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Technical Masonry Repair Specification

Freemasons Hall Front Entrance & Tower Masonry Facade Repairs

L05062 / SP1

The United Grand Lodge of England

clarkebond

MULTIDISCIPLINARY ENGINEERING CONSULTANTS

Technical Masonry Repair Specification

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Project
Freemasons Hall Front Entrance & Tower Masonry Façade Repairs

Client Name
The United Grand Lodge of England

Issue Date/ Revision	Status	Description of Amendments
25th October 2019 / 1	DRAFT	
10th December 2019 / 2	DRAFT	Generic masonry specification to Technical masonry repair specification
08th January 2020 / 3	DRAFT	Appendix F - Additional stones identified for removal. Appendix G – Amended photo captions
6th April 2020 / 4	DRAFT	Appendix F – Lightning cables & stone defects added Appendix G – Window/Door/Ironmongery/Leadwork
14th April 2020 / 5	FINAL	Appendix F/G/H - Additional stones identified for removal on Elevation B and asphalt scope refined.
20th April 2020 / 6	FINAL	For Planning and Listed Building Consent Application

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Contents

1 Introduction

1.1 Clarkebond (CB) has been appointed by The United Grand Lodge of England (UGLE) to produce a technical masonry repair specification for the Front Entrance & Tower facades of the Freemason's Hall, 60 Great Queen Street, London WC2.

1.2 Vertigo Access Solutions Ltd (Vertigo) on behalf of CB undertook a non-intrusive tactile visual abseil inspection via specialist rope access of the front entrance and the tower facades.

1.3 This Specification has been prepared to inform the tenderers of the likely repair methods required to maintain the facades.

1.4 This specification should be read in conjunction with the drawings contained within Appendix F:

1.4.1 Clarkebond drawings 5062-CLK-XX-XX-EL-S-0501 to L05062-CLB-XX-XX-EL-S-0509 and 5062-CLK-XX-XX-PL-S-0601 to 5062-CLK-XX-XX-PL-S-0602

1.5 Refer to Appendix A for the site plans that indicate the extent of the façade works as highlighted by the red lines.

1.6 No internal inspections were undertaken to determine the form of construction / structural framing. However owing to the age of the buildings they will be a combination of timber, in-situ concrete and steel filler joist floors, load bearing masonry walls and piers, and steel columns and beams with possibly some cast iron.

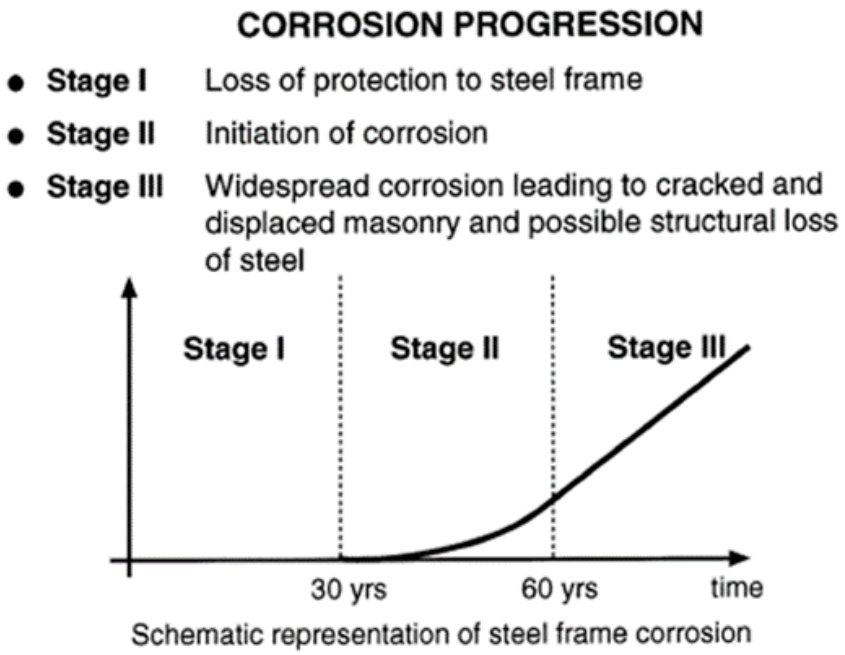
2 Regent Street Disease (RSD) Overview

2.1 During the early development of steel frame construction methods, engineers and architects generally failed to recognise and appreciate the risks of corrosion. At the time it was considered that the masonry cladding surrounding the structural steel would prevent the ingress of moisture, these assumptions were incorrect. Moisture and water vapour easily penetrated the external masonry with the resulting problems of corrosion damage now observed. The severity of water penetration related to a number of design details and maintenance problems, but, from day one, water could enter structures clad with naturally porous materials. Limestone is one of the more porous stones having a porosity in the range of 17-20% Although higher porosity materials may allow the ingress of water it must be noted that low porosity or relatively impervious materials can entrap moisture entering by other routes.

2.2 Corrosion problems in buildings constructed up to the late 1930s (and in certain cases beyond) are now becoming increasingly common. As the long term vulnerability of the steelwork corroding was not appreciated until it began to manifest itself on cracking to the stone / masonry there was never any great consideration given to ongoing Planned Preventative Maintenance, (PPM), until it became apparent that there was an underlying problem. Typical consequences include cracking of the external facade, and/or 'jacking' of the masonry due to the development of expansive corrosion products (rust). If left unattended, open joints and cracked masonry allow the direct penetration of moisture, thus accelerating corrosion and possibly leading to structural problems.

2.3 To put it into context, Figure 1 below identifies the 3 time stages of corrosion for early 20th century steel framed buildings. As the process reaches the end of Stage II (Initiation), the growth of corrosion becomes exponential during Stage III. Early intervention between Stages II and III is imperative. As the rate of corrosion increases exponentially so too does the cost or repairs.

Figure 1



Schematic representation of steel frame corrosion

2.4 The risks arising to the general public posed by such dilapidated facades is recognised. Existing UK legislation deals principally with *post-facto* situations - problems when facades have already become unstable and are visibly dangerous.

2.5 The Health and Safety Executive (HSE) has recently changed its guidance, refer to Section 2.7, regarding inspections but this has not been widely publicised despite a number of threats to life and fatalities as a consequence of falling masonry, not necessarily triggered during high winds and rain, but occurring later.

2.6 While such incidents remain, however rare, they demonstrate the need for vigilance on the part of owners, property portfolio managers and agents, and robust procedures regarding heritage management, particularly of large commercial listed buildings where full external access and regular maintenance inspections may have been a relatively low priority in the past.

2.7 The HSE has issued revised 'Workplace Regulations Approved Code of Practice and Guidance' in relation to Regulation 4A. This promotes the principle that workplace buildings must have stability and solidity appropriate to their use but as this is issued as 'guidance' rather than as part of the Code of Practice itself it carries less weight - but might be a material consideration in any litigation arising from building failures.

2.8 A duty to have a solid and stable workplace building was defined by the European Union as long ago as 1989 and the UK Government was advised about failure to implement the directive in 2002. As a consequence, although a duty was imposed it was not considered necessary to have

an inspection regime to identify problems before these become dangerous. This situation lasting for more than a decade has now been rectified by the HSE's recent update.

2.9 Paragraph 38 states:

'An inspection and maintenance regime, appropriate to the building's type and use, should be determined to ensure that any defect which may cause an unacceptable safety risk is detected in good time, so appropriate remedial action can be taken. All inspection and maintenance should be carried out by suitably competent people. An inspection and maintenance regime does not necessarily need to be documented.'

Paragraph 39 states:

'Inspection and maintenance may require only the following:

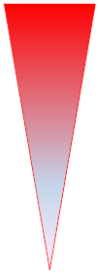
- *a general understanding of building construction and maintenance requirements;*
- *an awareness of the limitations of your experience and knowledge;*
- *the willingness and ability to supplement existing experience and knowledge, when necessary by obtaining external help and advice.'*

2.10 Paragraphs 38 and 39 of the HSE's Workplace Health Safety and Welfare contextualises the necessary considerations and approach to be taken.

2.11 Figures 2 and 3 following highlights the relationship between the Health and Safety Risks to the need for Maintenance / Repair Priority.

Figure 2

HEALTH AND SAFETY RISK



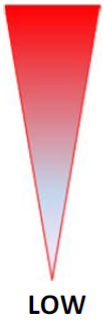
HIGH Requires immediate attention due to the considerable potential of failure causing a risk to safety.

Requires attention in the next 5 – 10 years due to the moderate potential to develop a risk to safety.

Requires attention in the next 10 – 25 years due to the low potential to develop into a risk to safety

LOW No urgency, unlikely to develop into a safety risk.

Figure 3
MAINTENANCE / REPAIR PRIORITY



Repair will remove a considerable potential for exponentially increasing and thus potentially high future maintenance costs

Repair will remove some risk of increased future maintenance costs

Repair to unlikely influence future maintenance costs

The cost of repair might be excessive and a monitoring and minor repair strategy might be more appropriate.

3 Scope of Services

3.1 The scope of investigative / repair works provided in Appendix G form the basis of a tender package.

3.2 The approach is to undertake investigative works on the elevations using specialist testing companies and the appointed specialist stone contractor.

3.3 The aim of the investigations is to:

3.3.1 Establish the underlying cause(s) for the masonry defects such as the corrosion of buried steelwork i.e. steel fixings (cramps, dowels etc) or steel members (beams and columns),

3.3.2 Extent of the defects, and

3.3.3 Causation for the defects.

3.4 The Contractor should allow for targeted non-intrusive investigations and intrusive investigation at all masonry cracking / masonry bed joint disturbance as highlighted in Section 3.7 with reference photos in Appendix G.

3.5 Subject to full scaffold access and the site findings and the Conservation Officer approval, the final scope of investigative / repair works related to Regent Street Disease may increase through further targeted non-intrusive investigations as per Section 7.2 and further targeted intrusive investigations to ensure there are no hidden defects that have not yet caused cracking to the facade.

3.6 Keyhole inspections are only of limited success and experience has shown that larger areas of masonry need removing to better assess the nature and extent of corrosion. Such intrusive inspections will also assist in better understanding the construction details and how best to deconstruct and reinstate where intervention is required.

3.7 Where masonry cracking / disturbance is found to coincide with buried steel members it will be necessary to locally expose the steel members by forming approximately a minimum 1 m^2 exploratory hole or remove whole or part ashlar block (circa 100-300mm thick) whichever is the easier and including the backing masonry. Such an opening size will allow much better inspection of the steel members with regard assessing the nature and extent of corrosion. Corrosion product to be preserved for measurement purposes. Refer to Section 7.5.

3.8 Where heavy / laminar corrosion is encountered at the exploratory opening, further removal of whole or part ashlar blocks (circa 100-300mm thick) /brickwork including backing masonry to fully expose the corroded steelwork until no further laminar corrosion is found i.e. until mill scale / surface corrosion borders the heavy / laminar corrosion area.

3.9 Full exposure of the top and bottom flanges into the building may be required to allow unimpeded visual tactile inspection and sufficient access for cleaning and treating of the steelwork.

3.10 The inspection process broadly involves the following iterations:

3.10.1 Inspecting the exploratory holes, photographing and log the details as necessary.

3.10.2 If CB requires additional opening up due to the degree of laminar corrosion found, the masonry specialist contractor shall extend the opening up until extent of corrosion is considered by the CB not to be excessive i.e. mill scale rust.

3.10.3 If the steel member is structurally adequate, clean and paint as per specification and MGDUFF International Limited/Zingametall bvba Specification/Technical Datasheet.

3.10.4 Prior to the reinstatement of the masonry (stonework/brickwork), the MGDUFF International Limited/Zingametall bvba paint coating inspector and/or CB is to re-inspect and sign off if works as per Section 3.10.3 are deemed to be to specification.

3.10.5 The masonry specialist contractor is to provide all the necessary reinstatement details including stone/brickwork fixing details and CB will provide comments, where required/deemed necessary.

3.10.6 If a steel member is found to have lost excessive section thickness following cleaning, then any strengthening works will need to be agreed / specified by the CB.

3.10.7 Where required the CB will comment on any necessary specialist sub-contractor temporary works design proposals with regards to their impact on the masonry facades.

3.11 The masonry specialist contractor is responsible for logging / photographing all repair works throughout the various stages of opening up and reinstatement i.e. before opening up, after opening up and showing exposed untreated steel if present, after blast cleaning of steel, after application of protective paint coating such as Zinga, during installation of stone fixings and after

reinstatement of masonry. The information is to be held in a DropBox account or similar and real-time access provided to the project team.

3.12 All defects to be repaired shall be identified and marked out by the Contractor. These areas will be recorded on a suitably scaled drawing and documented to allow all works to be traced and to be held on the same Dropbox account or similar as per Section 3.11. This defect/repair location and identification procedure shall be to the satisfaction and approved by the PM / CA / CB. These will need to be developed into 'As-Builts' for the Operations & Maintenance (O&M) or Health and Safety file.

3.13 The Contractor is to keep a daily site diary which is to be held on the same Dropbox account or similar as per Section 3.11.

3.14 The Daily site diary is to include as a minimum the items below:

- 3.14.1 Date
- 3.14.2 Weather forecast
- 3.14.3 Air temperature log (maximum and minimum for the day and overnight)
- 3.14.4 Material temperature
- 3.14.5 Number of operatives and trades onsite
- 3.14.6 Works carried out and including locations

3.15 The nature of the works is such that they will need to be sequenced to avoid overstressing adjacent retained stone/brickwork due to load redistribution within the masonry façade.

3.16 The WWII London Bomb Damage Maps indicated the opposite historic building on Wild Street sustained 'damage beyond repair'. The Freemasons Hall building did not sustain bomb damage. The full scope of historic remedial works to the elevations is currently unknown. The method of repair, i.e. installing cramps across the cracks would be consistent with repairs undertaken after the war. If the repairs were carried out in the 1980's stitching with stainless steel dowel pins, set in resin would have been more common.

3.17 These targeted intrusive investigations will allow the defects to be categorised as below:

- 3.17.1 Masonry cracking coincident with steel beams / columns buried within the elevations.
- 3.17.2 Masonry bed joint disturbance/lateral displacement coincident with steel beams / columns buried within the elevations.
- 3.17.3 Masonry cracking coincident with discreet ferrous cramps, dowels, pins etc.
- 3.17.4 Masonry cracking / disturbance remote from either buried steel members or discreet ferrous cramps, dowels, pins etc.

3.18 Items (3.17.1) and (3.17.2) can be gleaned from a review of the available archive structural drawings coupled with specialist testing and where information is missing the facade.

3.19 For items (3.17.3) and (3.17.4) type defects i.e. where cracking is occurring remote from steel beams / columns buried within the elevations then it may be necessary to undertake specialist testing to detect the presence of buried ferrous fixings and if necessary coupled with localised opening up works.

3.20 Where there is confidence that the cracking is remote from any steelwork then an appropriate repair such as replacement of brickwork, stone indenting, mortar repair, stitching and weather sealing or just weather sealing will be appropriated depending on the nature of the defect.

3.21 The final scope of repair works will be subject to what is found on site via full scaffold access. Generally the more vulnerable areas will be at parapets, cornices, balustrades i.e. locations where rain water can stand or poor / degraded weathering details between interfaces.

3.22 A schedule of rates for the various generic defect types will need to be identified within the scope of works for contractors to price and this re measured on completion of the works. For this reason it is important that specialist masonry contractors familiar with this type of historic restoration works are invited to tender. A particular technical challenge will be re securing stone back to the structure. Unlike modern cladding systems which can be designed to have isolated members removed, traditional self-supporting masonry facades were built from the bottom up relying on gravity and restraining pins and steel to provide support. Removing random isolated sections can be technically challenging hence the need for only using suitably experienced masonry specialist contractors.

3.23 Consideration will need to be given to the sequencing of repairs and the impact that the phasing may have on the load distribution within the elevations to avoid the risk of damaging masonry due to load redistribution. The reinstatement of the masonry will also need consideration to ensure it continues to act as a homogenous mass particularly over window heads.

3.24 If consideration is given to installing an Impressed Current Cathodic Protection (ICCP) modular system to the front entrance and tower façade elevations of Great Queen Street and Wild Street to minimise the need for heavy intrusive intervention other than at locations where the structural integrity of a steel member is a concern due to excessive loss of section thickness.

3.25 A holistic design is required for the ICCP system for the building in its entirety although this phase of remedial works is standalone. The overall ICCP system will need to be open protocol and allow for future phases of ICCP system installation to be integrated to the existing system. The stone contractor will take ICCP contractor on as subcontractor. It would be advisable to engage with a specialist at an early stage for them to advise on the suitability of such an approach and budget costs and scope any particular investigations required for validation of their design approach. A peer review of the ICCP specialist design will be required by an

independent corrosion specialist and in this regard it is recommended that a Level III Cathodic Protection Engineer is to be appointed to carry this out. Refer to Appendix I for a typical ICCP specification.

3.26 For pricing purposes, allow for the installation of ICCP to provide full protection of the designated steel beams and columns of the front entrance and tower façade elevations of Great Queen Street and Wild Street within this phase of remedial works from ground level to roof level (Elevations B, C, D, E, F, G, H, J, Q & Z as per elevation drawings in Appendix F and refer to Section 7G).

3.27 The tender should be obtained on the basis that the work will be re measured at the end of the contract. The budget therefore allows for additional work which will become apparent during the contract.

3.28 The extent of remedial works required to the metal windows, leadwork, asphalt, cast iron rainwater goods above ground and sealants will be subject to what is found on site via full scaffold access.

3.29 Rainwater Pipes above ground

3.29.1 Allow for a CCTV survey to be undertaken to all rainwater pipes above ground.

3.29.2 All cast iron rainwater pipes to be cleaned/refurbished/relined or replaced and painted to this specification, where necessary.

3.29.3 Where plastic pipes have been found, these are to be replaced with same size cast iron pipes.

3.30 The Lightning protection works such as reconnection and testing will need to be undertaken by the incumbent maintenance contractor where disconnected due to masonry remedial works. The Contractor will need to take account of these works in their programming and liaise directly incumbent maintenance contractor.

3.31 The Specification has been prepared on the basis of undertaking works such as structural, local superficial repairs and cleaning that relate to masonry surface repair works to weatherseal and maintain weathertightness of the building elevations which are warranted for 10 years until next maintenance stage.

3.32 The works relating to the component parts of the ICCP system are normally warranted in excess of 10 years but less than 20 years (Design life of the ICCP system).

3.33 The Design Life of an ICCP system will depend on the performance of individual items installed within the building. With the exception of the anodes and reference electrodes embedded in the structure, all component parts will need to be maintained and replaced as when required as part of the ICCP Operational Plan.

3.34 Operational life of catalysed titanium anode is in excess of 75 years, pseudo reference electrodes (MMO titanium or graphite) is in excess of 50 years and Ag / AgCl reference electrodes are up to 20 years. However, the electronics associated with the power supplies and remote monitoring system are expected to have a life in excess of 20 years. With appropriate repair and maintenance of the electronic circuitry, this could exceed 30 years.

3.35 MGDUFF International Limited will provide a 20-year product-quality guarantee on the 'Zinga' one-component anti-corrosion zinc coating system if a minimum two site applied coats to achieve a minimum Dry Film Thickness (DFT) of 180 µm as per the manufacturer's instructions and to conform to the ISO 12944-6: C5-M/I-High specification. 'Zingaspray' shall not be used. Refer to 6.2.40 and Section 7F.

3.36 CONTRACTOR'S DESIGN ITEMS

3.36.1 All temporary works,

3.36.2 Overall stability of the façade whilst undertaking the works,

3.36.3 All masonry fixings and,

3.36.4 Replacement of any structural elements within the facades.

3.36.5 Impressed Current Cathodic Protection System and associated masonry reinstatement works

4 General Description

4.1 The existing building of 60 Great Queen Street was constructed as the "Masonic Peace Memorial Building" and as a memorial to Freemasons who lost their lives during the First World War. The hall is the central headquarters of United Grand Lodge of England and was constructed between 1927-33.

4.2 Designed by HV Ashley and Winton Newman, whose ingenious fitting of the plan to the irregular polygonal site won them the commission as the result of a competition.

4.3 The art deco building is a steel frame construction faced with Portland stone and is Grade II* listed.

4.4 Massive building in stripped Classical style with a tower. Long facades (with slightly projecting entrance bays) emphasised by string courses and heavy cornice above 1st floor. 2 attics stepped above, culminating across the west angle in the corner tower, which echoes the form of the Temple entrance beneath and is flanked by 2 giant fluted columns. This defines the diagonal axis along which the Temple itself lies, as well as its associated processional access route. There are metal-framed windows along the elevations and decorative lamp brackets at the entrances to the building.

5 Typical Defects Observed

5.1 Typical defects observed are listed below and photographs are provided in Appendix G:

- 5.1.1 Open masonry joints (limestone or brickwork)
- 5.1.2 Cracking to masonry (limestone or brickwork)
- 5.1.3 Weathered or crazed masonry (limestone or brickwork)
- 5.1.4 Decayed and/or complete destruction of masonry (limestone or brickwork)
- 5.1.5 Defective previous/historic repairs (limestone or brickwork)
- 5.1.6 Defects around existing inserts or fixings and historic repairs where masonry is cracked such as at dentil details and other decorative details
- 5.1.7 Defects caused by corroding steelwork or decaying timbers behind masonry
- 5.1.8 Defects in balustrade upstands / parapets
- 5.1.9 Defects in asphalt waterproofing membranes and leadwork.
- 5.1.10 Defects in the metal windows

5.2 The marked up CB drawing No 5062-CLK-XX-XX-EL-S-0501 to L05062-CLB-XX-XX-EL-S-0509 contained within Appendix F highlights the extent of defects to be repaired but this extent may increase once scaffold is available during the main contract and opening up works have been undertaken to confirm the condition of any steelwork located at areas of cracked stone / masonry.

6 Materials and Workmanship

6.1 Protection of Heritage Listed Buildings

6.1.1 The building is a Grade II* listed building and it is essential to preserve the original fabric. Only in circumstances where this is impossible will new work be allowed. Any new work has to be in character with the old, and this eliminates many modern methods of construction.

6.1.2 In repairing a listed building, the skill of the workmen is of the utmost importance. The men employed such as conservation experienced stonemasons should have a true instinct for the right treatment of materials and it is important that they should be told of the need for preservation wherever possible. Qualifications and experience of operatives/workmen could be requested onsite.

6.1.3 Listed building consent from the local planning authority is required before carrying out of any works for the alteration or extension of a listed building in any manner that would affect its character as a building of special architectural or historic interest.

6.1.4 The requirement applies to all types of works and to all parts of those buildings covered by the listing protection (possibly including attached and curtilage buildings or other structures), provided the works affect the character of the building as a building of special interest.

6.1.5 The appropriate protection such as the use of, but not strictly limited to, robust ply sheeting (min. 15mm thick) with a sufficient depth of proprietary padding in between to prevent chafing and any incidental impact damage is to be placed in position especially at existing window locations before any scaffolding is erected and must remain in position until after the scaffolding has been struck.

6.1.6 Every precaution must be taken, with reference to Section 6.1.5, such as encasement before work is commenced to protect all delicate features from accidental damage or fracture.

6.1.7 External entrance doors are to be kept clear at all times to allow access. Scaffolding is to be erected and hoarded where required. The Contractor will be required to provide sketches, drawings and calculations for the proposed scaffold designs. Two layers of ply boarding with polythene sheeting in between are to be provided for the scaffold lift over the ground level and over external entrance doors or similar approved protection systems. Provide debris netting to scaffold as necessary. Timber hoarding to all vertical standards at ground level to a height of 2000mm. All hoarding is to be constructed from external quality ply and to incorporate a skirting and capping detail.

6.1.8 Fall ropes must not wear against beams and stonework, no damage is to be caused by the movement or concentrated pressure of scaffolding strutting, centring and shoring on or against stonework. Felt and bags stuffed with hay must be used to soften contact at these points and measures must be taken in these circumstances to transmit the pressure for such props over surfaces sufficient to receive it. Padded boards are to be attached to ladders resting against stonework.

6.1.9 All scaffolding must stand clear of the structure. Particular care must be taken to prevent any damage being caused by the scaffolding to the building fabric especially during erection and dismantling and all ends of putlogs adjacent to the building fabric are to be plastic capped. Existing scaffold tie ferrules/anchors are to be tested and used, where possible. All new drilled-in fixings such as anchor ties made to the wall of an historic structure must be of stainless steel and their use, minimised. Listed building consent may be needed before permanent drilled-in fixings are installed.

6.1.10 Repair / refurbishment work is generally of an architectural / aesthetic nature and are not caused by any underlying defect. Should it be suspected that there may be an underlying defect such as corroding structural steelwork, decaying timber, etc underneath the surface layers, the matter should be referred to Structural Engineer (CB) for further assessment before repairs are undertaken.

6.1.11 Repairs are always to be sympathetic with the existing external fabric of the building.

6.2 General Observations on Materials and Workmanship

6.2.1 All materials and workmanship, whether or not particularly described herein, shall be in accordance and not limited to the following current good practice and the latest edition of the relevant British Standard or other recognised Standard which applies to the work;

6.2.1.1 BS 890:1995 – Building Limes

6.2.1.2 BS ENV 459-1:2001 – Building lime: definitions, specifications and conformity criteria

6.2.1.3 BS EN 998-1 – Specification for mortar for masonry: Part 1: Rendering and plastering mortar.

6.2.1.4 BS EN 998-2:2016 – Specification for mortar for masonry-Part 2: Masonry mortar.

6.2.1.5 BS EN 1008:2002 – Mixing water for concrete - Specification for sampling, testing and assessing the suitability of water, including water recovered from processes in the concrete industry, as mixing water for concrete

6.2.1.6 BS 4551:2005 + A1:2010 - Mortar – Methods of test for mortar – Chemical analysis and physical testing

6.2.1.7 PD 6678 – Guide to the selection and specification of masonry mortar.

6.2.1.8 BS 7079:2009 – General introduction to standards for preparation of steel substrates before application of paints and related products

6.2.1.9 BS 7913:1998 – Guide to the principles of the conservation of historic buildings

6.2.1.10 BS 7913:2013 – Guide to the conservation of historic buildings

6.2.1.11 BS 8221-1:2012 - Code of practice for cleaning and surface repair of buildings – Part 1: Cleaning of natural stone, brick, terracotta and concrete

6.2.1.12 BS 8221-2:2000 – Code of practice for cleaning and surface repair of buildings – Part 2: Surface repair of natural stones, brick and terracotta

6.2.1.13 BS 8298:2010 – Code of practice for design and installation of natural stone cladding and lining

6.2.1.14 BS EN 13139:2002 – Aggregates for mortar

6.2.1.15 BS EN ISO 12696:2012 – Cathodic protection of steel in concrete (ISO 12696:2012)

6.2.2 All materials and workmanship for metal windows, leadwork, asphalt, cast iron rain water goods above ground and sealants are to NBS Specification in Section 8.

6.2.3 All workmanship is to be the best of its respective kind, carried out to the satisfaction of the Project Manager (PM) / Contract Administrator (CA) / CB where such standards may be a matter for the opinion of the PM / CA / CB, and only tradesmen skilled in the appropriate work are to be used.

6.2.4 The proprietary repair materials specified within this Specification are to be utilised. A replacement proprietary repair material shall be subject to review and approval by CB before use. The material shall meet all specified relevant features for repair material and not react detrimentally with the existing masonry or associated member of the structure being repaired.

6.2.5 Where appropriate, manufacturer's instructions for the application and use of materials must be adhered to strictly.

6.2.6 The contractor is responsible for ensuring that the materials and workmanship in the contract meet the required standards; the Final Certificate or any certificate issued by the PM / CA / CB is not intended to and shall not operate as conclusive evidence that any of the work materials or goods or workmanship conforms to description or is in accordance with the Specification.

6.2.7 All defects to be repaired shall be identified and marked out by the Contractor. These areas will be recorded on a suitably scaled drawing and documented to allow all works to be traced. This defect location and identification procedure shall be to the satisfaction of the PM / CA / CB. These will need to be developed into 'As-Builts' for the Operations & Maintenance (O&M) file.

6.2.8 All structural repair works are to be sequenced in a manner that does not impair the structural integrity of the load bearing elevations or result in damage to the elevations.

6.2.9 Cutting and non-percussion methods such as water jet cutting should be used to remove the stone and any backing masonry to expose the defective member(s) to allow for either their in-situ treatment/repairs or replacement.

6.2.10 The Contractor is responsible for the temporary works scheme as per Section 3.36 such as adequate back propping of the masonry elevations prior to commencing with any masonry removal and undertaking the necessary exploratory works to allow him to finalise his temporary works scheme.

6.2.11 Where ashlar blocks are to be removed no block is to be left vertically unsupported in its temporary condition.

6.2.12 The Contractor is to undertake appropriate sampling of "original" mortars, renders, stone and brickwork for materials assessment to determine the compatibility of replacement materials.

6.2.13 Restoration/repair works are not to be carried out until the materials assessment results (as per Section 6.2.12) have been provided for review and the Contractor has submitted for review the proposed compatible repair materials.

6.2.14 The Contractor should submit for review the following samples:

6.2.14.1 Lime mortar

6.2.14.2 Render

6.2.14.3 Stone

6.2.15 The Contractor should ensure that all masonry repairs are compatible with the original existing masonry and offer up a palette of techniques, based on their expertise and inspection of the elevations, as part of their repair methodology and tender submission.

6.2.16 Repairs to stonework requiring complete replacement or indents should be carried out using natural stone that match the original existing stone in terms of type. The original stone should be identified and enquires should be made to find out if it is still quarried. If available, the quality should be checked. If the original stone is not available, a suitable matched/compatible alternative should be chosen. The matched/compatible

alternative should be chosen geological (petrographically compatible); the durability, porosity, strength and qualities of the replacement stone should relate to its particular location; and the visual qualities such as colour and texture, although these are often most paramount from a client/user viewpoint.

6.2.17 Replaced stone should be matched to the original face of the stone and not to adjacent weathered surfaces. A rule of thumb is that if it is not causing a structural or a health and safety risk then leave it alone. Weathering issues can often be addressed by careful use of flashings.

6.2.18 Repairs to brickwork requiring replacing bricks should be carried out using bricks that match the original existing brickwork in terms of type, surface colour, texture and finish, durability and size, and a detailed specification for this must be agreed before work starts.

6.2.19 Wherever possible as much historic fabric as possible should be retained. The Contractor needs to have the adequate skills and knowledge of traditional materials and quality conservation repair.

6.2.20 Generally, brickwork that has lost its structural quality or is too badly decayed should be carefully cut out and matching replacement brickwork keyed in.

6.2.21 Replacement brickwork should be of similar dimensions of the original existing brickwork and laid to match the existing wall, unless otherwise agreed. Samples of any new brickwork to be used should be approved.

6.2.22 All fixings such as cramps, ties, pins, angles or other fabrications must be austenitic stainless steel grade 1.4401 (BS EN10088-2 and BS EN 10088-3), formerly known as 316 S31 as per BS 8298-1:2010 in Table 4 and set in appropriate synthetic adhesives, with a suitable lime mortar applied to the joints.

6.2.23 Synthetic adhesives (thixotropic epoxy resin such as Sikadur 31 Rapid or CF Normal or similar product unless otherwise indicated) to either fix detached bits of masonry or for securing fixing dowels/pins should only be used locally to the rear of the repair area.

6.2.24 Mixing and use of adhesives should only be carried out by experienced applicators, ensuring that no spillage occurs to the face of the masonry.

6.2.25 Mortar mixes should be designed to suit each individual building, location and exposure. The material, texture, colour, porosity, hardness, vapour permeability, strength and durability of the “original” construction mortar should be determined and matched prior to undertaking the work.

6.2.26 All replacement mortar should be compatible with and should match the unweathered interior of the original mortar, in composition, strength, colour, and texture, subject to the results of sample testing of the original existing mortar. Proprietary coloured mixes or colouring additives should not be used. Joints should be finished to match any specific “original” feature (e.g. lined-out or tuck pointed mortar joints in brickwork).

6.2.27 Mortar analysis will be required to determine original binder/ aggregate types, ratios, colours etc and grading of sand. EH can give advice on companies able to undertake such work, if alternative to those specified. Representative “original" mortar samples per elevation should be obtained for mortar analysis. Samples should be discreet lumps (not powder). About 40 g to 50 g per sample is usually required for comparative analysis and for reference material. At least three samples should be taken from different areas and analysed. Samples should be clearly labelled. The testing laboratory should be informed of the exact information required from analysis. The range and type of tests should be agreed prior to sampling. Chemical analysis of mortars should be undertaken in accordance with BS 4551. Interpretation of results should be closely linked with visual examinations. The type, shape and colour of aggregate particles should be determined by acid-wash separation (for non-calcareous aggregates), sieve grading, and visual examination by hand lens or low-powered microscope.

6.2.28 Aggregates should match the original as closely as possible. Sand for pointing/mortar repairs should be clean and well graded with particles to suit the substrate to be repaired. Sand should conform to BS EN 13139 with reference with BS1199 and BS 1200.

6.2.29 Water used in mortar mixes should be potable, be clean and free from detrimental amounts of oil, salt, acid, alkali, organic matter, or other deleterious substances. If mains water is not available from a Public Utility, it should otherwise be clean and should not contain material (in solution or suspension) in quantities sufficient to harm mortar or metals, or to impair durability of construction. If the water quality is not known, it should be sampled and tested in accordance with BS EN 1008:2002.

6.2.30 In general, care should be taken to anticipate and prevent damage or disfigurement to the finished work due to adverse weather such as wind, rain and frost, and direct sun.

6.2.31 For adverse weather in general, do not use frozen materials or lay masonry units on frozen surfaces.

6.2.32 For the following air temperature requirements, do not lay masonry;

6.2.32.1 In hydraulic lime:sand mortars when ambient air temperatures at or below 5°C and falling or unless it is at least 3°C and rising.

6.2.32.2 Hydraulic lime mortars must be kept damp for the first 72 hours to ensure the hydraulic set is initiated.

6.2.32.3 In non-hydraulic lime:sand mortars in cold weather, unless approval is given.

6.2.32.4 In cement gauged mortars when ambient air temperatures is at or below 3°C and falling or unless it is at least 1°C and rising. Cement gauged mortars should not be used unless approved by the PM / CA / CB.

6.2.32.5 In thin joint mortar glue when outside the limits set by the mortar manufacturer.

6.2.33 New pointing mortars should be “cured” by intermittent, fine-mist spraying with potable water for several days.

6.2.34 Temperature of masonry during curing should be above freezing until mortar has hardened.

6.2.35 For newly repaired masonry, protect at all times when work is not proceeding from rain and snow and drying out too rapidly in hot conditions and in drying winds.

6.2.36 All hollow and debonded render are to be replaced with a compatible repair material to match existing.

6.2.37 Appropriate detailing to avoid electrolytic reaction such as neoprene washers or similar will be required.

6.2.38 Full masons scaffold with allowance for adaptations to accommodate any necessary temporary works requirements.

6.2.39 The Contractor will have no internal access to the building. They will only have access if agreed with the Landlord in advance.

6.2.40 All corroded steelwork should be cleaned to Sa 2 ½ and 2-3 coats of site applied Zinga to achieve a minimum 180µm total dry film thickness (DFT) as per the manufacturer’s instructions and to conform to the ISO 12944-6: C5-M/I-High specification. ‘Zingaspray’ shall not be used. All adjacent surfaces to be adequate protected during cleaning and coating application phases. Regular DFT testing should be undertaken to prevent under and/or excessive total dry film thickness. Refer to Section 7G.

6.2.41 The Contractor would need to liaise with MGDUFF International Limited/Zingametall bvba for the first 2no. batches (1 site visit per batch) of exposed steelwork cleaning and treating so that a MGDUFF International Limited/Zingametall bvba representative can be present to monitor the activities of the operatives during the following stages as stated in the project specification:

6.2.41.1 Grit-blasting according to ISO 8501.1

6.2.41.2 De-dusting according to ISO 8502-3

6.2.41.3 Checking WFT's using the paint comb

6.2.41.4 Correctly calibrating and measuring with the electronic DFT gauge on site

6.2.41.5 Recording all measurements accurately.

6.2.42 Subsequent periodic site inspections after the first 2no. site visits is subject to the standard of documentation undertaken by the Contractor as per the MGDUFF International Limited/Zingametall bvba datasheets/instructions.

6.2.43 The installation of the ICCP modular system would not require heavy intrusive intervention other than at locations where the structural integrity of a steel member is a concern due to excessive loss of section thickness.

6.2.44 Investigations necessary to confirm beam and column sizes in sufficient locations is required to allow for the ICCP design.

6.2.45 For heritage buildings, ICCP often meet the major requirements of conservation and is fully supported by both the major statutory heritage bodies in the United Kingdom, Historic Scotland and English Heritage.

6.2.46 The ICCP system usually requires future maintenance to ensure protection of the building. Such maintenance regimens are usually specified in detail, in advance. To ensure protection of the building, a full operation and maintenance manual is produced as part of the design process.

6.2.47 An ICCP specialist with the appropriate skills in conservation, electrochemistry, and electrical installations should be engaged at an early stage to undertaken the design, installation and maintenance of the ICCP system.

6.2.48 Refer to Appendix I for a typical ICCP specification.

6.3 Elevation Cleaning

6.3.1 Cleaning should only be undertaken by trained operatives to prevent damage to the masonry facade.

6.3.2 Before cleaning commences tests should be undertaken on a small area for each type of masonry façade (stonework/brickwork) to assess the type and effectiveness of the cleaning to be carried out.

6.3.3 Undertake DOFF / TORIK steam clean to entire masonry elevations to remove surface deposits, staining and algae growth and to leave clean and uniform appearance.

6.3.4 Construct network of drainage channels to collect the water runoff from the elevation cleaning. Drainage to be connected to mains rainwater outlets.

6.3.5 The Contractor is to protect and seal all windows and doors to the elevation whilst masonry facade cleaning is undertaken.

6.3.6 Undertake cleaning by Torc spray to isolated areas of heavy staining to the masonry facade elevations only. Locations to be agreed with the PM / CA / CB on site.

6.3.7 Use UNIL Torc aggregate size to suit the specific environment and level of staining to the elevation. Micron sizes available are 80, 180, 250 and 500.

6.3.8 250 microns will be the most used size allowing for the general removal of heavy carbon staining. The Contractor to advise of areas requiring increased micron size aggregate.

6.3.9 Undertake graffiti cleaning, if required, by application of graffiti paint remover such as AGS Graffi Clean 300 by Tensid or similar proprietary products and wash off with high pressure 90°C hot water as per Tensid's specification/datasheets. Tensid provide a range of products and the aim is to find a chemical that attacks the binder in the paint. Some ghosting may require a poultice or Graffi Ghost and Graffi Rinse or similar proprietary products. Locations to be agreed with the PM / CA / CB on site.

7 Refurbishment / Repair Works

7.1 Typical Repair Types to Observed Defects

7.1.1 The typical refurbishment / repairs to the facade can be categorised as but is not limited to the following table:

Table 7-1 Typical Refurbishment/Repairs

Defect Type	Repair Type	Specification Section Reference
a) Open/cracked masonry joints (limestone or brickwork)	Re pointing of cracked / weathered / disturbed bed joints	7A
b) Cracking to masonry (limestone or brickwork)	In situ repair, stitch or pinning as necessary	7B
c) Weathered or crazed stonework (limestone or brickwork)	Limewater, lime mortar, plastic, re-dressing or chemical treatment repair techniques if affecting structural integrity.	7C
d) Decayed and complete destruction of masonry (limestone or brickwork)	Indenting / replacement of stonework (limestone, sandstone or granite) if affecting structural integrity.	7D
e) Defective previous/historic repairs (limestone or brickwork)	Assess the integrity of the previous/historic repair and re-instate the repair if deemed necessary.	7E
f) Defects around existing inserts or fixings and historic repairs where masonry is cracked.	Where caused by fixings: repair / replace fixings as necessary and undertake local repairs Where caused by inserts: remove inserts, replace if necessary / appropriate and undertake local repairs	7F
g) Defects caused by corroding steelwork behind masonry	Remove masonry façade, expose steelwork to treat / repair and reinstate masonry façade. Installation of ICCP modular system.	7G
h) Cracking, crazing, delaminated sections and paint defects to render finish	Replacement of hollow and cracked areas of render and reinstate. Carefully remove render to painted facades to confirm whether the brickwork is cracked to allow for repairing i.e. either stainless steel stitching or if cosmetic just re rendering. DOFF/abrasive or high pressure cleaning clean to rendered facades, subject to trial areas. Re-rendering painted facades Repainting masonry rendered facades	7H
i) Defects in balustrade upstands / parapets	Refurbishment of balustrades and handrails	7I

7.2 The contractor is to allow for non-intrusive exploratory works such as:

7.2.1 Impulse radar / Ground penetrating radar (GPR) scanning using a GSSI SIR3000 GPR with a 2.6GHz to 1.5GHz antenna or similar model from other manufacturers.

7.2.2 Ferro Scanning using a Hilti PS200 Ferroscan or similar model from other manufacturers.

7.2.3 Metal detector using a Protovale Imp or similar model from other manufacturers.

7.2.4 Borescope with coring

7.2.5 Core sampling to assessment moisture profiling, chloride content and sulphate content.

7.2.6 Potential wheel/Half-cell potential survey using a Proceq Canin^{+} Configuration with Rod and Wheel Electrodes or similar model from other manufacturers.

7.2.7 Polarisation resistance using a BAC Corrosion Control portable Linear Polarisation Resistance (LPR) kit with a LPR meter / Testconsult BGCMAP rate of corrosion tester or similar kits from other manufacturers.

7.2.8 Resistivity measurements using a Proceq Resipod or similar model from other manufacturers.

7.2.9 Infrared thermography

7.3 Non-intrusive exploratory works are to be completed and provided for review before the scope of repairs is agreed.

7.4 The contractor is to allow for metallurgic inspection of samples removed from steel or cast iron members within the elevations. Steel thickness assessment by coring to obtain 10-20mm core samples and by ultrasonic thickness gauge using a Olympus 38DL Plus or similar model from other manufacturers.

7.5 Where cracking or displacement of the elevations has been found to be coincident with buried steel members, or other decaying members, then the Contractor is to allow for undertaking sufficient exploratory works that allows CB to form an initial assessment on the extent of corrosion. Initially the Contractor should allow for:

7.5.1 Minimum 1 m^2 opening per location to fully expose the steelwork above the top flange and below the bottom flange and to the inner edge of the flange into the building.

7.5.2 Ashlar stone blocks circa 100-300mm thick or the ashlar block and including the backing Fletton brickwork/masonry are to be removed as part of the exploratory works.

7.5.3 Corrosion product to be preserved for measurement purposes.

7.6 Keyhole exploratory works in itself is not sufficient to assess the magnitude of decay.

7.7 It should be assumed that there are steel or concrete lintels over all openings (possibly timber lintels).

7 A Open/Cracked Masonry Joints (Limestone / Sandstone / Granite / Brickwork)

7.8 Re-pointing/Deep tamping of external masonry should be kept to the absolute minimum necessary and comprehensive re-pointing for cosmetic reasons is not acceptable. Refer to English Heritage (EH) Practical Building Conservation Technical Handbooks Volumes I & II, EH video “Making the Point: Pointing Brickwork the Traditional Way”.

7.9 For tender purpose allow for minimum 50% of the façade elevation to be re-pointed.

7.10 Stonework / Brickwork should be re-pointed or bedded in an appropriate mortar mix (that is, one weaker and more porous than the adjacent masonry and usually in a lime- based mortar).

7.11 The use of putty lime (non-hydraulic lime), rather than natural hydrated lime (NHL), should be used in the first instance, as should the preparation of coarse stuff (i.e. mixed sand and lime, kept covered until needed). Mixes should be based on the following proportions (by volume): Lime – brick/stone dust pozzolan - sand: 1:0.5:2.5. Samples of compatible mortar mixes, finishing and surface texture should be agreed, on site, prior to undertaking the work.

7.12 Making lime: sand mortars generally:

7.12.1 Batching: By volume. Use clean and accurate gauge boxes or buckets.

7.12.2 Mixing: Mix materials thoroughly to uniform consistency, free from lumps.

7.12.3 Contamination: Prevent intermixing with other materials, including cement.

7.13 Alternatively, carefully considered mixes based on hydraulic limes may be appropriate and subject to the mortar analysis of the original existing mortar as per Section 6.2.27. Feebly-hydraulic lime mortars (NHL2) with well graded coarse/sharp sands with medium and some large aggregate should be used as a bedding material; this can also be used for the final pointing mortar with a brushed finish. (1:3 = NHL2 lime or weaker : Sand/Aggregate/Brick dust.)

7.14 Making hydraulic lime: sand mortars generally:

7.14.1 Mixing: Follow the lime manufacturer's recommendations for each stage of the mix.

7.14.2 Water quantity: Only sufficient to produce a workable mix.

7.14.3 Working time: Within limits recommended by the hydraulic lime manufacturer.

7.15 The blending and use of hydraulic lime and non-hydraulic lime should not be undertaken to form a gauged lime “hybrid” mortar mix.

7.16 For brickwork only and subject to the mortar analysis of the original existing mortar as per Section 6.2.27, generally in exposed positions, the addition of cement may be appropriate, but no weaker than 1:3:12 (research has also shown that adding less than half a part of cement: lime can adversely affect the frost resistance of the mortar). Mixes stronger than 1:2:9 may be inappropriate on historic masonry.

7.17 The specification for repointing should take into consideration the time of year/ provision of skilled craftspeople/ aftercare needed and be detailed enough on items such as placing, compaction and protection of mortars to ensure high quality work. The standard of work should be clearly specified at each stage [e.g. raking out of joints (cleaning of loose, weathered mortar with hand-held, non-mechanical tools), replacement of pinnings, placement of mortar (including cleanliness of the masonry face), joint finish, finishing procedures].

7.18 The mortar from joints should be carefully raked out manually using hand tools of suitable size to fit within the joint width such as toothed masonry, plugging and jointing chisels along with padsaw/hacksaw blades or bent spikes to a depth of at least 2.5 times the width or minimum 25 mm (1"), depending upon the width of the joints but if this is not sufficient to get back to sound mortar it may be necessary to rake out to a greater depth.

7.19 After the joint has been fully raked out, all dust and debris should be vacuumed clear/flushed out, then well dampened but not saturated with clean water to limit suction and the new mortar pressed well in. Cutting out of existing mortar with a mechanical disc is not acceptable. Never use hacking hammers or cold chisels.

7.20 Where strong cement has to be removed, drilling can be used to start removal. Small diamond disc cutters may be used on regular work but only with extreme caution, with prior approval, and in exceptional circumstances, and after fixing steel rules to act as guides. Stitch drilling may be necessary to square off the ends of the cuts.

7.21 The joints should be filled with new lime mortar (subject to the mortar analysis of the original existing mortar as per Section 6.2.27) and pushed firmly into the prepared joint between the ashlar blocks/bricks, ensuring it is fully compacted into the back of the joints and finished flush. Pointing tools should fit the joint thickness. When replacing stone inserts such as pinning during repointing, the load-bearing purpose of these should be reinstated. Where mortar in joints has disintegrated to a large depth, it should be deep tamped with replacement mortar as per Section 7.27. If necessary, the joint can then be finished with a joint profile to match the stonework/brickwork.

7.22 If a weathered appearance is required, upon approval by PM / CA / CB, to match existing stonework/brickwork, a roughed texture can be produced after the initial set of the mortar has taken place by light spraying, by stiff bristle stippling or by dabbing with coarse sacking. Experience, but above all an understanding of what is required on the part of the mason/bricklayer is essential.

7.23 Joints should on no account be struck, or finished proud of the masonry face to form "strap" or "ribbon" pointing, or feathered over the edge of eroded stonework/brickwork. Care should be

taken to finish the joints to match the surrounding work and the width of the original joints should not be increased.

7.24 Where the existing masonry is generally eroded, the face of the mortar should be kept back to the point at which the joint remains the original width. Repointing should not increase the width of the original joints.

7.25 Mortar for re-pointing should be coloured by the use of appropriate sand to match the original joints before weathering. Proprietary coloured mixes or colouring additives should not be used.

7.26 Samples of mortar colour/ texture and joint finishing and the checking of depth of compaction within the joint may be appropriate.

7.27 Deep tamping

7.27.1 Deep tamping is essentially a dry packing process that is used for structural repair and where full depth reinstatement of bed joints are required.

7.27.2 Existing mortar filling of fractures and mortar joints is completely removed together with any debris in the voids behind. Remove all fine dust and debris using a vacuum cleaner or similar suitable machine. The void is then flushed through with water to reduce suction in the masonry and aid mortar curing. The void must be thoroughly wetted with water but mortar should only be placed when the masonry is damp to the touch, not glistening with water.

7.27.3 A lime mortar is prepared using sharp sand with suitably sized aggregate. The mortar is mixed to a semi-dry consistency which is crumbly when mixed but holds together when compressed in the hand. The mortar consistency is critical and experience is required. The mortar is then pushed into the back of the void and tamped into place using a tamping iron or timber. It is essential for the mortar to be pushed to the back of the void excluding any gaps. The void is then filled in mortar layers repeating the tamping process for each layer. Layers are usually built up in relatively shallow depths of about 10 or 12mm to ensure the void is completely filled without any gaps.

7.27.4 Care and experience is required since overzealous tamping can loosen masonry or even fracture stones. When correctly carried out, a durable repair is achieved preventing uncontrolled water entry and support and adhesion is provided to the surrounding masonry.

7 B Cracking to Masonry (Limestone / Sandstone / Granite / Brickwork)

7.28 All work items to stonework / brickwork including crack stitching and pinning and natural vents and calcite seams.

7.29 Where the render is cracked the Contractor is to remove the render to confirm the condition of the masonry (brick or stone) substrate. Once the condition of the masonry has been established and the appropriate repairs have been carried out, the render shall be reinstated to suit existing.

7.30 Where the crack is reflected in the brickwork the Contractor is to allow for the following repair methods having first established that there is no other underlying cause for the cracking such as corrosion of buried structural steel members, ferrous fixings or decaying timber:

7.30.1 For cracking in excess of 2 mm, cut out the damage brickwork and tooth in new brickwork of a similar quality and a mortar to be compatible with the existing.

7.30.2 An alternative to (7.30.1) may be installing HeliFix HeliBar using HeliBond or similar product within the horizontal bed joint to straddle the crack by 500 mm either side at bed joint centres and the stitch drill using resin bonded stainless steel 6 mm dowels. Refer to HeliFix product sheet for installation details.

7.30.3 For cracking less than 1 mm, stitch drill the crack using a resin injection method with stainless steel pins 8 mm diameter at centres to be agreed subject to the extent of the cracking. For tender purpose allow for pins at 75 mm centres, 250 mm long.

7.30.4 Alternately allow for installing HeliFix HeliBar using HeliBond or similar product within the bed joint at every other bed joint straddling the crack by 500 mm. Refer to HeliFix product sheet for installation details.

7.31 Where the crack is 0.3 mm or greater and less than 3 mm is reflected in the natural stone the Contractor is to allow for the following repair methods having first established that there is no other underlying cause for the cracking such as corrosion of buried structural steel members, ferrous fixings or decaying timber:

7.31.1 Generally the intention will be to stitch drill the fractured stone blocks using resin injection to chemically fix typically 8 mm diameter by 150mm long stainless steel pins at circa 100mm cross centres 250 mm long and the crack filled with a non-shrink thixotropic epoxy resin such as Sikadur 31 Rapid or CF Normal and finished with lime mortar.

7.31.2 Where the cracking is deemed to be excessive (greater than 3 mm) then the stone is to be locally cut either side of the crack and a new indent of matching stone installed which is to be resin stitched using 8 mm diameter stainless steel pins and restraining clamps to the adjacent retained undisturbed stone and if necessary also pinned back to the backing masonry.

7 C Weathered or Crazed Masonry (Limestone / Sandstone / Granite / Brickwork)

Limewater and lime mortar repair techniques

7.32 Limewater and lime mortar repair techniques can be used to consolidate the stonework that has weathered and/or crazed.

7.33 Lightly clean the area of stonework to be consolidated using hand held sprays of clean water, with small bristle brushes, to remove soiling and pollution layers; use toothbrushes on areas of fine detail to avoid the risk of damage or stone loss. Avoid over cleaning.

7.34 Carefully remove soft decayed stone, picking soft material from behind exfoliated layers with dental picks, back to sound material capable of consolidation. Then apply limewater by mopping each coat after saturation to avoid lime bloom.

7.35 Provide temporary soft lime mortar packing behind fragile exfoliation during consolidation to avoid loss. Where the exfoliated stone may have distorted the line of any carving or moulding, then it may be appropriate to cut off the exfoliated skin locally, to set on one side for later reaffixing to the surface of the moulding in the proper line, in consultation with the PM / CA / CB.

7.36 Mortar repairs are to be kept recessed from the surrounding work, either mouldings carving or plain ashlar, cut in at edges and packed under overhanging or exfoliated skins, and modelled to replicate decayed surfaces. No attempt is to be made to build up the mortar to copy mouldings.

Plastic/Mortar Repairs for stonework

7.37 Mortars should only be used for minor repairs.

7.38 The stone repair mortar must have the same or similar properties to the stonework surrounding it. It needs to have similar rates of expansion and contraction and, crucially, it must allow any trapped moisture to evaporate. The most important factor is the porosity of the mix with the natural ingredients being chosen to provide colour match, etc. Allow for carrying out trials of mixes for approval prior to the commencement of work. Refer to Section 6.2.12, 6.2.13 and 6.2.15.

7.39 Lime based mortar repairs are to be undertaken in the first instance, these require skill but because of their porosity they form less of a barrier to moisture movement.

7.40 Sand cement based mortars used in the past can be counterproductive, removing original stone as they fall off or hastening decay. They will not be permitted on listed buildings. Care should also be taken with resin based alternatives that they are not too strong for a particular stone. Resin based mortar alternatives should not be used without prior approval by PM / CA / CB.

7.41 Provide plastic/mortar repairs over sunk or consolidated decayed areas in lime mortar, mixed to match the colour of the native stone. Natural earth pigments and burnt sienna may be used to achieve good colour match. Allow for carrying out trials of mixes for approval prior to the commencement of work.

7.42 Prepare trial mixes as dry as possible, cover and allow for a drying period before inspection and approval.

7.43 Correct cutting back to a rectilinear surface shape and preparation is required to find suitable sound stone. Decayed surfaces should be cut back, a minimum depth of 25mm, to a sound and even base and the new surface well keyed. All edges should be as sharp as possible and slightly undercut to avoid feathered edges (except for the bottom edge, which should be straight cut). Edges of repairs should be parallel to the existing jointing.

7.44 Original joints and stone profiles should be retained and pointed as original stones, maintaining the jointing system. Mortar joints are not to be scratched into larger areas of the plastic/mortar repair.

7.45 A mechanical method of fixing as opposed to chemical bonding agents is required for plastic/mortar repairs and the depth of mortar repair should take into account the required cover to the fixing. Stainless steel cramps/pins/wires are required to form the mechanical key with successive 10mm thick layers of mortar build-up to form a composite repair and consolidated thoroughly to minimise shrinkage problems.

7.46 Mortar repairs for stonework are to be kept recessed from the surrounding work, either mouldings carving or plain ashlar, cut in at edges and packed under overhanging or exfoliated skins, and modelled to replicate decayed surfaces. No attempt is to be made to build up the mortar to copy mouldings. Tooling marks and other patterns of the original stone should be reproduced.

Re-dressing

7.47 When surface failure has occurred a technique sometimes considered is re-dressing of the stonework to its original profile. It is a skilled stone mason's task. It is also possible to reface chemically consolidated stonework as discussed above particularly rockfaced walling that has deteriorated on the face. Generally only 25-30 mm of the decay stone is removed to allow realignment to the original profile and is used for decayed stone that is particularly deeply bedded within the wall which has minimal decay, yet is disfigured. Doorcases and window cills are some particular examples. This technique should not just be considered as a cosmetic exercise. Care should be taken to recreate tooling and detail lost by the process. Disk marks are

often the result of poor application of this technique. Hand held disc cutters rarely provide a satisfactory result.

Chemical Treatments

7.48 These should only be considered as a last resort and should be based upon detailed analysis. Experience has shown that the long term effects will be hard to quantify. In common with 'plastic' repairs this technique offers a method of repair that can be seen as 'economic', but long term problems if not used with care can exacerbate the costs of future maintenance. If such a technique is considered it is vital that detailed records of the application are kept for future reference. The main current area of use in Northern Ireland is with sandstones, particularly the poorer quality ones, eg, Scrabo stones which can exhibit large scale areas of decay and surface dusting/scaling.

7.49 There are two techniques of chemical treatment - consolidants and water repellants.

Consolidants

7.49.1 These aim to restore the binding element in the stone matrix thus reclaiming the strength of the original stone. Whilst the application of the chemicals is comparatively simple and does not require traditional stone masonry skills, the technique must never be undertaken without a thorough laboratory test programme. This identifies the geology, and physical and chemical properties of the stone, in order to allow assessment of a suitable chemical choice and to determine the reaction and depth of penetration. This establishes a hardness profile which is consistent through the depth of the stone, yet does not restrict the porosity of the stone itself.

Water repellents

7.49.2 These may be necessary for water protection, which again must be fully tested prior to application to control water related decay mechanisms. These systems must never be viewed as 'cure alls'. Their use must be well researched and evaluated.

7.49.3 All surface applied techniques are at the mercy of the operative applying them and they rarely penetrate more than 25 mm. They may cause a chemical change between this outer layer and the rest of the stone hastening decay mechanisms at the interface.

7.49.4 Water repellents are likely to need to be reapplied on a regular timespan. There is a real danger that once water gets behind this surface it will be trapped in the wall adding to damp and decay problems in the long term.

7.49.5 The associated chemistry and geology may be well beyond many professional architect's traditional fields of expertise. Laboratory and site testing with specialist personnel is strongly recommended.

7 D Complete Replacement or Indenting of Stonework/Brickwork

Complete Stone Replacement

7.50 Complete replacement with new stone can be either newly quarried stone or salvaged stone.

7.51 This is usually only undertaken when failure of the original stone is such that none of the other techniques can be applied, and is often associated with large-scale failure due to fracturing or large scale spalling where it has created large losses of stone.

7.52 Replacement stone should match the original face of the stone.

7.53 All areas are to be fully recorded by the Contractor using photography and marked up record drawing prior to removing stonework, noting position of stones, the nature and style of the stone and style of the bedding and pointing. All materials resulting from taking down operations are to be carefully handled, salvaged stored on site. They will remain the property of the Landlord until such time as they are instructed specifically for disposal.

7.54 Release stones by cutting out jointing material, cutting through anchors, fixings and the like and easing/levering stones from their backing, by adopting such methods necessary to prevent damage to stones being removed and surrounding work. Use manual tools only, i.e. chasing chisels and hacksaws. Power tools will not be permitted. Suppress dust by adequate sprinkling of water. Notify the PM/ CA / CB of any signs of structural movement found within the masonry elevation when stones have been removed.

7.55 Thoroughly clear out void using hand tools and brushes. Temporarily support surrounding work. Cut out and remove, label and set aside on site existing corroded cramp/cramps from stone and bed. Provide new stainless steel cramps to match those removed and fix.

7.56 Thoroughly clean stones set aside/stored for reuse to the approval of the PM /CA/CB removing any remaining adhering mortar. Move and handle stones, loading, unloading, and lowering or hoisting into position by adopting such methods necessary to prevent damage to stones. Provide to masons copies of all photographs, records etc necessary for the accurate resetting on the stones.

7.57 When laying replacement stone units, the following are to be adhered to:

- 7.57.1 Exposed faces of new material: Keep to agreed face lines.
- 7.57.2 Faces, angles and features: Align accurately. Set out carefully to ensure satisfactory junctions with existing masonry and maintain existing joint widths.
- 7.57.3 Joint surfaces: Dampen to control suction as necessary.
- 7.57.4 Laying units: On a full bed of mortar, all joints filled.
- 7.57.5 Exposed faces: Keep clear of mortar and grout.

Stone Indenting

7.58 In essence indenting is a variation of the complete stone replacement system when individual stones are being considered for either total replacement or refacing.

7.59 Selection of a suitable new stone is again important, the geological match being critical.

7.60 The identified damaged stone should be cut out in a rectilinear surface shape of appropriate depth to expose sound stone removing any damaged or decaying material. The area cut out must be a minimum depth of 50 mm in thickness and a maximum depth of 100mm and is dependent on the amount of decay on the existing stone. Where damaged areas of stone are deeper than 100mm consideration should be given to full stone replacement.

7.61 The new piece of stone should fit the prepared cavity exactly with no joint between the edges of the repair within the block and secured with resin bonded fixings.

7.62 Fixings must be chemically resined stainless steel pins with a suitable mortar applied to the joints. Resin should be used only to secure pins; the new stone should be bedded and jointed using fine-grained lime mortar. It is important that any mortar to the rear of the indent is lime rich and does not create a barrier to moisture transfer.

7.63 Good practice usually means that a complete face of the original stone is replaced.

7.64 However, small localised repairs can also be undertaken using this technique to replace broken elements. Care needs to be taken to consider the overall aesthetic impact of such work on a building.

7.65 The main advantage of this refacing technique is that it is only a facial repair and less disruptive than having to remove the whole stone from the body of the wall. Some stone features like cornices are tied deep into an inner wall and the consequent structural considerations of replacement are avoided.

Complete Brickwork Replacement

7.66 Weathered, decayed or damaged bricks should be cut out carefully, usually of whole bricks, using hand tools only and replaced with sound replacement bricks to match the existing original in size, type, colour, texture and durability.

7.67 The surrounding joints may need to be removed first, particularly if they are in cement-rich mortar. This should be done with quirks and long necked jointing chisels with parallel faces, not wedge shaped chisels which damage the arrises. The cavities and bricks are dampened as necessary to reduce suction, but with engineering bricks the suction is so low that dampening may be unnecessary. Replacement bricks are placed on a mortar bed with lead or slate packing as necessary. The side and top joints are then packed solid with mortar and pointed up. Where

the replacements form a patch of several bricks, temporary supports or wedges may be needed to prevent the masonry from collapsing.

7.68 Where structurally necessary, agreed areas of unsound brickwork should be carefully re-built, re-using the existing bricks where possible. “Plastic” or mortar repairs are not to be used.

Plastic Repairs for brickwork

7.69 Plastic or mortar repairs for brickwork are not to be undertaken in lieu of complete brickwork replacement under any circumstances.

7 E Defective Previous/Historic Repairs

7.70 If visible delamination of previous repair, and / or visible breakdown of previous repair, removed defective area and address as Section 7A to 7D above as appropriate.

7.71 If no visible delamination, hammer test to detect whether bonding to substrate remains sound. If hollow, refer to CB for further advice.

7 F Defects around Existing Fixings or Inserts and Historic Repairs where Masonry is cracked

7.72 Corroded iron or steel cramps or dowels/pins that have fractured masonry by expansion should, unless otherwise indicated, be removed and replaced with austenitic stainless steel (SS) fixings grade 1.4401 (BS EN10088-2 and BS EN 10088-3), formerly known as 316 S31 as per BS 8298-1:2010 in Table 4 and set in appropriate synthetic adhesives such as Sikadur 31 Rapid or CF Normal.

7.73 New masonry fixings (anchor bolts, armatures, cramps, dovetail slots, dowels, pins, wall ties or other reinforcement) should also be austenitic stainless steel (SS) grade 1.4401 (BS EN10088-2 and BS EN 10088-3), formerly known as 316 S31 as per BS 8298-1:2010 in Table 4.

7.74 Undertake repairs such as crack stitching and or pinning where necessary as per Section 7B above as appropriate.

Modillions, Dentils and other decorative features

7.75 Sufficient exploratory works are to be undertaken by the contractor to allow finalisation of repair detail in advance of any works commencing.

7.76 Generally the intention will be to secure all modillions, dentils and other decorative features back to the cornice stone, stone mullions and/or oriel windows stone with resin bonded fixings.

7.77 Fixings must be chemically anchored threaded stainless steel pins/bars. Resin should be used only to secure pins/bars.

7.78 Where there are cracks or joints at the interface between the modillion/scroll and other decorative features and the cornice stone, stone mullions and/or oriel windows stone, a suitable mortar should be applied to the cracks/joints as per Section 7A and 7B.

7 G Defects Caused by Corroding Steelwork behind Facing Stonework

7.79 All work items to stonework with a structural implication including wholesale block replacements and partial rebuilding to be repaired / refurbished as per Section 7A to 7D above as appropriate.

Treating and Painting Corroding Steelwork

7.80 Carefully dismantle stonework to expose embedded corroding steelwork.

7.81 Fully expose the flange and toes of the flange in the case where the flange is parallel with the face or the web, insides of the flange, toes and 25-30mm of the outside of the flange where the web is parallel with the face.

7.82 Surface preparation of all corroded steelwork surfaces should be in accordance with the Zinga Technical Data Sheet as provided by MGDUFF International Limited.

7.83 Steam-clean to degrease and remove all contamination from porous surfaces.

7.84 Exposed steelwork shall be grit blasted in accordance with ISO 8501-1: 2007 to Sa 2 ½ or to the cleanliness degree as described in the standards SSPCSP10 and NACE nr 2.

7.85 This means that the steel surface must be free from rust, grease, oil, paint, salt, dirt, mill scale and other contaminants.

7.86 After grit blasting has been completed, the surface should be de-dusted with non-contaminated compressed air according to the standard ISO 8502-3 (class 2).

7.87 The surface profile shall have a roughness grade of fine to medium G (Rz 50 to 70 µm) according to the standard ISO 8503-2:2012, and should be in the middle of the given range.

7.88 The abrasive used for blasting shall be clean, dry and free from oil and other contamination. Slag or abrasives containing free silica shall not be used for blasting.

7.89 All adjacent surfaces to be adequate protected during cleaning and coating application phases.

7.90 Paint with four site applied coats of ‘Zinga’ one-component anti-corrosion zinc coating system to manufacturer’s instructions to achieve a minimum DFT of 180 µm and to conform with the ISO 12944-6: C5-M/I-High specification to qualify for a 20-year product-quality guarantee by MGDUFF International Limited. ‘Zingaspray’ shall not be used.

7.91 Install original stonework where possible, or new, where damaged, stone to original details with stainless steel restraint fixings and any necessary site welding.

7.92 A 10mm steel plate is to be welded to the flanges of the steelwork with a 8mm continuous fillet weld where found to be excessively corroded.

7.93 Where cornice / parapet beams require strengthening due to excessive loss of cross section from corrosion, the Contractor is to allow for 10mm mild steel plates with 8mm continuous fillet weld to top and bottom flanges and web (full width / full depth) assuming plate lengths equivalent to 20% of each beam length. SW is to provide a cost per beam which will be pro rata to agree a total final cost on completion of the works. Prior to site welding of existing steel the steel is to be inspected for laminar tearing by the use of ultrasound.

7.94 Remove rivets from corroded portion of steel and cut out section to be replaced with new plate. Install new plate to match existing and replacing the rivets with close fit grade 8.8 black bolts.

7.95 Where the new plate abuts to the existing, a butt weld is applied across the joint.

7.96 A welding procedure/methodology is to be submitted for review before commencement of site welding.

7.97 A 20mm soft void is to be left around the steel and to prevent this filling with snots, it is to be filled with Aerofil with taped joints. Include for lifting beams over obstructions for distribution at roof level.

Impressed Current Cathodic Protection (ICCP) System

7.98 ICCP recommendation would be to provide full protection of the designated steel beams and columns of the front entrance and tower façade elevations of Great Queen Street and Wild Street within this phase of remedial works (RSD3) from ground level to roof level (Elevations B, C, D, E, F, G, H, J, Q & Z as per elevation drawings in Appendix F).

7.99 The ICCP system shall be divided into zones across the building to provide independent control of protection current to distinct areas of the building.

7.100 ICCP system finalised locations would be subject to the site findings from the non-intrusive and intrusive investigations and Specialist Contractor/Sub-Contractor Design.

7.101 The design, the installation, the energizing, the commissioning and the long-term operation of all of the elements of cathodic protection systems for the structural steel frames shall be fully documented and comply with the relevant standards and code of practices.

7.102 The design considerations of the detailed design of the ICCP system should include, as a minimum, the following:

7.102.1 Detailed calculations including electrical calculations,

7.102.2 Detailed installation drawings,

7.102.3 Detailed material and equipment specifications including:

7.102.3.1 The area of steel to be protected,

7.102.3.2 Continuity bonding,

7.102.3.3 Distribution of anodes and zoning,

7.102.4 Detailed method statements or specifications for installation, testing, energizing, commissioning and operation,

7.102.5 Monitoring and control, and

7.102.6 Masonry removal and replacement.

7.103 Refer to Appendix I for a typical ICCP specification and drawings.

Window / Door heads

7.104 Where there is an underlying cause found for the cracking such as corroding steelwork or decaying timber lintel the following should be allowed for.

7.105 The stone is to be carefully removed to expose the supporting structural member.

7.106 The contractor is to allow for adequate back propping of the masonry elevations prior to commencing with any stone removal and undertaking the necessary exploratory works to allow him finalise his temporary works scheme.

7.107 In advance of any works commencing method statements are to be submitted to the CA / CB for approval.

7.108 The stone is to be removed in a manner that allows the re use of any undamaged stone wherever possible.

7.109 Where it is unavoidable that some stone has to be damaged then moulds need to be taken to allow for the accurate manufacture of the replacement stone(s).

7.110 Cutting and non-percussion methods should be use to remove the stone and any backing masonry should be carefully removed using needle guns to expose the defective member(s) to allow for either their in-situ treatment or replacement.

7.111 The method of back propping is the suit the contractors preferred method of sequencing but taking cognisance of any restrictions / limitations mentioned within the contract.

7.112 Where decaying timber lintels have been found, these need to be replaced with the appropriate concrete lintels.

Cornice / Parapets

7.113 Sufficient exploratory works are to be undertaken by the contractor to allow finalisation of repair detail in advance of any works commencing.

7.114 In the event of some local steel framing been identified at cornice / parapet level then the contractor should allow for the following works:

7.114.1 The stone is to be carefully removed to expose the supporting structural member.

7.114.2 The contractor is to allow for adequate back propping of the masonry elevations prior to commencing with any stone removal and undertaking the necessary exploratory works to allow him finalise his temporary works scheme.

7.114.3 In advance of any works commencing method statements are to be submitted to the CA / CB for approval

7.114.4 The stone is to be removed in a manner that allows the re use of any undamaged stone wherever possible.

7.114.5 Where it is unavoidable that some stone has to be damaged then moulds need to be taken to allow for the accurate manufacture of the replacement stone(s).

7.114.6 Cutting and non-percussion methods should be use to remove the stone and any backing masonry should be carefully removed using needle guns to expose the defective member(s) to allow for either their in-situ treatment or replacement.

7.114.7 The method of back propping is the suit the contractors preferred method of sequencing but taking cognisance of any restrictions / limitations mentioned within the contract.

7.114.8 Cornices can be particularly challenging with regard their temporary stability particularly where they rely on gravity loads from above to restrain them. Removal of the stone to expose supporting steel or reinforced concrete members may in itself de-stabilise the assembly and for this reason it is important the contractor fully considers all outcomes particularly with regard temporary stability.

7.114.9 Re assembling the cornice will equally require detailed consideration and the contractor is to allow for all necessary stainless steel fixings such as HeliFix HeliBar or similar product back to the main structure and provide all necessary calculations to justify the method of support and submit to the CA / CB for comment and to building control for approval.

7.114.10 The cracked joints to the parapet capping stones are to be resin stitched using 8 mm stainless steel threaded rods and clamped / pinned to the ornate supporting stone columns. The contractor is also to allow for installing vertical threaded stainless steel rods set in resin tying the capping stone, supporting balustrade and supporting plinth together.

Entablature

7.115 In the event of some local steel framing been identified at / or within the entablature level then the contractor should allow for the following works:

7.115.1 The stone is to be carefully removed to expose the supporting structural member.

7.115.2 The contractor is to allow for adequate back propping of the masonry elevations prior to commencing with any stone removal and undertaking the necessary exploratory works to allow him finalise his temporary works scheme.

7.115.3 In advance of any works commencing method statements are to be submitted to the CA / CB for approval

7.115.4 The stone is to be removed in a manner that allows the re use of any undamaged stone wherever possible.

7.115.5 Where it is unavoidable that some stone has to be damaged then moulds need to be taken to allow for the accurate manufacture of the replacement stone(s).

7.115.6 Cutting and non-percussion methods should be use to remove the stone and any backing masonry should be carefully removed using needle guns to expose the defective member(s) to allow for either their in-situ treatment or replacement.

7.115.7 The method of back propping is the suit the contractors preferred method of sequencing but taking cognisance of any restrictions / limitations mentioned within the contract.

7.115.8 Entablature can be particularly challenging with regard their temporary stability particularly where they rely on gravity loads from above to restrain them. Removal of the stone to expose supporting steel or reinforced concrete members may in itself de-stabilise the assembly and for this reason it is important the contractor fully considers all outcomes particularly with regard temporary stability.

7.115.9 Re assembling the entablature will equally require detailed consideration and the contractor is to allow for all necessary stainless steel fixings such as HeliFix HeliBar or similar product back to the main structure and provide all necessary calculations to justify the method of support and submit to the CA / CB for comment and to building control for approval.

Existing Balustrades and Handrails

7.116 The existing railings are to be carefully removed to allow the stone plinths be reconstructed with new and retained stone.

7.117 The fixing of the handrail will need to be modified as its current base fixing detail is not adequate due to it been insufficiently anchored to resist lateral loading.

7.118 The vertical posts will need to be fixed to base plates secured to the head of the retaining wall with a “stool” post extending up to receive the vertical posts.

7.119 Each plinth stone will also need to be mechanically secured to the head of the retaining wall using 10mm stainless steel threaded rods set in resin and plates.

Stucco / Rendered Elevations

7.120 Contractors are to allow for a tapping survey to identify all hollow areas and identify on the elevation drawings for submittal to the CA / CB.

7.121 Non-intrusive inspections may detect widespread mesh type steel – possibly expamet. This may prevent any clear detection of buried steel lintels over window heads and at cornice locations. For this reason the contractor is to allow undertaking repairs as specified in the Window / Door heads Section above.

7 H Cracking, Crazing, Delamination and Paint Defects to Render Finish

Rendering

7.122 Re-rendering and render repairs generally should be carried out in a lime mortar mix or an appropriate mix based on an analysis of original material.

7.123 The mix and character chosen should match the strength of the original rendering or stucco, unless otherwise agreed.

7.124 New rendering should generally be applied in three coats, and no metal beads or stops should be used externally; arises and angles should be formed in the traditional manner. Cracks in existing render should be cut back to the masonry face and the surrounding render undercut to provide a key. Coursing (or blocking) lines should be reinstated in areas of new render, where appropriate.

7.125 Samples of new render should be agreed before the commencement of work.

7.126 Consideration should be given to the moisture content of the masonry where cement based render has been removed - and possible drying out time needed before re-coating.

7.127 Cornices, window surrounds and other mouldings should be re-run in situ with a template in the traditional manner, building up in coats to the full original profile and accurately formed: mouldings should be copied from an undamaged existing section cleaned of all paint. It is important for all existing features requiring repair to be recorded by photographs, drawings and templates, if necessary, before work starts.

7.128 Subsequent redecoration of rendered areas should be with traditional lime wash/silicate paints/alkyd oil paints where appropriate (n. b. mineral paint may bond irreversibly to an historic substrate and may sometimes be inappropriate): otherwise, with a smooth, water-permeable masonry paint system. Textured or impermeable sprayed coatings are not acceptable. The proposed colour scheme for redecoration should be agreed.

7 I Refurbishment of Balustrades and Handrails

7.129 Decorative ironwork, such as railings, should be carefully repaired in a technique and the same material i.e. cast or wrought iron and not mild steel. If absolutely necessary, features may be

reinstated accurately to the original pattern and detail, in a similar material (unless otherwise agreed). Existing decorative ironwork requiring repair or replacement should be recorded by photographs or drawings before work starts, and the existing paint finish analysed to determine the original colour scheme. Drawings for any new/replacement ironwork will be required for approval.

7.130 New or repaired ironwork should be painted with a gloss, or other technically appropriate paint system, to the original colour scheme. Any alternative colour scheme proposed should be agreed.

8 NBS Specification

- **H71 - Leadwork**
- **J21 - Asphalt**
- **L10 - Windows**
- **R10 - Drainage – cast iron rainwater goods above ground**
- **Z22 - Sealants**

H71 Lead sheet fully supported roof coverings/ flashings

430 COVER FLASHINGS To asphalt and stone joint

- Lead:
  - Thickness: Code 8.
- Dimensions:
  - Lengths: Not more than 1000 mm.
  - End to end joints: Laps of not less than 100 mm.
  - Overlap to upstand: Not less than 50 mm.
  - Cover to roof: Not less than 75 mm.
- Fixing: Lead wedges into bed joint, clips to lead upstand at laps and 500 mm centres.

470 FLASHINGS Generally

- Lead:
  - Thickness: code 8.
- Dimensions:
  - Lengths: Not more than 1500 mm.
- Fixing: Fixing: Nail top edge at 150 mm centres and welt edge. Clip bottom edge at laps and 500 mm centres.

GENERAL REQUIREMENTS/ PREPARATORY WORK

510 WORKMANSHIP GENERALLY

- Standard: To BS 6915 and latest edition of 'Rolled lead sheet. The complete manual' published by the Lead Sheet Training Academy.
- Fabrication and fixing: To provide a secure, free draining and completely weathertight installation.
- Operatives: Trained in the application of lead coverings/ flashings. Submit records of experience on request.
- Preforming: Measure, mark, cut and form lead prior to assembly wherever possible.
- Marking out: With pencil, chalk or crayon. Do not use scribers or other sharp instruments without approval.
- Bossing and forming: Straight and regular bends, leaving sheets free from ripples, kinks, buckling and cracks.
- Solder: Use only where specified.
- Sharp metal edges: Fold under or remove as work proceeds.
- Finished work: Fully supported, adequately fixed to resist wind uplift but also able to accommodate thermal movement without distortion or stress.
  - Protection: Prevent staining, discolouration and damage by subsequent works.

516 LEADWELDING

- In situ welding: Is permitted, subject to completion of a 'hot work permit' form and compliance with its requirements.

520 LEAD SHEET

- Production method:
  - Rolled, to BS EN 12588, or
  - Machine cast and BBA certified, or
  - Sand cast, from lead free from bitumen, solder, other impurities, inclusions, laminations, cracks, air, pinholes and blowholes; to code thicknesses but with a tolerance (by weight) of ±10%.
- Identification: Labelled to show compliance with the harmonized standard (hEN) BS EN 14783, where appropriate, and detail of the thickness/ code, weight and type.

580 EXISTING METAL REUSED

- Type/ Location/ Extent: Existing roofs and flashings.
- Handling/ Storage: Keep for reuse in the Works.

585 EXISTING METAL REMOVED TO REMAIN THE PROPERTY OF THE EMPLOYER

- Type/ Location/ Extent: Existing roofs and flashings.
- Removal: Give notice when the metal is to be stripped.
  - Handling/ Storage: Keep for reuse by the Employer.

610 SUITABILITY OF SUBSTRATES

- Condition: Dry and free of dust, debris, grease and other deleterious matter.

620 PREPARATION OF EXISTING TIMBER SUBSTRATES

- Remedial work: Adjust boards to level and securely fix. Punch in protruding fasteners and plane or sand to achieve an even surface.
- Defective boards: Give notice.
- Moisture content: Not more than 22% at time of covering. Give notice if greater than 16%.

625 EXISTING MEMBRANE

- Defective, unsuitable or missing membrane: Give notice.

627 EXISTING AVCL

- Defective, unsuitable or missing AVCL: Give notice.

640 TIMBER FOR USE WITH LEADWORK

- Quality: Planed, free from wane, pitch pockets, decay and insect attack (ambrosia beetle excepted).
- Moisture content: Not more than 22% at time of fixing and covering. Give notice if greater than 16%.
- Preservative treatment: Organic solvent as section Z12 and Wood Protection Association Commodity Specification C8.

650 LAYING UNDERLAY

- Handling: Prevent tears and punctures.
- Laying: Butt or overlap jointed onto a dry substrate.

  - Fixing edges: With copper or stainless steel staples or clout nails.
  - Do not lay over roof edges but do turn up at abutments.
- Wood core rolls: Fixed over underlay.
- Protection: Keep dry and cover with lead at the earliest opportunity.

FIXING LEAD

705 HEAD FIXING LEAD SHEET

- Top edge: Secured with two rows of fixings, 25 mm and 50 mm from top edge of sheet, at 75 mm centres in each row, evenly spaced and staggered.
- Sheets less than 500 mm deep: May be secured with one row of fixings, 25 mm from top edge of sheet and evenly spaced at 50 mm centres.

710 FIXINGS

- Nails to timber substrates: Copper clout nails to BS 1202-2, or stainless steel (austenitic) clout nails to BS 1202-1.
  - Shank type: Annular ringed, helical threaded or serrated.
  - Shank diameter: Not less than 2.65 mm for light duty or 3.35 mm for heavy duty.
  - Length: Not less than 20 mm or equal to substrate thickness.
- Screws to concrete or masonry substrates: Brass or stainless steel.
  - Diameter: Not less than 3.35 mm.
  - Length: Not less than 19 mm.
  - Washers and plastic plugs: Compatible with screws and lead.
- Screws to composite metal decks: Self tapping as recommended by the deck and lead manufacturer/ supplier for clips.

715 CLIPS

- Manufacturer: Submit proposals.
- Material:
  - Lead clips: Cut from sheets of same thickness/ code as sheet being secured.
  - Copper clips:
    Thickness: 0.70 mm.
    Temper: BS EN 1172, designation R220 in welts, seams and rolls, R240 elsewhere; dipped in solder if exposed to view.
  - Stainless steel clips:
    Thickness: 0.71 mm.
    Grade: BS EN 10088-1, 1.4301(304) terne coated if exposed to view.
- Dimensions:
  - Width: 50 mm where not continuous.
  - Length: To suit detail.
- Fixing clips: Secure each to substrate with either two screw or three nail fixings not more than 50 mm from edge of lead sheet. Use additional fixings where lead downstands exceed 75 mm.
- Fixing lead sheet: Welt clips around edges and turn over 25 mm.

760 CONTINUOUS CLIPS

- Material:
  - Lead continuous clips:
    Thickness: To match existing.
  - Copper continuous clips:
    Thickness: To match existing.
    Temper: BS EN 1172, designation R220 in welts, seams and rolls, R240 elsewhere.
  - Stainless steel continuous clips:
    Thickness: To match existing.
    Grade: BS EN 10088-1, 1.4301(304).
- Dimensions:
  - Width: To suit detail.
- Fixing clips: Secure at required locations as agreed with Clarkebond.
- Fixing lead sheet: Welt edge around continuous clip and dress down.

770 WEDGE FIXING INTO JOINTS/ CHASES

- Joint/ chase: Rake out to a depth of not less than 25 mm.
- Lead: Dress into joint/ chase.
  - Fixing: Lead wedges at not more than 450 mm centres, at every change of direction and with at least two for each piece of lead.
- Sealant: Submit proposals.
  - Application: As section Z22.

780 WEDGE FIXING INTO DAMP PROOF COURSE JOINTS

- Joint: Rake/ cut out under damp proof course to a depth of not less than 25 mm.
- Lead: Dress lead into joint.
  - Fixing: Lead wedges at not more than 450 mm centres, at every change of direction and with at least two for each piece of lead.
- Sealant: Submit proposals.
  - Application: As section Z22.

JOINTING LEAD

810 FORMING DETAILS

- Method: Bossing or leadwelding except where bossing is specifically required.
- Leadwelded seams: Neatly and consistently formed.
  - Seams: Do not undercut or reduce sheet thickness.
  - Filler strips: Of the same composition as the sheets being joined.
  - Butt joints: Formed to a thickness one third more than the sheets being joined.
  - Lap joints: Formed with 25 mm laps and two loadings to the edge of the overlap.
- Bossing: Carried out without thinning, cutting or otherwise splitting the lead sheet.
  - Details where bossing must be used: As directed by Clarkebond.

830 STANDING SEAM JOINTS

- Joint allowance: 100 mm overlap, 75 mm underlap and copper or stainless steel clips at not more than 750 mm centres.
- Forming joint: Welt overlap and clips around underlap, loosely turn over to form a standing seam of consistent cross section.

840 WOOD CORED ROLL JOINTS WITHOUT SPLASH LAP

- Wood core:
  - Size: 45 x 45 mm round tapering to a flat base 25 mm wide.
  - Fixing to substrate: Brass or stainless steel countersunk screws at not more than 300 mm centres.
- Undercloak: Dress half way around core.
- Copper or stainless steel clips: Fix to core at not more than 450 mm centres. Do not restrict thermal movement of the undercloak.
- Overcloak: Dress around core with edge welted around ends of clips, finishing 5 mm clear of main surface.

845 WOOD CORED ROLL JOINTS WITH SPLASH LAP

- Wood core:
  - Size: 45 x 45 mm round tapering to a flat base 25 mm wide.
  - Fixing to substrate: Brass or stainless steel countersunk screws at not more than 300 mm centres.
- Undercloak: Dress three quarters around core.
  - Fixing: Nail to core at 150 mm centres for one third length of the sheet starting from the head.
- Overcloak: Dress around core and extend on to main surface to form a 40 mm splash lap.

847 HOLLOW ROLL JOINTS

- Joint allowance: 125 mm overcloak and 100 mm undercloak.
- Copper or stainless steel clips: Fix to substrate at not more than 450 mm centres.
- Overcloak: Welt with clips around undercloak to form a roll of consistent cross section.

860 DRIPS WITH SPLASH LAPS

- Underlap: Dress into rebate along top edge of drip.
  - Fixing: One row of nails at 50 mm centres on centre line of rebate.
- Overlap: Dress over drip and form a 40 mm splash lap.

862 DRIPS WITH SPLASH LAPS

- Underlap: Dress up full height of drip upstand.
  - Fixing: Two rows of nails to lower level substrate, 25 mm and 50 mm from face of drip. At 75 mm centres in each row, evenly spaced and staggered. Seal over nails with a soldered or leadwelded dot.
- Overlap: Dress over drip and form a 75 mm splash lap.
  - Fixing: Lead clips, leadwelded to underlap, with not less than one per bay.

865 DRIPS WITHOUT SPLASH LAPS

- Underlap: Dress into rebate along top edge of drip.
  - Fixing: One row of nails at 50 mm centres on centre line of rebate.
- Overlap: Dress over drip to just short of lower level.

880 WELTED JOINTS

- Joint allowance: 50 mm overlap and 25 mm underlap.
- Copper or stainless steel clips: Fix to substrate at not more than 450 mm centres.
- Overlap: Welt around underlap and clips and lightly dress down.

970 PATINATION OIL

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Location: New and existing leadwork.
- Application: As soon as practical, apply a smear coating to lead, evenly in one direction and in dry conditions.

J21 Mastic asphalt roofing/ insulation/ finishes

EXECUTION GENERALLY

510 ADVERSE WEATHER

- General: Do not lay mastic asphalt in wet or damp conditions unless effective temporary cover is provided over working area.
- Unfinished areas of the roof: Keep dry.

520 INCOMPLETE WORK

- Daywork joints in warm roofs and edges of phased roofing: Adequately protected and fully weathertight.

525 PREPARING EDGES OF EXISTING MASTIC ASPHALT

- Single coat applications:
  - Cut edges: Soften and clean.
- Two coat applications:
  - Cut edges: Soften and remove half depth of softened material for minimum width of 75 mm.
  - Jointing: Lapped between new and existing material at prepared edges.
- Torching: Not permitted.
- Timing: Immediately prior to laying mastic asphalt.

530 APPLYING PRIMERS

- Coverage per coat (minimum): 0.2 L/m².
- Surface coverage: Even and full.
- Coats: Fully bonded. Allow volatiles to dry off thoroughly between coats.

540 APPLYING BONDING COMPOUNDS

- Roof sited boilers: Permitted.
- Temperature of compound: Suitable to achieve bond over the whole surface. Do not overheat.
- Heat sensitive insulation materials: Use cold bituminous adhesive recommended by the insulation manufacturer.

SUBSTRATES/ AIR AND VAPOUR CONTROL LAYERS/ WARM DECK ROOF INSULATION

610 SUITABILITY OF SUBSTRATES

- Substrates generally:
  - Secure, even textured, clean, dry and frost free.
- Preliminary work: Completed, including:
  - Chases (minimum): 25 x 25 mm.
  - External angles: Chamfered where required to maintain full thickness of mastic asphalt.
  - Formation of upstands and kerbs.
  - Grading to correct falls.

  - Movement joints.
  - Penetrations/ Outlets.
- Moisture content and stability of substrate: Must not impair integrity of roof.

620 REMOVING EXISTING MASTIC ASPHALT

- Areas to be removed: Submit proposals.
- Existing roof: Do not damage.
- Timing: Only remove sufficient mastic asphalt as will be replaced and made weathertight on same day.

630 MAKING GOOD EXISTING MASTIC ASPHALT

- Existing items to be removed: To be confirmed by Clarkebond.
- Defective areas of mastic asphalt: Soften and carefully cut out.
  - Hammers, chisels, etc.: Do not use to cut cold mastic asphalt.
  - Substrate: Clean and dry.
  - Separating membrane: Make good.
  - Mastic asphalt: Patch level with existing surface in two coats, the top coat lapped minimum 75 mm on to existing asphalt and to half its depth.

640 FIXING TIMBER TRIMS

- Fasteners: Sherardized steel screws.
- Fixing centres (maximum): 400 mm.

642 KEYING TO VERTICAL/ SLOPING DENSE CONCRETE

- Surface preparation: Remove mould oil, clean and apply proprietary high bond primer or proprietary keying mix of cement:sand slurry incorporating a bonding agent.

644 KEYING TO NEW BRICKWORK/ DENSE BLOCKWORK

- Joints: Flush pointed.
- Surface preparation: Apply proprietary high bond primer.

646 KEYING TO EXISTING BRICKWORK/ DENSE BLOCKWORK

- Joints: Sound and flush pointed.
- Surface preparation: Clean and apply proprietary high bond primer.

648 KEYING TO METAL SURFACES

- Surface preparation: Clean and apply proprietary high bond primer.

649 APPLYING METAL LATHING TO VERTICAL/ SLOPING Existing roofs and stonework

- Placing:
  - Long way of mesh: Horizontal.
  - Pitch of horizontal strands is sloping upwards away from background.
- Butt joints: Wire tie between sheets at 75 mm centres.
- Method of fixing: Stainless steel staples.
  - Perimeter edges: 75 mm centres.

- General areas (maximum): 150 mm vertical and horizontal centres.

660 JOINTS IN RIGID BOARD SUBSTRATES

- Cover strip: Lay centrally over substrate joints before laying vapour control layers or coverings. Adhere to substrate with bonding compound along edges only.

670 LAYING AIR AND VAPOUR CONTROL LAYER

- Attachment: Secure.
  - Bond: Continuous with no air pockets.
  - Appearance on completion: Smooth.
- Side and head laps: Seal using materials and method recommended by membrane manufacturer.
- Joints in second layer (if any): Stagger by half a sheet.
- Upstands, kerbs and other penetrations: Enclose edges of insulation. Fully seal at abutment by bonding or taping.

695 SEPARATING LAYER

- Give notice: Where it is or becomes apparent that a separating layer is required.

ASPHALTING

720 DELIVERY

- Condition of mastic asphalt as delivered to site:
  - Hot-prepared, do not remelt on site, or
  - Blocks: Remelt on site, mix thoroughly, Temperature of material (maximum), 230°C.

730 TRANSPORTING

- Transport distances: Minimize to avoid excessive cooling of molten mastic asphalt.
- Buckets, barrows or dumpers used for mastic asphalt: Line with minimum quantity of fine inert dust. Use silica or similar acid resisting dust where acid resisting mastic asphalt is being used.

735 LOCALIZED HEATING

- Blowlamps and gas torches: Use only types with controlled gradual heating during laying, removal and repair of mastic asphalt.

740 LAYING MASTIC ASPHALT

- Standard: To BS 8218.
- Application:
  - In bays to even thickness.
  - Re-heated asphalt: Do not use.
- External angles, junctions and tuck-ins: Maintain full thickness of asphalt.
- Fillets at internal angles: Solid, fully fused to asphalt coating.
- Previously laid coats: Protect whilst exposed.
- Successive coats:
  - Timing: Apply without delay and within same working period.
  - Coats: Apply at right angles to preceding.

  - Stagger joints between bays in consecutive coats (minimum): 75 mm.
- Condition of contact edges of previously laid bays: Warm and clean.
- Blowing: Pierce and make good affected areas while mastic asphalt is still at working temperature.
- Completion: During final floating operation, whilst asphalt is still warm, apply sand to horizontal surfaces and rub in well using wooden float. Remove surplus material.
- Surface condition at completion: Smooth and free from imperfections. Firmly adhered, weatherproof and free draining.

750 MASTIC ASPHALT SKIRTINGS AND VERTICAL WORK

- Top edge: Tuck into 25 x 25 mm continuous splayed chase or groove.
- External angles: Maintain full thickness of asphalt.
- Splayed top: Form to shed water away from substrate.

775 INSTALLING PROPRIETARY MOVEMENT JOINTS

- Location: Centre over structural movement joint, and bed to exact finished level.
  - Bedding: Proprietary epoxy mortar.
  - Fixing: Chemical anchor.

785 FIXING PERIMETER TRIMS

- Separating layer: Terminated at trim. Do not carry under or over.
- Trim:
  - Setting out (minimum): 3 mm from wall or fascia.
  - Fasteners: 50 mm stainless steel countersunk wood screws.
  - Fixing: 30 mm from ends of trims and 300 mm (maximum) centres.
  - Jointing sleeves: Fix one side only.
  - Expansion gap between ends of trim: 3 mm.
  - Corner pieces: Purpose made.

COMPLETION

910 INSPECTION

- Interim and final roof inspections: Submit reports.

940 COMPLETION

- Roof areas: Clean.
  - Outlets: Clear.
- Work necessary to provide a weathertight finish: Complete.
- Storage of materials on finished surface: Not permitted.
- Completed mastic asphalt roof coating: Do not damage. Protect from petroleum based solvents and other chemicals, traffic and adjacent or high level working.

L10 Windows/ Rooflights/ Screens/ Louvres

To be read with Preliminaries/ General conditions.

GENERAL

120 PRECONSTRUCTION SURVEY

- Procedure: Before starting work on designated items take site dimensions, record on shop drawings and use to ensure accurate fabrication.
- Designated items: Existing openings within stonework - existing windows to be matched in profile, material, glazing and finish.
- Primary support structure: Carry out survey sufficient to verify that required accuracy and security of erection can be achieved.
- Timing: Before fabrication.

PRODUCTS

310 STEEL WINDOWS

- Standard: To match existing due to listed status.
- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Finish as delivered: To match existing removed.
- Thermal performance (U-value maximum): To match existing removed.
- Acoustic performance rating: To match existing removed.
- Fire resistance: To match existing removed.
- Glazing details: To match existing removed.
  - Beading: To match existing removed.
- Ironmongery/ Accessories: To match existing removed.
- Fixing: To match existing removed.

EXECUTION

710 PROTECTION OF COMPONENTS

- General: Do not deliver to site components that cannot be installed immediately or placed in clean, dry floored and covered storage.
- Stored components: Stack vertical or near vertical on level bearers, separated with spacers to prevent damage by and to projecting ironmongery, beads, etc.

730 PRIMING/ SEALING

- Wood surfaces inaccessible after installation: Prime or seal as specified before fixing components.

740 CORROSION PROTECTION

- Surfaces to be protected: To be confirmed by Clarkebond.

- Protective coating: Two coats of bitumen solution to BS 6949 or an approved mastic impregnated tape.
  - Timing of application: Before fixing components.

750 BUILDING IN

- General: Not permitted unless indicated on drawings.
  - Brace and protect components to prevent distortion and damage during construction of adjacent structure.

760 REPLACEMENT WINDOW INSTALLATION

- Standard: In accordance with BS 8213-4.

765A WINDOW INSTALLATION GENERALLY

- Installation: Into existing openings.
- Gap between frame edge and surrounding construction:
  - Minimum: To match existing.
  - Maximum: To match existing.
- Distortion: Install windows without twist or diagonal racking.

781 FIXING OF STEEL FRAMES

- Standard: As section Z20.
- Fasteners: To match existing.
  - Spacing: When not predrilled or specified otherwise, position fasteners not less than 50 mm and not more than 190 mm from ends of each jamb, adjacent to each hanging point of opening lights and at maximum 900 mm centres.

790 FIRE RESISTING FRAMES

- Gap between back of frame and reveal: Completely fill with intumescent mastic or tape.

800 BACKFILLING OF STEEL FRAME SECTIONS

- Windows fixed direct into openings: After fixing, fill back of steel frame with waterproof cement fillet.

810 SEALANT JOINTS

- Sealant:
  - Manufacturer: Submit proposals.
    Product reference: Submit proposals.
  - Colour: Submit proposals.
  - Application: As section Z22 to prepared joints. Finish triangular fillets to a flat or slightly convex profile.

820 IRONMONGERY

- Fixing: In accordance with any third party certification conditions applicable. Assemble and fix carefully and accurately using fasteners with matching finish supplied by ironmongery manufacturer. Do not damage ironmongery and adjacent surfaces.

- Checking/ Adjusting/ Lubricating: Carry out at completion and ensure correct functioning.

R10 Rainwater drainage systems

PRODUCTS

315 CAST IRON GUTTERS

- Standard: To BS 460, except for shape and dimensions.
- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Profile: To match existing.
- Jointing type: To match existing.
- Nominal size: To match existing.
- Finish as supplied: Anti rust primer, to receive paint finish to match existing.
- Brackets: To match existing.
  - Fixings: To match existing.
    Size: To match existing.
- Accessories: To match existing.

345 GUTTER LININGS

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Material: Aluminium foil and rubberised bitumen.
- Size: To match existing.
- Outlets: To match existing.

345A GUTTER & RAINWATER PIPE LININGS

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Material: Submit proposals.
- Size: To fit within existing pipe without compromising flow rates.
- Outlets: To match existing.

360 SEALANT FOR GUTTERS

- Type: Submit proposals.

375 CAST IRON PIPEWORK - FLEXIBLE COUPLINGS

- Standard: To BS EN 877, Agrément certified.
- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Coupling type: To match existing.
- Nominal size: To match existing.
- Finish as supplied: Anti rust primer, to receive paint finish to match existing.
- Brackets: To match existing.
  - Fixings: To match existing.

Size: To match existing.

- Accessories: To match existing.

EXECUTION

600 PREPARATION

- Work to be completed before commencing work specified in this section:
  - Below ground drainage. Alternatively, make temporary arrangements for dispersal of rainwater without damage or disfigurement of the building fabric and surroundings.
  - Painting of surfaces which will be concealed or inaccessible.

605 INSTALLATION GENERALLY

- Electrolytic corrosion: Avoid contact between dissimilar metals where corrosion may occur.
- Plastics and galvanized steel pipes: Do not bend.
- Allowance for thermal and building movement: Provide and maintain clearance as fixing and jointing proceeds.
- Protection:
  - Fit purpose made temporary caps to prevent ingress of debris.
  - Fit access covers, cleaning eyes and blanking plates as the work proceeds.

610 FIXING AND JOINTING GUTTERS

- Joints: Watertight.
- Brackets: Securely fixed.
  - Fixings: To match existing.
    Fixing centres: To match existing.
  - Additional brackets: Where necessary to maintain support and stability, provide at joints in gutters and near angles and outlets.
- Roofing underlay: Dressed into gutter.

615 SETTING OUT EAVES GUTTERS - TO FALLS

- Setting out: To true line and even gradient to prevent ponding or backfall. Position high points of gutters as close as practical to the roof and low points not more than 50 mm below the roof.
- Outlets: Align with connections to below ground drainage.

616 SETTING OUT EAVES GUTTERS - LEVEL

- Setting out: Level and as close as practical to the roof.
- Outlets: Aligned with connections to below ground drainage.

630 INSTALLING RAINWATER OUTLETS

- Fixing: Secure. Fix before connecting pipework.
  - Method: To match existing.
- Junctions between outlets and pipework: Accommodate movement in structure and pipework.

635 FIXING PIPEWORK

- Pipework: Fix securely, plumb and/ or true to line.

- Branches and low gradient sections: Fix with uniform and adequate falls to drain efficiently.
- Externally socketed pipes and fittings: Fix with sockets facing upstream.
- Additional supports: Provide as necessary to support junctions and changes in direction.
- Vertical pipes:
  - Provide a loadbearing support at least at every storey level.
  - Tighten fixings as work proceeds so that every storey is self supporting.
  - Wedge joints in unsealed metal pipes to prevent rattling.
- Wall and floor penetrations: Isolate pipework from structure.
  - Pipe sleeves: As section P31.
  - Masking plates: Fix at penetrations if visible in the finished work.
- Expansion joint pipe sockets: Fix rigidly to buildings. Elsewhere, provide brackets and fixings that allow pipes to slide.

640 FIXING VERTICAL PIPEWORK

- Bracket fixings: To match existing.
- Distance between bracket fixing centres (maximum): To match existing.

650 JOINTING PIPEWORK AND GUTTERS

- General: Joint with materials and fittings that will make effective and durable connections.
- Jointing differing pipework and gutter systems: Use adaptors intended for the purpose.
- Cut ends of pipes and gutters: Clean and square. Remove burrs and swarf. Chamfer pipe ends before inserting into ring seal sockets.
- Jointing or mating surfaces: Clean and, where necessary, lubricate immediately before assembly.
- Junctions: Form with fittings intended for the purpose.
- Jointing material: Strike off flush. Do not allow it to project into bore of pipes and fittings.
- Surplus flux, solvent jointing materials and cement: Remove.

655 JOINTING INTERNAL PIPEWORK

- Jointing: Cold caulking compound.

660 JOINTING EXTERNAL PIPEWORK

- Jointing: Cold caulking compound.

675 CUTTING COATED PIPEWORK AND GUTTERS

- Cutting: Recoat bare metal.

685 IDENTIFICATION OF INTERNAL RAINWATER PIPEWORK

- Standard: In accordance with Water Regulations Advisory Scheme (WRAS) Information and guidance note 9-02-05 and BS 8515.

690 ELECTRICAL CONTINUITY - PIPEWORK

- Joints in metal pipes with flexible couplings: Clips (or suitable standard pipe couplings) supplied for earth bonding by pipework manufacturer to ensure electrical continuity.

COMPLETION

905 INTERNAL PIPEWORK TEST - ENGLAND, WALES, IRELAND AND NORTHERN IRELAND

- Preparation: Temporarily seal open ends of pipework with plugs.
- Test apparatus: Connect a 'U' tube water gauge and air pump to pipework via a plug.
- Testing: Pump air into pipework until gauge registers 38 mm.
- Required performance:
  - Allow a period for temperature stabilization, after which the pressure of 38 mm is to be maintained without loss for at least 3 minutes.

910 GUTTER TEST

- Preparation: Temporarily block all outlets.
- Testing: Fill gutters to overflow level and after 5 minutes closely inspect for leakage.

Z22 Sealants

EXECUTION

610 SUITABILITY OF JOINTS

- Presealing checks:
  - Joint dimensions: Within limits specified for the sealant.
  - Substrate quality: Surfaces regular, undamaged and stable.
- Joints not fit to receive sealant: Submit proposals for rectification.

620 PREPARING JOINTS

- Surfaces to which sealant must adhere:
  - Remove temporary coatings, tapes, loosely adhering material, dust, oil, grease, surface water and contaminants that may affect bond.
  - Clean using materials and methods recommended by sealant manufacturer.
- Vulnerable surfaces adjacent to joints: Mask to prevent staining or smearing with primer or sealant.
- Backing strip and/ or bond breaker installation: Insert into joint to correct depth, without stretching or twisting, leaving no gaps.
- Protection: Keep joints clean and protect from damage until sealant is applied.

630 APPLYING SEALANTS

- Substrate: Dry (unless recommended otherwise) and unaffected by frost, ice or snow.
- Environmental conditions: Do not dry or raise temperature of joints by heating.
- Sealant application: Fill joints completely and neatly, ensuring firm adhesion to substrates.
- Sealant profiles:
  - Butt and lap joints: Slightly concave.
  - Fillet joints: Flat or slightly convex.
- Protection: Protect finished joints from contamination or damage until sealant has cured.