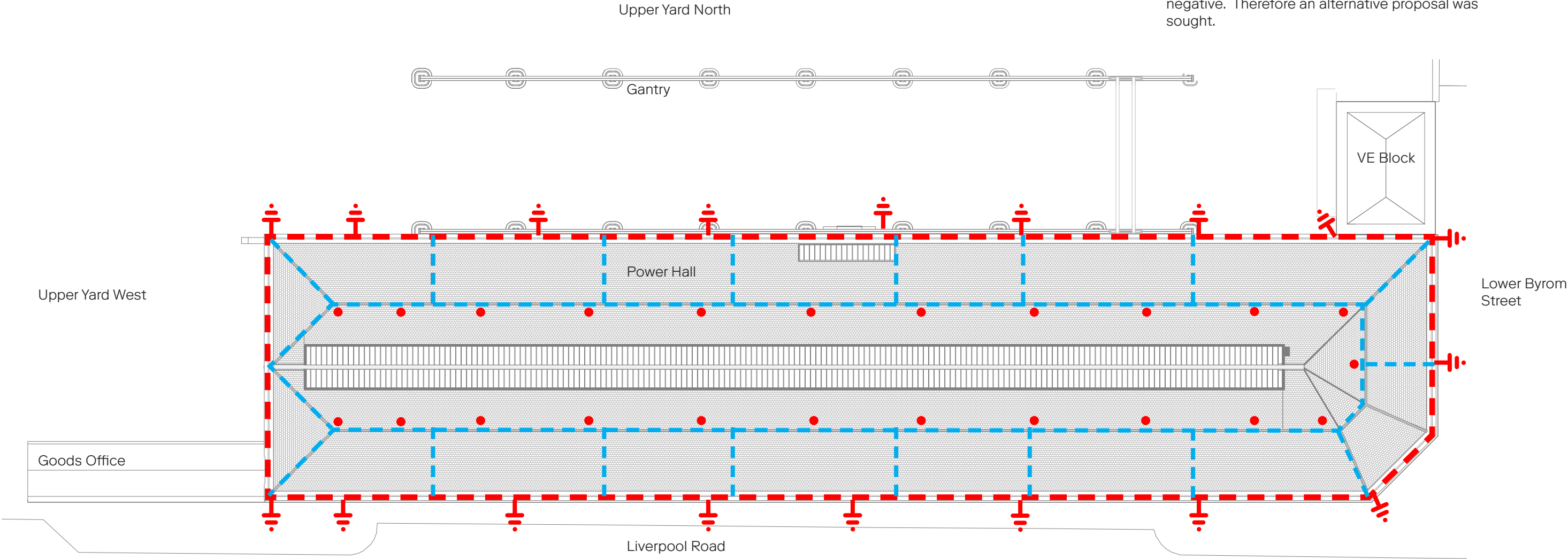
The risk assessments concluded that it is recommended to provide a Class III lightning protection system, mainly to preserve the new electrical infrastructure and the refurbished roof structure.

Based on their experience across their estate, the Science Industry Museum has acknowledged the recommendation, confirming the need to protect the new equipment and the building fabric elements.

Therefore a new lightning protection system is proposed to be installed to the Power Hall, with the main target to minimise the installation and visual impacts that may affect the historic significance of the building.

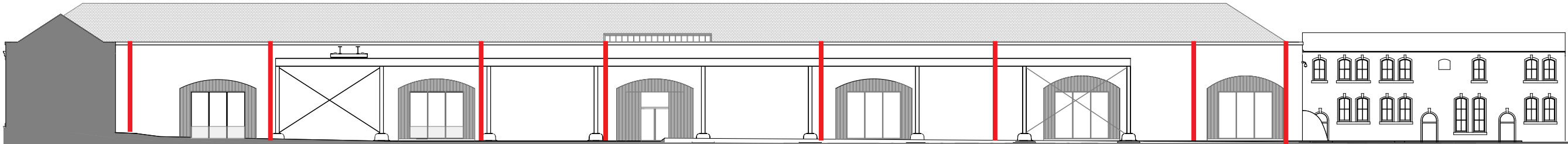
The initial proposal considered the Power Hall building only. The neighbouring gantry in the Upper Yard, VE Block and Goods Office were not taken into consideration.

The scheme has a large number of down conductors that will cause a high degree of visual impact. Along the north yard elevation and Liverpool Road elevations, there are 8 down conductors on each. The Liverpool Road elevation does not have any external rainwater pipes to help hide the down conductors and the visual impact of this was considered particularly negative. Therefore an alternative proposal was sought.

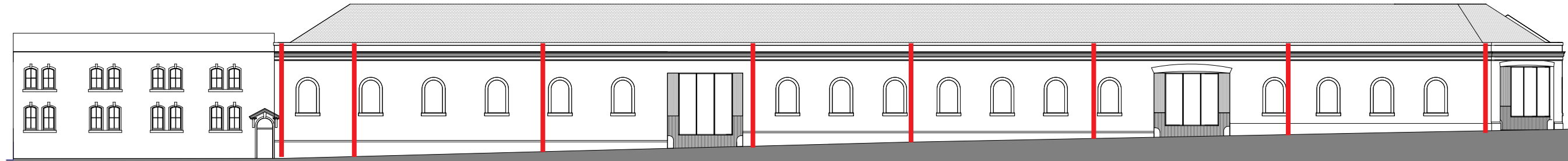


Initial Roof Plan Mark-Up by Specialist Lightning Company

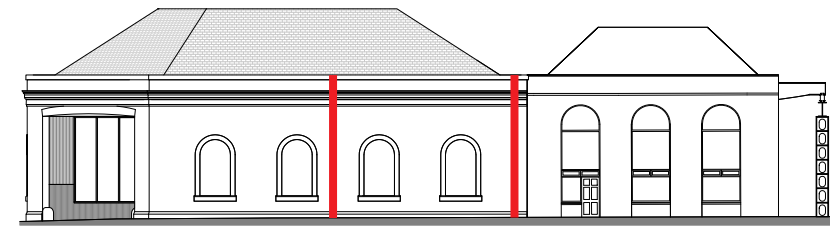
- Key**
- Strike plates at circa. 5m centres
 - — Conductor within roof build-up
 - - - Conductor to rear of parapet
 - ⏏ Down conductor



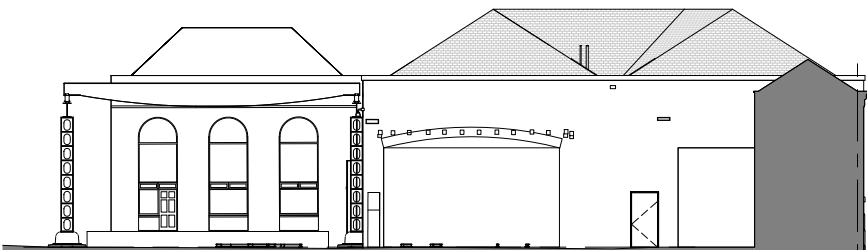
Upper Yard North Elevation with down conductors shown



Liverpool Road Elevation with down conductors shown



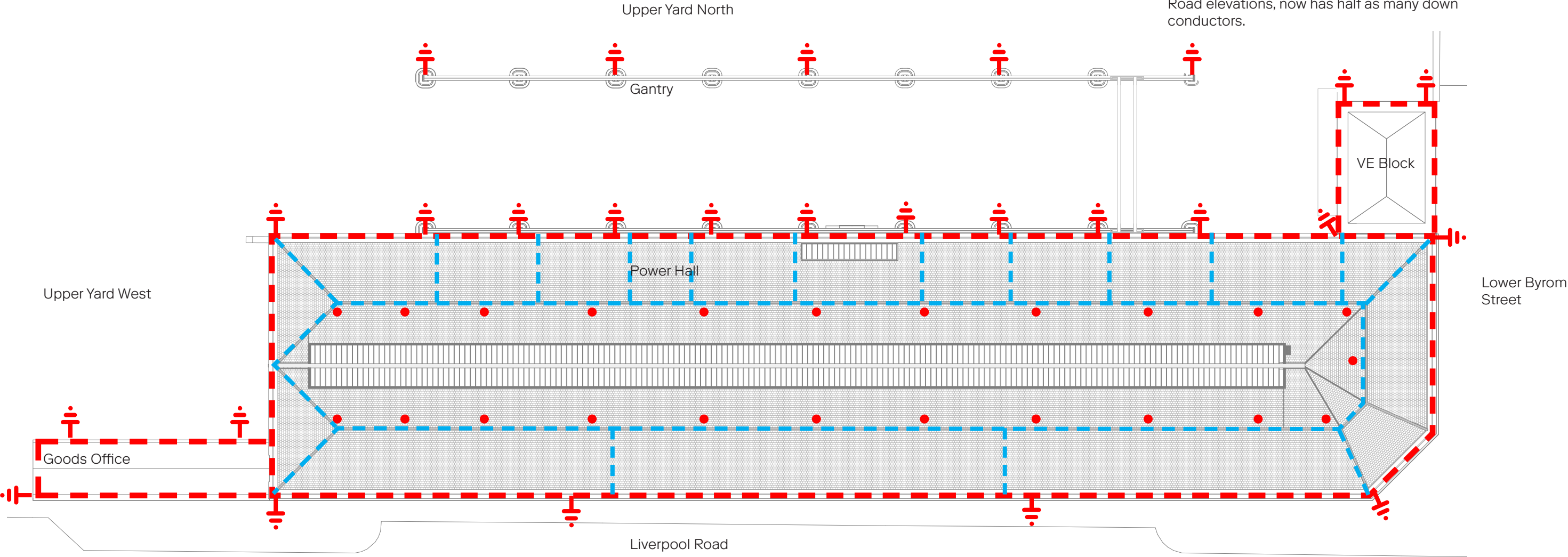
Lower Byrom Street Elevation with down conductors shown



Upper Yard West Elevation with down conductors shown

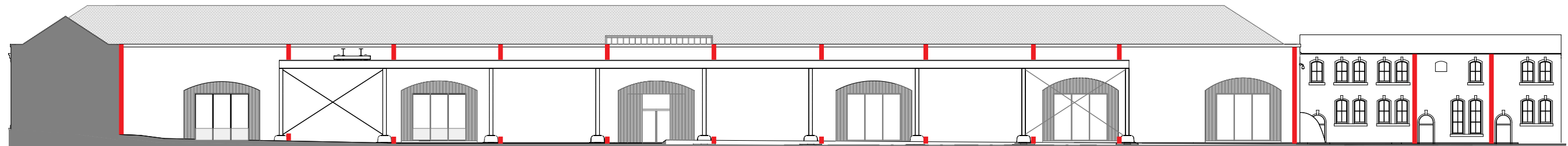
The current proposal takes into consideration the Power Hall, neighbouring gantry in the Upper Yard, the VE Block and the Goods Office.

Although, the scheme has a greater number of down conductors overall these will have a a reduced degree of visual impact. Along the north yard elevation, the down conductors can be hidden behind the gantry columns adjacent to the Power Hall. The gantry itself can work as a down conductor and the tapes only need to connect to the top and base of the gantry columns. As a result, the Liverpool Road elevations, now has half as many down conductors.

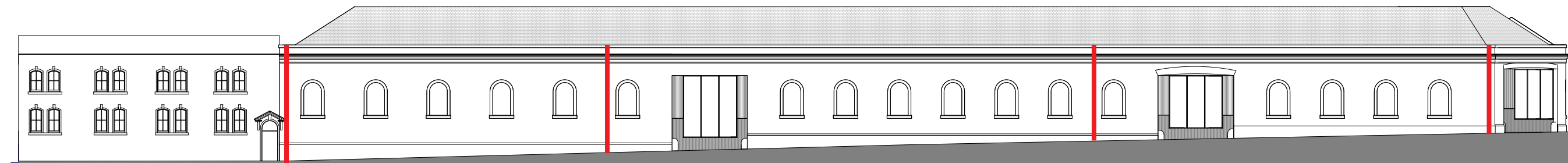


Current Roof Plan Mark-Up by Specialist Lightning Company

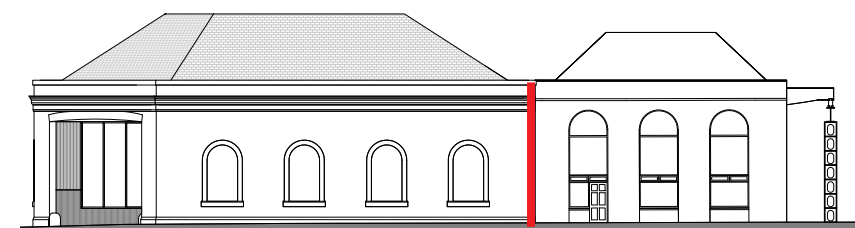
- Key**
- Strike plates at circa. 5m centres
 - — Conductor within roof build-up
 - - - Conductor to rear of parapet
 - ⌋ Down conductor



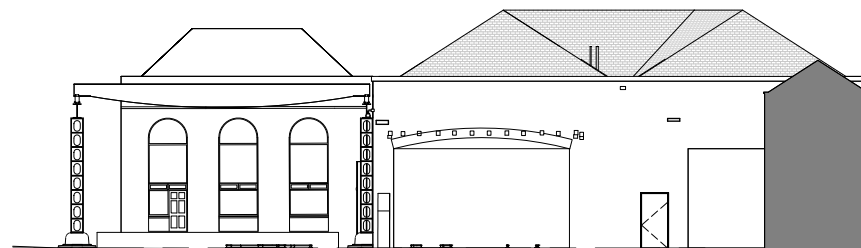
Upper Yard North Elevation with down conductors shown



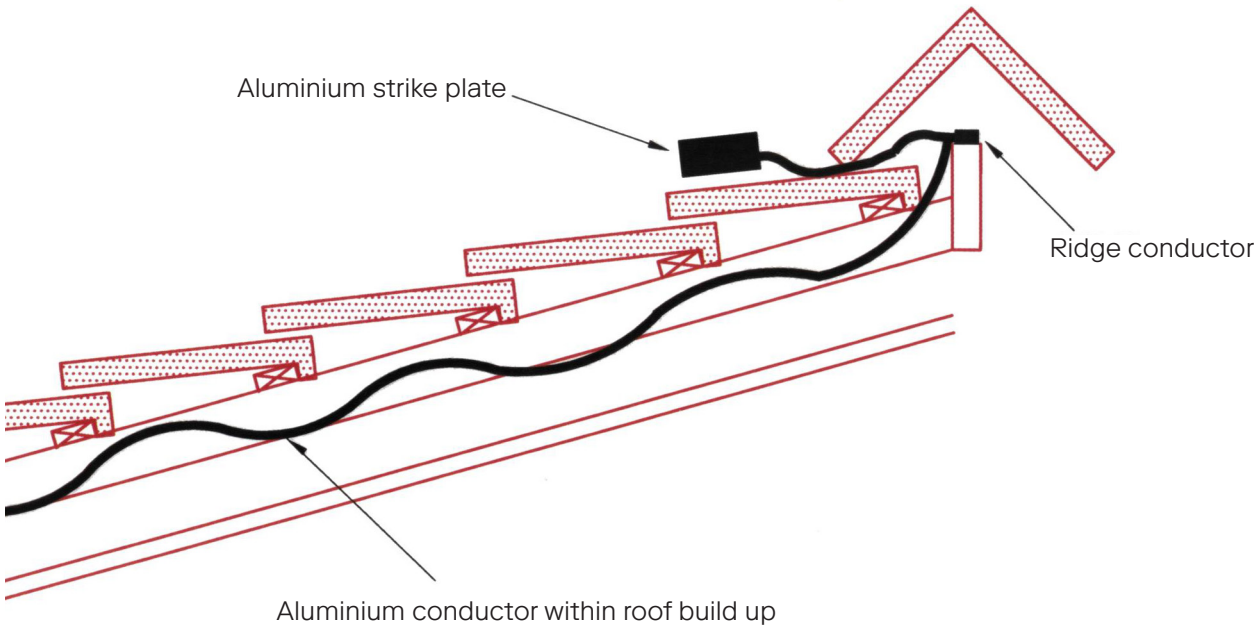
Liverpool Road Elevation with down conductors shown



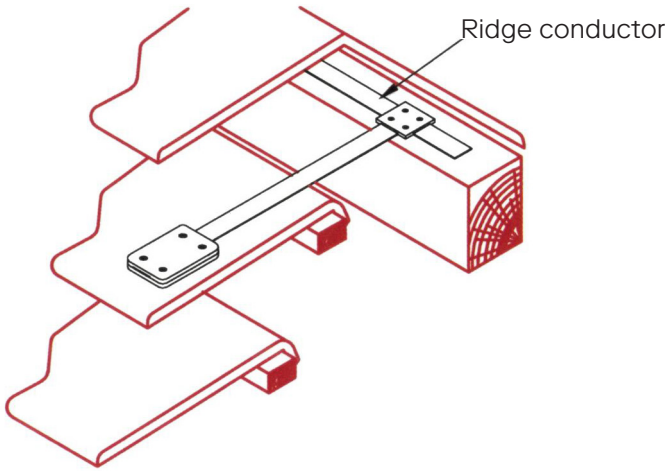
Lower Byrom Street Elevation with down conductors shown



Upper Yard West Elevation with down conductors shown



Roof strike plate detail



Ridge conductor detail

There are multiple components that make up the lightning protection system. At roof level, there will be a conductor tape that runs along the ridge beam, under the ridge tile. A number of conductor tapes run off this primary conductor tape and sit within the rafter zone and therefore are not visible from above or below.

Strike plates are relatively small and discrete and can sit on the inside slope of the roof. Strike plates were chosen instead of air rods which would have to protrude at least 300mm above the top of the roof level, which would be detrimental to the visual appearance of the Power Hall.



Black flat down conductor tape



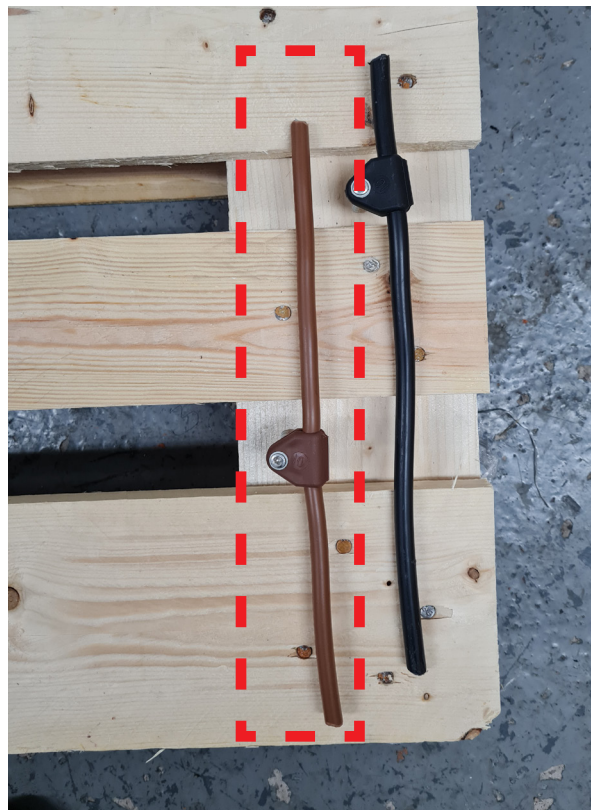
Brown flat down conductor tape



Black round down conductor tape

The most visible component of the lightning protection system is the down conductor tape. Various options were considered, flat tape in black and brown, round tape in black and brown.

The preferred option is the round tape in brown, as this is the most subtle option and the fixings are also considerably smaller overall and require fewer fixings into the brickwork mortar joints.



Preferred Brown round down conductor tape