Lacock Abbey

Lightning Protection Report

Revision C

17 November 2022

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ISSUE HISTORY

Issue	Date	Description
A	11.12.2019	Preliminary issue for client review
B	18.08.2021	Updated and issued for Planning/Heritage Review
C	17.11.2022	Updated with Appendix C to incorporate LPS calculation sheets

MAX FORDHAM LLP TEAM CONTRIBUTORS

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CONTENTS

1.0 INtrodcution 4
2.0 LPS Risk Assessment 5
3.0 Materails & Fixings 6
3.1 Air Termination Network 6
3.2 Roof Level Fixings 6
4.0 Chimney Installation 8
4.1 Down Conductors 8
5.0 Wall/Down Conductor fixing 9
6.0 Earth Pit Installation 11

7.0 Testing and Maintenance 12
8.0 Presentation of Design 13
9.0 Appendix A – LPS Drawings 14
10.0 Appnedix B – Preliminary Elevation Markups 18
11.0 Appendix C – Schedule of Down Conductor Positions 20
12.0 Appendix C – Preliminary LPS Calculations 29
12.1 Notes On Initial LPS Assessments 32

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1.0 INTRODCUTION

The National Trust
Founded in 1895 The National Trust is Europe's largest conservation charity that owns, operates and maintains some of the most historically important properties and spaces in England, Wates and Northern Ireland.

As a registered charity The National Trust relies totally on the generosity of its members and visitors.

Setting
Lacock Abbey is a Grade 1 listed building. The building forms a courtyard and cloister area within the Abbey and has had many interventions throughout its life and as such consists of various periods of architecture. Of significant note are the many external decorative chimneys and detailing at roof level.

Max Fordham LLP has been engaged by The National Trust to design and specify a new Lightning Protection System (LPS). The system will be installed in conjunction with a number of roof repairs and provision of permanent access measures to maintain the roofs in a safer manner.

Project Aims
The key aims of the new LPS are to;

- Reduce the risk to the entire property and collections within.
- Provide a design solution that balances compliance with the British Standards and sensitivity to the buildings historic character and individual features.
- Provide a design solution that is acceptable to external authorities, The National Trust and their Insurers.
- Have minimal impact during installation, allowing the property to remain open throughout the works.
- Be (where possible) compliant with the relevant British Standards and statutory requirements.

Lightning Protection System's
Lightning Protection System's (LPS's) are designed to protect buildings and contents from both direct and indirect damage caused by the high voltage currents of a lightning strike. Whilst LPS's are not mandatory in the UK many building owners opt to install them to provide additional protection to their buildings and contents. The design, installation and specification of these systems are described in BS EN 62305. The standard is comprised of multiple sections and primarily consists of a design risk assessment and design strategy.

Non-conventional lighting protection systems such as those that utilise Early Streamer Emission (ESE) principles have not been considered as these devices are contentious and have previously been rejected by the Trust's insurers.

Max Fordham LLP have undertaken an independent risk assessment and have produced a preliminary design proposal for review, fully compliant with BS EN 62305.

Lacock Abbey has never been protected by any LPS system and as such any new system will require interventions to be made to the building and its fabric. Minimising these interventions and maintaining a visually acceptable solution will be required in order to meet the various constraints.

The initial design provided with the report presents options in some areas, for which we will require confirmation of the best way to proceed, or if certain areas of LPS should in fact be omitted entirely in order to preserve the historic appearance of the existing building. These may represent a deviation from the British Standard and would need agreement from the insurers.

2.0 LPS RISK ASSESSMENT

A risk assessment has been undertaken for the main sections of the Lacock Abbey building in accordance with the methodology set out in BS EN 62305-2:2012.

The results of the assessment are presented in the adjacent table. Two different classes are possible (i.e. a lower class of protection can be used on the southern half of the Abbey) due to the location of a fire resistant line within the building, and the location of the sleeping quarters.

The location of this line in the East wing has been taken from the March 2015 Fire Risk Assessment report, and subsequent alterations to the fire lines with the incorporation of the tea rooms at ground level that have been indicated by the Trust.

The National Trust has indicated that space 53 (to the right, just below the red line) is occasionally occupied. However, this lies just outside the northern fire compartment line. This would mean the entire SW wing would also need to be included in Risk class II if this area is assumed as lived in. For the purpose of this design, it is assumed the frequency of occupation is minimal and can be managed, as a proportional response instead of increasing the LPS class required.

Area	Risk Class	Rolling Sphere Radius (m)	Mesh/Grid Spacing (m) x (m)	Zone of Protection[1]	Down Conductor Spacing[2]
North	**II**	30	10 x 10	15	10
South	**IV**	60	20 x 20	24	20

Table 1 – Lightning Protection Risk Classification and Protection Requirements

The LPS class for Lacock Abbey was found to be primarily influenced by four main elements of the building:

- number of occupied hours
- fire load
- panic factor
- fire extinguishing measures

Of these four values, the most significant driver of the class of LPS is associated with the loss of life, and hence the number of occupied hours plays a large role in the resultant risk to life. Due to Lacock Abbey housing several sleeping quarters, these areas of the building (i.e. the Courtyard to the North) must be assumed as occupied 24 hours a day. However, due to the fire line, the building can be split into 2 separate zones (i.e. homogeneous areas) which house the sleeping quarters (where occupied hours must be assumed as 24 hours per day) and those which do not (for which a lower assumption of 8 hours per day can be assumed).

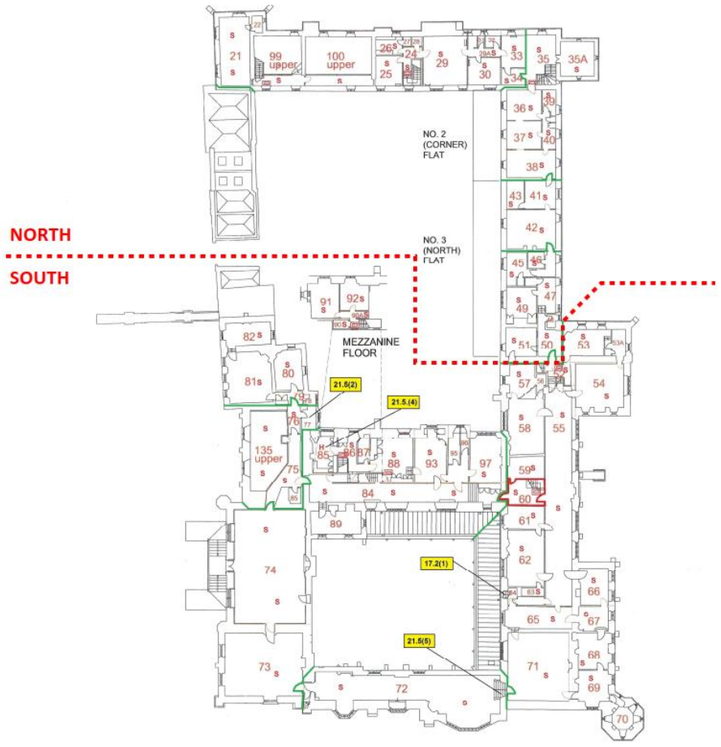

Figure 1 - Location of North/South split in LPS classes (first floor level)

The values used in the risk assessment calculation are derived from tables in the BS. These have been agreed with the Client. The resultant risk for each zone is then added to calculate the risk for the whole building. The class of LPS is then chosen to reduce the total risk to acceptable, predefined values.

The assessment puts relatively little emphasis on the economic value of the building and contents. If there were an estimate of the value of the building and contents, we could better assess this, but as this value is probably subjective with many items being considered irreplaceable the risk assessment is quite poor at considering this.

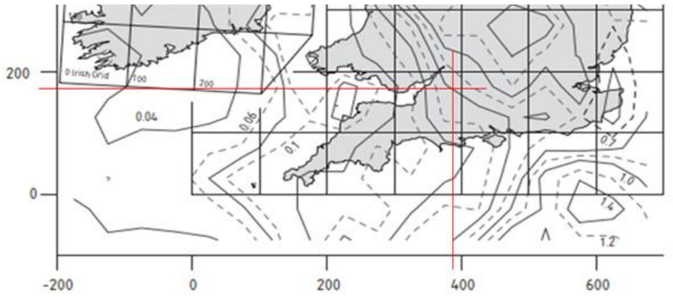

Figure 2 - Lightning Flash Density Map from BS EN 62305-2:2012

[2] The Zone of Protection is the area around the LPS that is considered to be protected by the system. The distance noted is at a height of 5m above ground level and is an amalgamation of the rolling sphere and protection angle methods.

[3] The BS acknowledges that it may not be practical to stick to the exact spacing's and makes allowance for the distance between down conductors to be increased up to 20% of the value **but** the average spacing for the class must be maintained.

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3.0 MATERAILS & FIXINGS

There are a number of Lightning protection equipment manufacturers that include Furse, AN Wallis and Dehn. Their ranges whilst similar in many aspects provide a number of alternative fixing and installation methods.

3.1 Air Termination Network

The Air Termination Network (ATR) is the point of connection for a lightning strike and typically consists of a meshed conductor arrangement covering the roof of the building. It is in turn linked to down conductors located at the corners/changes of direction of the façade.

The Air termination network can be run in copper or aluminium as flat 3mm x 25mm insulated or uninsulated 'tape' conductor or as ø8mm insulated or uninsulated circular conductor.

Where suitable metallic roof finishes re present these can be utilised in place of the tape providing, they comply with some relevant material thickness and separation requirements set out in BS EN 62305.

Conditions specific to Lacock
There are a number of features at roof level that will be tricky to protect and keep concealed. These include:

- Decorative Chimneys of which there are various designs used around the property
- Decorative gargoyles / Stone statues.

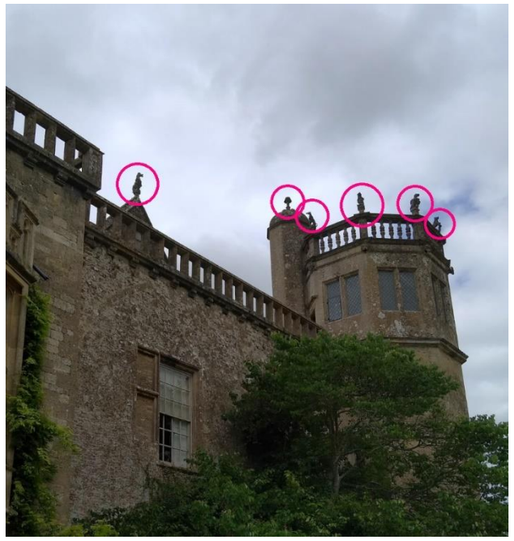


Figure 3 - Stone Roof Statues

It has been agreed with the national trust that the visual intrusion that would be imposed to protect these individually or via a Final to utilise the rolling sphere when compared to the low height and relative same increase in risk of these elements sitting above the ATN is acceptable to leave them without any additional protection.

3.2 Roof Level Fixings

With regards to the fixing methodology of

In a heritage setting there is no single fixing method that will be employed the Air Termination Network (ATN) at roof level throughout as the roof finishes are rarely homogeneous and unless re-roofing works are coordinated with the LPS install there is usually no intention to remove roof finishes to install.

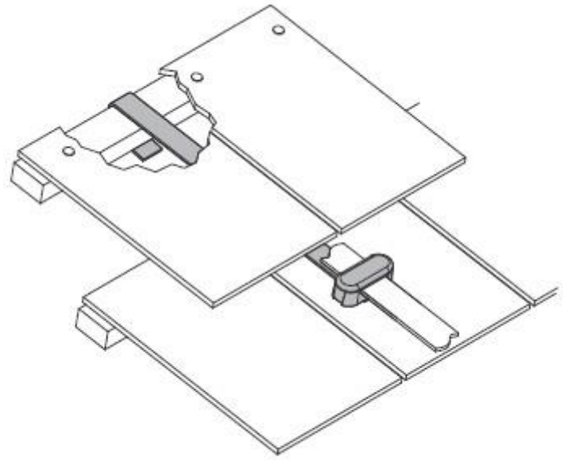
Mechanical fixing is the preferred method as it provides longevity, but it is trickier to install without removing all the tiles or in the case of leaded areas allowing hot works to be undertaken on the building.

In tiled or areas of slate roof Mechanical fastenings are never directly installed onto the tiles and if direct fixing is required then this will be a polymer-based solution.

Fixing intervals vary but are generally in the 600-1200mm range depending on contouring and/or flatness of the surface along which the ATN is running and fixed.

Hold Fasts
Slate/Tile hold fasts are the preferred method for fixing the ATN across tiled sections of roof. These can sometimes be installed without having to remove tiles or with only very localised removal of tiles/slates. These are the preferred method for fixing the ATN as it provides longevity and requires no fixing to the tiles/slates directly.

The detail below shows and exploded/cut away view of a hold fast installation.



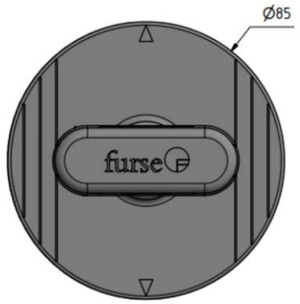
Lead Straps/Saddles
Where there are sections of lead covered roof it is possible to 'burn' on lead straps in order to mechanically fix the ATN in place. However, unless this is done as part of lead replacement works it requires hot works in situ on the building and in a heritage setting hot works on the building itself are usually reserved for emergency repairs only and are strictly monitored.

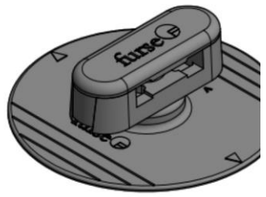
If lead strap fixing is utilised, then the ATN it is more common for the ATN to be copper in this instance as it mitigates any risk associated with bimetallic corrosion which is more of a concern where aluminium and lead are in contact with each other.

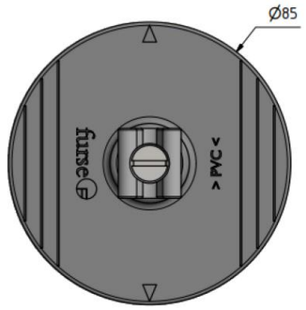
Glue Downs
On areas where it is not possible to utilise 'hold fast' fixings the alternative is to bond to the tiles using an adhesive and a glue down ATN conductor holder as seen in the following images the first image is of a flat tape holder the second is of a circular conductor holder.

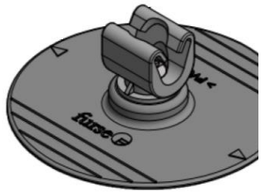
Glue downs can be used on many surfaces including flashed roof covering and other flat roof installation membranes etc.

When utilising glue downs the condition of the substrate has a huge impact on the adhesion and the life of the bond. On new virgin surfaces this is much better but in historic settings where the surfaces have been subject to weathering for some considerable time these bonds don't tend to last as long as expected.









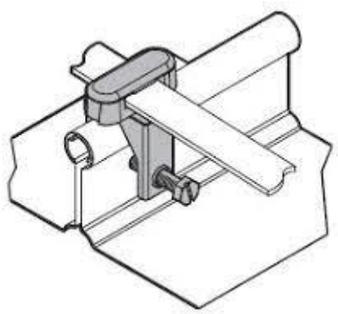
Strike/Interceptor Plates
The terms ‘strike plate’ or ‘interceptor plate’ can be slightly misleading. To those unfamiliar with LPS installations. It is used to refer to an element of the ATN that has been specifically exposed and/or positioned to try and intercept a strike.

In the case of concealed tape installations (i.e. run below the roof covering) the strike plate has a marginally lower resistance than part of the ATN that are concealed and is installed in order to minimise a strike flashing through the surface finish and causing damage.

In most cases the concealed conductor would be tape purely because it is flat and can be routed through the roof build up easier. In many instances a section of tape is left protruding and is finished with a 50mm x 50mm clamp being installed on the end of a 25mmx 3mm flat tape as the following detail.

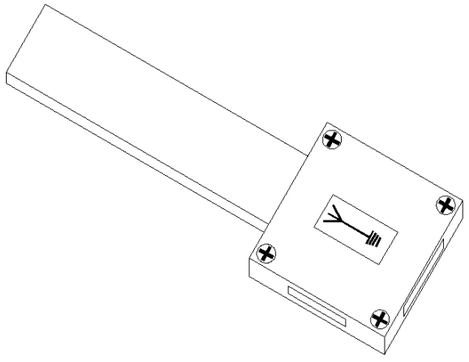
Bu they can be slightly more elaborate/custom to the project as can be seen in the proposed sketch detail for the Ickworth house project re produced below.

Standing Seam Fixing
Where there are areas of standing seam roof there is a specific standing seam clamp fixing that is employed.

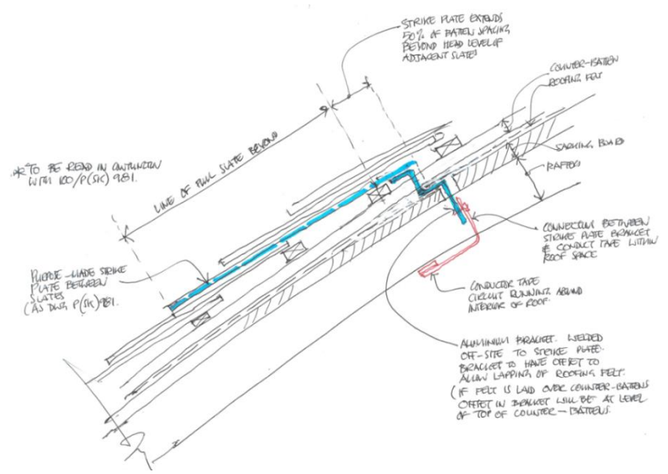


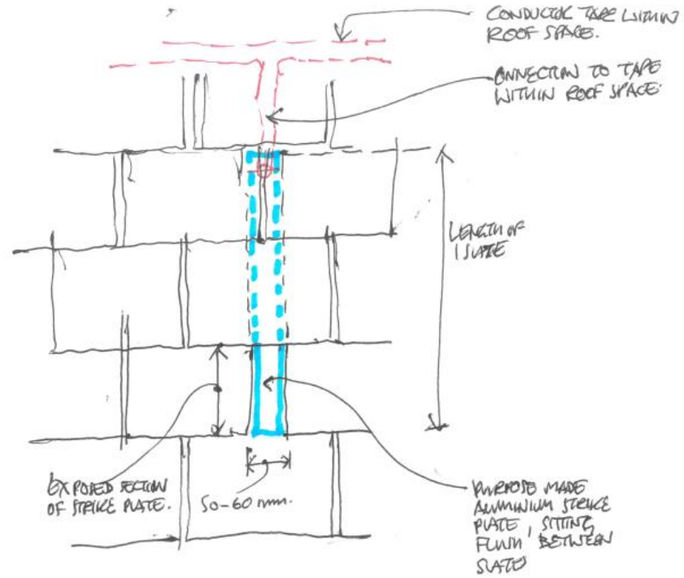






Bu they can be slightly more elaborate/custom to the project if required and this can be seen in the proposed sketch detail for the Ickworth house project re produced below for reference.





PLAN OF SEATING SHOWING STRIKE PLATE.
(NOT-TO-SCALE.)

Ridge Conductor
Where roofs are pitched and the conductor needs to run along the ride as the highest point but there is no re-roofing works taking place to conceal a

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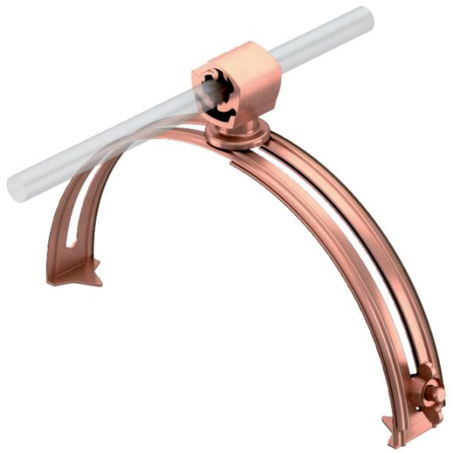
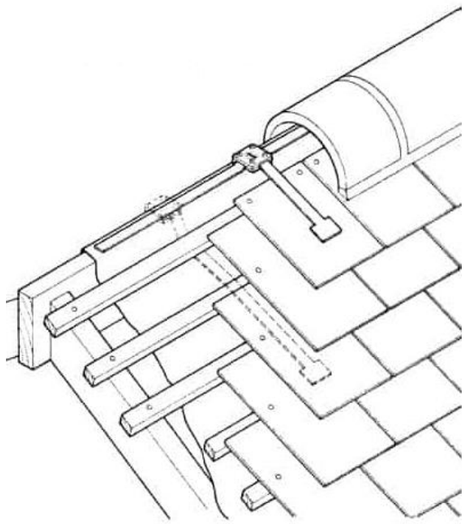
conductor under the ridge tile a ridge clamp is used to secure the ridge conductor in place.



During any future re-roofing works that would allow for the concealment of the ridge conductor (and the installation generally) the ridge conductor can be run under the ridge tile as shown in the following diagram with interceptor plates run out through the mortar joints at intervals to provide the exposed elements of the ATN



Finials

Finials are a vertical conductive rod that offers a localised zone of protection as a cone from the top of the rod. They can be utilised to provide local protection to particular feature or to provide and extended area of coverage to areas where there is a taller structure (e.g. a chimney) that increases the zone of protection and minimizes the need to run taps to all areas. This is the method historically employed on church spires.



Figure 4 - Ornate Chimney Details

The finals provide protection by ensuring that the rolling sphere of protection does not come into contact with the dome by having finals at the upper balustrade level and the parapet gutter associated with the lower corona of the dome.

The finials could be employed to protect any of the details that cannot be protected within the rolling sphere by any other method.

4.0 Chimney Installation

Chimneys form the highest part of most roof areas and as such require protection as they will sit out of the area of the ATN protecting the roof itself. Where a chimney or other tall roof structure sits significantly higher than the surrounding area roof, they can be used to provide relative protection to the area surrounding them and minimise the amount of ATN required in the area.

There are a few ways to protect a chimney. In most instances they are protected by running a conductor up the least visible/visually intrusive side of the breast. At the top the conductor wraps over the top edge of the chimney and is fitted with a 50mm x 50mm strike plate fixed to the top edge. Ideally this would be mechanically fixed to prevent the chance of it lifting in the future but depending on the substrate a glue down may have to be utilised in this location.

An alternative installation is to use a short finial that would be mounted on a small bracket located on the side of the chimney. Unless there is an intention to protect any greater area from the position the finial need not extend much higher than the tallest part of the chimney.

4.1 Down Conductors

The Down Conductors are used in a LPS to transmit the lightning strike from the Air Termination Network to the Earth Termination Network. Typically, down conductors are installed at corners of buildings or on the façade if the length exceeds the maximum distance set out by the class of system. There is some tolerance allowed on the spacing that can be applied to keep the down conductors hidden by facade detailing or placing adjacent to rainwater pipes. Lighting Conductors are available in two standard profiles:

- 8mm Circular conductor (approx. 10m overall with a PVC insulating sheath)
- 25mm x 3mm ‘Flat Tape’ (approx. 27 x 5mm overall with PVC insulating sheath)

There is no benefit of one system over another and they are typically selected based on the aesthetics of the installation.

The conductors are manufactured in a range of standard colours in accordance with Figure 3.

Conductor colour chart

Colour	Standard
Black	18B29*
Green	BS 6746C
Grey	00A07*
Stone	08B23*
White	10B15*
Brown	06C39*

*PVC colours to BS 5252

Figure 5 – Standard Tape Insulation Colours

Although custom colours can be manufactured Furse (a leading LPS manufacturer) have indicated that in their experience the quantities that would be required for typical sizes of jobs make the cost for this option prohibitive.

In addition to the high cost barrier, it is also noted that it is unlikely that a single custom colour would address the issue due to the weathering, various ages, materials, exposure and quality of the material around one building, make it difficult to find a single colour which blends with the entire building

Generally flat tape is considered easier to install and is used on installations where the aesthetic of the final installation is of less concern. It can be slightly more visible than the circular conductor but due to its profile it can be easier to install in straight vertical/horizontal lines.

Circular conductor is slightly more difficult to install and by the nature of its profile can be more difficult to install in 'true' vertical/horizontal lines. But because of its much smaller profile it is less visible than tape conductor. It can be profiled to match façade detailing which helps make it more discreet. The downside is it require more time and care to install. Straightening tools are used to straighten out the conductor as it is supplied as a coil. Post-tensioned copper cable can also be used; however, this requires more substantial fastenings to implement.

In a heritage setting where profiling to match the façade detailing is important circular conductor will be the method of choice. The use of aluminium conductor makes it easier to cold work the conductor to match profiling without having to impart any force on the substrate which, being the building façade, is undesirable.

The image below from Test Strike UK Ltd is a good example of discrete profiling of down conductors.

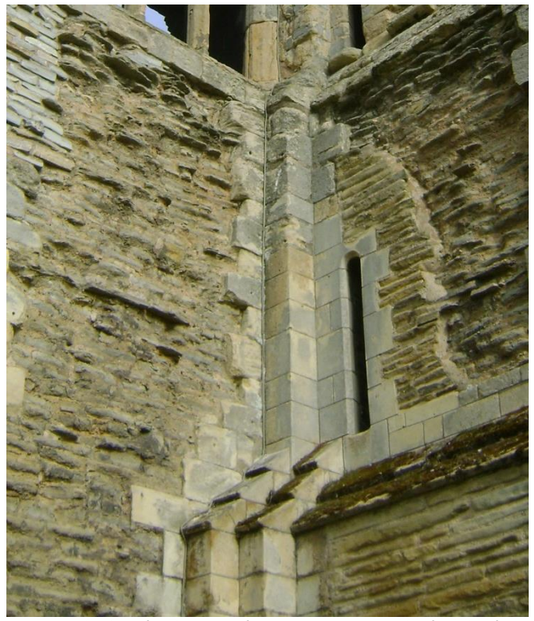


Figure 6 – Circular Down conductor in corner – Test Strike UK Ltd

The final selection of he down conductor profile and material will be determined with the NTs representatives following a discussion with the property manager, building surveyor and NT heritage advisors.



Figure 7 - External facing corner condition example at Lacock Abbey

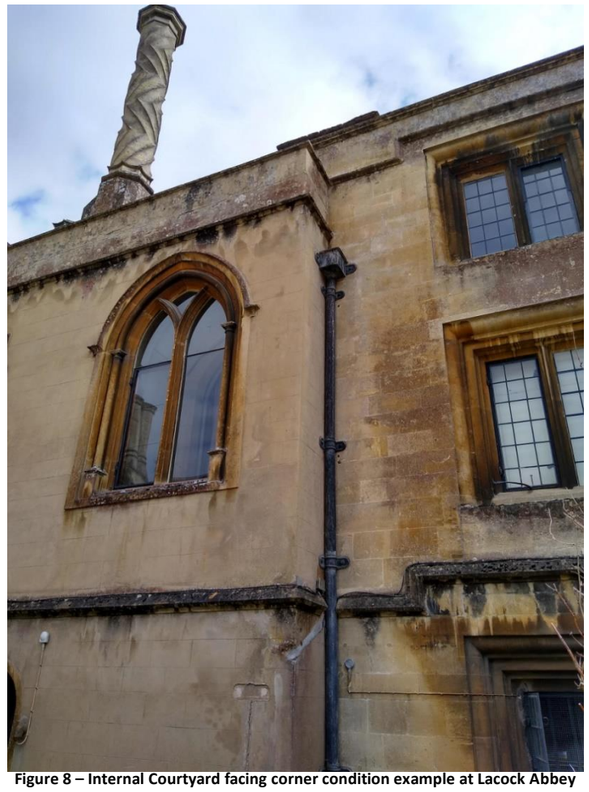


Figure 8 – Internal Courtyard facing corner condition example at Lacock Abbey

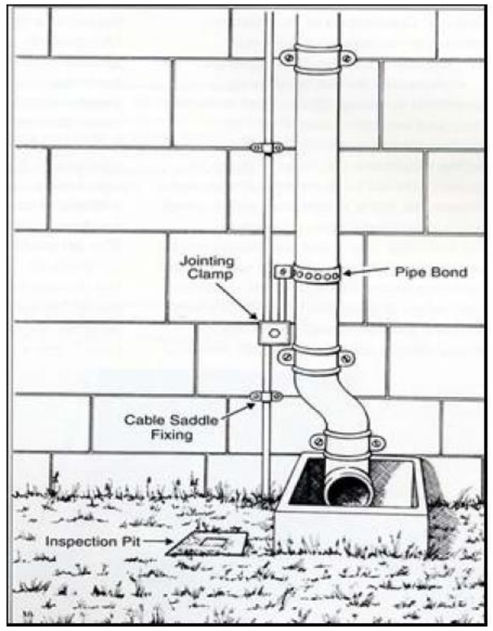
5.0 Wall/Down Conductor fixing

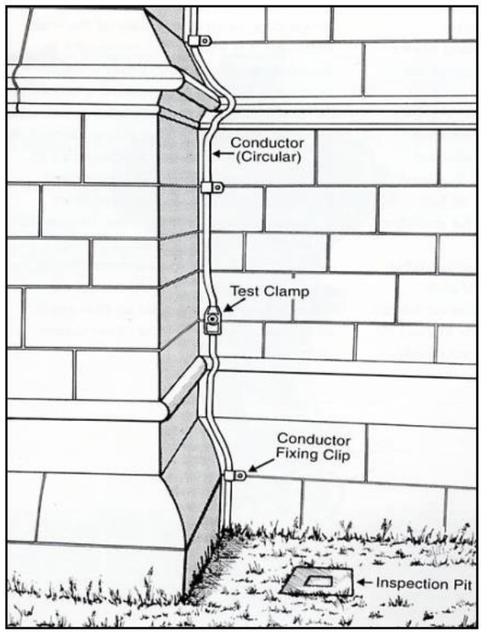
In a heritage setting it is more typical to utilise round/circular conductor for the drops. These tend to be sheathed or unsheathed aluminium over copper as it is much easier to cold work aluminium to achieve and desired contouring and to get the conductor tight into corners. Copper requires more force in order to shape and no force should ever be imparted on the building face, detailing or finishes in order to achieve the contoured profiling so it is generally avoided. If, however, plumb lines are possible and there are other copper features it can sit well within those settings.

In order to get tight fixing to the surface and reduce the overall visual impact of the installation plastic 'push in' clips as those produced by A N Wallis, and sometimes referred to as 'coffin clips' by installers, are utilised along with stainless steel fastenings to minimise any potential surface marking that could result from oxidisation of the fixing over time.



In order to minimise any unnecessary damage to original features, particularly stone and historic brickwork the fixing should be made in material joints as it is simpler to make these good if ever required. There are some useful illustrations of a neat installation showing the principles described above that are found in the Heritage England guidance document "*Lightning Protection For Churches: A guide to design and* installation" and these are reproduced below for reference as this is the level of workmanship that will be expected of the installer and will be required by our specification..

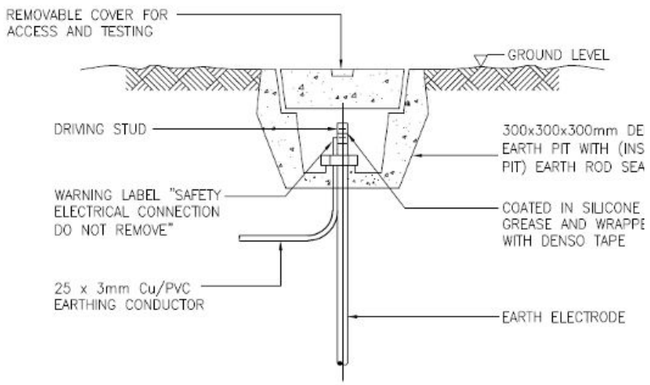




6.0 Earth Pit Installation

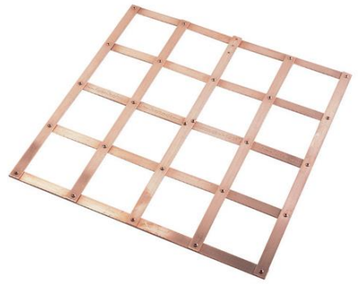
Earth electrodes will be installed at the base of each and every down conductor. These are most usually copper rods of 16mm diameterand are usually in the order of 2.5-4m in overall length. They are installed/drivien in sections and the next section coupled to the previous section to acehive the overall required length.

The exact depth cannot be confirmed until installtion as the length required is a function of the resistance but the rods will bea minimum of 2.4m. The earth pits usualy sit within a couple of metres of the face of the building and for Lacock assuming there is no obstructions and it can be coordinated with the grounds team in many cases these would be located in the perimeter beds. A typical section through an earth pit is shiwn in the following detail.



EARTHING PIT

If for any reason it is not possible to installed an earth rod due to obstructions in any location then a lattice earth mats as a 900 x 900 wide copper mesh would be installed Theese would not have inspection pits associated with them but they are wherever possilble to be avoided as they require much greater intervention to install.



Surge Protection
During a lightning strike the electrical current surges through the building from the point of contact to ground. Should one of the paths to ground pass through the electrical or IT systems the surge can disrupt or damage these systems. Whilst the external LPS, if designed and installed correctly, will act as a faraday cage shielding the installation from a direct strike, the buildings systems can still be damaged from an indirect strike to an incoming power or telecommunications line. These can be both aerial and below ground lines.

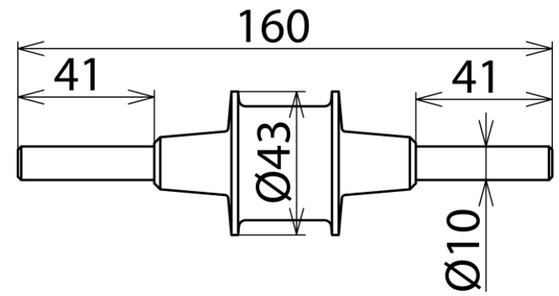
A surge protection device can be installed on the incoming service lines to protect the internal building systems. Typically, these devices are installed on the main distribution board only as the risk of telecommunication lines transmitting dangerous surges to the building is far lower than power lines.

Equipotential Bonding and Cross Flash
Equipotential bonding is where metallic building components and systems are electrically connected or bonded to a common earth. This is typically the main building earth bar and the LPS must be connected to this.

In addition, wherever the LPS components pass within a certain distance, known as the separation distance, of conductive building components these components must be bonded to the LPS. Normally this includes metallic gutters, downpipes, roofs and other metallic fixtures. The reason for this is to minimise the risk of dangerous cross flash whereby the lightning surge jumps from the LPS to a nearby conductive component potentially sparking a fire or physically damaging the building.

Spark Gaps
Spark Gaps are an arrangement of two conducting electrodes separated by a gap and are designed to allow for high voltage surges to safely discharge from two functionally isolated systems.





Where a building has two or more two incoming electrical supplies, the spark gaps are used to electrically isolate the individual areas unless a strike takes place. Under normal circumstances the systems will be completely electrically isolated from one another. However, in the event of an lightning strike there is a risk that the strike could dangerously jump from one LPS to the other, potentially sparking a fire or causing direct physical damage.

These would be employed if required to separate electrical supplies from the annex and the main house.

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7.0 TESTING AND MAINTENANCE

Testing and Maintenance Regime
LPS require regular testing and periodic maintenance to ensure safe and correct operation of the system. The testing regime for lightning protection systems is set out within the standards and the following clauses apply.

- *All lightning protection systems should be visually inspected by a competent person during installation after completion and after alteration or extension, in order to verify that they conform to the recommendations off this code. Visual inspections should be repeated at fixed intervals, preferably not exceeding 12 months.*

- *In addition, the mechanical condition of all conductors, bonds, joints and earth electrodes (Inc reference electrodes) should be checked and the observations noted and recorded.*

The following Isolated and combined measurements and or checks should be made, and the results recorded in a lightning protection system logbook.

- The resistance to earth of each electrode and in addition the resistance of the complete air termination system.
- Each local electrode should be measured in isolation with the test point between the down conductor and earth electrode in disconnected position (isolated measurement).

Earth Resistance Testing
Prior to installation and design of a LPS an earth resistance test needs to be carried out to enable the design of the Earth Termination Network.

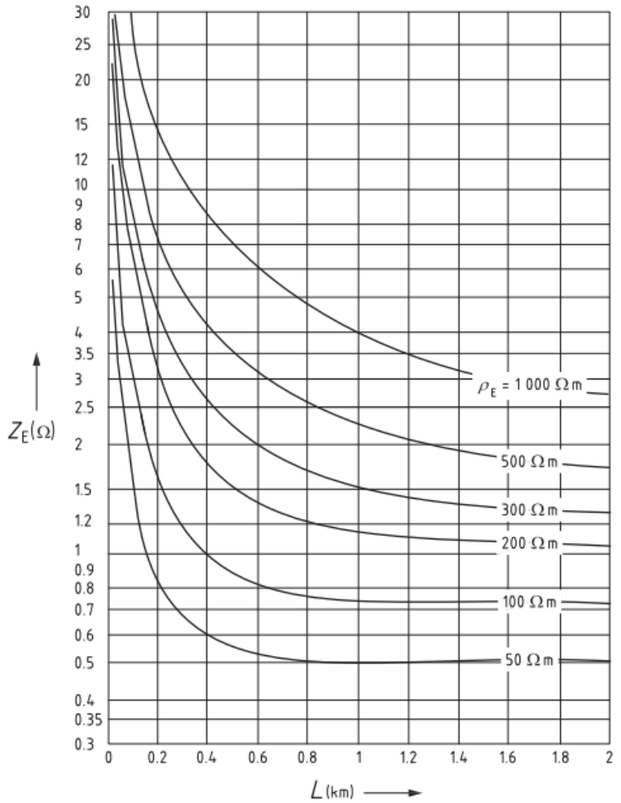
There are two applicable standards in relation to the resistance of a Lightning Protection System (LPS);

- BS EN 62561 - Protection Against Lighting
- BS 7430:2011 - Code of practice for protective earthing of electrical installations

BS EN 62561 - Protection against Lighting; requires earth resistance be measured using specialised equipment designed to so with accepted test methodologies. The total resistance of the earth termination system should not exceed 10 Ohms. But it does not define the methodology for this test to be carried out.

BS 7430:2011 - Code of practice for protective earthing of electrical installations; recommends the widely accepted test utilising the 4 probe Wenner method for determining the earth resistance. For the test to be valid the depth of each probe should not exceed 5% of the separation distance.

Soil resistivity varies with depth to approximately the figure below (reproduced from BS7430.



A lower resistance is achieved by driving the earth rod deeper but with decreasing effectiveness. To further reduce the earth resistance additional rods must be driven. Therefore, an efficient earth termination system will balance both earth rod depth and quantity.

Soil resistivity is affected by soil type, moisture content, temperature and buried services or natural geological features. All of these factors can vary significantly with both depth and distance. As the test method requires that the probe depth be no deeper than 5% of the separation distance, deeper probes require larger test areas and will be more susceptible to the variability of the ground conditions as they cover larger areas.

Such a survey should be commissioned prior to finalisation of the design, in order to confirm the soil resistivity values on which the Risk Assessment outputs are currently based.

8.0 PRESENTATION OF DESIGN

The drawings provided in Appendix A represent the current design proposal for comment and agreement by the Client and their insurers.

The design is an optimised but not a fully compliant BS EN 62305 design as there are a number of issues that make a dogmatic following of the standard inappropriate for the solution at Lacock Abbey. These include:

- visually obtrusive down conductor routes.
- air termination tape runs to numerous historic stonework chimneys and other artistic masonry.

As part of the design process these have been considered in detail to ensure that the most appropriate compromise between technical issues and the aesthetic and heritage considerations have been reached. Any deviations from the BS are noted on the design drawings.

Architectural and Heritage Considerations
Air terminations, earth pits, test links and joints between all parts of the LPS require annual visual inspection.

Visual Inspection can be carried out from roof level or remotely using drones or other high pol mounted inspection equipment.

Typically, the new LPS components run completely external and exposed as there is no planned remedial works to the roof and disturbing the roof finish to either conceal the tape or to provide secure mechanical fixing for the exposed tape is likely to generate more problems than it will solve.

We would suggest that in the future the routes could be concealed, or mechanical fixing added to support exposed tapes. If the tapes are concealed, then as part of these works Interceptor plates would be added at the required intervals to provide the required exposed strike point for the lighting.

Minimising the visual impact of down conductors ins a setting such as Lacock Abbey is of prime importance and as such down conductors are to be masked by installing tight into corners, run adjacent to existing rain water down pipes and the sheath colour matched to suit wherever possible, or behind and shrubbery. Indicative Down conductor routes for some typical conditions can be found in the appendix as SK-W[52]20191211-1 and SK-W[52]20191211-1.

The approach to the highest turrets may need to be different, and the Client should confirm if the main concern is the tape being visible to visitors, or at high level from aerial filming. The approach regarding the LPS design can be tailored to suit.

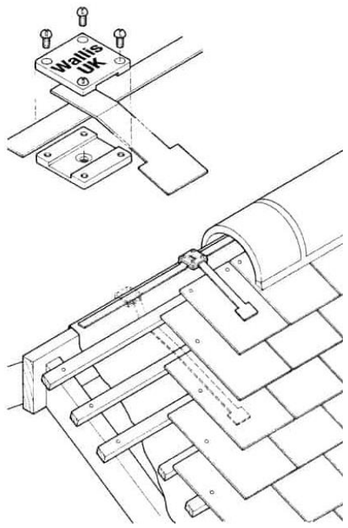


Figure 9 - Concealed Roof Tape with interceptor plate

Earth Pit Locations
Where basement areas would make it difficult to drive earth rods horizontal interconnected earth tape or mesh installations will be utilised. In other areas earth pits will be offset to avoid below ground services.

Access and Working at Height Considerations
Access will be required to roof level to review the potential routes to some of the high points. This will either need to be carried out be a Steeple Jack or potentially via a drone survey.

Future inspection of the roof level installation could be carried out a similar way or with other remote reviewing equipment as the building is not greater than two storeys with chimney projections.

It is our understanding that the existing latchway/restraint system is not safe and as such the client must make any potential surveyors and/or specialist aware of this when they visit site.

Down Conductors & Earth Pits
A detailed survey of the down conductor positions will be undertaken and scheduled as part of the design development following review of the initial report and drawings by the client.

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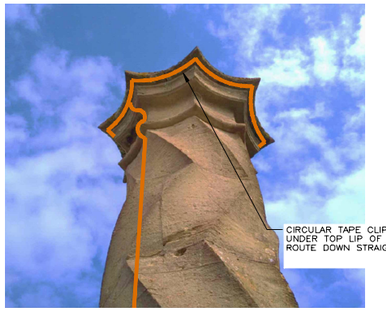
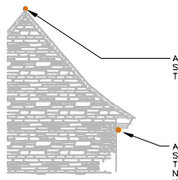
9.0 APPENDIX A – LPS DRAWINGS

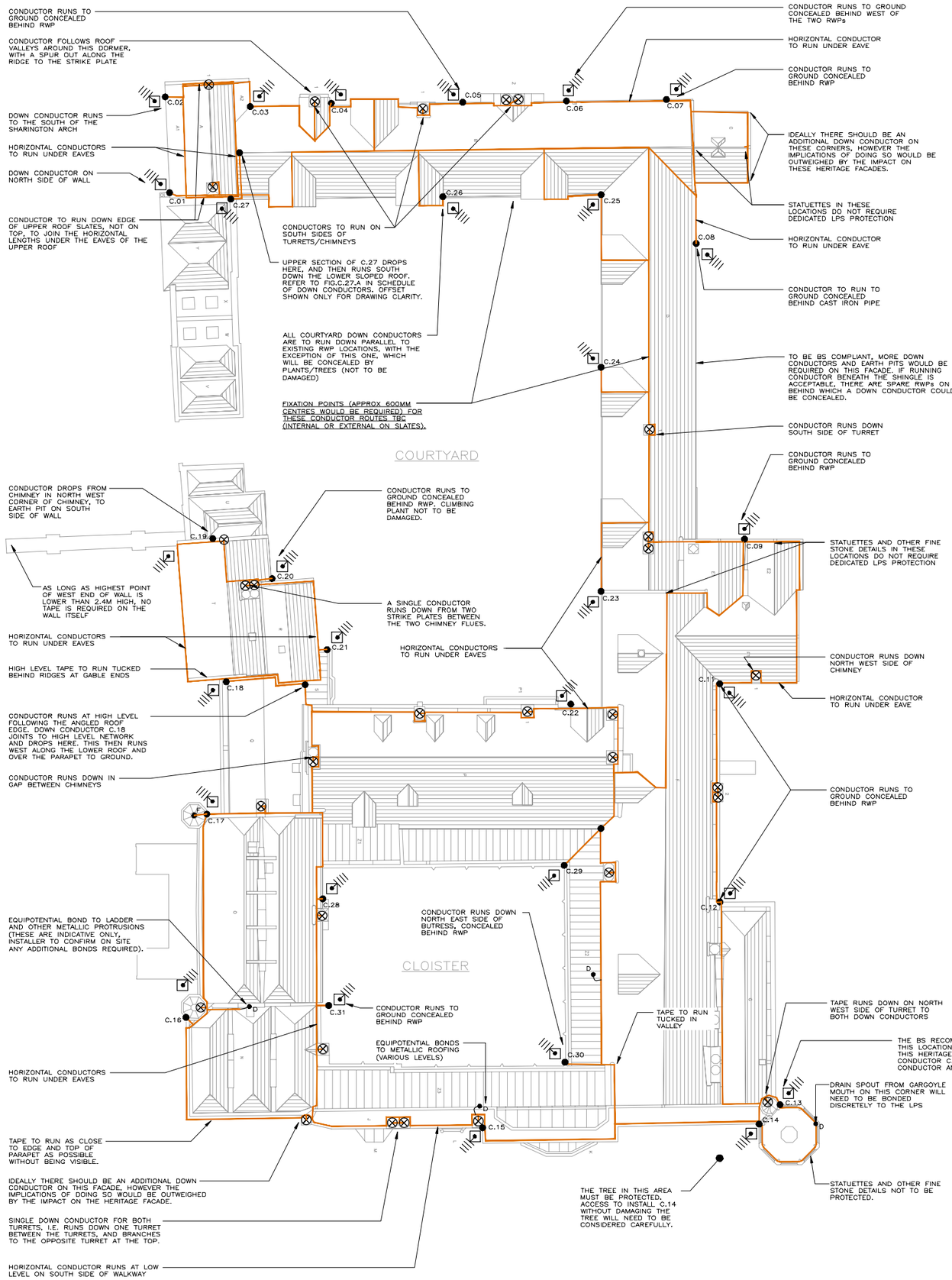
DETAIL A – BESPOKE TAPE DETAIL TO CHIMNEY
(NOT VISIBLE FROM ABOVE)



ALTERNATIVE OPTIONS COULD BE:
- A STRIKE PLATE TO THE TOP OF THE CHIMNEY (NOT VISIBLE FROM BELOW)
- OMIT PROTECTION TO THE CHIMNEYS IN ORDER TO PRESERVE EXISTING APPEARANCE. WOULD NEED AGREEMENT FROM INSURERS.

DETAIL B – HORIZONTAL TAPE RUN OPTIONS





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job title
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LIGHTNING PROTECTION

project leader	date	scale (at A1)
AJS	NOV '19	1:200

drawing title
PRELIMINARY DESIGN
ROOF LAYOUT

job no	dwg no	rev
J6666	W[52]100	/A

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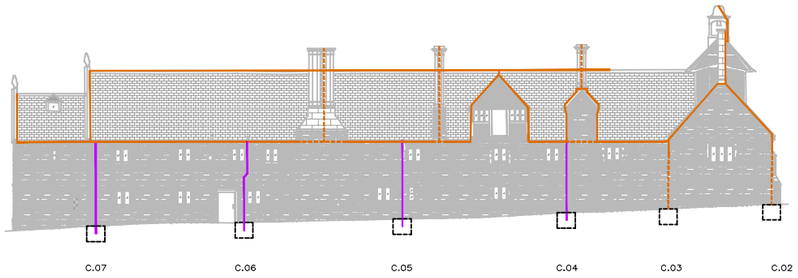
NORTH ELEVATION



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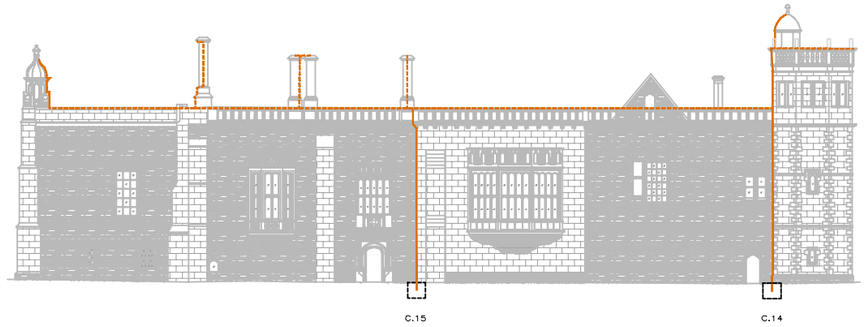

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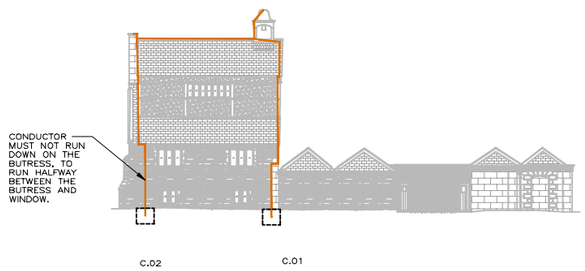
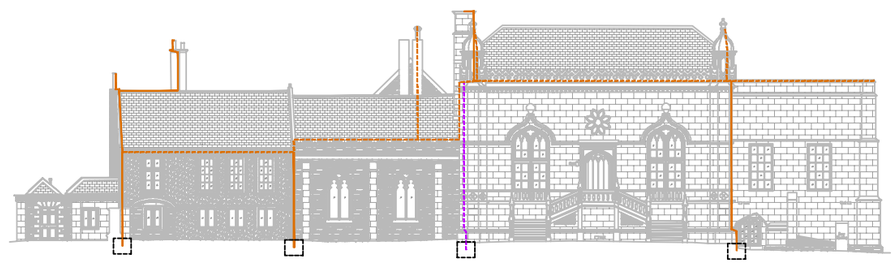
WEST ELEVATION





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PRELIMINARY DESIGN
OUTER FACADE ELEVATIONS

job no	dwg no	rev
J6666	W[52]200	/A

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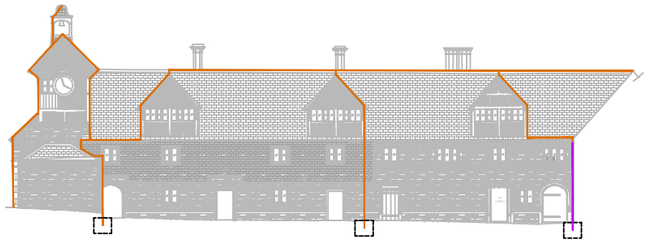
COURTYARD – NORTH ELEVATION



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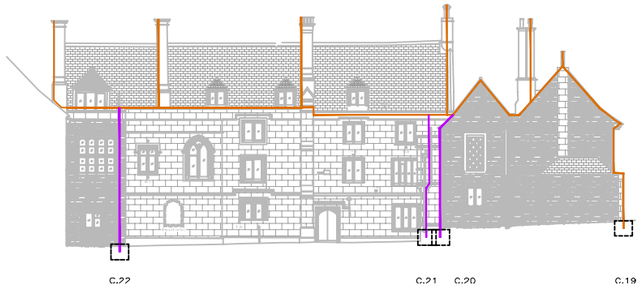

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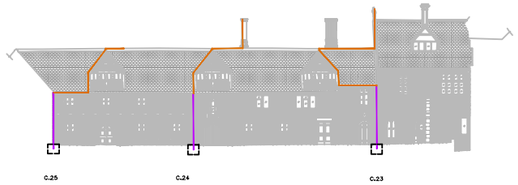
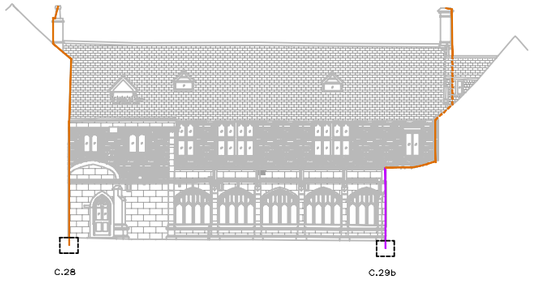


COURTYARD – WEST ELEVATION



CLOISTER – NORTH ELEVATION



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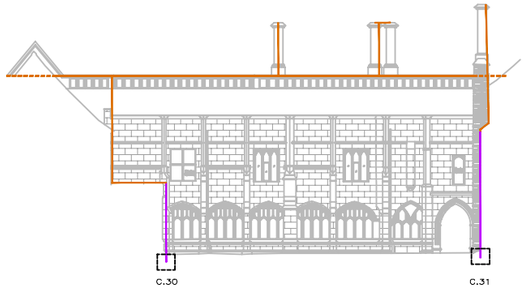

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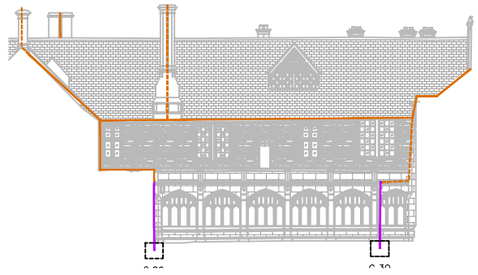

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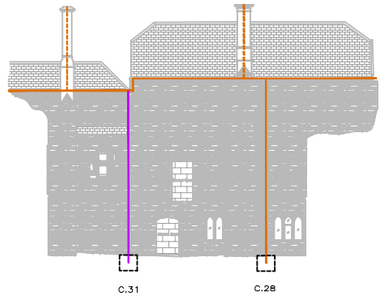

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PRELIMINARY DESIGN
COURTYARD/CLOISTER FACADE
ELEVATIONS

job no	dwg no	rev
J6666	W[52]000	/A

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10.0 APPNEDIX B – PRELIMINARY ELEVATION MARKUPS

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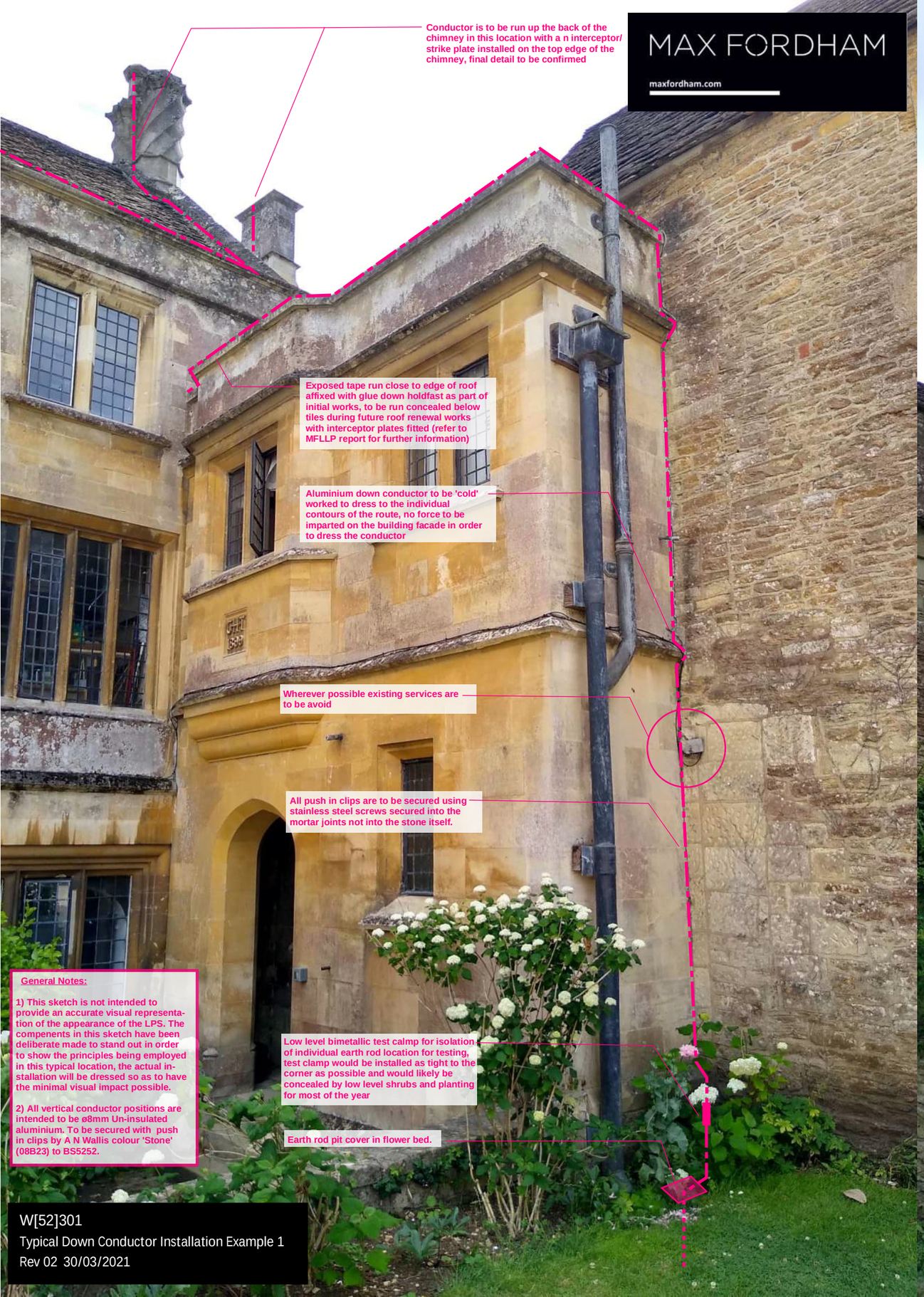

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1) This sketch is not intended to provide an accurate visual representation of the appearance of the LPS. The compenents in this sketch have been deliberate made to stand out in order to show the principles being employed in this typical location, the actual installation will be dressed so as to have the minimal visual impact possible.

2) All vertical conductor positions are intended to be ø8mm Un-insulated aluminium. To be secured with push in clips by A N Wallis colour 'Stone' (08B23) to BS5252.

W[52]301

Typical Down Conductor Installation Example 1

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General Notes:

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W[52]302

Typical Down Conductor Installation Example 2

Rev 02 30/03/2021

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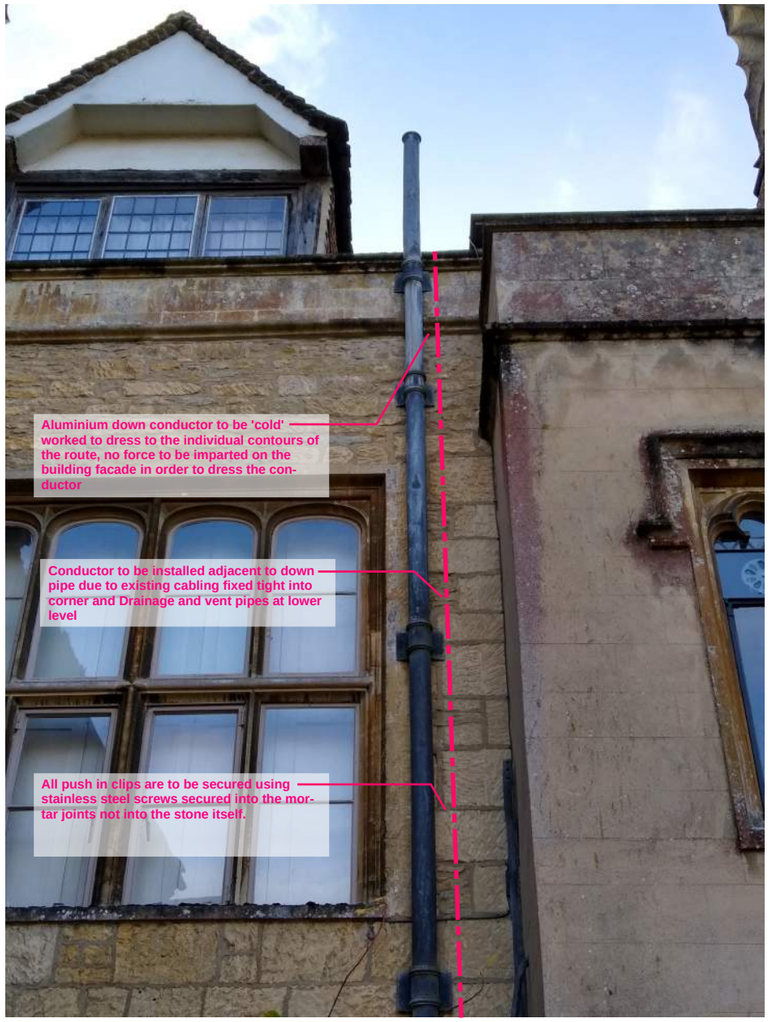
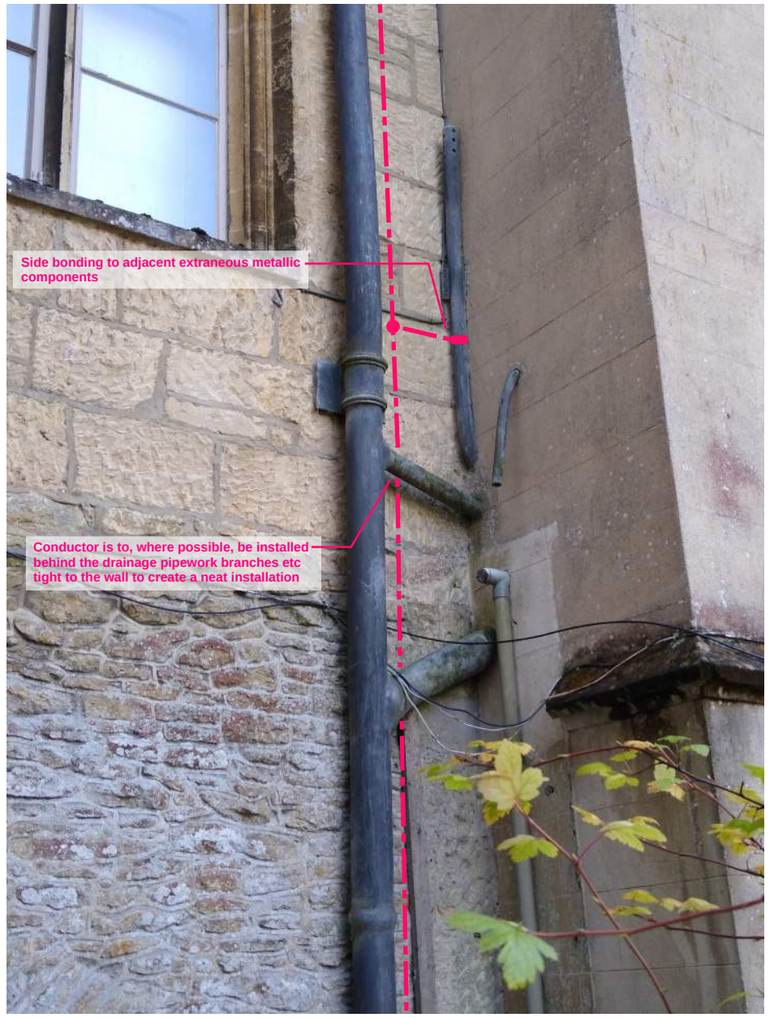
1) This sketch is not intended to provide an accurate visual representation of the appearance of the LPS. The compenents in this sketch have been deliberate made to stand out in order to show the principles being employed in this typical location, the actual installation will be dressed so as to have the minimal visual impact possible.

2) All vertical conductor positions are intended to be ø8mm Un-insulated aluminium. To be secured with push in clips by A N Wallis colour 'Stone' (08B23) to BS5252.







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W[52]303

Typical Down Conductor Installation Example 3

Rev 01 30/03/2021

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11.0 APPENDIX C – SCHEDULE OF DOWN CONDUCTOR POSITIONS

Lacock Abbey Lightning Protection - Schedule of Down Conductors

This report details the proposed down conductor routes. The positions are set out in the Max Fordham LLP drawings W[52]100, 200 and 201, with which this schedule should be read.
These drawings indicate the positions of the referenced down conductors, earth pits and conductor routes.
This site inspection was carried out on 08/12/20.

Material Notes

1	Material	1 ø8mm Aluminium Conductor
2	Sheath	1 Stone (ø10mm OA)
3	Fixing Method	1 Wallis push-in clips secured using stainless steel screws for longevity, and slate hangers only where essential (refer to specification for workmanship clauses).

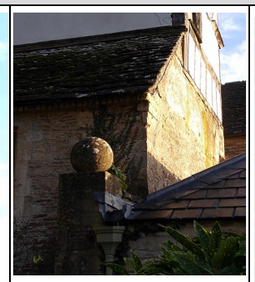
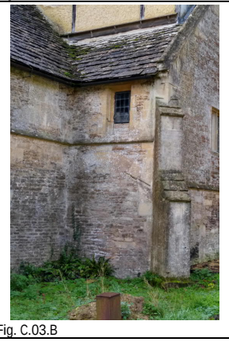
General notes for conductor routing

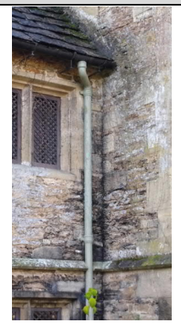
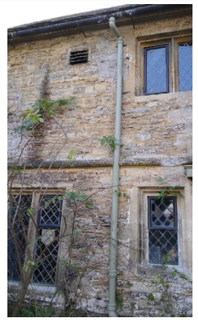
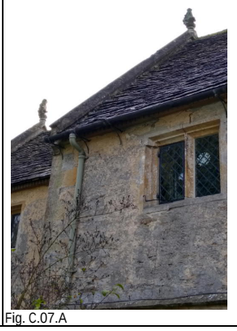
4 There is generally a high level of intricate contouring of the conductor required to get from the roof level down the building. No significant force must be applied to the existing historic fabric in order to dress the conductor.

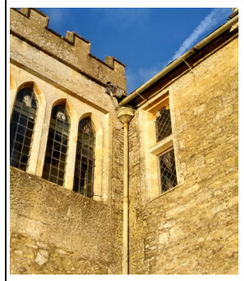
5 If spacing can permit then it is suggested that the historic rain water pipework (believed to be painted lead) Is left unbonded as it is unlikely to be electrically continuous and bonding each section will visually intrusive.

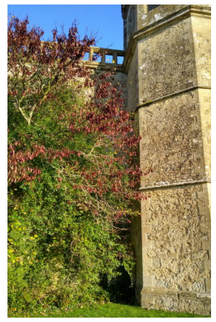
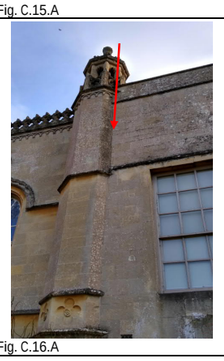
6 There are several proposed conductor routes, for which the exact dimensions of the structure are not known, and it cannot presently be confirmed that the necessary separation distance to avoid flashovers can be maintained (between the conductor and itself where a sharp turn is made). The Contractor will need set out the minimum separation distance to be maintained once the risk assessment has been finalised, and confirm all conductor routes obey this. Any changes require to the routes proposed below will need to be discussed with MFLLP and the Client before proceeding.

7 Method by which conductor tape should be affixed to the fragile roof slates is to be agreed with Client and Contractor on site.The existing slate/shingle finish on multiple roof areas is not do be disturbed or damaged in any way. Moving or using the slates as fixation points for any elements of the LPS installation should be avoided unless no other external route is possible. Any areas of doubt should first be confirmed with the Client and MFLLP beforehand. Internal routes are to be avoided.

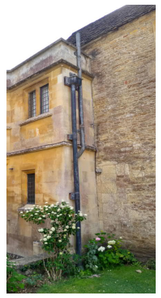
Ref.	Material *(Note 1)*	Sheath/ Colour *(Note 2)*	Fixing Method *(Note 3)*	Down conductor route description and obstructions	Earth pit notes	Images
C.01	1	None	1	Conductor shall run from a high level strike plate on the north side of the angled roof of the belltower, down the north side of one leg of the tower to the internal floor of the bell tower. From here conductor shall run on top of the slates and run over the eave at the SW corner. Conductor will then run down fixed externally along the SW corner of the building to the southernmost edge of lower slate roof area. The conductor must then route at the underside of the slates on the south edge, so as not to disturb or require affixing to the existing slates. One it reaches the western facade, it shall run down the external face of the building, then down the corner on the north side of the feature wall to the earth pit.	Some vegetation, no obstructions or other services noted at time of inspection.	 Fig. C.01.A  Fig. C.01.B  Fig. C.01.C  Fig. C.01.D
C.02	1	None	1	Conductor shall route from high level strike plate/conductor loop (best method TBC by Contractor once high level access is established) and down the recess of the SW corner of the chimney to the lower slated roof, jointing on the way with the horizontal loop running around the underside of the eaves and edges of the upper slate roof section. At the top of the lower slate roof, the conductor shall run affixed to the southern side of the small stone ridge at the north edge of the roof, down the west side, and run over the eave (see note 6). The conductor shall then run horizontally southward for a short distance, such that the vertical run down to ground level occurs approximately halfway between the buttress and the window. The conductor must not run on the buttress. Damage to the buttress must be avoided as this is a historically significant architectural feature.	Some vegetation, no obstructions or other services noted at time of inspection.	 Fig. C.02.A  Fig. C.02.B
C.03	1	None	1	Similar to C.03 - the conductor shall run down from the chimney air termination (TBC by Contractor), down the NE recessed corner of the chimney, jointing to the horizontal loop FROMunder the eaves of the upper slate roof section. At the top of the lower slate roof section, the conductor shall run fixed to the southern side of the small stone ridge at the north edge of the roof down to the lower east eave. The conductor shall then run over the eave (see note 6), turn immediately southwards to run horizontally tucked under the eave, and drop on the convex corner, away from the butress. Conductor shall run down dressed neatly against the brickwork of the ground level, matching any contours in the facade surface, to the earth pit.	Some vegetation, no obstructions or other services noted at time of inspection.	 Fig. C.03.A  Fig. C.03.B

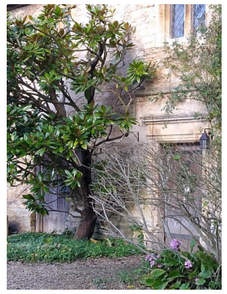
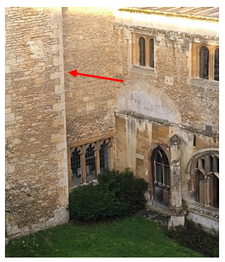
Ref.	Material (Note 1)	Sheath/ Colour (Note 2)	Fixing Method (Note 3)	Down conductor route description and obstructions	Earth pit notes	Images				
C.04	1	None	1	Refer to layout for the route of the horizontal conductor network around this dormer. Conductor shall run from strike plate vertically down the south side of the turret. Then running south along the roof ridge. Conductor to then run down each valley from the rear of the dormer ridge, to the lower roof eave (see note 7). At the sides of the dormer, the conductor is to be fixed to the stone side of the dormer, not the slates if possible. From the east side of the dormer, a down conductor shall drop externally over the eave (see note 6) and be tucked neatly behind the west side of the RWP (see note 5). Conductor shall then run down alongside the RWP, being dressed neatly to follow the contour of the string course (Fig. C.04.B) and plinth course (C.04.C) into the earth pit.	Some vegetation, no obstructions or other services noted at time of inspection.	 Fig. C.04.A	 Fig. C.04.B	 Fig. C.04.C		
C.05	1	None	1	Down conductor joints from the horizontal network which will run concealed under the eave and will follow behind the west side of the RWP, dressed and fixed neatly to the stonework (see note 4). Conductor to be dressed to follow contours of the strike and plinth courses and stay recessed behind the RWP before entering the earth pit.	Some vegetation, no obstructions or other services noted at time of inspection.	 Fig. C.05.A	 Fig. C.05.B			
C.06	1	None	1	Down conductor joints from the horizontal network which will run concealed under the eave and will follow behind the west side of the western RWP in this area, dressed and fixed neatly to the stonework (see note 4). Conductor to be dressed to follow contours of the strike and plinth courses and stay recessed behind the RWP before entering the earth pit.	RWP terminates in private garden box. Below ground services in this area unknown. Care to be taken and trial hand-dug pits to investigate any existing service in the proposed pit location. Exact location of earth pit TBC with Client. Any work required to the concrete surround to the RWP pit are to be confirmed with Client.	 Fig. C.06.A	 Fig. C.06.B			
C.07	1	None	1	Down conductor joints from the horizontal network running beneath the eave. Over the ridge of the roof, the conductor is to be affixed to the side of the small stone ridge at the east gable end, rather than on top of the slates. Down conductor will continue to run down behind the west side of the RWP (see note 5), and will be dressed and fixed neatly to the stonework (see note 4). Conductor to be dressed to follow contours of the strike and plinth courses and stay recessed behind the RWP before entering the earth pit.	Some vegetation, no obstructions or other services noted at time of inspection.	 Fig. C.07.A	 Fig. C.07.B			

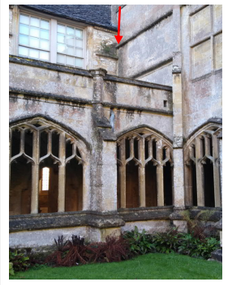
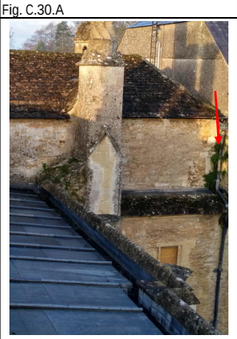
Ref.	Material *(Note 1)*	Sheath/ Colour *(Note 2)*	Fixing Method *(Note 3)*	Down conductor route description and obstructions	Earth pit notes	Images				
C.08	1	None	1	Horizontal conductor network runs out southwards under the lower eave of the east side of the east wing, and drops vertically to meet the existing cast iron pipe which exits the building at mid-wall. The conductor will then be tucked behind the north side of this pipe, and dressed neatly around the string course and any pipe supports.	The bottom of this pipe terminates in operational foul drain pit. The earth pit will need to be suitable distanced from this. Contractor to confirm exact location.	 Fig. C.08.A	 Fig. C.08.B			
C.09	1	None	1	Horizontal conductor will run northwards in the bottom of the valley to this north facing façade. Conductor then turns down to run tucked behind the west side of the RWP, dressed and fixed neatly to the stonework. Conductor to be dressed to follow contours of the strike and plinth courses and stay recessed behind the RWP before entering the earth pit.	Some vegetation, no obstructions or other services noted at time of inspection.	 Fig. C.09.A	 Fig. C.09.B	 Fig. C.09.C		
C.10				CONDUCTOR NOT REQUIRED. THIS AREA IS SOUTH OF THE MAIN FIRE COMPARTMENTATION LINE. SLEEPING QUARTERS IN SPACE #53 SHOULD BE MANAGED EITHER VIA CHANGE OF USE OF SPACE, OR ADDITION OF INTERNAL FIRE STOPPING TO THIS SPACE, RATHER THAN INCREASING THE RISK CLASS OF THE LPS TO THE ENTIRE SOUTH WEST WING WHICH HAS MORE ONEROUS IMPLICATIONS.						
C.11	1	None	1	Horizontal network to run behind the parapet, down and round the north end of the parapet to run east beneath the eave. Down conductor joints from above the RWP (see note 5) and runs down tucked behind the west side of the RWP, dressed and fixed neatly to the stonework (see note 4) before entering the earth pit.	Some vegetation, no obstructions or other services noted at time of inspection.	 Fig. C.11.A	 Fig. C.11.B			
C.12	1	None	1	Horizontal conductor from the south will need to run up and over the parapet (see note 6) and run down behind the south side of the RWP (see note 4), dressed and fixed neatly to the stonework, especially at the low level plinth course, before entering the earth pit.	Some vegetation, no obstructions or other services noted at time of inspection. The adjacent door arch is a main public circulation route through the site. Timing of work in this area must be communicated and agreed well ahead of time with the client.	 Fig. C.12.A	 Fig. C.12.B			

Ref.	Material *(Note 1)*	Sheath/ Colour *(Note 2)*	Fixing Method *(Note 3)*	Down conductor route description and obstructions	Earth pit notes	Images				
C.13	1	None	1	REQUIREMENT FOR THIS DOWN CONDUCTOR TO BE CONFIRMED - NO SUITABLE ROUTE WHICH WOULD NOT BE OF SIGNIFICANT DETRIMENT TO THE HERITAGE OF THIS FAÇADE. CLIENT/INSURERS TO CONFIRM DEVIATION FROM THE BRITISH STANDARD IS ACCEPTABLE.	TBC	 Fig. C.13.A	 Fig. C.13.B			
C.14	1	None	1	The tree adjacent to this proposed down conductor is of special significance, and care must be taken to prevent any damage to it. The access arrangement must be discussed and agreed with the Client prior to work commencing. The conductor shall route from a strike plate at high level on the NW side of the domed turret (avoiding the central finial), but then run down the NW side of the domed turret, to meet with the horizontal conductor running around the rim of the main turret parapet. From here the down conductor shall continue to low level on top of the main turret and run out between the turret parapet balustrades, dressed neatly over the cornices to run vertically in the join between the domed and main turrets. At the top of the door cornice, the conductor shall turn and follow to the top of the door cornice to the SW, and drop again down the south side of the door (see Fig. C.14.A). These areas are highly visible and prominent from the ground, and so special care should be taken to ensure a) the conductor is dressed neatly to the stonework and b) as few fixings as possible are used to minimise the visual intrusion of the LPS. Once it reaches low level at the parapet walkway, it shall turn and run out from the lower parapet balustrades (Fig. C.14.B) and be dressed and fixed neatly into the convex corner, following the stonework and the multiple stone course prominences (Fig. C.14.D) before reaching the ground and entering the earth pit.	Some vegetation, no obstructions or other services noted at time of inspection.	 Fig. C.14.A	 Fig. C.14.B	 Fig. C.14.C	 Fig. C.14.D	 Fig. C.14.E
C.15	1	None	1	Down conductor joints to the horizontal conductor network at low level behind the parapet, and shall run out at low level between the parapet balustrades. Conductor is then dressed and fixed neatly over the parapet overhang, to run in the corner. The dressing in the corner and over the plinth stonework at low level must be neat as this is in a prominent visible location adjacent to a main walkway.	Some vegetation, no obstructions or other services noted at time of inspection.	 Fig. C.15.A	 Fig. C.15.B	 Fig. C.15.C		
C.16	1	None	1	Conductor shall run from strike plate on east side of domed turret, avoiding the central finial. Conductor to run dressed neatly to follow the contours of the turret cornice and detailing on the rear side of the turret (TBC, access not possible at time of inspection) to low level behind the turret, jointing with the horizontal conductor network running behind the parapet. Conductor shall then run over the parapet, and is dressed and fixed neatly to the parapet overhang, and continues to run down vertically in the crevice (see Fig. C.16.A), being dressed neatly against the multiple string courses with minimal fixings, as this is in a high visibly public area.	Some vegetation, no obstructions or other services noted at time of inspection. Proposed location will be on a slope, or in the mouth of the recessed window which will be visible from inside the building. The exact location of this earth pit is to be agreed with the Client.	 Fig. C.16.A	 Fig. C.16.B	Fig. C.16.C		

Ref.	Material *(Note 1)*	Sheath/ Colour *(Note 2)*	Fixing Method *(Note 3)*	Down conductor route description and obstructions	Earth pit notes	Images				
C.17	1	None	1	Strike plate and run from the upper turret as per C.16. Conductor shall then run over the parapet, to run down the east side of the RWP (see note 5), being fixed to the stonework and dressed neatly around the RWP support brackets. Space around the RWP at low level is limited; being constrained on one side by the proximity to the window and on the other by the stone plinth course. Contractor to confirm if conductor can be neatly recessed in the available gap on the east side of the RWP (see Fig. C.17.D).	Some vegetation, no obstructions or other services noted at time of inspection. Proposed location visible from inside the building. The exact location of this earth pit is to be agreed with the Client.	 Fig. C.17.A	 Fig. C.17.B	 Fig. C.17.C	 Fig. C.17.D	
C.18	1	None	1	The high level conductor network will drop on the east side of the southern facade, to minimise visibility (refer to Fig. C.18.A and drawing W[52]100). The conductor will need to joint, run neatly over the small ridge and drop fixed to the south facing wall. From here the conductor shall run west and up and neatly over the parapet, then running down in the corner, being dressed nearly to the string courses.	Some vegetation, no obstructions or other services noted at time of inspection.	 Fig. C.18.A	 Fig. C.18.B			
C.19	1	None	1	Conductor is to run from a strike plate on the chimney, down the south side of the chimney flue to meet the network running around the rim of the slated roof. Conductor must then turn neatly over the ridge, and run down fixed into the corner on the west side of the chimney. Conductor then follows the tiled rooves west in the join between roof and wall, and turns down vertically. At the top of the feature wall, it then turns southward and is to be threaded and dressed neatly between the wall coping shown in Fig. C.19.B, to continue down to ground fixed into the corner on the south side of the wall.	Some vegetation, no obstructions or other services noted at time of inspection.	 Fig. C.19.A	 Fig. C.19.B	 Fig. C.19.C		
C.20	1	None	1	High level conductor from the chimney stack and running behind the ridge of the north gable end. Down conductor is to joint and turn over the ridge adjacent to the base of the chimney, to meet the top of the RWP (see note 5). Conductor follows the RWP down, being fixed to the stonework and dressed neatly to follow the contours of the RWP supports. Damage to the climbing plant must be minised, which could obstruct installation significantly depending on the time of year of installation.	There is a small stone upstand at the base of the RWP. Contractor and Client to discuss best approach and exact earth pit location.	 Fig. C.20.A	 Fig. C.20.B	 Fig. C.20.C		

Ref.	Material *(Note 1)*	Sheath/ Colour *(Note 2)*	Fixing Method *(Note 3)*	Down conductor route description and obstructions	Earth pit notes	Images				
C.21	1	None	1	Horizontal conductor will run on top edge of slate roof eave. Down conductor is to joint and drop onto the small parapet area in a location not visible from the ground, i.e. to the SE corner of the slate roof. Conductor shall then run to north end of the flat roof, and neatly up and over the parapet against the west side of the taller RWP (see note 5). Conductor then continues to run fixed to the stonework and dressed neatly to the contours of the stone string courses, being concealed behind the RWP to ground level.	Some vegetation. A small RWP pit is located in the border here. Below ground structure and drainage service routes TBC before final earth pit location is confirmed.	 Fig. C.21.A	 Fig. C.21.B	 Fig. C.21.C		
C.22	1	None	1	Horizontal conductor route is on underside of roof eave. Down conductor to joint, rise neatly up and over the edge of the roof, and drop on the west side of the RWP (see note 5). Conductor then continues to run fixed to the stonework and concealed behind the RWP to ground level. There are some existing unknown electrical cables running horizontally around this area, over which the conductor will need to pass.	Earth pit location must be coordinated with existing open surface drain connections and below ground drainage network (route unknown).	 Fig. C.22.A	 Fig. C.22.B	 Fig. C.22.C		
C.23	1	None	1	Conductor from strike plate on the single turret shall run down the south side of the turret to join the horizontal conductor running along the roof ridge (see note 7). The down conductor shall then joint and branches to run out west along the ridge of the dormer. At the end of the dormer slate, it will run south down the southern slope of the dormer (see note 7), and drops round the eave of the main roof. Conductor shall then run southward underneath the eave, to the top of the RWP. Conductor shall then run down recessed behind the south side of the RWP, fixed to the stonework and dressed neatly around any RWP supports to the ground. There is some unknown cabling running behind the RWP position.	There is a large drain in the vicinity of the proposed earth pit location. Surrounding services and structure below ground is unknown. Contractor to advise and investigate carefully on site.	 Fig. C.23.A	 Fig. C.23.B	 Fig. C.23.C		
C.24	1	None	1	As C.23, the down conductor branches from the horizontal conductor running along the main roof ridge and shall run out west along the ridge of the dormer. Conductor shall then run down on the slate (see note 7) of the north side of the sloped dormer roof, and drops vertically to meet the top of the main slate eave. Conductor then turns over the eave (see note 6) and meets the RWP under the soffit (see note 5). Conductor shall then run down recessed behind the north side of the RWP, fixed to the stonework and dressed neatly around any RWP supports to the ground.	Some vegetation, no obstructions or other services noted at time of inspection.	 Fig. C.24.A	 Fig. C.24.B	 Fig. C.24.C		

Ref.	Material *(Note 1)*	Sheath/ Colour *(Note 2)*	Fixing Method *(Note 3)*	Down conductor route description and obstructions	Earth pit notes	Images				
C.25	1	None	1	As C.24, but the down conductor will run horizontally from the dormer on the south face of the north wing to the roof valley (see note 7). From here the conductor will then run down recessed behind the north side of the RWP, fixed to the stonework and dressed and fixed neatly around the stone string and plinth courses, and any RWP supports to the ground.	Some vegetation, no obstructions or other services noted at time of inspection.	 Fig. C.25.A	 Fig. C.25.B	 Fig. C.25.C		
C.26	1	None	1	As for the dormers on previous down conductors, the route will be out along the ridge of the dormer (see note 7) and down the east side of this dormer, then over the dormer eave and be fixed to the side of the dormer. The conductor will then run over the roof eave (see note 6) and drop vertically down the ground level wall, fixed to the stonework. There are several intricate stone edges and courses, including a cornice over the door, to which the conductor must be neatly dressed in this location (C.26.C). The conductor should eventually run tucked into the stone edge on the left side of the door before it reaches ground. Care must be taken to ensure no damage occurs to the tree during access and installation of this down conductor route.	Some vegetation, no obstructions or other services noted at time of inspection.	 Fig. C.26.A	 Fig. C.26.B	 Fig. C.26.C	 Fig. C.26.D	
C.27	1	None	1	Refer also to C.01. The down conductor on this side of the belltower shall drop from the underside of the upper roof eave on the east side, to the ridge of the lower slate roof, fixed to the side of the belltower in the crevice, not the roof slates. The conductor must make a small transition over the lower slate roof and gutter, to run vertically down the ground level stone wall, tucked into the corner between the two wings. There are some existing unknown cabled services running in this area and penetrating from the western wall.	There are some electrical cables protruding from the wall just above the ground. This proposed down conductor location also terminates in a doorway. The exact location of the earth pit is to be agreed with the Client.	 Fig. C.27.A	 Fig. C.27.B	 Fig. C.27.C		
C.28	1	None	1	Horizontal conductor shall run at lower edge of the tiled roof above the gutter, from which the down conductor shall drop tucked into the corner where the building steps out (see Fig. C.28.B).	Some vegetation, no obstructions or other services noted at time of inspection.	 Fig. C.28.A	 Fig. C.28.B			

Ref.	Material *(Note 1)*	Sheath/ Colour *(Note 2)*	Fixing Method *(Note 3)*	Down conductor route description and obstructions	Earth pit notes	Images				
C.29	1	None	1	Refer to layout for the route of the horizontal conductor network in this location as it is slightly complex. From the underside of the dormer front, the conductor shall run into the small valley between the upper slate roof sections on the north and east sides of the cloister area. This will then drop tucked behind the east side of the upper RWP (see note 5). At the base of the RWP the conductor will need to turn and run down the second lined roof valley (to which bonding will be required) to the parapet at the outer edge of the cloister wall. It may be possible to route the conductor out via the existing penetration for the RWP. Contractor to confirm. If this will not be possible, the conductor will need to run neatly up and over the parapet, to drop tucked behind the east side of the lower RWP (see note 5). The conductor must then follow the RWP to ground, being dressed and fixed neatly to the stonework and following the contours of the stonework, and any supports on the RWP. Damage to the buttress feature must be avoided. The stone features at low level are prominent but it may be possible to route the conductor behind the RWP all the way to ground. Contractor to confirm.	Some vegetation, no obstructions or other services noted at time of inspection.	 Fig. C.29.A	 Fig. C.29.B	 Fig. C.29.C		
C.30	1	None	1	The down conductor will need to joint from the horizontal route along the south edge of the parapet walkway. This will present a trip/touch hazard which will need to be mitigated by the Client. The conductor must then drop in the SE into the upper lined roof area in the corner (see Fig. C.30.A), run north down the lined roof (to which bonding will be required), and run over the stone lip at the northern edge. From here the conductor will need to drop vertically, and be fixed and dressed neatly around the stone sting courses (see Fig. C.30.C) to meet the lower lined roof area (to which bonding will be required). The conductor shall then run across the lower lined roof area to the parapet, at the point where the RWP penetrates. The conductor shall run out through the parapet via this penetration and be tucked neatly behind the east side of the RWP, running to ground being fixed to the stonework and dressed to follow the contours of the stonework and any supports for the RWP.	Some vegetation, no obstructions or other services noted at time of inspection.	 Fig. C.30.A	 Fig. C.30.B	 Fig. C.30.C	 Fig. C.30.D	 Fig. C.30.E
C.31	1	None	1	The down conductor will need to joint to the horizontal route running under the east edge of the slate eave, to just above the RWP location (see Fig. C.31.A). From here it will drop directly down to a very small lower slate roof section, and run out to the top of the RWP (see note 5) and run down the north side of the RWP, being dressed and fixed neatly to match the supports of the RWP to ground level.	Some vegetation, no obstructions or other services noted at time of inspection.	 Fig. C.31.A	 Fig. C.31.B	 Fig. C.31.C		

12.0 APPENDIX C – PRELIMINARY LPS CALCULATIONS

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Lacock Abbey North

Job	J6666 - Laycock Abbey
Date	17/11/2022
Engineer	SMW/AJS

BS EN 62305-2 Lightning Protection Risk Management

Variable Inputs

	Value	Unit	Symbol
Lightning Flash Density	0.6	fl/km²/yr	Ng
Length of Building	91	m	L
With of Building	50	m	W
Height of Building	13.7	m	H
Length of Adjacent Building	0	m	La
With of Adjacent Building	0	m	Wa
Height of Adjacent Building	0	m	Ha
Length of Connected Line	1000	m	Ll
Soil Resitivity	150	ohms	p
Mesh width of LPS	100	m	Wm1
Mesh width of LPS	100	m	Wm2
Rated Impulse Withstand kV	1.5	kV	Uw
Daily Occupancy	24	hr/day	tz
Ratio of users in protected zone to total building users.	0.6		nz/nt
Cost of Protection Measures	3	£/m2	Cp
Interest Rate	3	%	i
Amortisation Rate	5	%	a
Maintenance Rate	2	%	m
Cost of Loss	£25	£	Cl
Animals Present in Building	N	Y/N	
Risk of Explosion	N	Y/N	
Aerial Or Burried Line	B	A/B	

Risk Component	To Structure			Near Structure	Connected Line			Near Connected Line
	Ra	Rb	Rc	Rm	Ru	Rv	Rw	Rz
R1	x	x	xa	xa	x	x	xa	xa
R2		x	x	x		x	x	x
R3		x				x		
R4	xb	x	x	x	xb	x	x	x

a - Only where there is a risk of explosion, or where failure of internal systems immediately effects human life

b - Only for where animals may be lost

Risk Components

			Loss of Life	Loss of Public Service	Loss of Heritage	Loss of Economic Value
Tolerable Risk			0.00001	0.00100	0.00010	1.83238
			R1	R2	R3	R4
Shock to People due to Flashes to Structure	Ra	= Nd Pa La =	1.70784E-08			
Physical Damage due to Flashes to Structure	Rb	= Nd Pb Lb =	4.2696E-06	8.5392E-08	5.6928E-08	2.8464E-07
System Failure due to Flashes to Structure	Rc	= Nd Pc Lc =	0	6.83136E-07		1.70784E-08
System Failure Due to Flashes Near Structure	Rm	= Nm Pm Lm =	0	2.80715E-05		7.01787E-07
Shock to People due to Flashes to connected Line	Ru	= (NL + Ndj) Pu Lu =	5.4E-09			0
Physical Damage due to Flashes to connected Line	Rv	= (NL + Ndj) Pv Lv =	0.00000135	0.000000027	0.000000018	0.00000009
System Failure due to Flashes to connected Line	Rw	= (NL + Ndj) Pw Lw =	0	0.00000054		1.35E-08
Risk due to Flashes near connected Line	Rz	= Ni Pz Lz =	0	0.0000144		0.00000036
		Calc. Risk	5.64208E-06	4.3807E-05	7.4928E-08	1.46701E-06
			Pass	Pass	Pass	Pass
		LPS Class	Class II			

Assessment of Dangerous Annual Events

Events to Structure	Nd	= Ng Ad Cd 0 =	0.0056928
Events to Adjacent Structure	Ndj	= Ng Adj Cdj Ct 0 =	0
Events Near Structure	Nm	= Ng Am 0 =	0.5263404
Events to Connected Line	NL	= Ng Al Cl Ce Ct 0 p / 400 =	0.0045
Events Near Line	Ni	= Ng Ai Cl Ce Ct 0 =	1.2

Area Factors

			Building	Adjacent Building
Collection Area (Rectangular Structure)	Ad	= L W + 6H (L + W) + Pl (3 H) ^2 =	9488	0
Collection Area Near Structure	Am	= 1000 La Wa + Pl 500 =	877234	
Collection area of Line	Al	= 40 Ll =	40000	
Collection Area Near Line	Ai	= 4000 Ll =	4000000	

Direct Strike Probabilities

Probability Flash will injure Living Being	Pa	= Pta Pb =	0.05
Probability of System Failure	Pc	= Pspd Cld =	0.02

Nearby Strike Probabilities

Probability of System Failure	Pm	= Pspd Pms =	0.008888889
	Pms	= KS1 KS2 KS3 KS4 ^2 =	0.444444444
	KS1	= 0.12 Wm1 =	1
	KS2	= 0.12 Wm2 =	1
	KS4	= 1/ Uw =	0.666666667

Line Strike Probabilities

Probability Flash will injure Living Being	Pu	= Ptu Peb Pld Cld =	0.02
Probability of Physical Damage	Pv	= Peb Pld Cld =	0.02
Probability of System Failure	Pw	= Pspd Pld Cld =	0.02
Probability that a flash near a line will casuse a system failure	Pz	= Pspd Pli Cli =	0.002

Loss Assessment Damage Type

	Typical Loss	Formula		Tables C2/C3/C4/C5/C6
Loss due to Injuries	La	= rt Lt nz / nt tz /8760 =		0.00006
Loss due to Injuries	Lu	= rt Lt nz / nt tz /8760 =		0.00006
Loss due to Physical Damage	Lb	= Lv = rp rf hz Lf nz / nt tz /8760 =		0.015
Loss Due to System Failure	Lc	= Lm = Lw = Lz = Lo nz / nt tz /8760 =		0

* For single zone buildings nz/nt = 1 if tz is unknown tz/8760 = 1. Otherwise it is the ration of users in a zone to structure or user time in structure

Loss to Public Service

				Tables C4/C5/C8
Loss due to Physical Damage	Lb	= Lv = rp rf Lf nz / nt =		0.0003
Loss Due to System Failure	Lc	= Lm = Lw = Lz = Lo nz / nt =		0.006

Loss of Heritage

				Tables C4/C5/C10	cz/ct
Loss due to Physical Damage	Lb	= Lv = rp rf Lf cz / ct ;it between zone and structure =		0.0002	0.4

Economic Loss

				Tables C3/C4/C5/C12
Loss due to Injuries	La	= Lu = rt Lt ca / ct		0
Loss due to Physical Damage	Lb	= Lv = rp rt Lf (ca + cb + cc + cs) / ct		0.001
Loss Due to System Failure	Lc	= Lm = Lw = Lz = Lo cs / ct		0.00015

ca = value of animals, cb = value of building, cc = value of content, cs = value of systems, ct = total value

Cost of Loss

Cost of Loss	Cl	= R4l ct =W39*AB114*AA114	£1,397.74
Cost of Residual Loss	Crl	= R4 ct	£24.59
Annual Cost of Protection Measures	Cpm	= Cp (i + a + m)	£891.60
Cost of Protection	Cp	=	£8,916.00
Annual Saving	Sm	= Cl - Cpm + Crl	£481.55
R4 Value when saving = 0	R4o	= (Cpm + Crl) / Ct	1.832

job title	date
J6666 - Laycock Abbey	17 November 2022
description	job no. / dwg no.
	J6333 / 1 of 1

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MAX FORDHAM

Lacock Abbey South

Job	J6666 - Laycock Abbey
Date	17/11/2022
Engineer	SMW/AJS

BS EN 62305-2 Lightning Protection Risk Management

Variable Inputs

	Value	Unit	Symbol
Lightning Flash Density	0.6	fl/km²/yr	Ng
Length of Building	91	m	L
With of Building	50	m	W
Height of Building	13.7	m	H
Length of Adjacent Building	0	m	La
With of Adjacent Building	0	m	Wa
Height of Adjacent Building	0	m	Ha
Length of Connected Line	1000	m	Ll
Soil Resitivity	150	ohms	p
Mesh width of LPS	100	m	Wm1
Mesh width of LPS	100	m	Wm2
Rated Impulse Withstand kV	1.5	kV	Uw
Daily Occupancy	8	hr/day	tz
Ratio of users in protected zone to total building users.	0.6		nz/nt
Cost of Protection Measures	3	£/m2	Cp
Interest Rate	3	%	i
Amortisation Rate	5	%	a
Maintenance Rate	2	%	m
Cost of Loss	£83	£	Cl
Animals Present in Building	N	Y/N	
Risk of Explosion	N	Y/N	
Aerial Or Burried Line	B	A/B	

Risk Component	To Structure			Near Structure	Connected Line			Near Connected Line
	Ra	Rb	Rc	Rm	Ru	Rv	Rw	Rz
R1	x	x	xa	xa	x	x	xa	xa
R2		x	x	x		x	x	x
R3		x				x		
R4	xb	x	x	x	xb	x	x	x

a - Only where there is a risk of explosion, or where failure of internal systems immediately effects human life

b - Only for where animals may be lost

Risk Components

											Loss of Life	Loss of Public Service	Loss of Heritage	Loss of Economic Value
Tolerable Risk											0.00001	0.00100	0.00010	1.94829
											R1	R2	R3	R4
Shock to People due to Flashes to Structure	Ra	=	Nd	Pa	La					=	3.8112E-08			
Physical Damage due to Flashes to Structure	Rb	=	Nd	Pb	Lb					=	0.000003176	5.7168E-07	7.6224E-07	1.9056E-06
System Failure due to Flashes to Structure	Rc	=	Nd	Pc	Lc					=	0	2.8584E-06		7.146E-08
System Failure Due to Flashes Near Structure	Rm	=	Nm	Pm	Lm					=	0	7.15469E-05		1.78867E-06
Shock to People due to Flashes to connected Line	Ru	=	(NL	+	Ndj)	Pu	Lu			=	4.5E-09			0
Physical Damage due to Flashes to connected Line	Rv	=	(NL	+	Ndj)	Pv	Lv			=	0.000000375	6.75E-08	0.00000009	0.000000225
System Failure due to Flashes to connected Line	Rw	=	(NL	+	Ndj)	Pw	Lw			=	0	0.00000135		3.375E-08
Risk due to Flashes near connected Line	Rz	=	Ni	Pz	Lz					=	0	0.000036		0.0000009
										Calc. Risk	3.59361E-06	0.000112394	8.5224E-07	4.92448E-06
											Pass	Pass	Pass	Pass
										LPS Class	Class IV			

Assessment of Dangerous Annual Events

Events to Structure	Nd	=	Ng	Ad	Cd	0						=	0.009528
Events to Adjacent Structure	Ndj	=	Ng	Adj	Cdj	Ct	0					=	0
Events Near Structure	Nm	=	Ng	Am	0							=	0.5366016
Events to Connected Line	NL	=	Ng	Al	Cl	Ce	Ct	0	p	/	400	=	0.0045
Events Near Line	Ni	=	Ng	Ai	Cl	Ce	Ct	0				=	1.2

Area Factors

																	Building	Adjacent Building
Collection Area (Rectangular Structure)	Ad	=	L	W	+	6H	(L	+	W)	+	Pl	(3	H)	^2		=	15880	0
Collection Area Near Structure	Am	=	1000	La	Wa	+	Pl	500								=	894336	
Collection area of Line	Al	=	40	Ll												=	40000	
Collection Area Near Line	Ai	=	4000	Ll												=	4000000	

Direct Strike Probabilities

Probability Flash will injure Living Being	Pa	=	Pta	Pb		=	0.2
Probability of System Failure	Pc	=	Pspd	Cld		=	0.05

Nearby Strike Probabilities

Probability of System Failure	Pm	=	Pspd	Pms					=	0.022222222
	Pms	=	KS1	KS2	KS3	KS4	^2		=	0.444444444
	KS1	=	0.12	Wm1					=	1
	KS2	=	0.12	Wm2					=	1
	KS4	=	1/	Uw					=	0.666666667

Line Strike Probabilities

Probability Flash will injure Living Being	Pu	=	Ptu	Peb	Pld	Cld	=	0.05
Probability of Physical Damage	Pv	=	Peb	Pld	Cld		=	0.05
Probability of System Failure	Pw	=	Pspd	Pld	Cld		=	0.05
Probability that a flash near a line will casuse a system failure	Pz	=	Pspd	Pli	Cli		=	0.005

Loss Assessment Damage Type

	Typical Loss		Formula													Tables C2/C3/C4/C5/C6
Loss due to Injuries	La	=	rt	Lt	nz	/	nt	tz	/8760						=	0.00002
Loss due to Injuries	Lu	=	rt	Lt	nz	/	nt	tz	/8760						=	0.00002
Loss due to Physical Damage	Lb	=	Lv	=	rp	rf	hz	Lf	nz	/	nt	tz	/8760		=	0.001666667
Loss Due to System Failure	Lc	=	Lm	=	Lw	=	Lz	=	Lo	nz	/	nt	tz	/8760	=	0

* For single zone buildings nz/nt = 1 if tz is unknown tz/8760 = 1. Otherwise it is the ration of users in a zone to structure or user time in structure

Loss to Public Service

												Tables C4/C5/C8
Loss due to Physical Damage	Lb	=	Lv	=	rp	rf	Lf	nz	/	nt	=	0.0003
Loss Due to System Failure	Lc	=	Lm	=	Lw	=	Lz	=	Lo	nz	/	nt	=	0.006

Loss of Heritage

												Tables C4/C5/C10	cz/ct
Loss due to Physical Damage	Lb	=	Lv	=	rp	rf	Lf	cz	/	ct	;t between zone and structure	=	0.0004	0.8

Economic Loss

																		Tables C3/C4/C5/C12
Loss due to Injuries	La	=	Lu	=	rt	Lt	ca	/	ct								=	0
Loss due to Physical Damage	Lb	=	Lv	=	rp	rt	Lf	(	ca	+	cb	+	cc	+	cs	)	/	ct	=	0.001
Loss Due to System Failure	Lc	=	Lm	=	Lw	=	Lz	=	Lo	cs	/	ct							=	0.00015

ca = value of animals, cb = value of building, cc = value of content, cs = value of systems, ct = total value

Cost of Loss

| | | | | | | | | | | | | | | | | | |

MAX FORDHAM

12.1 Notes On Initial LPS Assessments

These notes on the assumed input values are to be read in conjunction with the initial LPS assessments

Item	Noes on assumption	Individual Significance	Action/Comments
H – Building height	Allowance has been made for 13.7m. Building is not as tall but these includes the height of the chimneys. The setting of a lower average height does not affect the protection classes presented result	H	Reasonable allowance has been made following site review.
Building Plan Area	Areas taken from the record drawings available. The area does not make the calculation borderline or affect the protection classes presented result	H	Site review indicated plans and scale are accurate.
Ad – Collection area	This is a function of the building plan area and is therefore dependant on verification of the plan dimensions	H	Site review indicated plans and scale are accurate.
p – Soil Resistivity	Set at 150 Ohms based on "Loam and Clay" as closest approximation	H	Has been agreed as appropriate with the NT, soil resistivity testing to be carried out by LPS specialist prior to installation commencing.
tz – Daily Occupancy	Residential use to the North area so set at 24hr/day. Working/opening hours occupation to south area so set to 8Hrs A day	H	Residential occupation provides the most onerous case for the North area this is the most onerous case.
nz/nt	Ratio of users in protected zone to total building users	M	Set as 0.6 to each side of the building as it is modelled as two halves but has made some allowance for it not being possible to ensure an equal split between sides.
Wm1 & Wm2	Air termination network mesh spacing grid set according to the LPS class calcualted	M	Based on a class IV system to South and Class II to the north area.
Cd - Location Factor	Assumed factor set as 1 as building is essentially isolated from other buildings.	H	Modelled as 1 as there is no zone of protection afforded from any adjacent structures.
Cl – Line Routing	Assumed worst case factor of 1 for overhead line installations	L	To be Verified by NT and checked as part of site visit. It is likely that it will actually be a buried line. Makes little difference to the overall result.
rp – Fire Load	Assumed normal at a factor of 0.01 based on a fire load estimate of 400-800 J/m² fire load	H	Confirmed as appropriate with the NT.
rt – Reduction Factor	Reduction factor set at 0.0001 for carpeted floors, slight reduction possible for predominantly timber floors, but makes very little difference to calc	L	Mixed floor finishes exist but the setting to the most onerous case still does not increase the LPS class from IV.
Rf – Reduction factor	Set at 0.5 on assumption that the following is provided *"extinguishers, fixed manual alarm, hydrants, fire compartments, escape routes"*	M	To be confirmed as appropriate with the NT
hz – Special Hazard Factor	Set at a factor of 2 based on the assumption of *"Low level of panic (2 floors < 100 people)"*	M	This is the lowest category for a visitor attraction and has been agreed as appropriate with the NT.
Ct – Total Value of structure	Set at a factor of £1,000/m³ 2x the High cost for non-industrial buildings	M	To be confirmed as appropriate with the NT based on insured value. Building is Grade I Listed.
Pb – Level of LPS	Factor set to corresponding values for class to each area of the site.	H	Building does not pass the calculation with no protection.
Pspd – Level of LPS	Factor set to corresponding values for class to each area of the site.	H	Building does not pass the calculation with no protection.
Peb – Equipotential Bonding	Factor set at 0.05 to correspond to Class IV installation	H	Building does not pass the calculation with no protection.
Ptu – Protection measures against touch voltages	Set to None with a factor of 1	M	System is expected to have uninsulated down conductors which is the most onerous case.