



City of Westminster

WCC Earthing and Electrical Arrangements for Street Furniture

Identifying and formalising “WCC common practice” into standards



Document Control

Version Number	Purpose	File Name	Date of Issue
1.0	Draft – first comment	WCC Earthing and Electrical Arrangements for Street Furniture 2019 Draft Final.docx	20/01/20

Report of: City Commissioner of Transportation

Contact:

Dean Wendelborn
Project Manager – Street Lighting
City Highways

Westminster City Council
14th Floor
64 Victoria Street
Victoria
London
SW1E 6QP

T: 020 7641 1885
E: dwendelborn@westminster.gov.uk
www.westminster.gov.uk

CONTENTS

1.	Introduction	4
2.	Aims and Approach.....	5
3.	Identified practices not currently WCC standards	6
3.1	Identified Electrical and Earthing related documents issued to WCC but still in “draft” status	8
4.	Items and Methods in use in WCC but not captured in Specifications.	8
5.	Actions recommended forElectrical and Earthing related documents issued to WCC but still in “draft” status.....	21
6.	Summary	22



1. Introduction

It has been identified that electrical work within the public realm has been carried out using “accepted” methodologies and equipment that are not captured as “Standards” for use. This is partly because some of these pieces of equipment were considered trial items or best practice and never fully signed off. It has also been identified that several guidance documents, some of which form part of the current contract suite as annexes, have never been accepted and signed off and remain in a draft status. With the increase of 3rd parties working on developments and improvements within the City of Westminster the above has led to issues around being able to influence the quality, and respectively the safety, of equipment installed within WCC’s public realm areas by issuing these standards and guidance documents to said third parties prior to the design and construction works.

.

2. Aims and Approach

The aim of this report is to identify and list equipment, methodologies and guidance documents for electrical and associated installations in common use in WCC that are not yet included in the suite of approved standards and documents or are in use in there “draft” state and to create a report with recommendations as to adopt, discard or revisit due to technical progress. This report contains recommendations on the process that should be used to formalise and adopt or update each Item into standards or to formally discard it.

It should be noted that this report does not cover luminaires, Photo Electric Control Units (PECU) and Central Management Systems (CMS) or the selection of street lighting columns. Column foundations have been included due to the current approach of integrating an earth electrode into the foundation during construction.

The approach taken in developing this report was to question the lighting and electrical design team and construction team members as to the current practices in designing and supplying new installations within the Contract B remit, in Westminster, and collating those practices and methods that have evolved in the course of the current contract. These practices and methods have then been cross checked against original standards and those adopted through the Highways Specification process since the start of the contract. The history of the origins of those practices and methods not covered off in approved standards have then been explored to ascertain firstly their point of origin and secondly any benefits in their adoption.

3. Identified practices not currently WCC standards

The practices and materials in current use, that are not documented WCC standards, are identified below. Section 4 of this report then addresses the reason for their use and the rationale leading to this decision, on an item by item basis.

This section also contains a list of documents (sub section 3.1) that have been written to give guidance to practices and processes around on street electrical installations, that although issued to WCC, have never received formal sign off for inclusion in the Annexes to the core "*WESTMINSTER CITY COUNCIL Highways & Transportation Services Contracts (2014)*" (contract annexes) . Recommendations for any rework and process for formalising these documents are included in section 5.

- a) The use of NAL sockets as the default foundation for lighting column and wide base posts;
- b) Earth Mat installed below or adjacent to NAL Socket where NAL sockets are used for Lighting columns and wide base posts;
- c) The use of earth mesh rather than earth rods;
- d) The use of Marconite as a surround material for earth electrodes,
- e) Use of cables with internal earth conductor – armouring not to be used for primary Continuity Protective Conductor (CPC) aka earth wire. A minimum cross-sectional area of 6mm SWA cable, to ensure suitable CPC for all buried private cable networks;
- f) Prohibited use of Cable Earth Termination (CET) Glands for terminating Steel Wire Armoured (SWA) cables into ANY item of highway electrical street furniture. CCG Outdoor gland kit or similar where armouring is mechanically secured into gland and where armouring and inner Polyvinyl Chloride (PVC) sheath is not exposed and the glanded cable end is covered by a rubber shroud;
- g) Within each item of highway electrical street furniture, where there is a secondary isolator, Distribution Board (DB) or consumer unit. Protective devices and cable terminations are only accessible after unscrewing secondary compartment door/cover. These electrical Items cannot be accessed simply by opening the column/feeder pillar door;
- h) Surge Protection Device (SPD) to be included into cut-out on each Distribution Network Operators (DNO) supplied piece of equipment. This SPD should where practicable be equipped with an operation status indicator or link back to the Authorities street lighting Central Management System that will signal when the SPD is out of commission. The requirement for the SPD, at point of supply, has now become mandatory in accordance with BS7671;
- i) Chambers containing any termination boxes or joints should be positively drained.
- j) All sub surface connections to be made in chambers and be contained within a CCG heavy duty IP68 junction box, all cable glanding into these boxes to be

made with IP68 glands compatible with the box. Any jointing – by prior agreement only – to be carried out in chambers and be suitable for prolonged immersion and;

- k) All uplighters to be supplied with integrated cables and the complete assembly, inclusive of cable, to be rated as IP68 by the manufacturer. No units to require any disassembly for installation or maintenance. Faulty units should be replaced in their entirety, no repairs which affect the integrity of the IP68 rating shall be undertaken.

3.1 Identified Electrical and Earthing related documents issued to WCC but still in “draft” status

- A. ANNEX 21 Westminster Suite of Lighting Column Foundations Report
- B. Listed & Cherished Column Electrical and Earthing Termination Proposals Report
- C. Westminster Market Traders Electrical Supply Guidance
- D. The use of TFL GN12 Combined Column Installations (Traffic Signals on Lighting Columns) rather than a bespoke WCC document.

4. Items and Methods in use in WCC but not captured in Specifications.

a. The use of NAL sockets as the default foundation for lighting column and wide base posts.

It has become evident that insufficient depth is often found which prevents columns and posts being installed with a full standard root length.

The current Contract B contract includes an annex (ANNEX 21 Westminster Suite of Lighting Column Foundations Report), albeit not formally adopted by WCC. This Annex outlines a process for column foundation selection and a hierarchy of use. The foundations detailed in Annex 21 have been found to be too bulky and extensive and have caused subsequent problems when utilities undertake work within their vicinity, especially in the case of cranked roots, such as cutting the root itself, potentially leading to column instability.

The outcome of the above issue was to agree to adopt NAL sockets (*figure 1*) for default use. agreement has been reached with UKPN to install DNO supplies directly into the NAL socket lighting column foundation installation.

There is some misunderstanding that these foundations were adopted to allow for faster changing of damaged columns, but this is not the case and all decisions were made based on recurring depth constraints.



Figure 1 shallow depth NAL socket

Recommendation

It is recommended that the NAL foundations are adopted as the primary foundation type for use in Westminster via the DSB for Highways Specification route. It should also be noted that standard detail drawings for these sockets were accepted into the WCC suite of Standard Details in 2017 as SD13-09 rev B and SD 13-10 rev C and include detail of integrated earth mat arrangements.

b. Earth Mat installed below or adjacent to lighting column and wide base post foundations.

During the development of the 18th Edition wiring regulations (BS7671) it was understood that there would be a greater requirement for customers to provide their own additional earth as the DNO's own earthing arrangement could not be fully relied upon. Although this proved not to be the case the provision of a customer earth aligns with the requirements for the earthing of EV supply points and other non-lighting related electrical connections within the highway where customers are required to provide their own local earthing arrangements.

Note: *The Energy Networks Association Engineering Recommendation G12 permit public lighting to be supplied with a Protective Multiple Earthing (PME) termination (the neutral and earth are combined). All other equipment within the highway requires a Terra Terra ('TT') supply where only the live and neutral are provided and the customer must provide their own earth connection and suitable RCD protection. This earth connection generally must be less than 100 Ω (a maximum of 200 Ω is permitted but anything above 100 Ω is considered unstable).*

It was decided to future proof all new lighting column installations by including an earth mat within the column foundation. The thinking behind this was it would be quicker and cheaper to convert lighting column earthing systems from PME to TT should the need arise to utilise the lighting column supply for other applications. There will be a slight increase in initial cost of the column installation by including an earth mat but when it is compared to the cost of adding an earth mat later, coupled with the associated groundworks, it becomes a more feasible proposition to include the earth mat at the outset.

Recommendation

It is recommended to keep the current standard details for NAL foundations and adopt already completed standard detail drawings, showing addition of earth mats, for other standard WCC foundation types for specialised use, that have not yet been formally added to the current standard drawings. The drawing and specification updates can be done under the annual DSB for Highways Specification.

c. The use of earth mesh rather than earth rods.

It has been a long-term practice to use buried earth mats (figure 2) as opposed to driven earth rods (figure 3) when an earth electrode is required to be installed within WCC. Although the installation of an earth mat requires more ground work it has been accepted that the driving of rods carries unacceptable risks due to the congested nature of the ground in the WCC built environment.

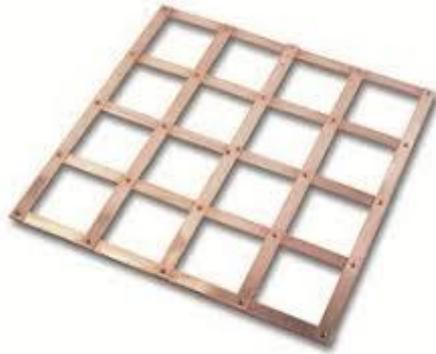


Figure 2 - Earth Mesh Electrode

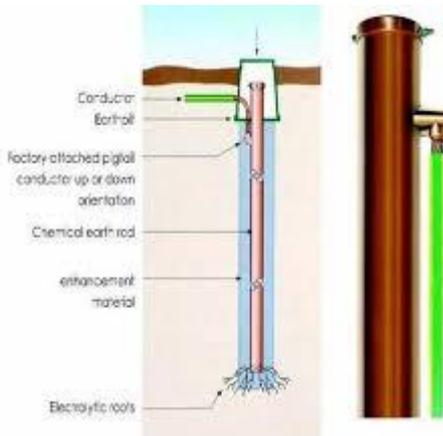


Figure 3 - Earth Rod Electrode

Recommendation

It is recommended to withdraw the current standard detail drawing for earth electrodes, which shows earth rods and replace it with a new drawing detailing copper mesh earth mats.

This can be done under the annual DSB for Highways Specification.

d. The use of Marconite as a surround material for earth electrode

When earth electrodes have been installed it has been noted that on some occasions the ground in which the installation was to be completed was of unknown earthing quality, often being made up of rubble and recycled ground. It was also identified that the cost of carrying out ground resistivity testing was unproportionate to the rest of the works so the incumbent Service Development Manager (Public Lighting) instructed that rather than calculating the mat size required, which requires ground resistivity testing results, one earth mat be installed and the mat resistance tested and then additional mats added until a suitable earth reading could be acquired.

To prevent issues developing in poor ground it was agreed, after some research, to encase the earth mats in Marconite to improve the effective ground conductivity. Marconite is a proprietary product, developed to increase ground conductivity for the earthing purposes. It is supplied in powder form to be added to a cement mix, which in our case we use to cover earth mats when pouring lighting column foundations (figure 4). This practice has resulted in the need for very few instances of multiple mats being installed at any location to date.

The resistivity of Marconite is in the order of 0.001-ohm metre. When mixed with cement the resulting conductive concrete is still only 0.19-ohm metres. This is significantly lower when compared to Bentonite another product which was considered, which has a typical resistivity of at least 3 ohms metre. Research also indicated that most products that improved ground resistance are corrosive and will corrode earth connections resulting in the loss of the system which is a safety hazard. Marconite with a PH of 7 is non- corrosive and is manufactured specifically for copper earthing materials,

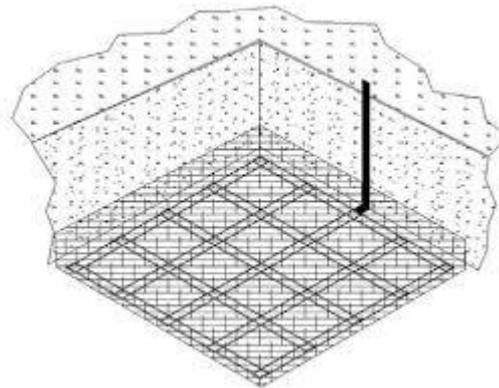


Figure 4 - Earth Mat installation sketch -dark hatching denotes Marconite mixed cement

Recommendation

It is recommended that this practice is continued and to this end Marconite or a similar product with a resistance of less than 0.2 ohm (when mixed with cement) and a product PH of 7 or above is specified as the material to be used for encasing earth electrodes within WCC. All drawings that show earth mat detail should be identified and the use of Marconite or similar as above be added to the drawing notes. This can be done under the annual DSB for Highways Specification.

e. Use of SWA cables with internal earth conductor – armouring not to be used for primary Continuity Protective Conductor (CPC).

As corrosion effects the flow of fault current through the armouring of SWA cable due to increased resistance at the termination points, WCC no longer use the armouring as a primary CPC.

When using SWA cabling 3 core cables, with current colouring (Brown/Blue/Yellow-green) are to be used for single phase circuits and 5 core cables, with current colouring (Brown/Black/Grey/Blue/ Yellow-green) for three phase circuits. As well as the above it is also recommended that a minimum

cross-sectional area of 6mm² SWA cable be used for all buried private cable networks to ensure a suitably sized earth conductor for all applications.

<i>Function</i>	<i>IEC Code for most of European Union</i>
Three Phase Line (L1)	
Three Phase Line (L2)	
Three Phase Line (L3)	
Neutral (N)	
Protective Earth or Ground (PE)	
Single Phase Line	

Figure 5 - Current Standards for cable core colours

Recommendation

It is recommended to keep this practice of not using armouring as a primary earthing conductor but still being part of the connected earthing system. It is recommended that the cable specifications and requirements for the use of an internal earth conductor core be included in the current Specification for Material and Workmanship. This can be done under the annual DSB for Highways Specification.

- f. **Prohibited use of CET Glands for terminating SWA cables into any item of highway electrical street furniture.**

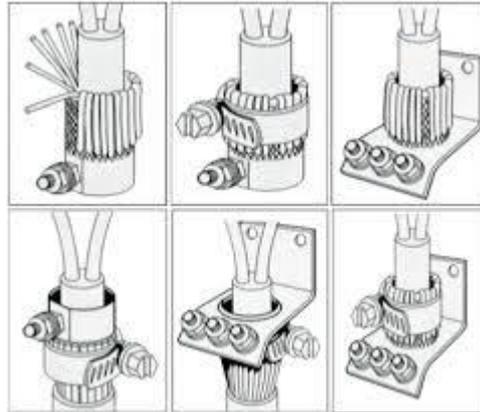


Figure 6 - CET Gland

Prior to the current version of Specification for Material and Workmanship there was a clause stating CET Glands (figure 6) should not be used and that CW type cable glanding (figures 7 and 8) should be used on all SWA cables. This clause is not present in the current Specification for Material and Workmanship as issued as part of the current WCC term contracts.

Notwithstanding from the start of this current contract the incumbent Service Development Manager (Public Lighting) was clear that his preference was not to use the CET type cable glands. CET glands, by their design allow no moisture ingress protection to the glanded cable end and, if the cable has the inner sheath damaged or removed in the preparation of the gland, exposes live conductors to inadvertent damage before they enter the secondary enclosure where they terminate. All glanding of SWA cables was to be by CW type glanding with the inclusion of a rubber. This is to prevent moisture ingress into the cable armouring to a greater degree, removes sharp metallic wire ends from the “maintenance area” and mechanically protect the cable inner cores. If the gland is to be made off into a non-metallic enclosure then an earthing tab or “banjo” as depicted in Figure 8 overleaf, should be used to continue earth bonding to the cables wire armouring.

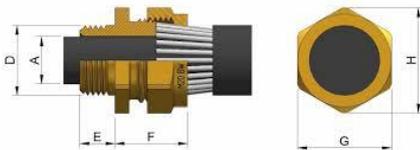


Figure 7 - CW Gland and Sheath



Figure 8 - CW Gland without Sheath

Recommendation

It is recommended to keep the practice of using CW glands and have the gland specifications included in the current Specification for Material and Workmanship. This can be done under the annual DSB for Highways Specification.

g. Secondary (Barrier) protection of switch gear within street furniture.

Within each item of highway electrical street furniture, where there is a secondary isolator, Distribution Board (DB), cut out or consumer unit, protective devices and cable terminations, these are only to be accessible after unscrewing a secondary door or cover using a tool. These items should not be accessible by unauthorised and non-competent people simply by opening the column/feeder pillar door. This is a health and safety consideration and is aimed at preventing inadvertent contact by unauthorised people who have gained access to the primary containment.



Figure 9 - An examples of secondary "barrier" protection in a feeder pillar and a lighting column.

Recommendation

It is recommended that a secondary barrier protection clause be included in the current Specification for Material and Workmanship. This can be done under the annual DSB for Highways Specification.

h. Surge Protection Device (SPD)

A Surge Protection Device (SPD) (figure 10) is to be included into the cut-out on each DNO supplied piece of equipment and should be of a type 1-2 or type 2 specification. This SPD should, where practicable, be equipped with an operation status indicator or link back to WCC's street lighting CMS that will indicate the service state of the equipment supplied. If there is a measured low safety risk, then consideration should be given to a "fail open" SPD device so that the equipment fed is rendered "out of use" to indicate that the device has been triggered and has now become inoperable.

The requirement for the SPD, at point of supply, has now become mandatory under BS7671. BS7671 also recommends SPDs be used at various points of a connected cable network but does acknowledge that the use of the additional SPDs may be risk assessed on a cost vs value of connected equipment basis.



Figure 10 - Surge protection devices

Recommendation

It is recommended to include SPDs in the current Specification for Material and Workmanship. This can be done under the annual DSB for Highways Specification.

It is also suggested that a report be commissioned, as an ASB, to develop a process to risk assess and identify where it would be practical and advisable to use "fail open" SPDs or include additional SPDs in electrical installations with an eye to SMART equipment in the future.

i. Chambers containing any termination boxes or joints

Chambers containing any termination boxes or joints are becoming more prevalent within the WCC built environment. There is a much bigger move to using architectural up lighters or other sources of lighting that require terminations below ground but close to the point of use. Early installations of this type were built using the standard detail for chambers as included within the current contract specifications and standard drawings. These drawings do not contain any reference to drainage, so the resulting chambers were effectively sumps. These chambers just collected run off water and ended up fully submerging equipment and terminations contained therein. The incumbent Service Development Manager (Public Lighting) advised that he wanted all such chambers to be positively drained by connection to a storm water drainage system near the chamber installation or chambers would not be considered to enable works.

No official standard drawing has been developed for this type of installation and current designs include what is effectively a sketch to guide in chamber construction/installation. (figure 11)

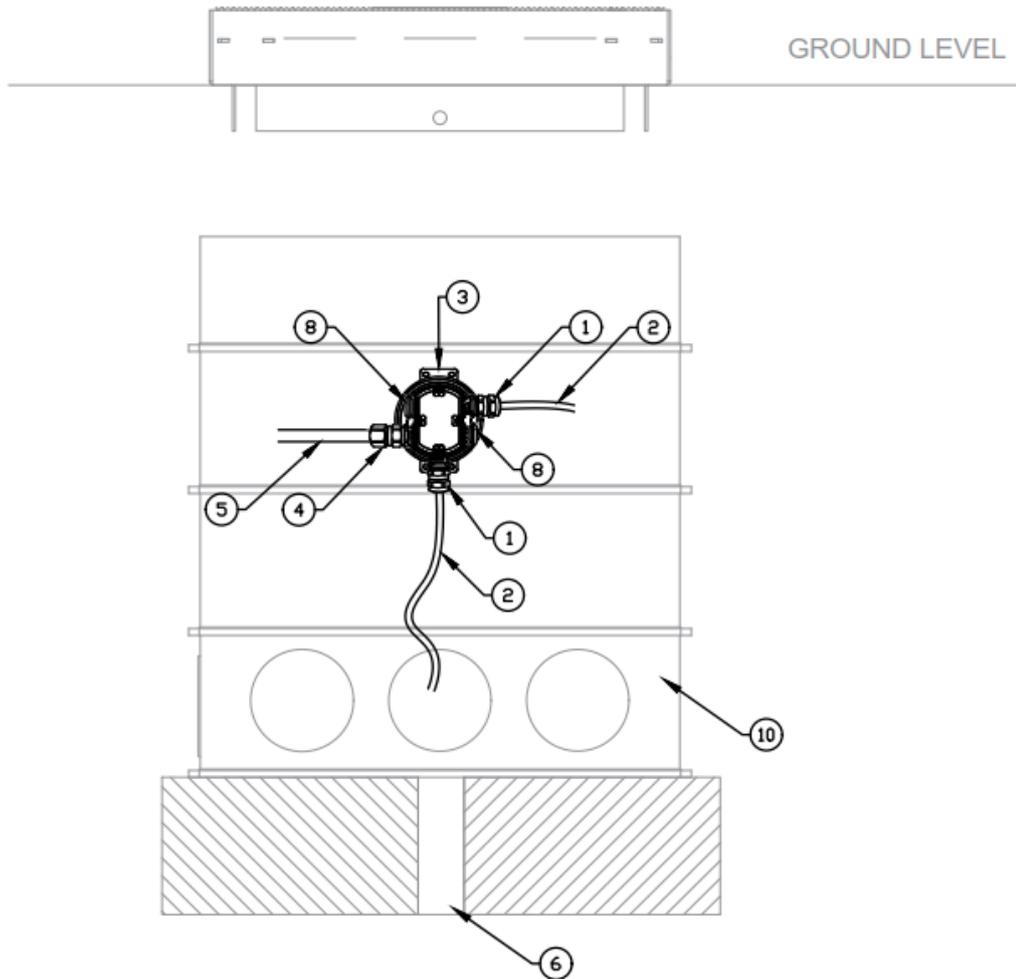


Figure 11 - Chamber detail showing drainage aperture (6)

Recommendation

It is recommended to a process of assessing the requirements for the level of drainage required in a chamber, influenced by its location within the environment, be developed, possibly as an ASB but being carried out by ground drainage experts. Subject to the outcome of the assessment, options of using soak away or positive drainage could then be chosen.

Standard detail drawings for both options need to be developed and added to the current Specification for Material and Workmanship. This can be done under the annual DSB for Highways Specification.

j. Sub surface connections and joints

It is current practice that all sub-surface electrical connections are required to be made in drained chambers and be contained within a CCG type heavy duty IP68 junction box (figure 12). All cable glanding into these boxes are to be made with

IP68 glands compatible with the box and to be carried out by suitably skilled and experienced persons.

It is also expected that any cable jointing is to be carried out in chambers. Joints need to be suitable for prolonged immersion. Jointing using a moulded resin type joint will only be allowed with prior agreement in writing from the WCC Project Manager – Street Lighting. The location of any jointing needs to be recorded on the WCC asset register.

On previous projects where sub-surface terminations have been carried out using square or oblong IP68 rated boxes the watertight integrity of the boxes have failed due to incorrect glanding, incorrect sealing of the boxes or distortion caused to the box by tensions developing in the cables terminated to them. It has been found, by experience and trial, that the round, threaded lid “CCG” type termination box is significantly more reliable for use in environments where flooding and immersion are likely to occur when used with compatible IP68 rated cable glands. These boxes are also available in various sizes to allow for multi cable or larger cross-sectional area cable terminations. These boxes have been used in WCC for around 3 years with no reports of failure. They are also relatively cost effective when compared to other IP68 solutions.



Figure 12 - "CCG" type round IP68 type connection box

Recommendation

It is recommended that the use of “CCG” type round IP68 boxes or similar non-metallic round box and matched IP68 materials and process for glanding be adopted as WCC standard materials and methods. To this end standard detail drawings for all cabling configurations and internal layout/wiring need to be developed and added to the Standard Detail Drawings. The boxes and glanding details need to be added to the current Specification for Material and Workmanship. This can be done under the annual DSB for Highways Specification.

Moulded jointing is currently covered in the Specification for Material and Workmanship but needs amending to cover the use of chambers and recording of locations.

k. All uplighters to be supplied with integrated driver and cables and the complete assembly, inclusive of cable, to be rated as IP68 by the manufacturer.

During the period of this contract, it has become apparent that many of the uplighters installed have failed within the first six months of their service life. There have been many reasons for these failures from actual product deficiencies to workmanship issues and selection of non-suitable equipment by outside parties specifying materials. As in ground uplighters are, by their very location of installation, prone to water ingress and subsequent damage; the decision was made that all uplighters considered for use had to be supplied with integrated driver and cable and the complete assembly, inclusive of the cable, are to be rated as IP68 by the manufacturer. The units should be 230v powered. It was further decided that no units used in WCC were to require any disassembly for installation and maintenance was to be by unit replacement only. At this point the incumbent Service Development Manager (Public Lighting) requested that the only up lighter to be considered for use in WCC was to be the Armadillo uplighter (figure 13).



Figure 13 - Armadillo uplighter

Recommendation

It is recommended that the principle of all uplighters to be supplied with integrated driver, the complete assembly, inclusive of the cable, to be rated as IP68 by the manufacturer and to be 230v powered needs to be adopted. The stipulation that no unit should require any disassembly for installation and maintenance and is to be by unit replacement only should also be adopted. These requirements should be written into the current Specification for Material

and Workmanship. This can be done under the annual DSB for Highways Specification.

It is not felt that the restriction to one manufacturer be upheld providing all the outlined criteria is met and sufficient warrantee is offered with the product.

5. Actions recommended for Electrical and Earthing related documents issued to WCC but still in “draft” status.

A. **ANNEX 21 Westminster Suite of Lighting Column Foundations Report**

The Westminster Suite of Lighting Column Foundations Report is included in the list of annexes within the current WCC contract although it is still at draft status.

The selection process for column foundation types and the hierarchy of available foundation types is no longer valid, if it is accepted that the NAL foundation is the default column foundation type to be used within WCC as proposed in 4a. It should be noted that Westminster Suite of Lighting Column Foundations Report also allows the selection of cranked root type foundations for use, which is no longer recommended.

Recommendation:

It is recommended that the Westminster Suite of Lighting Column Foundations Report be revisited and amended to suit the current foundation use and selection practices on this Lot B contract. This can be done under an ASB and the output report replacing the current report in the contract annexes via the Highways Spec DSB process.

B. **Listed & Cherished Column Electrical and Earthing Termination Proposals Report.**

The Listed & Cherished Column Electrical and Earthing Termination Proposals Report has never been formally signed off as accepted by WCC. It is felt that the contents of this report are still valid and do not require any further work.

Recommendation:

It is recommended that this report is accepted and approved by WCC and then included in the contract annex. This can be achieved by using the DSB for Highways Specification.

C. **Westminster Market Traders Electrical Supply Guidance.**

Although the contents of this report are still technically sound, there has been changes within WCC and their approach to market traders, in addition to the physical appearance and operational requirements for Market trader electrical Supply bollards.

Recommendation:

It is recommended that an ASB be raised to update this report to bring it in line with new British Standards and changes in approach within WCC. This report should then be approved by WCC and included in the contract annexes via the Highways Spec DSB process

D. TfL GN12 Combined Column Installations (Traffic Signals on Lighting Columns)

WCC have been allowing the use of combined traffic signal and lighting columns for several years now, but to date have not produced their own standard for this work, preferring to work off the back of TfL Guidance Note 12.

A guidance document was drafted a few years back but never approved by WCC and never put into use.

Recommendation:

It is recommended that a process document be drafted to integrate the use of TfL GN12 into WCC design practice. This would include a process for checking that the current version of TfL GN12 is being used and that all lines of communication to TfL traffic signals are clearly defined.

This could be commissioned as an ASB and the output document, once approved by WCC could then be included in the contract annexes.

6. Summary

- 6.1 The conclusion of this report is that 11 practices and 4 documents have been identified as being in common use or in circulation that effect the design and installation of electrical and earthing systems on the Westminster City Council Contract B contract. WCC will now need to assess the content of this report and issue instruction on whether they want to follow the recommendations contained within this report or request the termination of the identified practices and withdrawing of the documents listed.
- 6.2 If the items covered in this report are to be adopted, where the recommendation is that they are addressed via the Highways Spec DSB process, a written request from the Project Manager – Street Lighting, will be all that is required to initiate the process. Should the work recommended need to be carried out under an ASB then the Project Manager – Street Lighting, would need to request a scope and price for these works. Work would commence with the issue of an order from WCC and the agreement of a delivery program.



CHANDOS
STREET W1
CITY OF WESTMINSTER

PORTLAND
PLACE W1
CITY OF WESTMINSTER