

Manchester City Council
Our Town Hall Project
Lightning Protection Specification

OTH-ARU-TH-ZZ-SPE-E-0004

C01 | 13 March 2020

Job number 256650

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OUR
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PROJECT

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Appendix A

Existing Lightning Protection and Soil Resistivity Survey results

Appendix B

Drawing indicating existing Lightning Protection Electrodes

Document revisions

The following specification clauses / sections have been revised between version P02 and version C01 of this document. For clarity, references which previous stated 'the Contractor' have been replaced through with 'the Works Contractor'.

Revisions associated with update to Construction Status

The following revisions have been made associated with bringing the document up to Construction Status.

- 1.1.1.1
- 1.1.1.2
- 1.1.1.3
- 2.2.3.1
- 2.2.5.2
- 3.1.1.2
- 3.2.1.4
- 3.5.1.3
- 3.5.1.4
- 3.5.1.6
- 3.8.1.1
- 3.8.1.4
- 3.8.1.5
- 3.13.1.1
- 3.15.1.1
- 3.15.2
- 5.1.1.2
- 6.3.1.1
- 6.3.1.3
- 6.4.1.1
- 6.4.1.2
- 7.3.1.4
- 8.2.1.2
- 8.2.1.4
- 8.2.1.5
- 8.3.1.2
- 8.3.1.4

- 8.3.1.5
- 9.3.1.3
- 9.4.1.3
- 9.6.1.1
- 9.8.1.1
- 10.1.1.2
- 10.2.1.2
- 12.1.1.3
- 12.1.1.4.

Revisions associated with NG Bailey derogations

NG Bailey have not provided derogations against this specification – as these works are not within their scope. However, changes made to common specification clauses have been made in line with derogations made by NG Bailey on other specifications – these are included in the list above.

Revisions associated with route to affordability exercise

Arup have not been given instruction on agreed route to affordability items, and as such they have not been taken on board at this stage.

1 PURPOSE

- 1.1.1.1** This specification defines the Employer's Requirements (ER's) for the provision of lightning protection installations at Manchester Town Hall as part of the Our Town Hall (OTH) project.
- 1.1.1.2** This specification captures the agreed Stage 4 design and is provided for construction.
- 1.1.1.3** The OTH project is a high-profile redevelopment of the Grade I Listed Manchester Town Hall building, with significant heritage requirements. The careful and considered installation of the temporary and permanent lightning protection systems will be a key part of the success of the works.
- 1.1.1.4** This document shall be read alongside other relevant documents, including construction preliminaries and the Lendlease scope of work document.
- 1.1.1.5** All current documents are located on the web-based project document management system (Aconex). The latest revision of all documentation should be considered current, unless detailed otherwise. Any queries relating to the availability of information should be directed to the Lendlease document controller. Security-marked documents are not available on Aconex and will be distributed directly by MCC to individuals who have signed the project Security Aspects Letter.
- 1.1.1.6** The Works Contractor must ensure that all sub-contractors and supply chain partners for this project are provided with all relevant parts of the contract documents.
- 1.1.1.7** This specification is specific to this project and should not be relied upon for any other project and shall not be reproduced or altered without the express written permission of Ove Arup & Partners Ltd.

1.2 Reference to other Specifications

1.2.1.1 Please see below a list of Arup specifications for the OTH project:

Specification Name	Reference
Preliminary Lift Performance Specification	OTH-ARU-TH-ZZ-SPE-B-0001
Building Services Strip-out Specification	OTH-ARU-TH-ZZ-SPE-B-0002
Temporary Services Specification	OTH-ARU-TH-ZZ-SPE-B-0004
Building Services Commissioning Specification	OTH-ARU-TH-ZZ-SPE-B-0005
Fire Fighting Shaft Smoke Extract and Fire Escape Stairwell Pressurisation Performance Specification	OTH-ARU-TH-ZZ-SPE-B-0006
External Services Specification	OTH-ARU-TH-ZZ-SPE-B-0007
BMS / Controls and Metering Specification	OTH-ARU-TH-ZZ-SPE-B-0008
Building Services Fire-stopping Specification	OTH-ARU-TH-ZZ-SPE-B-0009
Mechanical and Public Health Services Materials & Workmanship Specification	OTH-ARU-TH-ZZ-SPE-B-0010
Mechanical & Public Health Services Particular Specification	OTH-ARU-TH-ZZ-SPE-B-0011
Temporary Heating Supplies Specification	OTH-ARU-TH-ZZ-SPE-M-0001
Electrical Services Specification	OTH-ARU-TH-ZZ-SPE-E-0001
Earthing Specification	OTH-ARU-TH-ZZ-SPE-E-0002
Heritage Lighting Procurement	OTH-ARU-TH-ZZ-SPE-E-0003
Heritage Lighting Specification	OTH-ARU-TH-ZZ-SPE-E-0006
General Lighting Specification	OTH-ARU-TH-ZZ-SPE-E-0007
Electronic Security Specification	OTH-ARU-TH-ZZ-SPE-E-0008
Audio-Visual Specification	OTH-ARU-TH-ZZ-SPE-E-0009
ICT Passive Infrastructure Specification	OTH-ARU-TH-ZZ-SPE-E-0010
ICT LAN Commissioning Specification	OTH-ARU-TH-ZZ-SPE-E-0011
ICT Wireless LAN Commissioning Specification	OTH-ARU-TH-ZZ-SPE-E-0012
Hostile Vehicle Mitigation Design Specification	OTH-ARU-EX-ES-SPE-Y-0001

1.2.2 Building Services Strip-out Specification

1.2.2.1 The Building Services Strip-out Specification covers the isolation of incoming utilities, isolation and proving-dead of services and strip-out of services.

1.2.3 Temporary Services Specification

1.2.3.1 The Temporary Services Specification covers the provision of temporary services including temporary substation, temporary electrics, temporary fire alarm and temporary electronic security.

1.2.3.2 At the time of writing, a specialist has yet to be appointed, and the specific requirements may change pending their appointment.

1.2.4 Earthing Specification

1.2.4.1 The Earthing Specification covers the requirements for earthing installations up to the point of the main earth bar.

1.2.4.2 The requirements for earthing and bonding within the building are captured in the Electrical Services Specification.

1.2.5 Electrical Services Specification

1.2.5.1 The Electrical Services Specification covers the requirements for earthing & bonding within the building as well as transient voltage surge suppression.

1.2.6 Building Services Commissioning Specification

1.2.6.1 The Building Services Commissioning Specification covers the requirements for the Independent Supervising Commissioning Engineer.

1.2.7 External Services Specification

1.2.7.1 The External Services Specification covers the provision of external services within the public realm including incoming utilities.

1.2.7.2 The Electrical Services Specification covers the systems within the building which support the external services installation.

2 THE PROJECT

2.1 Overview

- 2.1.1.1** The Our Town Hall (OTH) project is the refurbishment of Manchester Town Hall and the associated public realm within the project red line boundary.

2.2 The Building

- 2.2.1.1** Manchester Town Hall is a Grade I listed building located at Albert Square, Manchester, UK, M60 2LA.
- 2.2.1.2** The building comprises of nine habitable levels (LG through L7), plus additional roof space, towers, bridges, tunnels, sub-basements, moats and trenches.

2.3 The Public Realm

- 2.3.1.1** The public realm comprises of the following spaces within the project red line boundary: Albert Square, Lloyd Street, Cooper Street, Princess Street, Mount Street and County Street.

2.4 The OTH Project Team

- 2.4.1.1** The OTH Project Team comprises of the following parties:

2.4.2 The Client / Employer

- 2.4.2.1** The Client / Employer is Manchester City Council (MCC).

2.4.3 The OTH Design Team

- 2.4.3.1** The OTH Design Team comprises of the following parties:
- Purcell: Architect, Heritage Consultant, Access Consultant, CDM Principal Designer
 - Mace: Project Manager
 - Faithful and Gould: Cost Consultant and Contract Administrator
 - Arup: Building Services Engineer, Security Consultant, Fire Engineer, and Acoustician – referred to as the Resident Engineer
 - Ramboll: Civil and Structural Engineer
 - Planit: Landscape Architect.

2.4.4 The Management Contractor

- 2.4.4.1** The Management Contractor is Lendlease.

2.4.5 Works Contractors

2.4.5.1 Works Contractors will be appointed by the Management Contractor.

2.4.5.2 The Lightning Protection Contractor will be appointed as a works contractor. For simplicity, the Lightning Protection Contractor is referred to in this document simply as ‘the Works Contractor’.

2.4.6 The Building Maintainer

2.4.6.1 Engie are responsible for the ongoing maintenance of the building and have been appointed by Lendlease for the period for which they are responsible for the building.

2.4.6.2 Upon completion of the project, the Client may choose to appoint an alternative building maintainer through a competitive process. The Works Contractor will be responsible for appropriate handover and training of systems to the Building Maintainer.

2.4.7 The Catering Operator

2.4.7.1 MCC have appointed Manchester central as the Catering Operator for building.

2.4.8 Independent Supervising Commissioning Engineer

2.4.8.1 Lendlease are to appoint an independent supervising commissioning engineer who will be responsible for managing the commissioning activities. The Works Contractor will be responsible for carrying out all commissioning activities and for coordinating and demonstrating these to the independent supervising commissioning engineer.

2.4.8.2 For simplicity this role is referred to in this specification as the ‘Commissioning Engineer’.

2.5 Heritage considerations

2.5.1.1 The Town Hall building is Grade I listed as defined by Historic England. The monuments within Albert Square are of various listings, with Albert Memorial being Grade I listed.

2.5.1.2 Every possible effort shall be made to ensure that existing building fabric is not damaged, marked or defaced in any way by the lightning protection installation, except where agreed fixings, interventions and connections are made.

2.5.1.3 Purcell are heritage lead for the project and any queries relating to the heritage significance of the building and monuments should be referred to Purcell.

3 GENERAL

3.1 Works Contractor Responsibilities

3.1.1.1 For the avoidance of doubt, unless stated otherwise, the Works Contractor shall be responsible for the supply, installation, testing and commissioning and setting to work of all works indicated in this specification and all associated documents which form part of the Employers Requirements.

3.1.1.2 Key activities of the Works Contractor for during the works include:

- Attend meetings
- Manage and co-ordinate work elements
- Supply and deliver to site
- Erect and connect up
- Protection of installations and stored materials and products
- Make good defects
- Test on site
- Commission and set to work
- Provide O&M and record information
- Hand over in working order.

3.2 Health and Safety

3.2.1.1 When developing the scheme, Arup have considered Health and Safety and mitigated risk where possible. Arup have worked with the appointed CDM Principal Designer (Purcell) to identify and mitigate risks associated with the proposed development.

3.2.1.2 The Works Contractor shall be responsible for reviewing the hazard risk registers and completing the works with due cognisance of the identified risks and to mitigate risks where reasonably practicable.

3.2.1.3 Where reasonably practicable, the Works Contractor shall reduce and mitigate the overall health and safety risks associated with installation and ongoing future maintenance by the Building Maintainer.

3.2.1.4 The Arup Access and Maintenance Strategy drawings outline the design intent for maintenance and replacement of MEP plant and equipment. These shall be read alongside the Access and Maintenance Strategy documents which have been produced by the Architect.

3.3 Trade Names

3.3.1.1 Where trade names are utilised to describe a product such as 'Unistrut', the Works Contractor shall be free to procure similar products from any reputable supplier that have the same or better performance and identical finishes, unless specifically indicated otherwise. A technical submittal shall be provided, for review and approval by the design team.

3.4 Interpretation

3.4.1 General

3.4.1.1 This document has been written using simple, direct language wherever possible. Imperative terms such as ‘check’, ‘include’, ‘provide’, ‘submit’ means that the Works Contractor is to ‘check’, ‘include’, ‘provide’, ‘submit’ the item/service, etc. described.

3.4.1.2 The Works Contractor shall notify the Management Contractor / Contract Administrator if there is any doubt about the interpretation of, or discrepancies in, the Employers Requirements.

3.4.2 Abbreviations

3.4.2.1 Units and acronyms identified within the specification are described below.

Reference	Term
A	Current
AC	Alternating current
ACB	Air circuit breaker
AFDD	Arc fault detection device
AFFL	Above finished floor level
AV	Audio visual
AVB	Audio-visual box
BASEC	British Approvals Service for Cables
BIM	Building information modelling
BMS	Building management system
CCTV	Closed circuit television system (see also VSS)
COMA	Control, operation and maintenance agreement
CPC	Circuit protective conductor
CQHN	Civic Quarter Heat Network
CRI	Colour rendering index
CU	Copper
DC	Direct Current
DNO	Distribution network operator
EACS	Electronic access control system
Eh	Horizontal Illuminance
EPO	Emergency power off (switch)
ELV	Extra low voltage (<50V)
EMC	Electromagnetic compatibility

Reference	Term
ENWL	Electricity Northwest Limited
ERs	Employers Requirements (documents)
EVC	Emergency voice communication system
Ev	Vertical Illuminance
FAT	Factory acceptance test
FF&E	Furniture, fixtures and equipment
FPS	Frames per second
GAs	General arrangement drawings
HV	High Voltage (6.6kV)
IDC	Intelligent door controller
iDNO	Independent distribution network operator
IP	Internet Protocol
LAN	Local area network
LBC	Listed Building Consent
LED	Light emitting diode
LPA	Local Planning Authority
LS0H / LSZH	Low smoke zero halogen
LV	Low voltage (230V and 400V)
MCB	Miniature circuit breaker
MCCB	Moulded case circuit breaker
MEP	Mechanical, electrical, public health (building services)
MER	(ICT) main equipment room
MICC	Mineral insulated copper-clad (cable)
NVR	Network video recorder
No.	Number of
O&Ms	Operation and maintenance manuals / record information
PDU	Power distribution unit
PIN	Personal identification number
PME	Protective multiple earth
PMS	Power monitoring system
PoE	Power over Ethernet
PSCC	Prospective short circuit current
PTZ	Pan, tilt, zoom
PWM	Pulse width modulation
RCBO	Residual current circuit breaker with overcurrent protection
RCD	Residual current device
REF	Restricted earth fault

Reference	Term
RFID	Radio Frequency Identification
RMU	Ring main unit
RPM	Revolutions per minute
SAT	Site acceptance test
SCADA	Supervisory control and data acquisition systems
SMS	Security management system
SPN	Single phase and neutral (phase, neutral, earth)
SWA	Steel wire armoured
TPN	Three phase and neutral (phase L1, phase L2, phase L3, neutral, earth)
UGR	Unified glare rating
UPS	Uninterruptable power supply
V	Voltage
VA	Apparent power
VAD	(Fire alarm) visual alarm device
VSS	Video surveillance system
VT	Voltage transformer
W	Power
XLPE	Cross linked polyethylene

3.4.3 Terms

3.4.3.1 The meanings of terms used in the Employers Requirements documents (ERs) are given below. Terms may be used in their derivative form to suit the context (e.g. inspect / inspected / inspection).

3.4.3.2 Definitions of drawings, technical information and other documents are given in later parts of this section.

Term	Meaning
accept	accepted /acceptance by the Contract Administrator in writing.
agreed	agreed with /agreement with/agreed by the Contract Administrator in writing.
allow	allow/allowed for by the Works Contractor as part of the Works along with all associated costs.
as necessary	carry out the work to an extent, and by a method, consistent with good practice.
BMS & Controls Specialist	the Specialist responsible for providing the BMS and control system works.
Building Services Works	the complete works for the building services to provide a complete and fully operational building.
check	check / checked by the Works Contractor.

Term	Meaning
commissioning	the advancement of an installation from static completion to full working order to specified requirements. Commissioning includes setting to work and regulation.
compartment	functional compartment (e.g. associated with building fire compartmentation, acoustic compartmentation or air leakage).
Works Contractor's Documents	drawings, technical information, and other documents for the Building Services Works issued by the Works Contractor.
Works Contractor's Drawings/Model	Drawings/model for the Building Services Works prepared by the Works Contractor.
demonstration test	demonstration test, carried out by the Works Contractor and attended by the relevant parties, including tests on individual items of plant and equipment, entire systems, and the entire building, on site or off-site.
Employer	the Employer (Client) or his/her elected representative.
End User	parties using the completed building, including occupants, facilities management staff, maintenance Works Contractors.
equipment	plant and equipment required for the Building Services Works or provided for the Building Services Works including any engineering plant, machine or component.
equipment data sheet	specification sheet for a particular type of equipment including performance requirements.
examine	examine / examined by/examination by the OTH Design Team for compliance with the intent of the Building Services Documents.
factory acceptance test/testing	inspection and test/testing carried out at the manufacturer's factory (or an agreed testing facility) by the OEM, and verified by, the Works Contractor before being offered for demonstration.
Handover	Refer to Main Contract Documents.
include	include / included as part of the Building Services Works by the Works Contractor along with all associated costs.
including	including, but not limited to.
Independent Commissioning Engineer	the Commissioning Manager responsible for planning, monitoring and witnessing the Building Services Works.
inspect	inspect / inspected by / inspection by, and verification by, the Works Contractor before being offered for witnessing, including inspections of individual items of plant and equipment, entire systems, and the entire building.
installation	building services installation, a specific system or combination of systems, placed in position and set up for use.
Integrated Systems Test	A test on the whole of the buildings systems carried out on site after systems have been commissioned to verify the interaction and interoperability of the systems during different failure conditions and re-instatement scenarios.
offer	offer / offered to the Contract Administrator by the Works Contractor.

Term	Meaning
Others	others engaged in the Works whether on or off site (e.g. other Works Contractors, suppliers, statutory authorities, public utility providers, etc.).
otherwise indicated	otherwise indicated elsewhere in the Contract Documents.
performance testing	evaluation of a system which has been commissioned and is operating within permitted tolerances, proving commissioned installations meet the performance requirements of the Building Services Documents and relevant commissioning codes and guides.
Practical Completion	Refer to Main Contract Documents.
pre-commissioning	work activities necessary to advance an installation from a stage of static completion to a stage where it is ready for commissioning including systematic checks of its suitability for commissioning.
products	products, including plant, equipment, components and treatments.
provide	provide / provided as part of the Building Services Works by the Works Contractor, including all associated costs and activities generally described in the scope of works.
required	required by the Employers Requirements or by the Contract Administrator.
review	review / reviewed by the OTH Design Team for compliance with the intent of the Building Services Documents.
System Continuous Operation Performance (SCOP) test	system continuous operation performance test carried out on site, and verified by the Works Contractor before being offered for demonstration, including tests on individual systems, entire systems, individual areas of the building and the entire building.
site test	test carried out on site, and verified by the Works Contractor before being offered for demonstration, including tests on individual items of plant and equipment, entire systems, and the entire building.
Specialist	the Specialist supplying plant, equipment, materials or services providing parts of the Works in contract with the Works Contractor.
special tools	Special tools required to operate or maintain a particular item of equipment.
specification	description of performance, and materials and workmanship requirements given in the Contract Documents.
specified	specified in the Contract Documents.
static completion	the state of an installation when in accordance with the Building Services Documents, clean and ready for setting to work (e.g. for hydronic systems this includes, testing, flushing, cleaning, treating, filling and venting).
submit	submit / submitted to the Contract Administrator for review, in a timely fashion, by the Works Contractor.
Supplier	supplier of plant, equipment, materials or service.

Term	Meaning
system	including equipment, accessories, controls, supports, and suchlike necessary for a complete and fully functional installation.
Tender Proposals	the proposals made by the Works Contractor at Tender Stage in response to the Building Services Documents.
Trade(s)	Other specialist suppliers and installers
Works	the contracted scope of work.
works test/works testing	inspection and test/testing carried out at works (or an agreed testing facility) by the OEM, and verified by, the Works Contractor before being offered for demonstration.

3.5 Compliance with Regulations

3.5.1.1 The complete installation shall comply with all relevant standards and guidance documents, including but not limited to the following:

- British Standards (BS),
- All Acts and Regulations
- CE marking Directive
- Building Regulations
- Requirements of Statutory Authorities
- Local Byelaws and requirements of Local Authorities
- Institute of Engineering and Technology documentation.

3.5.1.2 Where standards, codes and guides are referred to, the latest current versions and amendments are to be used.

3.5.1.3 Unless agreed otherwise, recommendations given in British Standards, guides or other reference documents are to be followed. Where a particular option in a standard has not been specified, the Works Contractor shall seek clarity from the Resident Engineer.

3.5.1.4 Clause omitted.

3.5.1.5 Clause omitted.

3.6 Documentation

3.6.1 General

3.6.1.1 The Works Contractor shall submit documents and technical information required to describe the proposals for the Works including the information listed.

3.6.1.2 The Works Contractor's documents are to be written in clear, concise English.

3.6.1.3 Units used throughout the Works Contractor's documents are to be metric/SI.

3.6.2 Compliance

- 3.6.2.1** Tender submissions must be in compliance with the Employers Requirements.
- 3.6.2.2** Any items not compliant with the Employers Requirements must be advised and agreed on the return of the tender in a Technical Qualifications Report. Any items, which have not been agreed, and remain non-compliant after contract award will not be acceptable.
- 3.6.2.3** If qualifications or deviations are not identified the Tender will be deemed to fully comply with the Building Services Documents.

3.6.3 Alternatives

- 3.6.3.1** If alternatives are proposed, the Works Contractor (via the Management Contractor) shall submit a Technical Alternatives Report. Alternative design proposals, suppliers or specialists will only be considered if submitted in accordance with the Employers Requirements, or as otherwise agreed.

3.6.4 Electronic Format of Submissions

- 3.6.4.1** The Works Contractor shall provide information in an electronic format via Aconex and as detailed in the BIM Execution Plan (BEP).

3.6.5 Document References

- 3.6.5.1** The Works Contractor shall obtain acceptance of the document referencing system to be used before preparing any documents for submission.

3.7 Quality Assurance

- 3.7.1.1** The Management Contractor and their Contractors shall implement a quality assurance system to BS EN ISO 9001.

3.8 Materials & Products

- 3.8.1.1** Only new materials and products shall be installed, except where existing elements are re-used, such as the golden ball on the top of the Albert Square Tower.
- 3.8.1.2** The Works Contractor shall ensure that materials and products are provided in accordance with the appropriate British Standard or Code of Practice. Where there is no applicable British Standard provide an Agreement Certificate.
- 3.8.1.3** The Works Contractor shall ensure that the quality and performance of materials and products are appropriately certified under an approved BSI scheme, or BBA (or equivalent) scheme.
- 3.8.1.4** Clause omitted.
- 3.8.1.5** Clause omitted.

- 3.8.1.6** Materials or substances that are generally known at the time of use to be deleterious, a health risk, or a fire hazard, either in use or in their manufacture shall not be used
- 3.8.1.7** Substances known to deplete the ozone layer, whether or not specifically excluded from use by current EC legislation, as refrigerants or foaming or filling agents for insulation shall not be used.
- 3.8.1.8** Materials or substances that support mould, bacterial growth or vermin or cause objectionable odours under service conditions shall not be used.
- 3.8.1.9** The Works Contractor shall ensure materials and products delivered to site bear the manufacturer's name, brand name and any other data required to verify their performance and specification complies with the requirements of the Building Services Documents.
- 3.8.1.10** The Works Contractor shall ensure materials and products are appropriately CE marked.
- 3.8.1.11** The Works Contractor shall follow manufacturers' instructions on the use of materials and products.

3.9 Product selection

3.9.1 Overview

- 3.9.1.1** Arup have identified proposed products from reputable supply chain partners for the basis of the Stage 4 detailed design.
- 3.9.1.2** The Works Contractor shall be free to procure equipment of equal or better specification and identical finish from any reputable supply chain partner in the interests of fair competition, except where indicated otherwise. The Works Contractor shall be responsible for complying with the project KPIs with respect to supply chain partner appointment. The Works Contractor shall indicate all proposed supply chain partners and the associated products as part of the tender returns for approval by the OTH design team.
- 3.9.1.3** The Works Contractor will be responsible for the final selection of all products. Where specific model references are indicated in design documentation, the Works Contractor shall ensure that the final selected products are the latest available models at the time of placing the order and are provided with all the necessary proprietary fixings and accessories.
- 3.9.1.4** Except where supply chain input is required for specific product design, the OTH design team retain design responsibility, and as such all alternative products offered which have a design impact will require formal change control.
- 3.9.1.5** Any alternative products selected by the Works Contractor shall not impact the Listed Building Consent – Purcell should be consulted where any ambiguity exists.

3.9.1.6 The Works Contractor shall select materials & final products with regard to standardisation and availability of spare parts and for ease of maintenance.

3.9.1.7 The Works Contractor shall ensure the same manufacturer is used for materials or products of a similar type and that identical parts of similar products are interchangeable.

3.9.2 Samples

3.9.2.1 The Works Contractor shall provide samples for all final products where they will be on display for review and sign-off prior to procurement of systems.

3.10 Workmanship

3.10.1.1 The Works Contractor shall employ only operatives who are skilled and responsible craftsmen, fully experienced in their respective trades and who have gained a certificate of competency appropriate for the work being carried out.

3.11 Manufacturer's Guarantees & Warranties

3.11.1.1 The Works Contractor shall provide manufacturers' guarantees and warranties for materials and products.

3.11.1.2 The Works Contractor shall ensure that manufacturers' guarantees and warranties are valid up to the end of the Defects Liability Period following Practical Completion of the Works or as identified below.

Type	Commencing from	Duration
Manufacturers' Guarantees & Warranties	Practical Completion	12 months
Extended Guarantees for Repair under Defects Liability Period	Date of repair	12 months
Guarantee of availability of spares	Practical Completion	12 months
Longer term Manufacturers' Guarantees & Warranties	Practical Completion	24 months

3.11.1.3 The Works Contractor shall ensure materials and products normally guaranteed by the manufacturers for a period longer than that defined above remains under guarantee for the maximum period.

3.11.1.4 The Works Contractor shall provide an extended guarantee period from the date of the repair for any system part repaired during the Defects Liability Period as identified in the table above, normal wear and tear excepted.

3.11.1.5 The Works Contractor shall ensure any maintenance required by the Supplier is provided before Practical Completion and that records are kept and included in the O&M Manuals.

3.12 Service Life

- 3.12.1.1** All primary building services elements shall have a minimum lifespan as that identified in CIBSE Guide M.
- 3.12.1.2** The Works Contractor shall submit complete maintenance recommendations to ensure that the Building Services Works may be maintained to achieve the minimum service life required.

3.13 Fixing to the Building Structure and Built-in Items

- 3.13.1.1** The Works Contractor shall be responsible for ensuring fittings are installed in accordance with the manufacturer's recommendations having regard to the application and the load to be carried by the fixing device. It is the Works Contractor's responsibility to ensure that all methods of fixings are fit for purpose.
- 3.13.1.2** Where feasible, and where the integrity of the fixing would not be compromised, existing penetrations / fixing holes shall be utilised.
- 3.13.1.3** Where fixings are to existing building fabric which is identified of Very High Significance (as indicated on the Purcell Heritage Significance Plans), fixings shall be strictly in accordance with the agreed proposals which have been developed with due consideration for minimising damage and ensuring reversibility.
- 3.13.1.4** All fixing methods shall be agreed with the OTH design team prior to installation so as to ensure compliant with the Listed Building Consent.

3.14 Inspection, Testing, Commissioning and Performance Testing

3.14.1 General requirements

- 3.14.1.1** The Works Contractor shall be responsible for inspection, testing, commissioning and performance testing of systems.
- 3.14.1.2** The Works Contractor shall provide facilities necessary to enable the inspection, testing, commissioning and performance testing of the Works to be satisfactorily completed including labour, equipment, materials, instruments and suchlike.
- 3.14.1.3** The Works Contractor shall allow all relevant parties to witness inspections, tests, commissioning and performance tests.
- 3.14.1.4** The Works Contractor shall ensure the Works have been fully inspected, tested, commissioned and checked before offering any equipment or systems for witness testing so that the Performance Demonstration Tests can reasonably be expected to proceed without delays. Invite the relevant parties to Performance Demonstration Tests only when the associated Works are complete, fully checked and

commissioned and have passed the Works Contractor's acceptance tests and certified records have been submitted.

3.14.1.5 The Works Contractor shall submit method statements in advance of any test describing all aspects of the work required. Identify tests required on work before covering up during construction.

3.14.1.6 The Works Contractor shall coordinate the requirements with the Commissioning Engineer.

3.14.2 Commissioning & Testing Work Plan

3.14.2.1 The Works Contractor shall be responsible for producing a plan for inspection, testing, commissioning, performance testing and demonstration of the Works, including the stages identified below:

- Pre-commissioning inspections
- Testing and commissioning
- Demonstration tests.

3.14.2.2 Work plan to include the particular aspects identified below:

- Overall programme integrated with the overall building construction programme
- Method statements
- Co-ordination with others
- Attendance
- Documentation.

3.14.3 Site Inspection & Performance Testing

3.14.3.1 The Works Contractor shall carry out site inspections and tests to demonstrate that the Works comply with the Employers Requirements.

3.14.4 Instruments

3.14.4.1 The Works Contractor shall provide any instruments or other equipment necessary to review the accuracy, quality and performance of the Works. Provide any assistance required in the use of instruments and measuring equipment.

3.14.4.2 The Works Contractor shall ensure that instruments used for survey work, checking, inspection, testing and commissioning are correctly calibrated. Submit calibration certificates with test method statements and test records.

3.14.5 Defects

3.14.5.1 Where the performance of the Works fails to meet the requirements of the Employers Requirements, the Works Contractor shall submit a method statement for the proposed remedial works including measures to be taken to prevent any delay to the programme for the Works.

3.14.5.2 The Works Contractor shall rectify any defects that become apparent during inspection, testing, commissioning and performance testing. Retest defective parts of the Works, and any associated interdependent systems, and demonstrate that the Works operate in accordance with the Employers Requirements.

3.14.5.3 The Works Contractor shall submit without delay any record that indicates that any part of the Works inspected or tested does not comply with the Employers Requirements along with a proposal for rectification.

3.14.6 Commissioning & Testing Records

3.14.6.1 Ensure records are typed or completed in legible, neat writing. Ensure up to date design data has been added on test sheets before commissioning work is started.

3.14.6.2 Records of relevant information recorded during the inspection, checking, pre-commissioning, commissioning and testing procedures including:

- Project title
- Contractor's name
- Location of Test
- Agreed Test Method Statement
- Description of the system/service/section/sub section tested
- Scope, duration and number of tests
- Test Results and observations made during tests
- Description of failures or defects
- Description of corrective action taken
- Name and signature of person responsible for the tests
- Name and signature of the witness for the Contractor
- Name and signature of other witnesses
- Date of test.

3.15 Record Information

3.15.1 General

3.15.1.1 The Works Contractor shall provide O&M Manuals and other information necessary to enable the healthy, safe and efficient operation of the building for the entire the Works.

3.15.1.2 O&Ms shall include only relevant manufacturers' information. Ensure that manufacturers provide original literature as part of their plant and equipment orders.

3.15.1.3 Modify and update operating details to reflect the agreed commissioning results.

3.15.2 Specifics

3.15.2.1 Clause omitted.

3.16 Familiarisation & Training of Operational & Maintenance Staff

- 3.16.1.1** The Works Contractor shall provide training and assistance to the Employer's staff and Building Maintainer prior to Practical Completion.
- 3.16.1.2** Explain and demonstrate the Works, O&M Manuals and Record Drawings to the Employer's satisfaction.
- 3.16.1.3** Provide training in the form of both classroom sessions and tours of the building systems.
- 3.16.1.4** Allow for a repeat session for each topic where operating staff are unavailable or cannot be released simultaneously.
- 3.16.1.5** Submit copies of the training presentation for the future reference of the Employer / Building Maintainer.
- 3.16.1.6** Keep records of the training sessions including signatures confirming attendance and issue any certificates of competence.
- 3.16.1.7** Record training sessions on DVD.

4 SCOPE OF WORKS FOR LIGHTNING PROTECTION SYSTEM

4.1 Overview of Our Town Hall Project

- 4.1.1.1** As part of the Our Town Hall (OTH) project, there are extensive refurbishment works planned which interface with the lightning protection system, including the following:
- Excavation, new sub-base and finishes to courtyards and moats within the Town Hall
 - Excavation, new sub-base and finishes to external public realm on Albert Square, as well as alterations and repairs to the footways adjacent to the Town Hall of Cooper Street, Lloyd Street and Princess Street
 - Stonework cleaning and repairs to all facades and towers
 - Refurbishment of rainwater goods
 - New roof finishes to all roofs
 - New roof-top plant installations
 - Stonework cleaning and repairs to chimneys and flues
 - Guttering repairs and replacements
 - New roof access walkways and associated ladders / access ways.

4.2 Phases of work and scope of works

- 4.2.1.1** The works will be carried out in a phased manner and as such will require the Works Contractor to make multiple repeat visits to site to complete the various elements of works. The Works Contractor shall develop lightning protection phasing plans and make appropriate cost estimates for the phased nature of the installation. Refer to Lendlease phasing plans and construction preliminaries for details.
- 4.2.1.2** Due to the heritage significance of the Town Hall, it is imperative that a functional lightning protection system is always provided to protect the building, its contents and occupants. It is acknowledged that it will not always be feasible to provide connection to all lightning protection electrodes.
- 4.2.1.3** The following outlines key phases of the works:
- Ongoing maintenance of existing lightning protection system, until a point where it is no longer required.
 - Courtyard low-level lightning protection works:
 - Disconnection of the existing below-ground lightning protection earth electrodes from above-ground lightning protection down-conductors (at the test clamp).
 - Removal of existing below-ground lightning protection earth electrodes (by others).

- Installation of new lightning protection earth electrodes.
- Connection of new below-ground lightning protection earth electrodes to existing above-ground lightning protection down-conductors (at the test clamp).
- Scaffolding temporary lightning protection:
 - Bonding of scaffolding to existing lightning protection electrodes within the moats and external building perimeter.
 - Bonding of scaffolding to new lightning protection electrodes within the courtyards.
- Strip-out of existing lightning protection system.
- New above-ground lightning protection system.
- Bonding of new above-ground lightning protection system to existing and new elements.
- New lightning protection electrodes within the moats and external building perimeter.

4.2.1.4 Due to the substantial works planned to the below-ground drainage, it is not proposed to re-use any existing earth electrodes.

5 EXISTING LIGHTNING PROTECTION SYSTEM

5.1 Overview of existing Lightning Protection System

5.1.1.1 The existing Town Hall lightning protection system is understood to be approximately 30 years old (at its newest – some elements are thought to be significantly older) and consists of air terminals and an air termination network connected to ground-buried earth terminations via conductors running down the external façade of the building.

Based on a report by BEST Services Ltd. (2016) we understand that:

- The air terminals consist of 2No. copper taper pointed finials and 4No. copper multi point air terminal rods, fixed to the roof with horizontally / vertically mounted brackets.
- The air termination network is made up of a combination of dedicated copper lightning protection conductors and the use of metallic roof elements. The dedicated copper conductors are a combination of wire, tape and rope fixed to the roof with non-metallic slate holdfasts and non-metallic DC clips. The metallic roof elements used to form part of the lightning protection system are metallic ridge features, metallic perimeter handrails and metallic roof leadwork.
- The down conductors are made up of a combination of 4No. plain copper rope, 2No. unsheathed copper cable and 48No. PVC sheathed copper conductors. Most of the conductors are currently located alongside rainwater pipes. The maximum distance between the currently installed down conductors is approximately 16m. There are multiple down conductors with areas of the PVC sheath damaged or missing. Several conductors have come loose from the fixings.
- The earth terminations consist of 54No. terminations of unknown earthing specification, and 48No. conductors are connected to the earth terminations via gunmetal ‘coffin’ type test clamps and 6No. conductors are connected via brass junction connectors.
- Roof mounted metallic items are generally bonded to the lightning protection system via aluminium or gunmetal type ‘B’ bonds.

5.1.1.2 The key findings from the same report by BEST was as follows:

- The system seems to have been designed to BS6651:1999.
- Additional down conductors are required to comply with BS6651:1999, but it is noted that the Grade I listing of the building might not allow for this.
- Electronic surge protection is not provided as part of the electrical installation.
- A number of issues were identified, and remedial works were recommended to address:

- Some roof mounted metallic items (aerials, microwave dishes, access hatches and lights) as well as a cable tray and a gas pipe require bonding to the lightning protection system.
- Some of the connections to metallic rails are defective.
- Some of the down conductors are not securely fixed to the wall.
- Some of the down conductors don't have adequate earth continuity.
- One of the roof conductors (~70m long) requires re-fixing to the roof surface.
- The full extent of the air termination network could not be checked due to limited roof access.
- The continuity of the earthing systems could not be tested in several positions due to limited access.

5.1.1.3 Regular visual inspections and continuity testing of the existing lightning protection system are carried out by Best on behalf of Engie (current building maintainer), and earth impedance measurements are taken for the earth electrodes.

5.1.1.4 A survey report from April 2019 is included within the appendices which includes the results from measurements carried out on the existing lightning protection electrodes at the Town Hall. This also includes soil resistivity tests which were carried out at Sackville Gardens (for the purposes of building earth array design).

5.1.1.5 Extensive drone surveys have been completed of the roof, towers and building facades, and the Works Contractor shall request this from Lendlease if they feel it is beneficial.

5.1.1.6 Images of the existing installation are included below for reference.



Figure 1 – Existing copper multi point air terminal rod connected to a copper down conductor

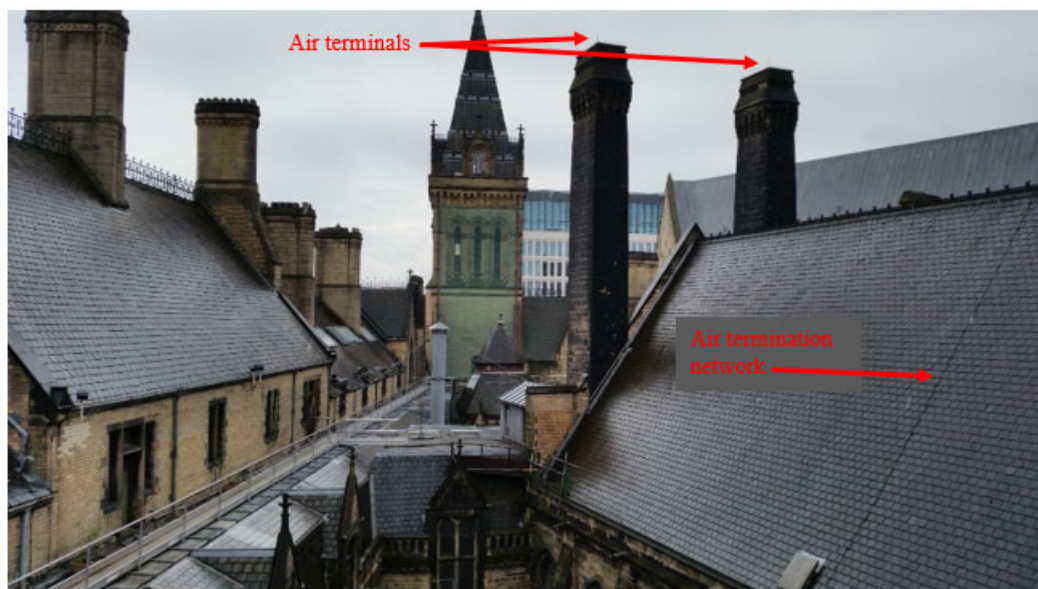


Figure 2 – Existing copper taper pointed finials and ceiling mounted copper 'air termination' rope



Figure 3 – Existing copper wire down conductor



Figure 4 – Existing copper wire down conductor connecting into the below ground earth terminal

5.2 Fortuitous use of existing Lightning Protection System

- 5.2.1.1** The existing lightning protection system shall be retained until such a time that it can be decommissioned due to protection being provided in another means. This occurs in several phases:
- The existing lightning protection electrodes within the courtyards will be replaced with new lightning protection electrodes as part of the courtyard works. The existing lightning protection down-conductors within the courtyards will then be connected to the new lightning protection electrodes at the test clamp, as to ensure that the building remains protected, prior to the scaffolding and temporary roof being complete.
 - The existing lightning protection electrodes within the moats and building perimeter will be retained for use during the construction works.
 - The existing lightning protection down conductors and air termination network will be retained until full protection is provided to the building from the scaffolding / temporary roof.

6 LIGHTNING PROTECTION SYSTEM

6.1 Lightning Protection Risk Assessment

- 6.1.1.1 Arup have carried out a lightning protection risk assessment in accordance BS EN 62305 using Furse Strikerisk software. This has identified the requirement for a Class I lightning protection system.
- 6.1.1.2 A Class I lightning protection system identifies the requirement for down-conductors at 10m centres, a lightning protection grid of 5m by 5m or a rolling-sphere diameter of 20m.

6.2 Rolling Sphere method

- 6.2.1.1 So as to reduce the visual impact of the lightning protection system, Arup have, where feasible, looked to rationalise the air termination network on the roof through fortuitous protection from taller elements such as the towers and chimneys.
- 6.2.1.2 Due to the complex geometry of the building, Arup have produced a bespoke software model which identifies areas of the roof for which fortuitous protection is provided as identified by the rolling sphere method.

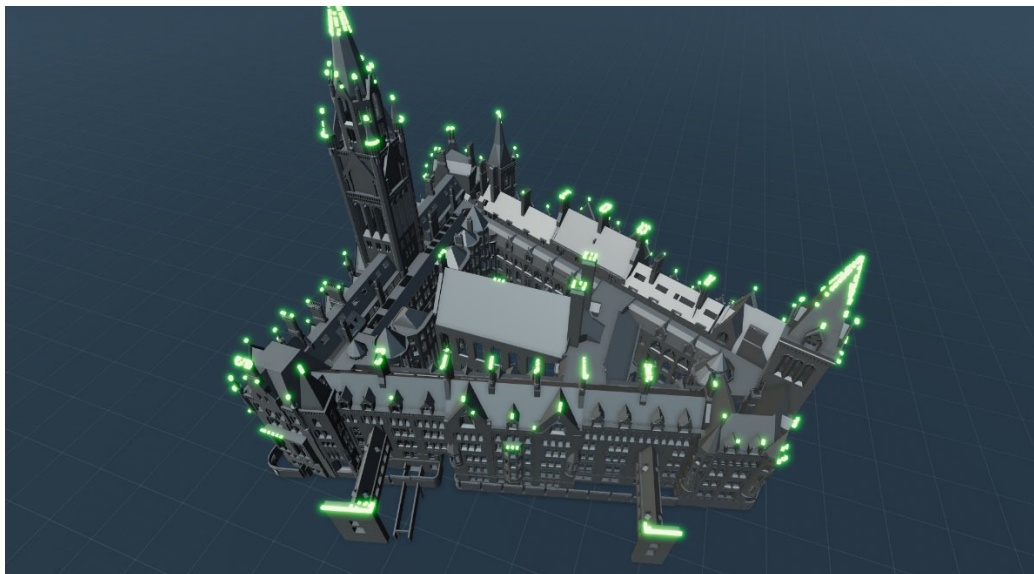


Figure 5 – Software model implementation of the rolling sphere method

6.3 Code-compliance

- 6.3.1.1 The complete lightning protection installation will be installed, tested and commissioned in line with BS EN 62305 for a Class I system. It is acknowledged, that due to the constraints of a Grade I Listed building, there will need be limited code-departures which are agreed with the OTH Design Team, Client and the building insurers as well as industry bodies.

- 6.3.1.2** Arup have identified a series of proposed code-departures as part of their design:
- To minimise aesthetical impact and due to heritage constraints, it is proposed to route several down conductors adjacent to rainwater pipes. As a result, the separation distance s as defined in BS EN 62305-3 6.3 cannot be maintained between the down conductors and the rainwater pipework. These existing rainwater pipes consist of 1.8m long sections (i.e. electrical continuity is not guaranteed), it is not practically feasible to bond every section to the lightning protection system.
 - Similar to the above, it is proposed to route several façade lighting cables alongside rainwater pipework and lightning protection down conductors, due to heritage and aesthetical constraints. As a result, the separation distance s cannot be maintained between the down conductors and the electrical cabling. To mitigate this, Type 1 surge protection devices shall be fitted to the distribution boards supplying external lighting.
- 6.3.1.3** Clause omitted.
- 6.3.1.4** The Works Contractor shall include on the final test certificates and handover documents a comprehensive description of all agreed code-departures.

6.4 Lightning Protection Components

6.4.1 General

- 6.4.1.1** Manchester Town Hall is Grade I Listed as identified by Historic England; and the courtyards, moats facades, towers and roofs are categorised as being of Very High Significance in accordance with the Purcell Heritage Significance Plans. The lightning protection system, whilst critical for protection of the building, contents and occupants, also has the potential to detract from the stunning appearance of this national asset. As such, every possible effort will be made to ensure that the lightning protection system is installed in a manner which is in keeping with the building.
- 6.4.1.2** The design life of the building is set at 60 years from project completion in 2024. Whilst it is acknowledged that the lightning protection system will need repairing and replacing in this time, it is imperative that the materials, components and fixings are selected with longevity in mind and as such, only copper materials shall be utilised.
- 6.4.1.3** New components will be utilised throughout the installation.
- 6.4.1.4** All lightning protection conductors will be copper, unless specifically agreed otherwise. Fixings will be copper or gunmetal copper alloy. Screws will be stainless steel fixed in to appropriate plugs where required.

- 6.4.1.5** The Arup design is based upon Furse (ABB) components – however the Works Contractor is at liberty to select alternative components of equal or better quality and identical finish.
- 6.4.1.6** Within their tender return, the Works Contractor shall include datasheets and images of all components proposed for the project, with a description of where they will be applied.
- 6.4.1.7** Upon appointment, the Contactor shall provide physical samples of all components for review by the OTH Design Team and the Heritage Conservation Officer.
- 6.4.1.8** Down conductors are proposed to be PVC coated copper – for the purposes of costing assume a black finish (18B29 to BS 5252), however an alternative finish from the standard range offered may be selected by the Architect prior to installation.

6.4.2 Specification of Components

- 6.4.2.1** Primary lightning protection components shall be as follows:
- 6.4.2.2** PVC covered copper tape (nominally 25mm by 3mm) compliant with BS EN 13601 (PVC colours to BS 5252).
- 6.4.2.3** Bare copper tape (nominally 25mm by 3mm) compliant with BS EN 13601.
- 6.4.2.4** Flexible copper braid (nominally 32mm by 6mm) compliant with BS EN 13602.
- 6.4.2.5** PVC covered solid circular copper (nominally 8mm diameter) compliant with BS EN 13601 (PVC colours to BS 5252).
- 6.4.2.6** Bare solid circular copper (nominally 8mm diameter) compliant with BS EN 13601.
- 6.4.2.7** Solid copper earth rods (nominally 15mm diameter and lengths of multiples of 1200mm) complete with spike, coupling dowel(s) and driving stud compliant with BS EN IEC 62561-2. Driving rods for the rods shall be high tensile steel and shall be fully threaded to ensure thread-to-rod contact. Couplings shall be counter-bored and of sufficient length to completely cover and protect the threaded portion of the rods, to minimise corrosion. Couplings shall be of silicon aluminium bronze and shall be fully threaded to allow metal-to-metal contact of the rods. Couplings shall have corrosion inhibiting paste applied to the threads.
- 6.4.2.8** Hard drawn copper air rods (nominally 15mm diameter) compliant with BS EN 50164-2.
- 6.4.2.9** Copper (gunmetal alloy) clamps, fixings and joints compliant with BS EN 50164-1 Class H.
- 6.4.2.10** Copper Strike Plates compliant with BS EN 50164-2.
- 6.4.2.11** The Works Contractor shall clearly identify any alternative components proposed.

- 6.4.2.12** All clamped arrangements shall be tightened using a torque wrench to manufacturer's approved torque settings.

7 LOW-LEVEL LIGHTNING PROTECTION SYSTEM WITHIN COURTYARDS

7.1 Overview

7.1.1.1 The low-level areas of the inner courtyards of the Town Hall are being refurbished as an early enabling works package so as to allow the installation of scaffolding within the courtyards. These areas are identified on the drawings as 'C' e.g. 'C07'.

7.1.1.2 The courtyard works will comprise of the following:

- Careful and considered removal of existing finishes – by others.
- Disconnection of existing below-ground lightning protection earth electrodes from the above-ground lightning protection down-conductors (at the test clamp) – by the Works Contractor.
- Excavation of existing courtyard sub-base and removal of existing lightning protection electrodes – by others.
- Installation of new sub-base and below-ground drainage – by others.
- Installation of new lightning protection electrodes – by the Works Contractor.
- Connection of new lightning protection electrodes to existing lightning protection down-conductors (at the test clamp) – by the Works Contractor.

7.2 Disconnection of existing Lightning Protection Down Conductors

7.2.1.1 At a point in time to be agreed with the Management Contractor, the Works Contractor shall disconnect the existing lightning protection earth electrodes within the courtyards from the lightning protection down conductors at the test clamp.

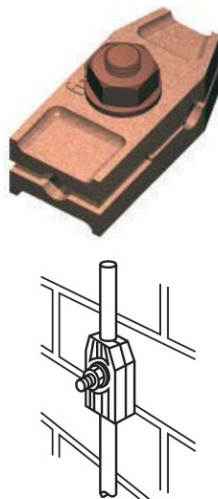


Figure 6 - Typical test clamp

- 7.2.1.2** The lightning protection down conductors and the test clamps shall be left in-situ.
- 7.2.1.3** The Works Contractor shall remove each existing lightning protection connection from the test clamp to the earth electrode, carefully removing any fixings so as to avoid damaging the stone-work.
- 7.2.1.4** The existing earth electrodes will be removed by others.

7.3 New Lightning Protection Electrodes

- 7.3.1.1** The Works Contractor shall survey the courtyards and verify the proposed positions of all lightning protection electrodes once the excavation works have been completed, offering alternative locations where below-ground constraints exist. The setting-out of all earth rods shall be agreed with the OTH Design Team on site – however typically these are proposed to be located approximately 450mm from the building to avoid the existing wall footings.
- 7.3.1.2** The Works Contractor shall supply, install and test new solid copper earth rods at each position indicated on the drawings. Earth rods shall be of an appropriate length to achieve the earth resistance values indicated in BS EN 62305.
- 7.3.1.3** Connections to earth rods will be via a PVC covered solid circular copper conductor, which will be buried under the surface finishes and pop up adjacent to the building. Each earth rod shall be exothermically welded to the circular copper conductor. Inspection pits will not be provided.
- 7.3.1.4** Record drawings shall be provided by the Works Contractor indicating the location and depth of all lightning protection electrodes. Labelled photographs shall be taken of all connections prior to backfilling, for inclusion in the record information.

7.4 Connections from Earth Electrodes to Test Clamps

- 7.4.1.1** The Works Contractor shall provide a connection from each existing test clamp to an adjacent new earth electrode in the form of a PVC covered solid circular copper conductor. The conductor shall not be fixed to the wall, and adequate spare conductor shall be provided to allow this to be fixed at a later date to suit the new down conductor positions.
- 7.4.1.2** Where the new earth electrodes do not align with the existing test clamps, a minimum 1000mm of spare conductor shall be provided and coiled up out of the way.
- 7.4.1.3** All exposed new lightning protection components shall be clearly marked at low-level using a robust weatherproof labelling system 'LIGHTNING PROTECTION CONNECTION – DO NOT REMOVE'.

8 TEMPORARY LIGHTNING PROTECTION SYSTEM

8.1 Overview

8.1.1.1 The Works Contractor will be responsible for the provision of temporary lightning protection to the building during the construction works.

8.1.1.2 As part of the construction works, the facades and towers will be encased in an extensive scaffold structure and the roofs covered by temporary roof structures. The scaffolding and roof structures will be constructed from substantial metallic elements which are clamped together at regular centres. It is therefore proposed that the temporary lightning protection to the building is provided by the scaffolding / temporary roof structure.

8.2 Bonding of Scaffolding to new Lightning Protection Electrodes within Courtyards

8.2.1.1 The Works Contractor shall provide a bond from each new lightning protection electrode within the courtyards to the adjacent scaffold pole.

8.2.1.2 Connections shall be flexible to allow the scaffolding to move as necessary and are proposed to be in the form of a flexible braid or braided circular conductor – minimum 70mm². The Conductor shall be connected to the scaffolding in the form of a clamp which clamps directly to exposed metal – with contact paste added. The Works Contractor shall agree the proposals with the Scaffolding Contractor.

8.2.1.3 The Works Contractor shall include for all necessary clamps / fixings including new test clamps where required so as to ensure that the existing air termination network remains operational until the temporary roof is completed. Bimetallic connections shall be provided where there are dissimilar metals.

8.2.1.4 As agreed on site between Lyndon (the Scaffold Contractor) and Best (the Lightning Protection Contractor appointed by Lydon for lightning protection to the scaffolding) on 04/03/2020, Lydon will free-issue short sections of scaffold pole for Best to bond to using a flexible braid connection and suitable clamp. Lydon will be responsible for clamping these short sections of scaffold pole to the main scaffolding installation adjacent to each earth electrode.

8.2.1.5 The Works Contractor shall provide labelled photographs of each bond made, for review by the Resident Engineer.

8.3 Bonding of Scaffolding to existing Protection Electrodes within moats and Building perimeter

- 8.3.1.1** The Works Contractor shall provide a bond from each existing lightning protection electrode within the moats and building perimeter to the adjacent scaffold pole – it is proposed that connection is be made at the test clamp.
- 8.3.1.2** Connections shall be flexible to allow the scaffolding to move as necessary and are proposed to be in the form of a flexible braid or braided circular conductor. The Conductor shall be connected to the scaffolding in the form of a clamp which clamps directly to exposed metal – with contact paste added. The Works Contractor shall agree the proposals with the Scaffolding Contractor.
- 8.3.1.3** The Works Contractor shall include for all necessary clamps / fixings including new test clamps where required so as to ensure that the existing air termination network remains operational until the temporary roof is completed.
- 8.3.1.4** As agreed on site between Lydon (the Scaffold Contractor) and Best (the Lightning Protection Contractor appointed by Lydon for lightning protection to the scaffolding) on 04/03/2020, Lydon will free-issue short sections of scaffold pole for Best to bond to using a flexible braid connection and suitable clamp. Lydon will be responsible for clamping these short sections of scaffold pole to the main scaffolding installation adjacent to each earth electrode.
- 8.3.1.5** The Works Contractor shall provide labelled photographs of each bond made, for review by the Resident Engineer.

9 NEW AIR TERMINATION SYSTEM

9.1 Overview

9.1.1.1 The air termination system is proposed to comprise of the following elements:

- Natural building elements, including:
 - Albert Square Clock Tower 'Golden Ball'
 - Tower pinnacles
 - Flagpoles
- Chimney air terminals (rods)
- Conductor installed under Great Hall ridge line (with strike plates)
- Conductors routed to top of stonework pinnacles
- Equipotential bonding to metallic elements.

9.2 Albert Square Clock Tower Golden Ball

9.2.1.1 Albert Square Tower has an existing lightning protection element which is thought to be original – a 'golden' ball located at the top of the tower.

9.2.1.2 The Works Contractor shall include for bonding this to the down conductors in a manner agreed with Purcell and the Conservation Officer which minimises the damage to the original material.



Figure 7 - Bonding of the Albert Square Clock Tower 'Golden Ball'

9.3 Tower pinnacles

9.3.1.1 The existing pinnacle of the Cooper Street Tower is connected to the lightning protection system through a large-diameter multi-stranded

circular conductor which is routed through the middle of the tower and embedded in to the timber. This shall be retained in situ.

9.3.1.2 The Works Contractor shall include for bonding this to the down conductor system in an agreed manner which does not impact the roof waterproofing.

9.3.1.3 The Works Contractor shall include for bonding pinnacles of the smaller towers (along Cooper Street, Lloyd Street and Princess Street) to the down conductor system in an agreed manner which does not impact the roof waterproofing. The Works Contractor shall submit proposals for review by the Resident Engineer.

9.4 Flagpoles

9.4.1.1 It is intended to utilise the 2No. flagpoles facing Albert Square as natural air termination components, utilising their height.

9.4.1.2 The Works Contractor shall include for performing conductivity tests to the flagpoles, to ensure suitability for use as air terminals.

9.4.1.3 The Works Contractor shall include for bonding the bases of the flagpoles to the down conductor system as indicated on the drawings.

9.5 Chimney Air Terminals (Rods)

9.5.1.1 The current installation comprises coronal conductors routed around the perimeter on top of the chimney stacks, this does not provide adequate protection to the chimney elements that are above the conductor (i.e. chimney pots, flues etc).

9.5.1.2 Air rods are proposed to be installed on top of chimney stacks, to provide lightning protection to the chimneys and surrounding building elements on lower roofs. The Works Contractor shall include for installing 10mmØ air rods and for bonding these to the down conductor system, the air rods shall be located as follows:

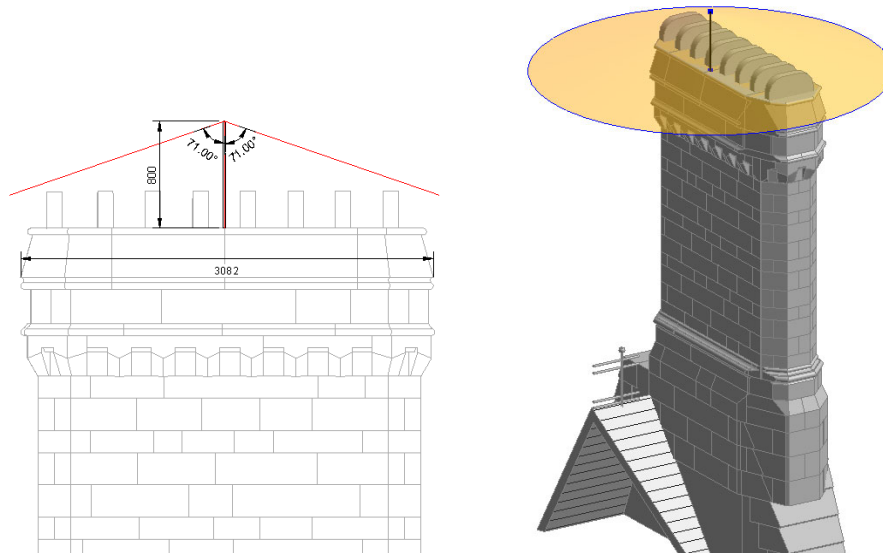


Figure 8 - 800mm rod positioned at the centre of one long edge of the chimney

9.6 Conductors installed under ridge lines

- 9.6.1.1** Air termination will be required to the top of the Great Hall pitched roof. This is proposed to be in the form of a flat conductor concealed beneath the ridge line, with discrete copper strike plates as shown on drawing OTH-ARU-TH-RF-DWG-E-24401. The concealed conductor shall be fixed every 1000mm using proprietary fixings.
- 9.6.1.2** The strike plates shall be 50mm x 50mm, 10mm thick gunmetal plates and shall be spaced at 5m centres as shown on drawing OTH-ARU-TH-RF-DWG-E-24401.

9.7 Conductors routed to top of stonework pinnacles

- 9.7.1.1** As demonstrated by the rolling sphere model, there are a number of stonework pinnacles that are prone to a lightning strike – as shown on drawing OTH-ARU-TH-RF-DWG-E-24401. These shall be provided with 8mm flexible copper conductors routed to the top of the stonework and connected to the down conductor system using bimetallic connectors.
- 9.7.1.2** The flexible conductors shall be fixed to the stonework using appropriate clips, the Works Contractor shall include for surveying these areas and submitting proposals of appropriate fixing methods to the OTH Design Team for approval.

9.8 Equipotential bonding to metallic elements

9.8.1.1 In addition to the natural air termination elements mentioned above, the Works Contractor shall include for cross bonding metallic elements to the lightning protection system using 25mm x 3mm copper tape, to minimise risk of flashovers, these shall include:

- Ridge metalwork
- Exposed metalwork
- Aerials and dishes
- Roof-top plant
- Plant screens
- Pipework and containment
- Ductwork
- Flues
- Walkways at regular intervals.

10 NEW DOWN CONDUCTOR SYSTEM

10.1 Removal of existing Down Conductors

- 10.1.1.1** At a point in time agreed with the Management Contractor, once the scaffolding and temporary roof is installed and providing protection to the building, the Works Contractor shall carefully remove the existing lightning protection down conductors, so as to allow stonework repairs and cleaning to be completed.
- 10.1.1.2** The Works Contractor shall remove the existing down conductors in a careful and considered manner which avoids damage to the existing building fabric. All screwed fixings shall be unscrewed. A method statement shall be submitted for review by Purcell.

10.2 Overview of new Down Conductor system

- 10.2.1.1** A new down conductor system shall be installed, providing multiple low resistance paths from the air termination system to earth. The down conductor system shall comprise:
- Down conductors from air termination elements (chimney air rods, clock tower, pinnacles etc)
 - Building perimeter high-level ring conductors
 - Courtyard perimeter high-level ring conductors
 - Vertical (façade mounted) down conductors.
- 10.2.1.2** Down conductors routed along sloped roofs shall be:
- Concealed beneath roof tiles and fixed to using proprietary fixings every 1000mm - note exposed strike plates will be required where conductors are concealed.

10.3 Installation of new Down Conductors

- 10.3.1.1** The Works Contractor shall be responsible for the supply, installation and testing of new lightning protection down conductors which will be installed on the external facades of the building in a phased manner, once the stonework repairs are complete, but prior to the scaffolding being taken down.
- 10.3.1.2** Down conductors will be PVC-covered circular solid copper conductors which are fixed at regular intervals (consistent across the façade) in line with the manufacturer's guidance using gunmetal heavy duty cast cable saddles which are screwed in to the façade using stainless steel screws.
- 10.3.1.3** Down conductors shall be installed plumb, except where existing building elements are not plumb, in which case they shall be installed parallel to the existing elements.
- 10.3.1.4** Down conductors shall be installed parallel to the façade and track the façade elements. Where passing over elements which stand proud

from the façade such as string courses, the down conductors shall be formed in a way to step over the extrusion in a curved manner which does not touch the extrusion, but which is consistent across the façade.

- 10.3.1.5** The final routing of the down conductors and fixing arrangements shall be agreed by the Works Contractor on site with the Architect.
- 10.3.1.6** Each down conductor shall connect in the associated earth electrode via a new gunmetal test clamp which is provided between 300mm and 450mm above grade at a level which is consistent across the facade.

10.4 Side-strike protection to Albert Square Tower

- 10.4.1.1** Albert Square Tower is approximately 88m tall. And as such side-strike protection is required to the top 20% of the tower as indicated on the drawings.
- 10.4.1.2** This is proposed to be in the form of down conductors which link at the top and form of a ring at the uppermost accessible level of the tower, which connects in to the main down conductors.

11 EARTH TERMINATION SYSTEM WITHIN MOATS AND BUILDING PERIMETER

11.1 Overview

11.1.1.1 The low-level perimeter areas of the Town Hall building including the moats and perimeter of the building will likely be completed once the scaffolding is removed - this is planned to take place in a phased manner.

11.1.1.2 Works will comprise of the following:

- Careful and considered removal of existing finishes – by others.
- Disconnection of existing below-ground lightning protection earth electrodes from the above-ground lightning protection down-conductors (at the test clamp) – by the Works Contractor.
- Localised excavation and removal of existing lightning protection electrodes – by others.
- Installation of new sub-base and below-ground drainage – by others.
- Installation of new lightning protection electrodes – by the Works Contractor.
- Connection of new lightning protection electrodes to lightning protection down-conductors (at the test clamp) – by the Works Contractor.

11.2 Disconnection of existing Lightning Protection Down Conductors

11.2.1.1 At an agreed point in time, the Works Contractor shall disconnect the existing lightning protection earth electrodes within the courtyards from the lightning protection down conductors at the test clamp.

11.2.1.2 The lightning protection down conductors and the test clamps shall be left in-situ.

11.2.1.3 The Works Contractor shall remove each existing lightning protection connection from the test clamp to the earth electrode, carefully removing any fixings so as to avoid damaging the stone-work.

11.2.1.4 The existing earth electrodes will be removed by others.

11.3 New Lightning Protection Electrodes

11.3.1.1 The Works Contractor shall survey the moats and building perimeter including full cat-scan surveys of buried utilities and verify the proposed positions of all lightning protection electrodes, offering alternative locations where below-ground constraints exist. The setting-out of all earth rods shall be agreed on site – however typically

these are proposed to be located approximately 450mm from the building to avoid the existing wall footings.

- 11.3.1.2** The Works Contractor shall supply, install and test new solid copper earth rods at each position indicated on the drawings. Earth rods shall be of an appropriate length to achieve the earth resistance values indicated in BS EN 62305.
- 11.3.1.3** Connections to earth rods will be via a PVC covered solid circular copper conductor, which will be buried under the surface finishes and pop up adjacent to the building. Each earth rod shall be exothermically welded to the circular copper conductor. Inspection pits will not be provided.
- 11.3.1.4** Record drawings shall be provided indicating the location and depth of all lightning protection electrodes. Labelled photographs shall be taken of all connections prior to backfilling, for inclusion in the record information.

11.4 Connections from Earth Electrodes to Test Clamps

- 11.4.1.1** The Works Contractor shall provide a connection from each test clamp to the adjacent new earth electrode in the form of a PVC covered solid circular copper conductor. The conductor shall be securely fixed to the wall in an agreed manner.
- 11.4.1.2** All exposed new lightning protection components shall be clearly marked at low-level using a robust weatherproof labelling system 'LIGHTNING PROTECTION CONNECTION – DO NOT REMOVE'.

12 ALBERT MEMORIAL

- 12.1.1.1** Arup have determined that Albert Memorial is at risk of lightning strike, since it is not afforded with fortuitous protection from other elements.
- 12.1.1.2** The lightning protection survey proposals for Albert Memorial are outlined on drawing OTH-ARU-EE-ES-DWG-E-24401.
- 12.1.1.3** Further information is required in the form of intrusive surveys to determine the specific requirements.
- 12.1.1.4** The following was agreed at the mid-tender interviews with the bidders in February 2020:
- The bidders should include for the following as a provisional sum item:
- An electrical continuity test from an exposed armature near the base of the memorial, to the top of the crown - confirming an impedance of less than 0.2 Ohm.
 - Two exothermic welds at low level to the armature, linking to two 25mm by 3mm bare copper tapes which will be run within the buildup of the steps, linking to two concrete earth pits, with copper test clamp and 15mm copper earth rod of 3.6m length.

Appendix A

Existing Lightning Protection and Soil Resistivity Survey results

The attached document produced by BEST Services in April 2019 provides a summary of the condition of the existing lightning protection system electrodes at Manchester Town Hall. This also includes soil resistivity measurements which were taken at Sackville Gardens in March 2019.

Our Ref: NG/SM/14-7675

Date: 01 April 2019

Manchester City Council
C/O MACE Group
Room 127 Town Hall
Albert Square
Manchester
M60 2LA

Alma House
Grimshaw Lane
Middleton
Manchester
M24 1GQ

Tel: 0161 655 3000
Fax: 0161 655 3001

Email: info@bestservices.co.uk
www.bestservices.co.uk

For the attention of Mr Benjamin Susca

Dear Sir,

Re: Manchester Town Hall
SOIL RESISTIVITY AND LIGHTNING PROTECTION EARTHING SURVEY AND TEST

Further to your valued emailed instruction, we are now pleased to submit our lightning Protection earthing survey report along with soil resistance analysis for the above project.



Contents:

Section	Description	Page
1.0	Preamble	2
2.0	Lightning Protection Earths	2-4
3.0	Soil Resistivity	4-8

1.0 Preamble:

BEST Services Ltd were appointed Manchester City Council to undertake a soil resistivity test and survey of the existing lightning protection earths installed to the town hall.

We understand that the purpose of the soil resistivity testing is to enable the data to be utilised in order to assist in the preparation of suitable calculations and designs for potentially, multiple protective earthing systems.

With regards to the lightning protection earthing, it is within our knowledge that the purpose of these surveys and testing works is to enable the selected consultant ARUP to determine if they wish to incorporate any of the existing earth terminations into the future proposed and new lightning protection system.

We also note the following tender information and associated standards.

1.1 Drawing Nos:	OTH-ARU-TH-ZZ-SKE-E-0052	
1.2 Physical Information:	Site surveys conducted by Peter Wellens & Richard Brown- Qualified Lightning Protection and Specialist Earthing Engineers	
1.3 Reference Standards:	BS EN 62305:2011/12 Parts 1-4 BS EN 62651:2011 Parts 1-8 BS 7430:2011 BS 7671:2011	Protection Against Lightning LP Components COP for Protective Earthing IET Wiring Regulations

2.0 Lightning Protection Earths:

As mentioned within section 1.0 of this document, BEST Services Ltd were appointed to undertake a survey and test of the existing lightning protection earth electrodes installed to the town hall. Our scope of works included plotting the locations of each individual earth electrode and obtaining a measurement of the depth of the top of the electrode below the existing finished floor level. In order to obtain these measurements, a specialist CAT 4+ type scanner and genny were utilised. The locations of the earth electrodes have been highlighted on site using a spray paint and we have also plotted these locations on drawing no. NG_SW_14-7675_P1_LPET.

In addition to the plotting of existing earth electrodes, we have also undertaken earth resistance testing at each earth electrode position and our readings obtained are below for your information. The readings were obtained using primarily the dead earth test method. This method is the standard test for lightning protection earth electrode testing. This method utilises the lightning protection system as a known earth and is perfect for identifying issues with continuity within the system. In some of the earth locations we encountered issues with poor continuity through the system and in these instances, we used the fall of potential test method to achieve a true earth resistance reading. This was achieved by isolation 2 No. local lightning protection earths and using these as known earths. We have listed any defects within section 2.2 of this document.

Our earth resistance readings obtained are contained within the table below-

2.1 Earth Resistance Readings:

External Earths	Resistance Ohms	External Earths	Resistance Ohms	Courtyard Earths	Resistance Ohms
EARTH No. O1	25.6	EARTH No. O26	110.6	EARTH No. C1	60.8
EARTH No. O2	260.0	EARTH No. O27	47.8	EARTH No. C2	106.3
EARTH No. O3	210.0	EARTH No. O28	173.8	EARTH No. C3	38.9
EARTH No. O4	127.3	EARTH No. O29	115.5	EARTH No. C4	113.5
EARTH No. O5	120.7	EARTH No. O30	17.4	EARTH No. C5	302.0
EARTH No. O6	142.1	EARTH No. O31	95.8	EARTH No. C6	41.8
EARTH No. O7	41.1	EARTH No. O32	18.5	EARTH No. C7	81.8
EARTH No. O8	118.8			EARTH No. C8	76.9
EARTH No. O9	252.0			EARTH No. C9	239.0
EARTH No. O10	449.0			EARTH No. C10	129.7
EARTH No. O11	284.0			EARTH No. C11	UTT
EARTH No. O12	439.0			EARTH No. C12	130.3
EARTH No. O13	81.5			EARTH No. C13	243.0
EARTH No. O14	206.0			EARTH No. C14	UTT
EARTH No. O15	164.5			EARTH No. C15	94.3
EARTH No. O16	256.0			EARTH No. C16	82.8
EARTH No. O17	182.			EARTH No. C17	40.8
EARTH No. O18	158.3			EARTH No. C18	1.18
EARTH No. O19	323.0			EARTH No. C19	135.1
EARTH No. O20	407.0			EARTH No. C20	84.1
EARTH No. O21	375.0			EARTH No. C21	39.8
EARTH No. O22	294.0			EARTH No. C22	60.9
EARTH No. O23	49.9				
EARTH No. O24	33.3				
EARTH No. O25	37.1				

Product of No Earth Points = 0.66 ohms

2.2 Highlighted Defects:

EARTH LOCATION	PROBLEM	REMEDIAL ACTION REQUIRED
EARTH No. C9	CONTINUITY ISSUE	Continuity issue to downtape – tested off neighbouring downtape
EARTH No. C11	MISSING EARTH	Tape enters building possible EQ Bond
EARTH No. C14	DOWNTAPE CUT	Tape cut 4m in air does not terminate to roof
EARTH No. O12	CONTINUITY ISSUE	Continuity issue to downtape – tested off neighbouring downtape

Commissioning Date:	21/03/2019	Testing Engineer:	R.Brown/P.Wellens
Instrument Number:	MLME 0019	Plant Used:	CATv 4+ / Genny

2.3 Lightning Protection Earthing Conclusion:

Following the survey and testing works we can confirm that all but two of the earths (C11 & C14) will be suitable to incorporate into the newly proposed system. Obviously the choice to incorporate these will be based on final measurements as we understand that a class I system is the required class of protection for the new installation and maximum increments between earth positions should not exceed 10 meter intervals.

In relation to the defects highlighted at C11 and C14.

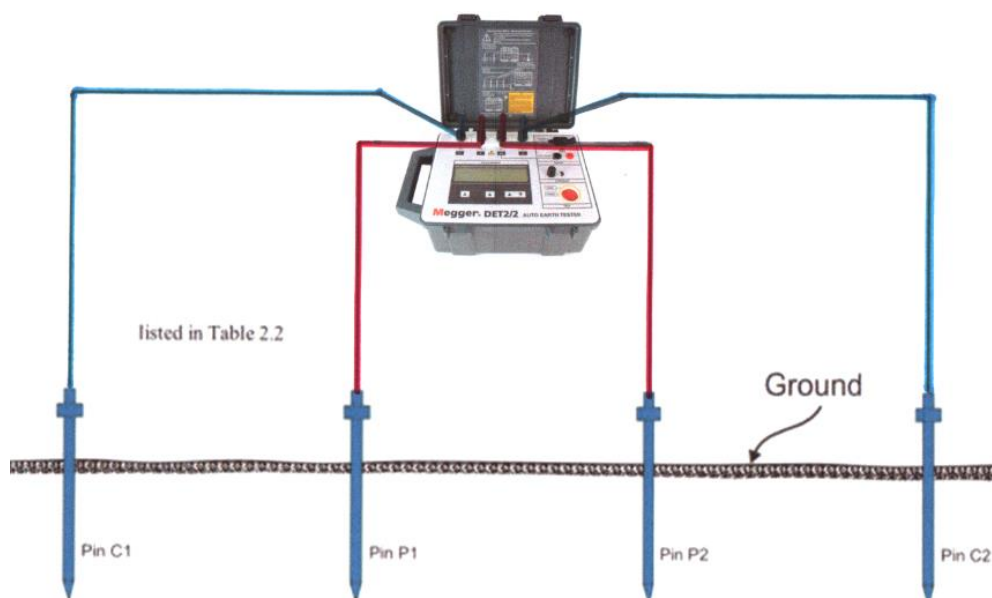
- C14 has been cut at low level and at high level. At some stage this did terminate to earth and to the air termination network but is now redundant.
- C11 appears to be an equipotential bond. This was traced as far as possible and it was noted that the conductor changed from 25 x 3mm to an unknown cable size within the building. We assume that this is routed to the MET.

3.0 Soil Resistivity:

As mentioned within section 1.0 of this document, BEST Services Ltd were appointed to undertake a soil resistivity survey in Sackville Park, Manchester. Our scope of works included 4 pole Wenner method tests and subsequent submission of readings and findings.

Due to the limited space within Sackville park, we only managed to obtain two long test routes which ran parallel and 3 smaller test routes in available areas.

General Setup of the Wenner test method.



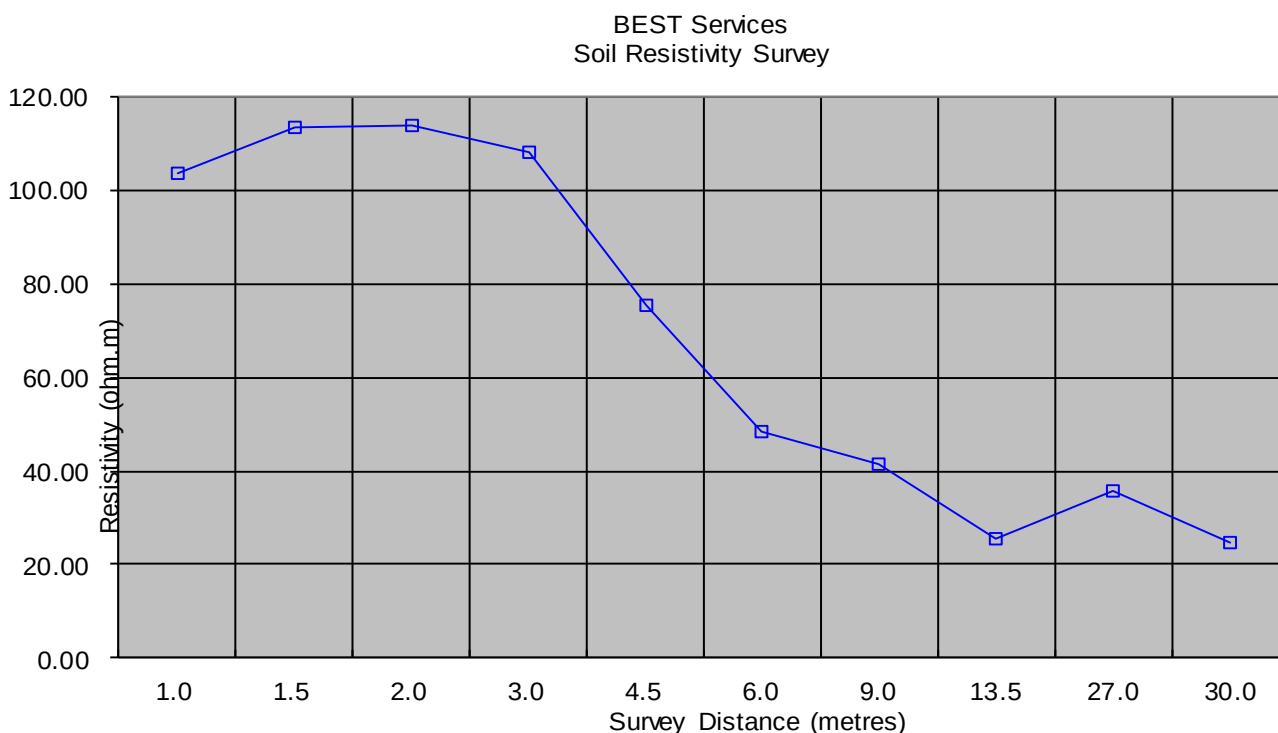
3.1 Results

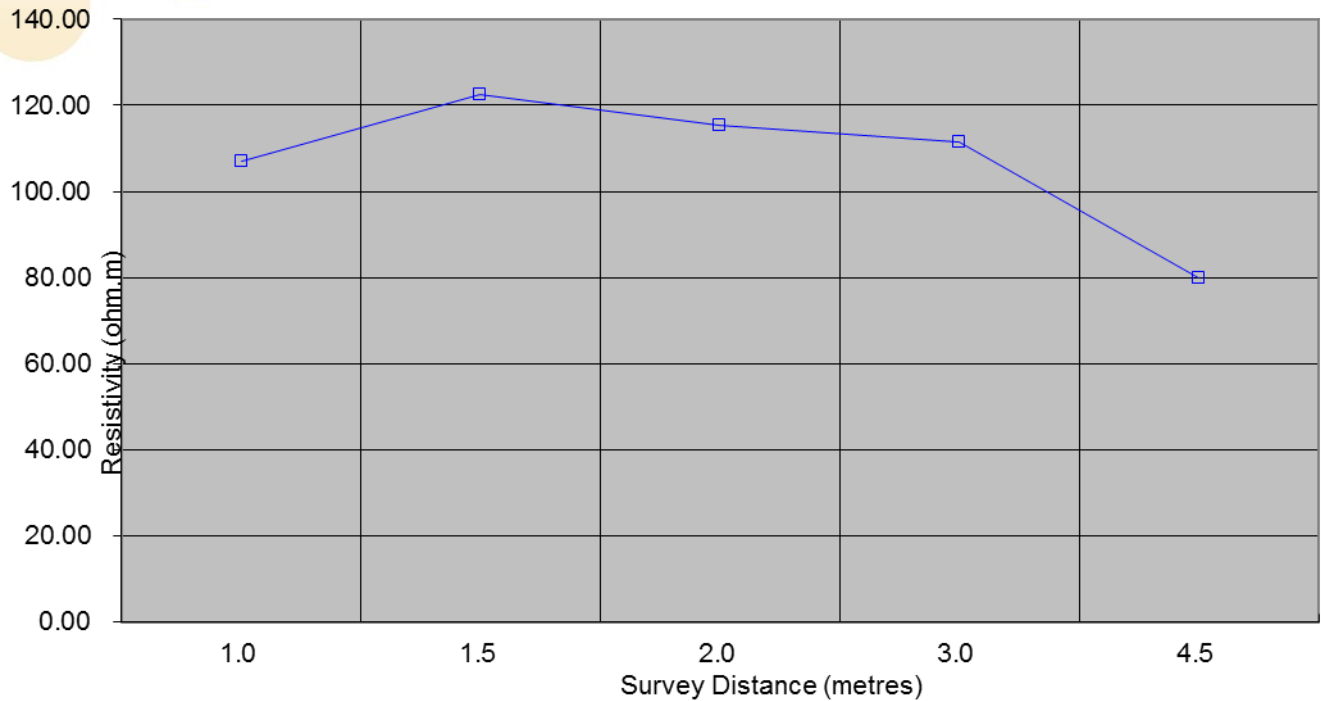
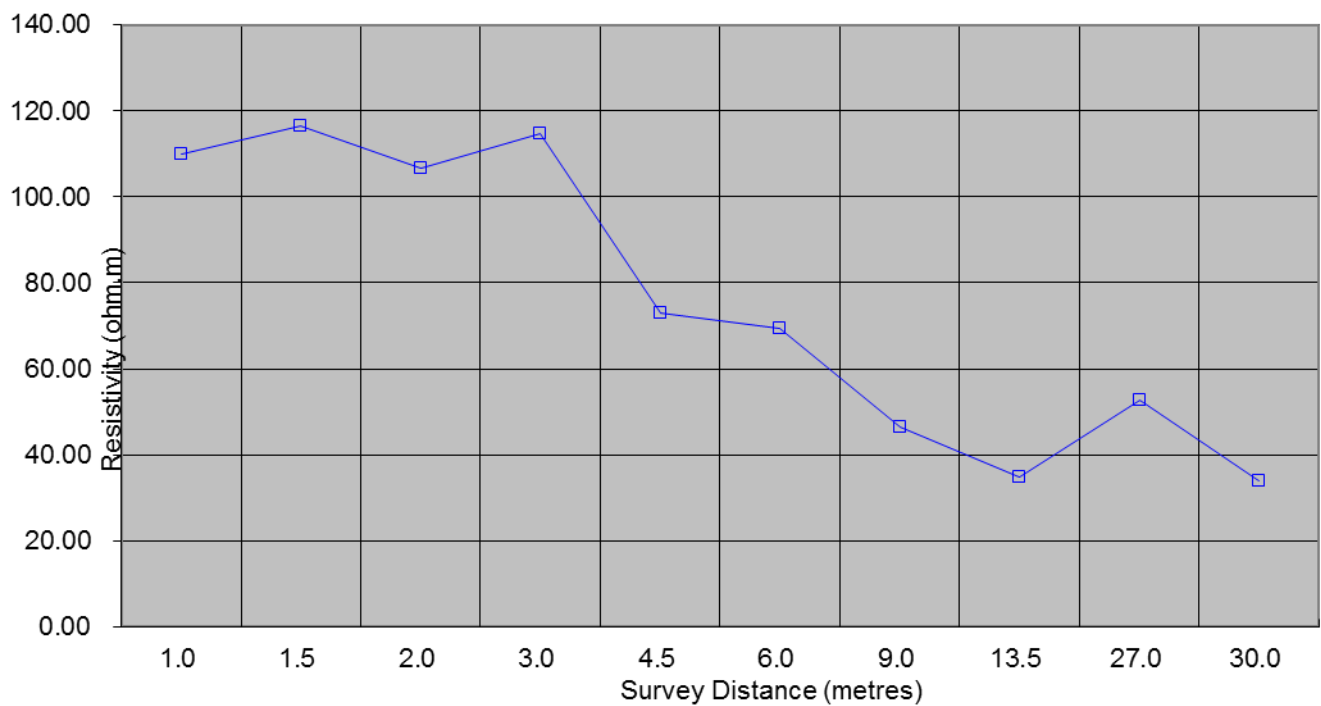
Soil Resistivity Test Route 1:			Soil Resistivity Test Route 2:			Soil Resistivity Test Route 3:		
Distance	Meggar	Resistivity	Distance	Meggar	Resistivity	Distance	Meggar	Resistivity
Meters	(Ohms)	(Ohm.m)	Meters	(Ohms)	(Ohm.m)	Meters	(Ohms)	(Ohm.m)
1.0	16.51	103.74	1.0	17.03	107.00	1.0	17.50	109.96
1.5	12.04	113.47	1.5	13.00	122.52	1.5	12.37	116.58
2.0	9.08	114.10	2.0	9.18	115.36	2.0	8.49	106.69
3.0	5.73	108.01	3.0	5.91	111.40	3.0	6.09	114.79
4.5	2.67	75.49	4.5	2.83	80.02	4.5	2.58	72.95
6.0	1.28	48.25				6.0	1.84	69.37
9.0	0.73	41.28				9.0	0.82	46.37
13.5	0.30	25.45				13.5	0.41	34.78
27.0	0.21	35.63				27.0	0.31	52.59
30.0	0.13	24.50				30.0	0.18	33.93

Soil Resistivity Test Route 4:			Soil Resistivity Test Route 5:		
Distance	Meggar	Resistivity	Distance	Meggar	Resistivity
Meters	(Ohms)	(Ohm.m)	Meters	(Ohms)	(Ohm.m)
1.0	18.62	116.99	1.0	16.79	105.49
1.5	13.03	122.80	1.5	12.21	115.08
2.0	9.25	116.24	2.0	9.18	115.36
3.0	5.82	109.70	3.0	5.63	106.12
4.5	2.74	77.47	4.5	2.74	77.47

3.2 Soil Resistivity Graph:

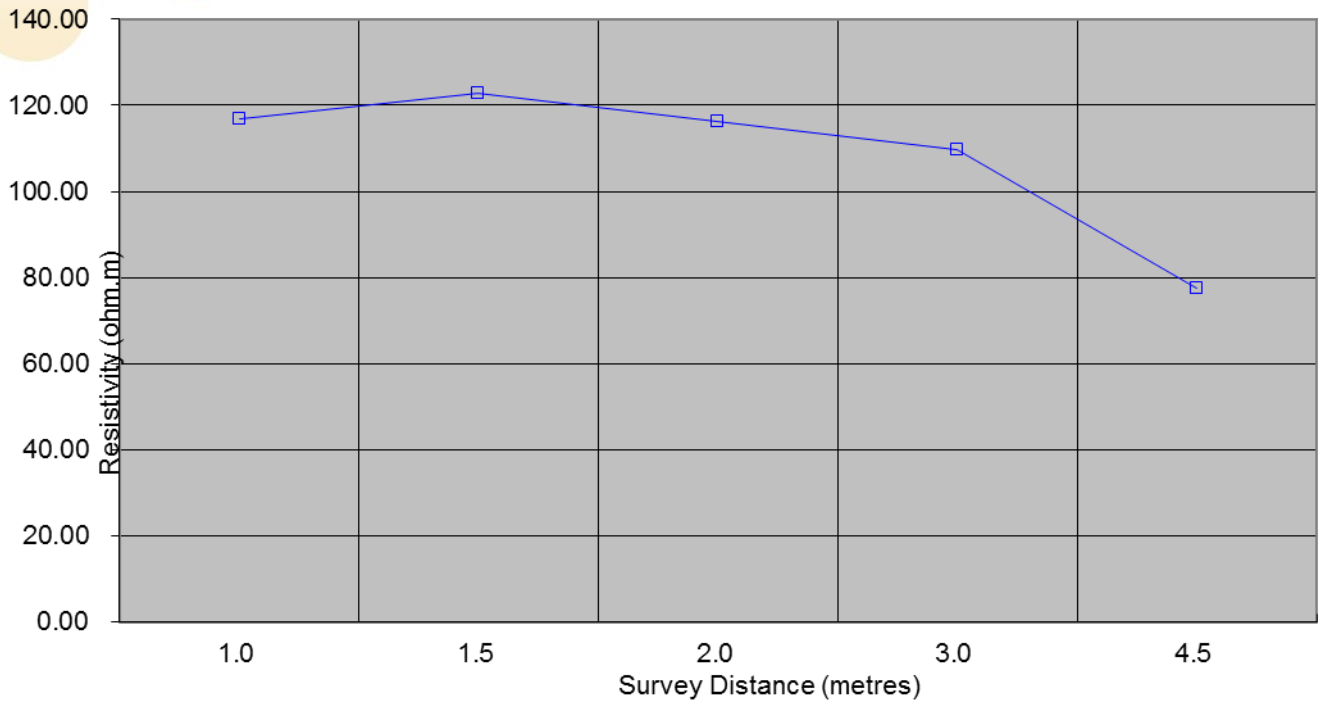
Test Route 1



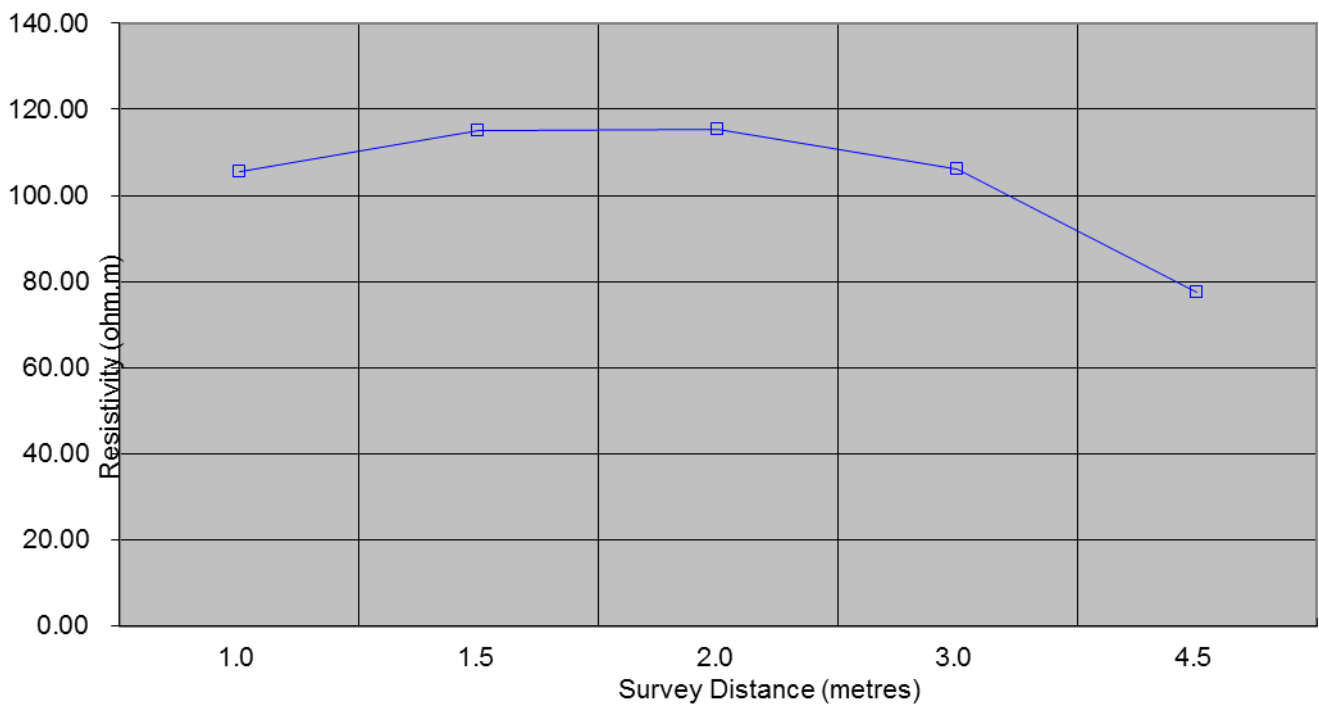
Test Route 2**BEST Services
Soil Resistivity Survey****Test Route 3****BEST Services
Soil Resistivity Survey**

Test Route 4

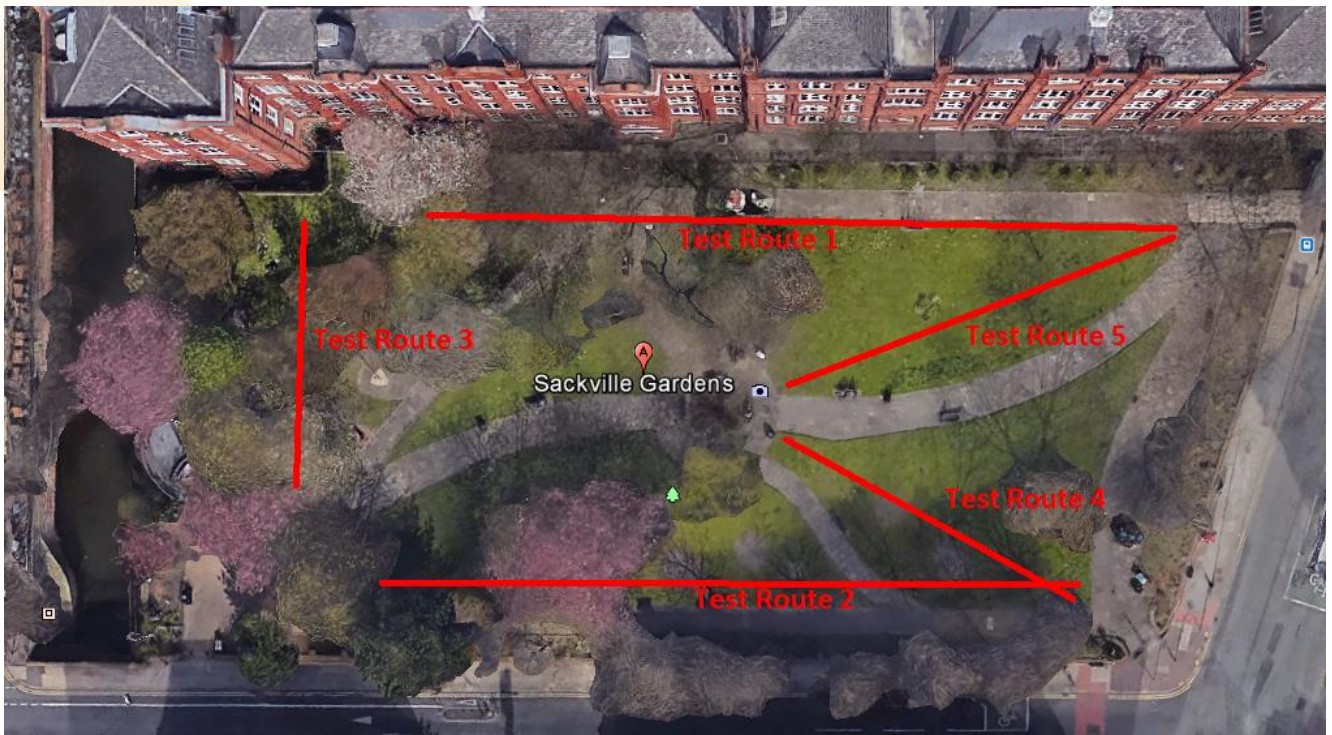
BEST Services
Soil Resistivity Survey

**Test Route 5**

BEST Services
Soil Resistivity Survey



3.3 Soil Resistivity Test Location:



We trust this information meets with your approval; however, should you have any queries in connection with this or any other projects you may be dealing with, please contact the writer at the above address.

Whilst assuring you of our close and careful attention at all times, we remain.

Yours faithfully

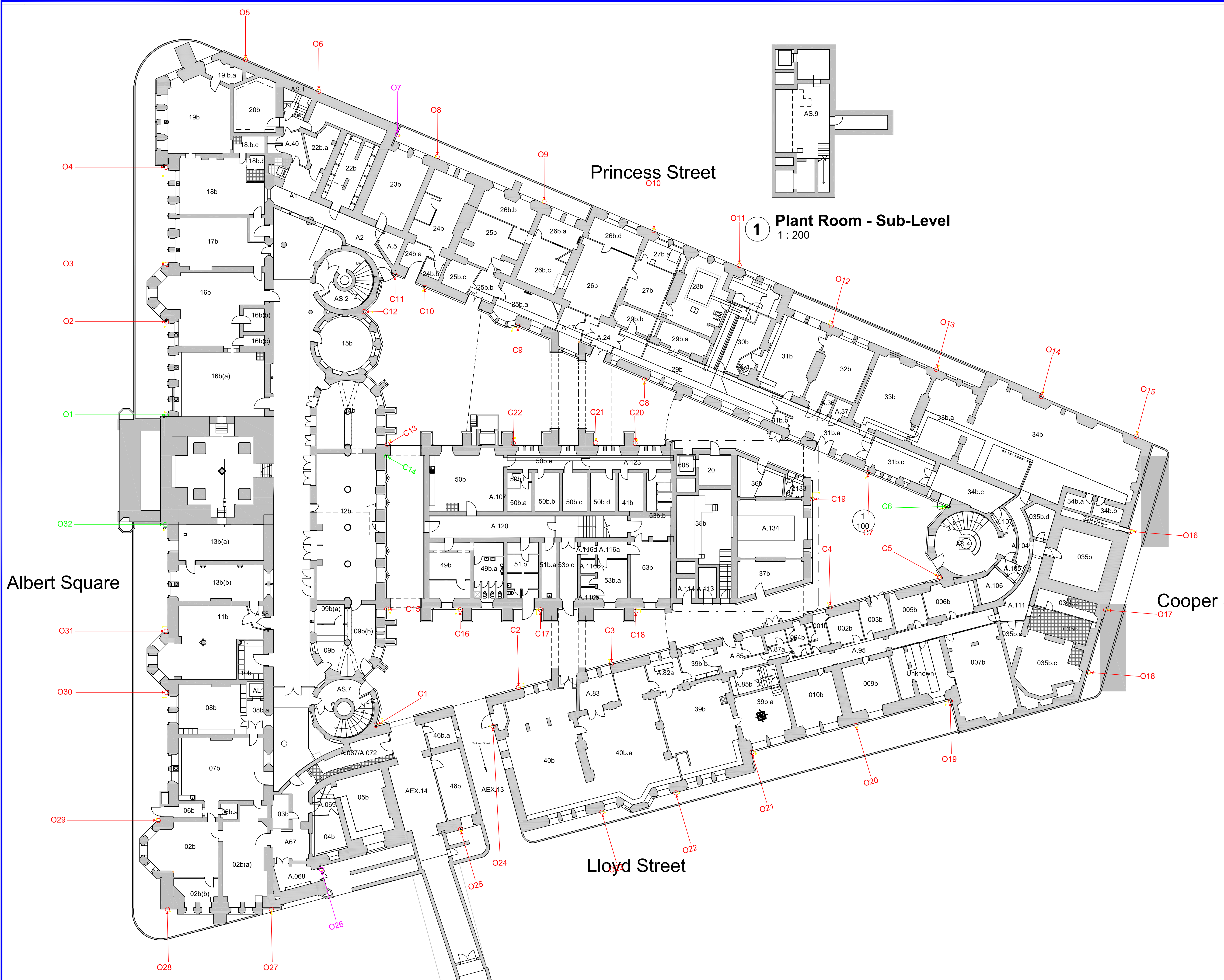
Nick Gill
LIGHTNING PROTECTION ESTIMATOR

Email: ngill@bestservices.co.uk
D.D. 0161 655 6086

Appendix B

Drawing indicating existing Lightning Protection Electrodes

The attached drawing produced by BEST Services in April 2019 outlines the positions of the existing lightning protection electrodes for cross-referencing to the lightning protection survey.



Notes

THE TOP OF ALL EXISTING EARTH ELECTRODES ARE LOCATED WITHIN 150MM BELOW FFL

* PLEASE NOTE- E11 & E14 ARE NOT SUITABLE TO INCORPORATE INTO THE NEW INSTALLATION.

Legend

LOCATION OF EXISTING EARTH TERMINATION

Rev Date Inits Details

Rev	Date	Inits	Details

Alma House
Grimshaw Lane
Middleton
Manchester
M24 1GQ

best

Brooke Edgley Specialist Technical Services Ltd

Client: MANCHESTER CITY COUNCIL

Project title:

LOCATIONS OF EXISTING LIGHTNING PROTECTION EARTH TERMINATIONS

Project Name:

MANCHESTER TOWN HALL

Location:

MANCHESTER

DWG No.

NG_SW_14-7675_P1_LPET

Date:

01.04.19

Project No:

14-7675

Drawn by:

NG

Checked by:

SW

Scale:

1:200 @ A1

Rev:

P1

Status:

'AS INSTALLED'