

Impressed Current Cathodic Protection

Rylands Building, Manchester

Detailed Works Design Document

*Prepared by: C-Probe Systems Limited
Date: 29th October 2024
Version: 1.0 - draft issue to Clan Contracting Ltd*

1.0 Introduction

C-Probe Systems Limited is contracted by Clan Contracting Limited to provide a design for the implementation of an impressed current cathodic protection (ICCP) system to protect the structural steel frame at Rylands Building in Manchester from future corrosion.

Reference information was used from the following documents:

1. *Geoffry Bell Architects drawings*

This document describes the design steps taken to prove that the system will operate successfully.

The design has been developed from similar systems installed to buildings of the same construction and era. Design principles are adopted in accordance (where relevant) to the BS EN ISO 12696:2022 and Level 4 BS EN ISO 15257:2017 standards.

Steel surface areas to be protected and their current requirements to be provided by the anode system are shown in Appendix 1.

ICCP layout arrangements are shown in drawings attached as Appendix 2.

Installation requirements for pricing by the contractor are detailed in Appendix 3.

Appendix 4 shows specimen installation QA/QC proforma to be completed by the Contractor during installation to ensure correct procedures have been followed.

On installation of the fully controlled system and electronic versions of the As Built drawings shall be uploaded and housed on the Achilles interactive Management Server (AIMS) to be used for the operation, reporting and management system.

2.0 Design and Installation Considerations

2.1 Areas to be Protected

The steel targeted for cathodic protection is the main structural steel columns and beams within the building envelope from ground level to level 8.

Ancillary (extraneous) steel and other metals are considered on their own merits with respect to the possible effect of stray currents that may arise following energisation of the ICCP systems.

A design current density of 10mA/linm of steel has been used throughout.

The installation is planned to be undertaken internally given open access to all walls to install the ICCP components.

2.2 Anode Grading and Current Requirements

The steel dimensions have been confirmed from areas where the brickwork has been removed around the steel members, and the design current density applied to identify the anode requirements per structural element.

A system preview was installed to test compliance with the calculated anode current output at various anode spacings. The report for this preview has been issued under separate cover.

Design drawings representing the anode placement in elevation and through section are attached in Appendix 2. This arrangement is a repeated pattern of drilling and chasing around the columns and beams developing the ICCP zoning level by level of the building.

DC anode circuitry shall be made as detailed in Appendix 3 (1) and cabling routed to the zonal enclosure as a positive ring main.

Details of any changes to these drawings arising from site activities shall be compiled in the Installation & Commissioning report and positions marked on the As Built shop drawings at the end of the project.

2.3 Steel (Cathode) DC Circuitry and Extraneous metals

DC cathode circuitry shall be made as detailed in Appendix 3 (2) and cabling routed to the zonal enclosure as a negative ring main.

All extraneous metals shall receive consideration for their likely effect on or by the installed ICCP systems. The concern is the possibility of stray current corrosion.

Found extraneous metals shall either be bonded to the main steel frame by welded threaded bolt and crimped ring connection and nut then made good with appropriate repair methods or isolated from the brickwork and/or blockwork of the façade.

Examples of extraneous metals include:

- a) Windows do not require bonding if new windows are spaced off the façade using non-metallic spacers to form a 3-5mm gap around the frame thereby insulating the window from the effects of the current from the ICCP system.

- b) Signage attached to the façade with metallic fixings.
- c) Ferrous downpipes and connections shall be bonded to the main steel frame at an opening to brickwork.

If other extraneous metals are identified by the Contractor during installation these shall be notified to C-Probe and their design considered on their merits and documented fully as to any remedial action within the final Installation and Commissioning document at the end of the project.

2.4 Monitoring

Corrosion rate probes (C-Probe CP200) shall be installed to 4 locations for each control zone as shown on the design drawings in Appendix 2. These locations may change once site work commences if a more representative location is identified.

All monitoring cabling shall be routed to the zonal enclosure installed within the zone.

The installation method is detailed in Appendix 3 (3).

2.5 Zoning

Each level is planned for 4 controllable zones giving a total of 32no zones across the building.

Each zone shall be operated using a Power and Control Unit (PU) on the AchillesICP network. Each PU is rated at 24V/ 3A and is therefore sufficiently graded for the task.

Zonal enclosures shall be located within the floor space with an accessible hatch to allow testing and replacement of electronics in the future.

All enclosures shall be IP65 rated for environmental protection of all electronics and terminations.

2.6 Electrical Installation

Appendix 3 (4) details the requirements of the electrical installation.

Cable management shall use galvanised or GRP trunking routed within the floor space.

The network cables shall be routed between zonal enclosures terminated at and managed using the Network Access Unit (NAU).

The NAU shall be the site of the 240VAC power supply, and the dedicated broadband connection and is planned to be installed the basement.

3.0 Future System Operation

3.1 Management System

The C-Probe Achilles interactive Management Server (AiMS) shall be used to acquire data from the network remotely. This data shall be databased and all calculations for potential decay performance and corrosion rate arising from linear polarization resistance (LPR) measurements shall be performed within the database functions.

These data shall be reported using AiMS accessed from the Client virtual private network. Secure access codes shall be set-up and reported within the installation and commissioning report at the end of the project.

The data shall be measured according to the following schedule:

a) As-found (ON) potentials	daily
b) Power and Control Unit applied current and driving voltages	daily
c) Instantaneous-OFF potentials	weekly
d) Potential decay sequence	monthly
e) Corrosion rate	monthly
f) Corrosion potential for EDS	daily
g) Updates to service life tracking	monthly

All data shall be uploaded from the NAU's datalogger on a monthly basis to AiMS for archiving within the management database.

Any control visits shall be decided quarterly unless the monthly data suggests urgent attention is necessary.

3.2 Acceptance Criteria

Monitoring and performance assessment shall be in accordance with BS EN ISO 12696:2022.

Measurement of As-found (ON) potentials and the power and control settings are performed to assure continuous operation. Should the power be disrupted for whatever reason then these data will provide information to show that disruption and provide alert through AiMS to the occurrence.

Instantaneous-OFF potentials are measured as the error-compensated value of the polarized potential and provides the "true" measurement of level of polarization when compared to

base values. It also acts as the zero point of the potential decay sequence allowing calculation of that value following 24-hour (the AchillesICP system allows for programmable sequence up to 22-hour OFF) interruption of the current.

The accepted level of potential decay is normally 100mV after 4hours or 150mV after 24hours.

Moreover, as more time passes with the ICCP systems in operation, it can be expected that the corrosion rate will reduce to levels that provide very low risk of damage. The value that we shall anticipate as being a very low level of corrosion rate will be $<2\mu\text{m}/\text{year}$ penetration rate.

A further assessment will be made of the potential at the end of the potential decay sequence as it compares to the original base potential measurement. We would anticipate that this end value should become more positive (noble) than the original base condition, which would be another indication of a movement to more passive condition.

In addition, the corrosion rate data shall be used to provide a tracking of service life through extrapolation of the accumulated corrosion/ protection rate, P_{corr} , this shall be shown within the AiMS facility and updated monthly.

Appendix 1: Steel & Anode Calculation Sheets

Steel Density Calculation Sheet



Contract Number: 10596 (Rylands Building)

Calculated By: Robert Gourley

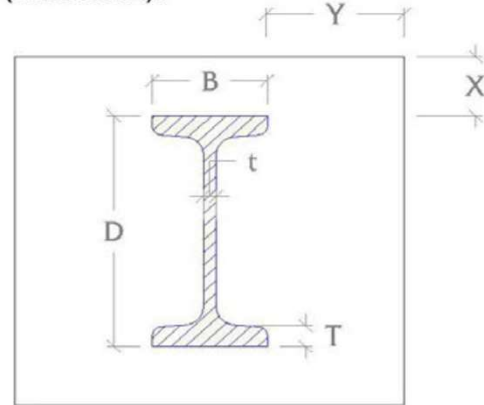
Date: 18th August 2024

Façade steelwork

Column and Beam 'I' beam sizes (")

T =	0.81
t =	0.67
D =	14
B =	6

(COLUMN):



Bar Mark	Length (ins)	Length (m)	Spacing (m)	No. per metre	Surface Area (m2)
1. 'I' beam 14"x 6"	50.66	1.287	1.000	1.000	1.287
2. Plate girder	0	0.000	n/a	1.000	0.000
3. 'I' beam	0	0.000	n/a	1.000	0.000
Laps/ties etc	Allow 5% for accessories & margin				0.064
			Area of steel	1.351	

Number of columns or beams 1

Surface Area of Steel 1.351

Current Density (mA/m²) 5

Zone Current Required (mA) 6.756

GP Anode 20/400 rating (mA) 1.76

Total Anode Holes Required (no.) 4

Nr of discrete 4

Sufficient anode provided	OK
Additional power required (mA)	0.000
Additional power provided by anode chase (mA)	Not required
Sufficient anode provided	OK

Note: Protection calculated for 4no encapsulated sides.

Appendix 2: ICCP Component Layouts



Unit 2 Wharton Street
Sherdley Road Industrial Estate
St Helens
Merseyside
WA9 5AA
United Kingdom
T: +44 (0) 1744 611555

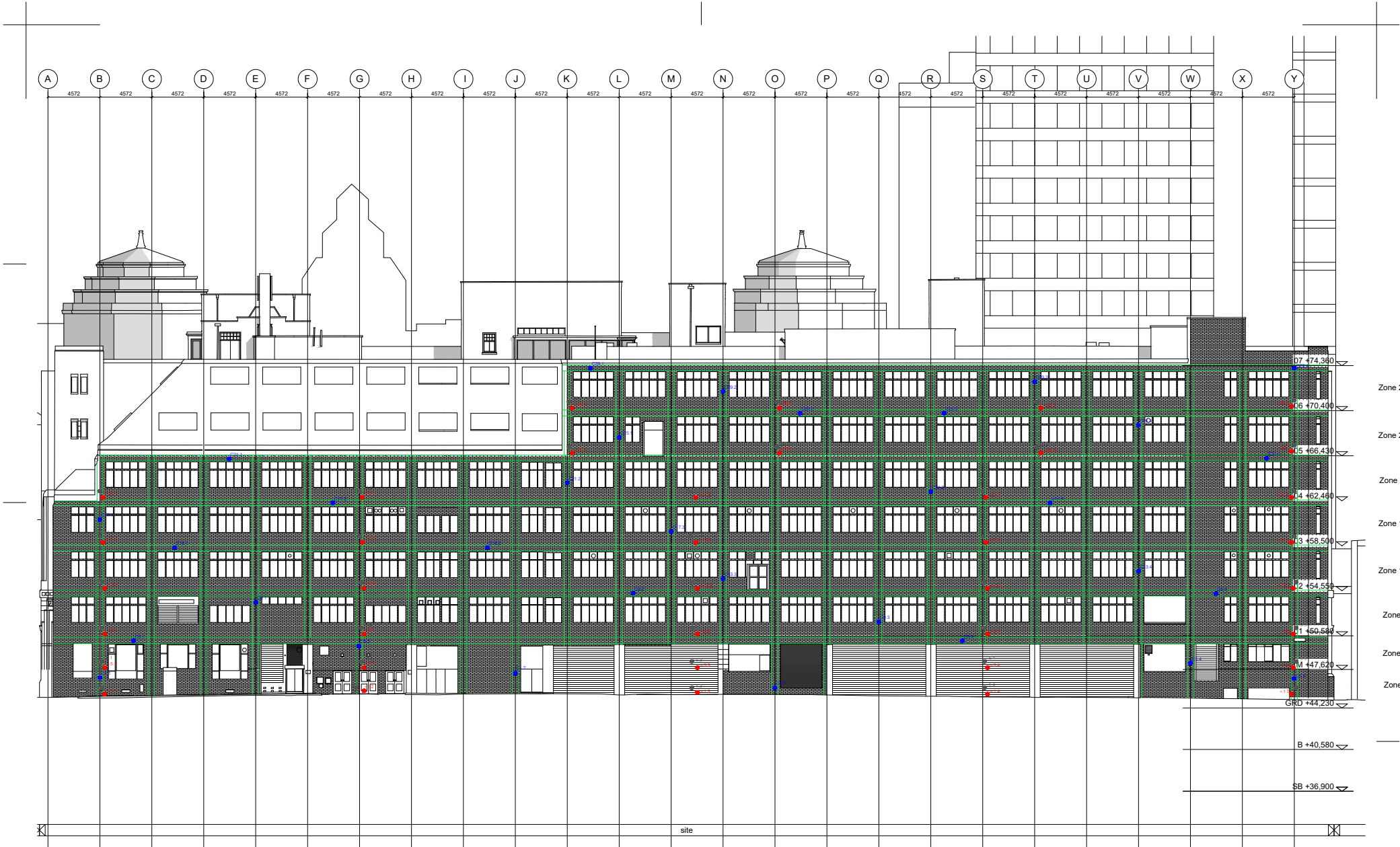
www.c-probe.com

Title

Rylands Building
Manchester
North Elevation

Legend / Notes

- LoCem +point anode in mortar joints and drill holes
- CP101 corrosion rate probe
- Anode connection
- Cathode connection



Issue	Description	Drawn	Date
Revisions			
Drawn	Authorised	Sheet No.	Sheet size
YC	SD	1 of 5	A3
Date	Scale	Project No.	
17/09/2024	1:150	10596	
Drawing No.			Revision
10596-CP-001			



Unit 2 Wharton Street
Sherdley Road Industrial Estate
St Helens
Merseyside
WA9 5AA
United Kingdom
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Title

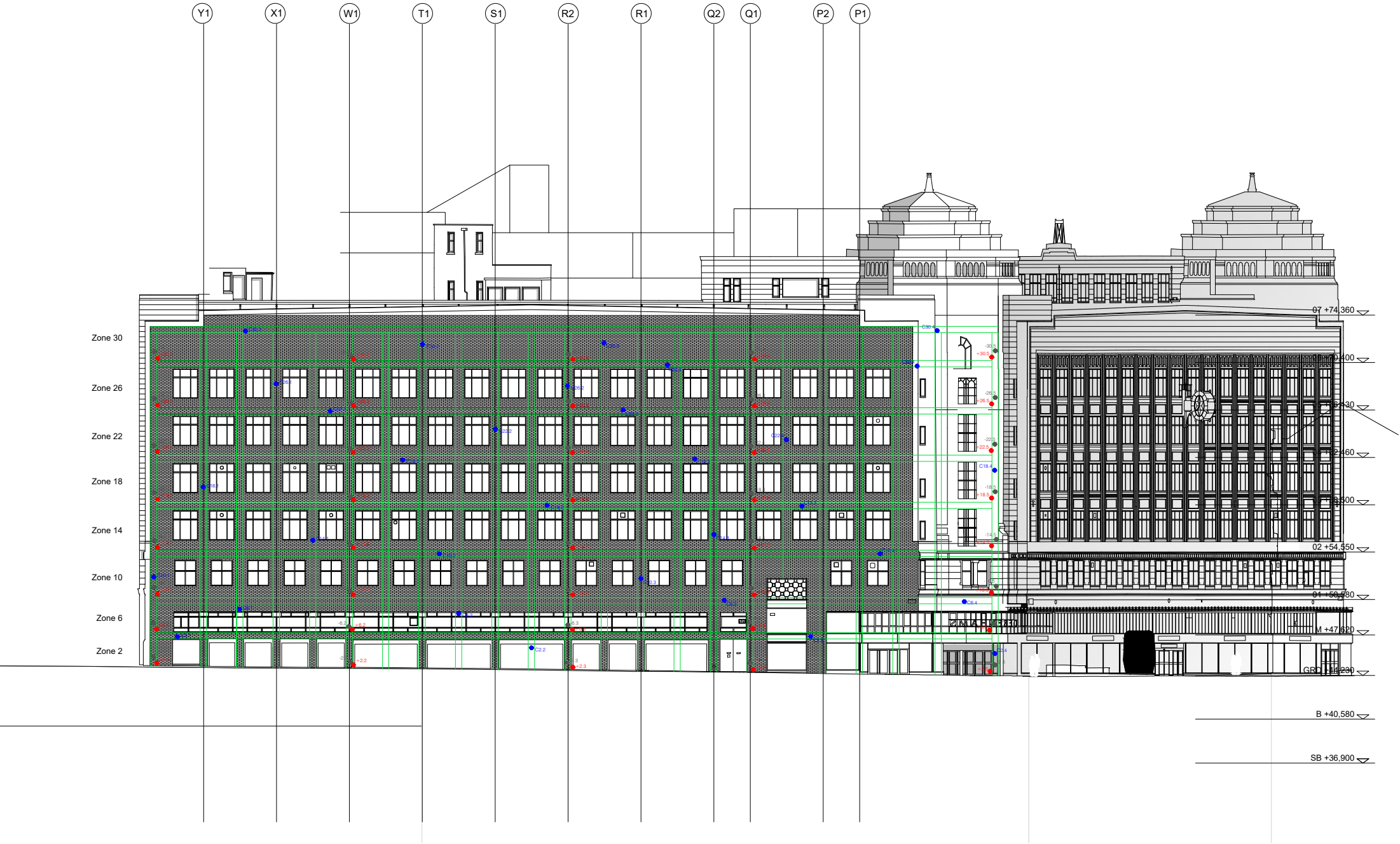
Rylands Building
Manchester
East Elevation

Legend / Notes

- LoCem + point anode in mortar joints and drill holes
- CP101 corrosion rate probe
- Anode connection
- Cathode connection

Issue		Description		Drawn	Date
Revisions					
Drawn	Authorised		Sheet No.	Sheet size	
YC	SD		3 of 5	A3	
Date	Scale		Project No.		
17/09/2024	1:150		10596		
Drawing No.			Revision		
10596-CP-003					

C-PROBE SYSTEMS LIMITED
Specialists in Corrosion Management
www.c-probe.com





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www.c-probe.com

Title

Rylands Building
Manchester
South Elevation

Legend / Notes

- LoCem +point anode in mortar joints and drill holes
- CP101 corrosion rate probe
- Anode connection
- Cathode connection



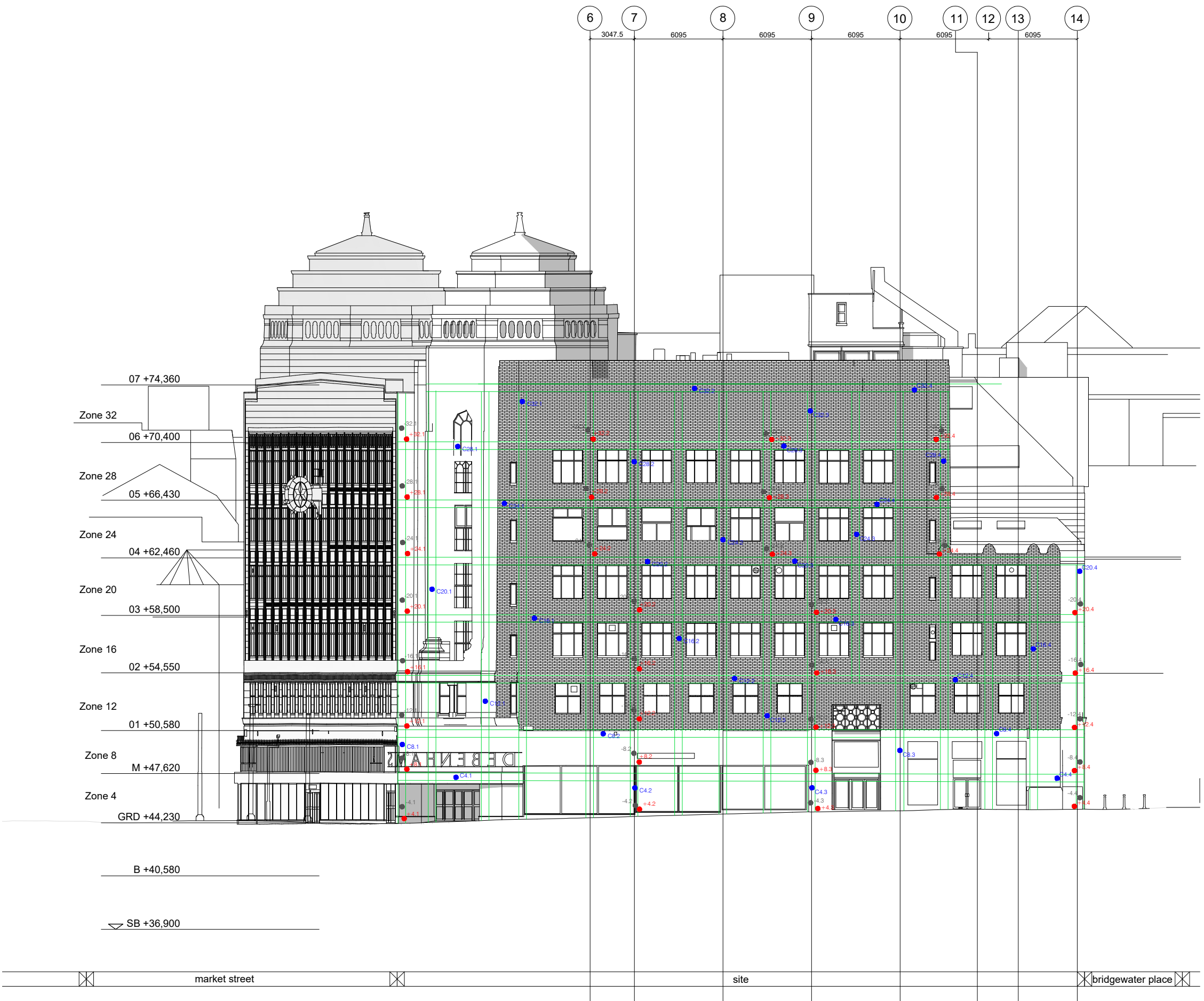


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Rylands Building
Manchester
West Elevation

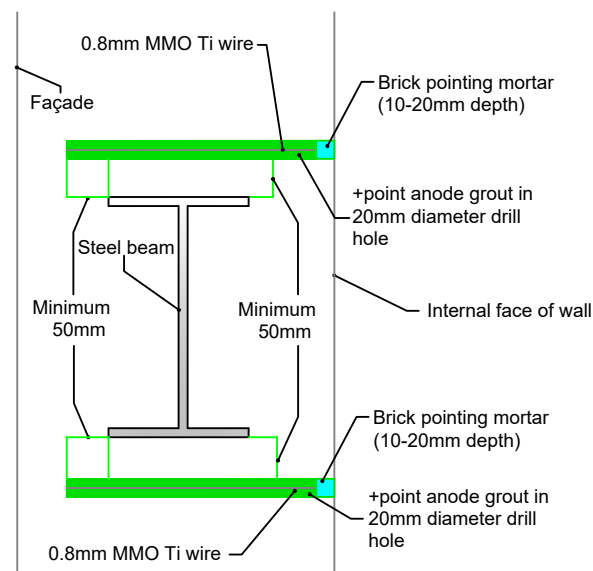
- Legend / Notes
- LoCem +point anode in mortar joints and drill holes
 - CP101 corrosion rate probe
 - Anode connection
 - Cathode connection



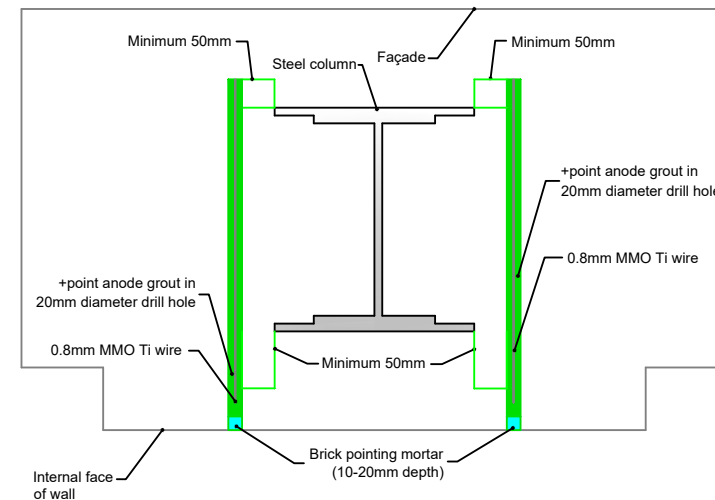
Issue Description		Drawn Date	
Revisions			
Drawn	Authorised	Sheet No.	Sheet size
YC	SD	1 of 5	A3
Date	Scale	Project No.	
17/09/2024	1:150	10596	
Drawing No.		Revision	
10596-CP-004			

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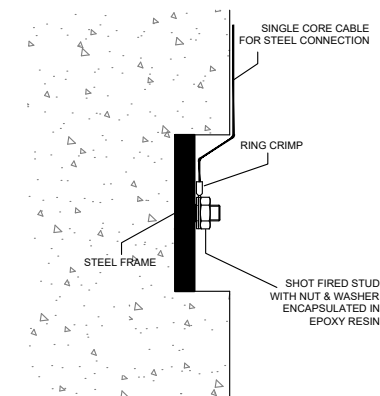
Steel Frame Building Cathodic Protection Standard Details



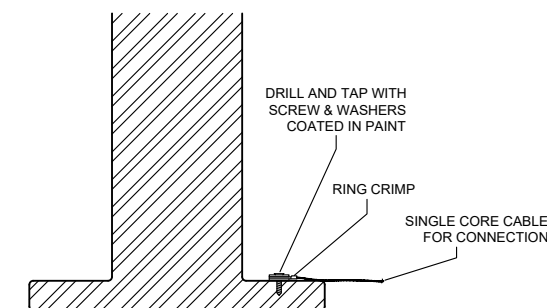
LoCem +point Anode Grout
Installation (Beams)



LoCem +point Anode Grout Installation (Columns)

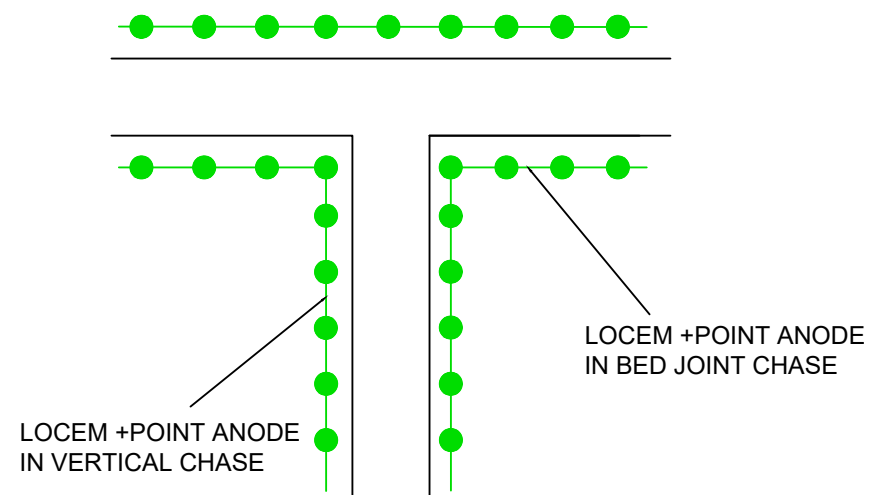


Installation of Cathode Connection

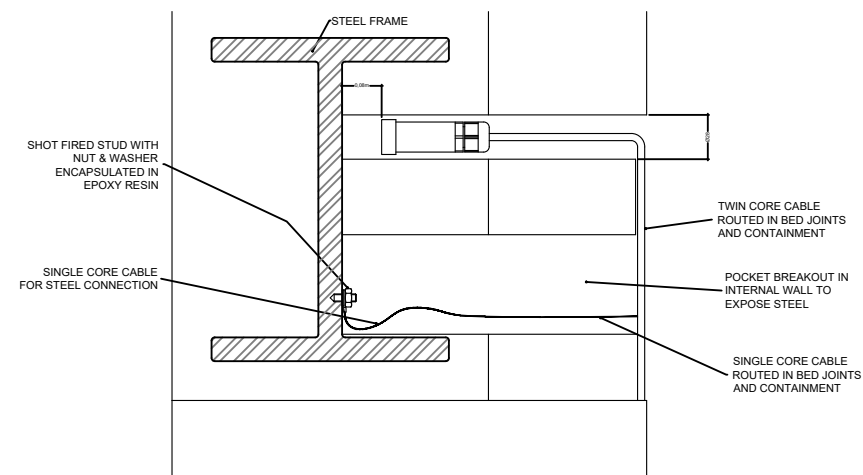
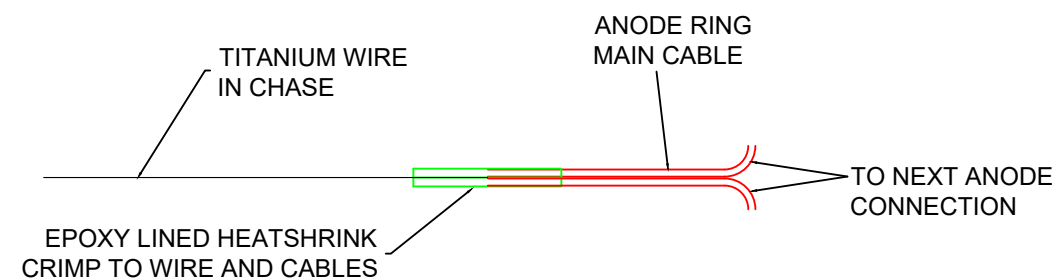


Extraneous Metals Connection

Beam/Column Anode Connection Detail

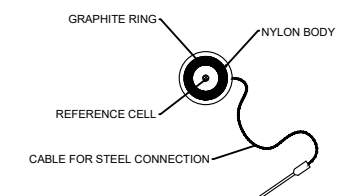
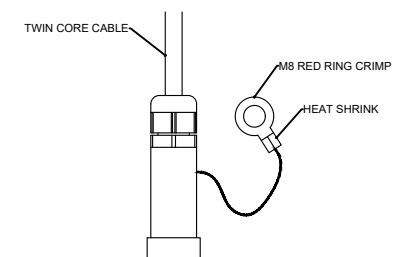
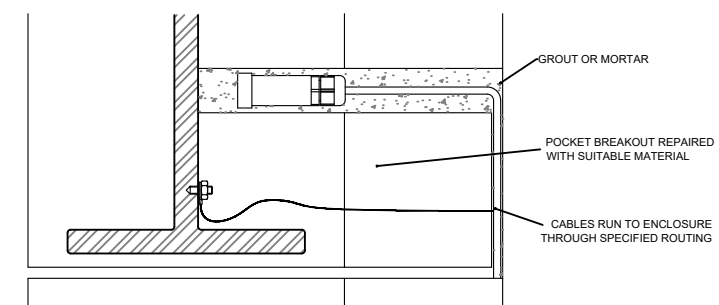


Anode Wire/Cable Connection



BUILDING FACADE

Installation of CP200 corrosion rate probe



CP200 CORROSION RATE PROBE

Issue	Description	Drawn	Date
Revisions			
Drawn	Authorised	Sheet No.	Sheet size
SCD		8 of 8	A3
Date	Scale	Project No.	
22/10/2024	1:125	10596	
Drawing No.	Revision		
10596-ICCP-005	C01		

Appendix 3: Installation Guidance for Contractors

Rylands Building, Manchester

ICCP System Installation Guidance Sheet:

Item	Brief Method	Unit	Total
<u>1</u>	<u>LoCem anode & feeder wire in sawcuts.</u>		
a	Set out the anode mortar lines above and below the beams and to the right and left of the columns on each level	m	14,268
b	Set out the cable lines along the beams on each level	m	4,848
c	Set out the anode holes above the beams and to the left of the columns. The holes should be at 600mm centres along the anode lines.	m	16,116
d	Drill the anode holes with a 20mm diameter drill bit such that the end of the hole is at least 50mm past the back face of the steel. (Average hole assumed to 350mm)	each	16,116
e	Sawcut each anode line to a width of 10mm and a depth of 50mm	m	14,268
f	Sawcut each cable line to a width of 10mm and a depth of 40mm	m	4,848
g	Check that each anode sawcut is clear of debris and insert the 0.8mm diameter MMO titanium wire in each anode line leaving 100mm extra at the anode connection points (6nr per zone)	m	14,268
h	Check that each anode hole is clear of debris and insert the 0.8mm diameter MMO titanium wire to the end of the hole leaving 75mm extra at the anode line	each	16,116
i	Connect the length of anode wire from each hole to the wire in the anode line by securely twisting the hole wire around the line wire	each	16,116
j	Insert the 2.5sqmm anode ring main cable in the cable line between each of the 6no. anode connection points and the relevant zone enclosure to form the anode ring main	m	4,848
k	Connect the cable to the wire with an adhesive lined butt crimp and heat to seal the connection at each of the anode connection points	each	192
l	Once all the anode connections are made within a zone, confirm the continuity between the ends of the anode ring main with a resistance meter by achieving a reading of < 1 Ohms in both directions	each	32
m	Mix anode mortar according to C-Probe instructions and fill the anode lines with the mortar ensuring that the wires are fully encapsulated in the mortar	m	14,268
n	Mix anode mortar according to C-Probe instructions and fill the anode holes with the mortar ensuring that the wires are fully encapsulated in the mortar	each	16,116
o	Leave the anode mortar for at least 4 days to fully cure before connecting to the power system		
p	Repoint the brick joints	m	19,116
<u>2</u>	<u>Steel Connections</u>		
a	Expose the steel frame at 4nr locations per zone	each	128
b	Insert 4 lengths of 2.5sqmm cathode ring main cable in the cable line between each of the 4no. cathode connection points and the relevant zone enclosure to form the cathode ring main	m	4,848
c	Attach a adhesive lined ring crimp at either end of the 4nr lengths of the 2.5mm cathode cable and heat to seal the connection.	each	256
d	Shotfire M8 threaded studs to the steel frame, connect the cathode cable to the stud via the ring crimp, cover the connections with epoxy resin and repair the pocket.	each	128
<u>3</u>	<u>Monitoring Inserts</u>		
a	Install the CP200 corrosion rate probes in accordance with the attached Method Statement	each	128
b	Shotfire M8 threaded studs to the steel frame, connect the monitoring cable to the stud via the ring crimp, cover the connections with epoxy resin and repair the pocket.	each	128
c		m	3,840
<u>4</u>	<u>Electrical Installation</u>		
a	Install zone enclosures at locations shown on drawings via the fixing lugs on the enclosures using screws and rawl-type fixings	each	32
b	Install the Network Access Unit (NAU) at position to be agreed close to the 240V AC supply and the fixed IP broadband connection	each	1
c	Route the AC and broadband cables to the NAU and terminate within NAU	m	25
d	Terminate anode and cathode ring mains, monitoring and network cables in the zone enclosures	C-Probe to perform this task	
e	Route network cabling (AC and DC power and communication) between the zone enclosures in the trunking on each level and to the NAU	m	2,306
	<u>System Testing, Commissioning and Operation</u>		
<u>5</u>	a To be performed by C-Probe in accordance with industry standards	C-Probe to perform this task	

**Appendix 4:
QA/QC Testing Proforma**

CONTRACT :

DATE: _____

ZONE NUMBER



the eye within....

ANODE INSERT CHECKLIST

[illegible]

CONTRACT : _____

DATE: _____

ZONE NUMBER _____



the eye within....

REFERENCE INSERT CHECKLIST

Sensor Number	Condition & Steel Size	Depth	Inserted (tick)	Potential Value (mV)	
				Post Setting	24 Hours
C1					
C2					
C3					
C4					

Sketch Area, (with dimensions)

C1	C2
C3	C4

Comments

--

CONTRACT : _____

DATE: _____

ZONE NUMBER _____



the eye within....

SYSTEM OVERVIEW CHECKLIST

Activity	Date Completed	Signature
Anodes Drilled/Chased		
Anodes Inserted		
Anodes Connected		
Rate Probes installed		
Rate Probes Tested		
Anode Connections Made		
Anode Connections Tested		
Cathode Connections Made		
Cathode Connections Tested		
Extraneous Metals Checks		
Actions For Extraneous Metal Completed		
Trunking Routed		
Enclosures Mounted		
Cables Routed to Enclosures		
Pre-Commissioning Carried Out		
Base Readings For Rate Probes		

**Appendix 5:
Technical Datasheets**

Technical System Information Sheet

ICCP System for Stone and Brick Clad Heritage Buildings

+point and AchillesICP



Providing Sustainable Life to Your Transitional Steelframe Building

What is +point®?

We have successfully designed, implemented and managed corrosion solutions for many buildings on behalf of private owners, pension funds, banks and other asset holders since 1998.

Our +point® system operates as an impressed current cathodic protection (ICCP) anode. It is installed using a conventional repointing gun and finishing tools and operate behind the heritage mortar finish to pass protection current to the structural steelframe of transitional era (1890-1950) buildings which are commonly affected by structural deterioration, otherwise known as Regent Street Disease.

Compliance:

This anode is manufactured by C-Probe and compliance tested at anode source to meet: ISO 12696:2016, BSI PAS8820:2016 and is designed to meet ISO 15257:2019 by Structural Healthcare



+point® has been successfully used on The Commerce Bank on 922 Walnut in Kansas City, originally built in 1908

C-Probe offers corrosion management solutions designed to **reduce the cost of traditional repair**, whilst contributing to **NetZero initiatives** through products and systems that are **Environmental Social Governance (ESG) compliant**.

Control zones also provide remote access to performance data from **embedded sensors and probes** and to **remotely control the current and voltage provided to each zone within the property**. A continuous record of performance is provided with C-Probe's online service live tracking facility. Owners have comfort that the building in its portfolio will have **enhanced resilience and is protected and managed for many years to come**.

Elements of the installed system:

- +point® anode mortar
- CP200 corrosion rate probes (4 per zone)
- AchillesICP power, control and monitoring network
- Electrical connections, wiring and environmentally protected enclosure
- AC and broadband connectors at the NAU
- AiMS facility for ongoing performance management and reporting.



Impressed current cathodic protection for permanent and continuous operation



Single life time application



Service life tracking and compliance with ICCP standards using our online AiMS facility.



Low carbon emissions and aligned with Environmental Social Governance (ESG)



Provides greater flexibility with the design parameters that influence service life



To be installed with AchillesICP digital management system for remote operation, control and real-time data.



Case Studies

+point® has been installed at **230 Park Avenue, The Helmsley Building, in NYC (right)**.

C-Probe designed and provided the materials for the installation of an ICCP system, to stop degradation of the colonnades of the Helmsley Building. These consist of hollow terra cotta masonry cladding around brick encasement, supported by a central core of built-up laced steel columns.

+point® is to be used for the historic restoration of commercial property, protecting them from corrosion caused by tightly packed stone or facing masonry around the internal steel frame.



+point® was used in the restoration of **Terry's Chocolate Factory in York, UK (below)**. This transformed a derelict building into prestige apartments worth £50 million.

**From 100 years old
and derelict...**

**...to restored and preserved
for another 100 years!**



RISEAWARDS 2015

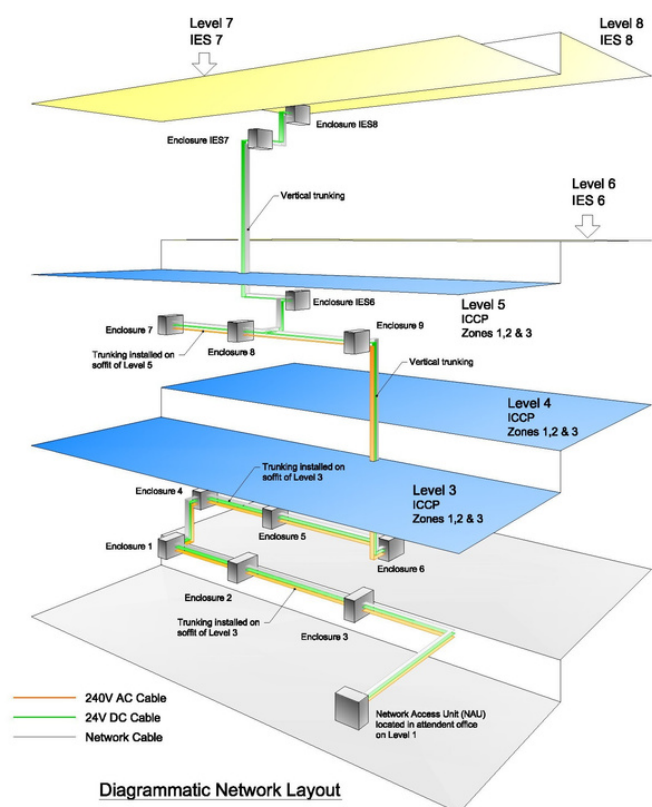
AchillesICP incorporating LANode®

The Cathodic Protection Management System

Cathodic Protection systems today are growing as a cost-effective option for the civil, structural and building engineer faced with the task of maintaining and ensuring the durability of structures. They do however need specific management which cannot always be performed manually even by the seasoned specialist. The answer can be found in the **AchillesICP System**. This is one of many software management systems offered by C-Probe under the Achilles Suite of Structural Healthcare Systems for **the management of corrosion and protection of reinforced concrete and building structures**. The system incorporates new generation hardware architecture evolving from programmable logic controllers to more flexible network architectures.

This allows both simple and complex network configurations, meaning that there is virtually no limitation to the expansion of the system. Simply decide on the quantity and distribution of anode zoning and measurement locations within the system design and AchillesICP will meet these requirements.

As a result, AchillesICP systems are available in non-networked stand-alone units but will combine to form a network of thousands of nodes from a single Network Access Unit (NAU).



The flexibility continues with the networking system allowing the choice of power and data transmission by simple mains, twisted pair or fibre optic cabling networks.

Monitoring and control of AchillesICP is achieved through C-Probe's interactive CAD, data-basing and reporting facility, known as Achilles interactive Management Server (AiMS). Standard features include, but are not limited to, the automated acquisition of corrosion potentials and voltage/ current power outputs and the performance trending in graphical outputs allowing easy analysis of steel responses to CP protection.

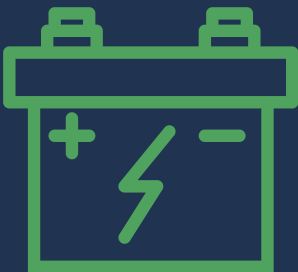
This secure server allows the user to manage a whole facility or to "zoom-in" to specific locations for criterion investigation. All server and user PC software utilises the latest advances in Microsoft Windows and Crystal reporting software.



Principal Components and Features

A. Power and Control Unit (PU)

AC Input: 110/ 240VAC; single phase; 50Hz or 60Hz.
DC Output: 24V; 3Amp (PU)
Control: Digitally Controlled Constant Current or Voltage
Functioning: Continuous or Intermittent (programmable).
Enclosure: IP65 rated GRP as standard (please discuss requirements)
Other Features: Low noise 50mV p-p
Lightening Surge Protection (to 4000V)

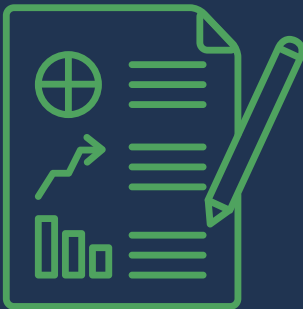


B. Measurement Unit (MU) or Measurement LANode®:

No. of Channels: 16 fully differential (potential monitoring)
Resolution: 18 bit; 16cps
Communication Speed: up to 2.5Mbps
Architecture: peer-to-peer; free topology
Networking: neural with choice of mains, twisted pair or fibre optic

C. Rate Measurement Unit (RMU):

No. of Channels: increments of 4 fully differential (potential monitoring) or 2 channel LPR and 2 channel potential monitoring.
Resolution: 18 bit; 16cps
Communication Speed: up to 2.5Mbps
Architecture: peer-to-peer; free topology
Networking: choice of mains, twisted pair or fibre optic



D. Network Access Unit (NAU): single network communication and management module

An IP65 enclosure which allows communication with the network either on-site or remotely via various methods, such as landline, GPRS and wireless technology, giving control of all power unit voltage/ amperage outputs and embedded sensors. Also in this enclosure are the network power supply and the data logger/scheduler/alarming modules.

CP200 - Drilled In Probe

The CP200 is manufactured as a robust assembly based on the established technology and record of the CP10P silver/silver chloride half-cell. The construction is such that the half cell and associated graphite counter electrode are mounted together in an inert resin to form an integral unit allowing installation as a one step process.

Electrochemical potential measurements are routinely used as an indicator of corrosion activity experienced by reinforcing bar within concrete. The information provided by this, although useful in itself, does not allow an instantaneous assessment of the rate of corrosion the bar is experiencing.

The corrosion rate is affected by changes in chloride and oxygen levels. The actual change in rate could be as great as an order of magnitude (in terms of rate of metal loss per year) before there was a noticeable change in corrosion potential. The CP200 allows the assessment of instantaneous corrosion rates by employing the linear polarisation resistance measurement (LPRM) technique. Traditionally this has been carried out manually, but may now be automated using computer controlled electrical ancillary equipment. Compatibility with all known datalogging equipment and remote sensing is guaranteed.

Interpretation Data

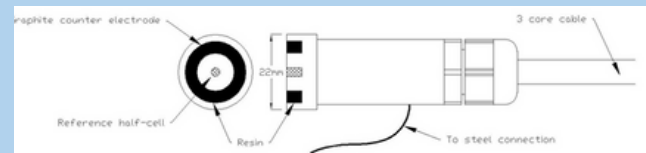
The interpretation of corrosion current densities in concrete has as yet no internationally recognised standard.

However, for guidance corrosion rates of less than $1\mu\text{m}/\text{yr}$ would generally indicate little expected damage to a structure in its lifetime (generally assumed to be 25 yrs).

In the range 1 to $10\mu\text{m}/\text{yr}$ the interpretation should be regarded in conjunction with local conditions. However, rates greater than $10\mu\text{m}/\text{yr}$ should give rise to protection systems being considered as a matter of urgency particularly if this is a continuing trend assessed over several data sets.

Specific circumstances are not considered within these guidance notes and the user may consult C-Probe for closer analysis of specific situations

Note: In all applications a welded or drilled/tapped steel connection must be provided.



CP200 Corrosion Rate Probe



CP200 c/w cable and steel connection



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