ENGINEERING STANDARD

GE-CIC-ES-0063

GTC Appendix A for ENA ENGINEERING RECOMMENDATION

G81-PART 1: DESIGN AND PLANNING

TITLE: **Part 1: Design and Planning** **Framework for New Low Voltage Housing Development Installations**			DOCUMENT NO: **GTC-CIC-ES-0063**			
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1. INTRODUCTION

This document forms Appendix to Energy Networks Association (ENA) Engineering Recommendation (ER) G81-Part 1: Design and Planning, "Framework **for new low voltage housing development installations** " and should be read in conjunction with that document.

Other documents, which must be read in conjunction with this appendix, are:

- GTC Contract Documents
- GTC Housing Development Framework Appendices relating to Materials Specification, Installation Records and Cable Recording Techniques.

Applicants will be required to demonstrate previous experience and competence in undertaking network design up to and including HV. This is to be demonstrated through NERS accreditation administered by Lloyds.

Under normal circumstances, applicants will be required to have GTC approval in writing before any site work commences. As an alternative, GTC would welcome discussions with NERs accredited Applicants with a view to validating such Applicants to enable them approve their own designs. In such an arrangement, GTC will take a regular audit of a sample of designs submitted by the Applicant.

GTC will require Applicants to meet the standards and specifications contained in the ENA G81 framework documents and GTC G81 appendices and to seek prior approval for any design variation.

Where GTC requirements are not specified in this document ICPs should plan to undertake any design work in accordance with best industry practice, complying with all appropriate legislation, including those referred to in the ENA G81 suite of documents. If an ICP chooses to use a design specification that is not included within this document, the ICP should liaise with GTC for confirmation that the proposals are in keeping with GTC design methodology. ICPs are also required to obtain design approval from GTC prior to implementation.

Please note that GTC is unable to provide copies of external documentation, standards and specifications referenced in this document, but copies may be obtained from the relevant issuing body (such as the British Standards Institution (BSI) or Energy Networks Association).

2. DESIGN INFORMATION-DATA REQUIRED FROM APPLICANT

The design information listed in section 4 should be provided as part of the network adoption process.

3. DESIGN AND PLANNING

3.1 General

The design of new networks to be adopted by GTC shall comply with all relevant legislation, including any updates and publications in keeping with good industry practice.

The design of GTC networks in its entirety shall be carried out in accordance with the provision of current, relevant and applicable, Energy Network Association documents, BS EN documents, British Standards Specifications and British Codes of practice.

The design of GTC networks shall also follow all relevant GTC's published standards and Policies.

3.2 Security of Supply

Networks shall be designed to a standard set out in ENA ER P2/6. However it should be noted that P2/6 does not apply to individual customers having load demand less than 1 MW but to groups of customers based on demand.

In order to restore supplies to customers during HV network faults, and to maintain supplies during maintenance, all substations will normally be looped into the existing HV network.

Connections to the DNO system shall normally be looped in so that a connection is available with a switched alternative from the DNO. Loads in excess of 1 MW and up to 12MW shall have two points of connection from the DNO.

Loads in excess of 12MW shall have a specific risk assessment to assess supply security to the GTC network.

Class of Supply	Range of Group Demand	Minimum demand to be met	
		After First Circuit Outage	After Second Circuit Outage
A	Up to 1 MW	In repair time: Group Demand	Nil
B	Over 1 MW to 12 MW	(a) Within 3 hrs: Group Demand minus 1MW (b) In repair time: Group Demand	Nil

3.3 HV Network

A simple network is a safe network. In designing any additions or alterations every step should be taken not to make the network more complicated.

The parameters as set out below should be applied when HV networks are designed.

Voltage	Design Fault Level in MVA	Design Fault Level in kA
20 kV	250	13.1
11 KV	250	13.1
6.6 kV	150	13.1

HV supplies are to be maintained at nominal voltage +6% 0r -6%.

The HV cable design used for substation connections shall ensure that there is no de-rating of the existing HV network.

Care will be required in substation siting and routing of HV and LV cable connections on previously developed (Brownfield) sites, particularly if existing DNO infrastructure and customers are to be transferred to the new network.

3.4 Distribution Transformers

Proposed transformer sizes must reflect maximum loading (choice of the size must be determined by assessed loads, including growth rates for current development and provision for credible future development) but should also minimise losses.

GTC employs unit type transformers to ENATS 35-1 with standard ratings of 315, 500, 800 and 1000kVA. Any circumstances where transformers are required larger than 1000 kVA will be subject to separate design approval from GTC's authorising Manager. It is important to note that transformer noise limit criteria are included in ENATS 35-1 but are not included in IEC 76. The maximum transformer losses currently accepted by GTC are:

Rating	No Load Losses (Watts)	Load Losses (Watts)
315kVA	360	3900
500kVA	510	5500
800kVA	650	8400
1000kVA	770	10500

Distribution transformers selected shall not exceed 130% of its rating. However, rating can exceed to 160% in London foot print subject to prior GTC approval.

Ground mounted transformers shall generally be in accordance with ENATS 35-1, BS EN60076:1997 & IEC 60076:2000 and will meet the EU 548/2014 Tier 1 ECO Requirements.

Padmount transformers shall generally be in accordance with ANSI C57-12-25/26. Their use will be restricted to temporary connections, pumping stations and street lighting installations, unless otherwise agreed with GTC authorising Manager.

Permissible cyclic ratings shall comply with the requirements of BS 7735/IEC 354 (taking into account load curves forecast by the developer and the effects of enclosure).

For standard free-standing substations transformers filled with oil complaint with BS 148:1998 shall be specified.

Transformers filled with MIDEL 7131 should be specified for situations where transformers are contained within buildings which require higher level of safety than would be afforded by an oil-filled transformer.

Vector group DY11 will be the standard.

Tapping facilities of +5 to -5 shall be standard. Off load tap changers will be installed.

Transformer losses should not exceed 1.5% of the total daily energy supplied during periods of maximum demand.

3.5 Distribution Substations

- Distribution substations shall be designed in accordance with *GTC Substation Specification GE-TGI-IG-0032.*
- GTC requires all new distribution substations to be free-standing brick constructed which shall be provided with security measures appropriate to the risk of unauthorised access and vandalism.
- All substations shall be located and, as appropriate, protected to mitigate the risk of flooding. Substations can be various sizes and types. They will be sized to accommodate different types of equipment from Padmounted transformers to Ring Main units. The design of the substation structure will be subject to the details provided in section 4 and *GE-TGI-IG-0032 Substation Specification* document.
- All plant and main cables shall be sized to take account of credible future developments.
- Siting of substations will require additional discussions between GTC and the developer to ensure that access is available at all times and to address the issues of noise, vibration and ventilation detailed below.
- Cables shall be laid at a suitable depth and adequately protected (by tile, tape or ducts) in accordance with NJUG recommendations.
- HV and LV cables shall be separated so far as is reasonably practicable, to prevent danger and to facilitate future works.

Looped 11kV networks and/or interconnection between LV networks shall be provided where P2/6 requires GTC to facilitate alternative supply.

3.5.1 Location of Substations

All substations shall be placed as near as practicable to the load centre, taking account of credible future developments. The designer must consider the following criteria when specifying or agreeing the location of a substation and where appropriate, should provide the Developer with a copy of the Substation Installation "Noise" and "Electromagnetic Fields" documents, which can be obtained from GTC's authorising Manager.

3.5.2 Time Fuse Link

The time fuse link shall comply with ENA TS-12-6 with exception of LPN area of UKPN where UKPN recommended time fuse shall be preferred to ENA TS-12-6.

3.5.3 Noise

Whether a substation will cause a noise problem is dependant to a large extent on the existing background noise levels in the locality. For general guidance the average background levels are:

Rural (residential) area = 30dB (A)

Suburban = 35dB (A)

Urban (City Centre) = 40dB (A)

Care should be taken in applying these area definitions because, due to changing industrial or traffic activity patterns, one area which may be classified as urban during working hours could have noise levels equivalent to rural during weekends or overnight. Complaints may be expected if the transformer noise level exceeds the measured background noise level by 5dB (A) or more. If the transformer noise level is 10dB (A) below the background levels, then complaints are unlikely.

3.5.4 Limiting Distances for Guidance Purposes

TRANSFORMER RATING (kVA)	**315**	**500**	**800**	**1000**
LIMITING DISTANCE (M) (From wall of substation) Rural/Residential Location	11	14	17	19
LIMITING DISTANCE (M) (From wall of substation) Suburban Location	7	9	10	12

If the proposed location of the substation is less than the distance shown in the table, the use of a low flux density transformer, combined with a brick built enclosure should be considered. Noise reducing baffles on ventilators can also be considered.

3.6 Distribution Substations' Earthing

Distribution substations' earthing shall be designed in accordance with one of GTC's relevant standards and GTC Standard Earthing Drawings listed below.

- GE-DPR-ES-0047 Substations, Dual Intake Earthing Design Data
- GE-DPR-ES-0048 Substations, GRP Earthing Design Data
- GE-DPR-ES-0049 Substations, Brick Built Earthing Design Data
- GE-DPR-ES-0050 Substations, Integral Earthing Design Data

GTC Standard Earthing Drawings

Details of the Earthing Layouts for the Substations listed in GTC substation specification GE-TGI-IG-0032 are shown on the following Drawings:

- GTC-E-EA-0001 Free-Standing Substation Earthing Layout (includes use of Conducrete)
- GTC-E-EA-0002 Integral Substation Earthing Layout
- GTC-EA-0003 Reinforcing Earth Mesh Connection Bar Layout

GTC's standard designs shall incorporate earthing systems which ensure that the Operator and the Public are safeguarded from the danger of electric shock, whilst inside or within close proximity to the substation, resulting from a rise in voltage of the equipment as a result of the passage of earth fault current.

The following features shall be incorporated in all GTC substations' earthing designs:

- The Substations' base and cable pits shall be fully bunded and incorporate welded reinforcement just below the concrete across the substation floor, cable pit sides and base. A welded connection bar is extended into the cable pit and connected by 120mm² copper cable to the substation earth bar.
- The substation equipment shall be earthed using 120mm² copper cable to the substation earth bar.
- All metal doors, door frames, ventilators etc shall be bonded to the Earth bar.

For free-standing substations, an outer earthing loop of 120mm² bare copper at 600mm depth shall be laid around the outside of the substation with 3.6m deep electrodes connected to it at each corner. At the front of the substation an outer loop of bare 120mm² copper shall be connected with substation earthing. For further details, please refer GTC's substation earthing layout GTC-E-EA-0001.

Conducrete (conducting concrete) shall be placed above the out earthing loop to improve its earthing performance and provide additional security against interference or theft.

These design features will ensure that an operator within the substation will always be standing on a surface which will be at the same potential as the metal enclosure of the switchgear, transformer and LV cabinet.

The ring electrode combined with Conducrete will minimise the danger from touch or step potentials outside the substation building and the outer door loop safeguards an operator in contact with an open metal substation door and standing in the doorway.

For Integral Substations, it is not possible to incorporate an external perimeter electrode. The Earth electrodes shall be installed through the substation floor and an internal perimeter of 25x4mm copper tape shall be used to connect them and bond all the substation equipment to the substation earth bar. Additional electrodes can be connected by installing 120mm² bare copper earthing conductor along the HV cable route and welded connections can be made to any local sheet piling or reinforcement mesh to improve the earthing value. For further details, please refer GTC's substation earthing layout GTC-E-EA-0002.

3.6.1 LV Neutral Earth

The neutral of the local distribution transformer in the substation shall be earthed via an earth electrode system which will be electrically separated from the substation steelwork earth described above, by means of a minimum of 9m of 70mm² PVC insulated copper earthing conductor. This will allow the earthing systems to be operated Combined (Cold) or Separate (HOT) depending upon the particular network. This design feature will allow GTC to change the type of earthing as the network develops.

3.6.2 Additional Earthing conductor

In certain soil conditions it may be necessary to lay additional earth conductor to achieve a low enough earth resistance to ensure safe touch and step potential. The procedure is to lay a 120mm² bare copper conductor below the HV cables for the calculated length to lower the overall earth resistance to the desired value.

3.7 LV Design requirements

The preferred method of LV network design is by using EA Technology's 'WinDebut' computer program. This program is generally accepted by all Distribution Network Operators in the UK and is approved for use on GTC's networks. However, for use of all other computer programs, the ICP will go through a separate approval process. The proposed computer program shall be proved by the ICP representative to GTC's authorising manager that the program will meet GTC's LV design requirements.

'WinDebut' recommended settings are detailed in Appendix 1

3.8 Voltage Regulation

The Design shall comply with relevant section of ESQCR.

The Maximum Voltage at the distribution system Exit Point shall **not** exceed 10% of Nominal voltage (230 V) i.e.253V and minimum voltage at the distribution system Exit Point shall **not** be less than -6% of nominal voltage (230V) i.e.216V.

Maximum voltage DIP allowable for motor starting is 1% at the point of common coupling.

3.9 Maximum Voltage Drop

The voltage regulation between the substation LV busbar and any customer's service termination shall not exceed 7% of the declared voltage (230V), with a maximum of 5% on the main and 2% on the service (35mm^2 service cable lengths to be a maximum of 29 metres).

In providing supply to multi-occupancy buildings, the incoming cable will be treated as a main with voltage regulation limited to a maximum of 5% at the incoming Multi Service Distribution Board (MSDB), to allow for regulation on developer/customer owned sub mains within the building.

3.10 Maximum Voltage Unbalance

The Maximum voltage unbalance at any point shall not exceed 10%

3.11 Voltage Disturbance

The network shall be designed so that voltage fluctuation associated with the normal operation of any apparatus connected within this design will be contained within the limits set out in ENA Engineering Recommendation P28. This requires that the maximum step voltage change caused by a switched single phase load of 7.2kW (i.e. an electric shower) should not exceed 3% at the point of common coupling with other customers (i.e. the service breech joint).

Service connections shall be arranged to promote load balance.

3.12 Maximum Earth Loop Impedance

The maximum value of earth loop impedance to the electrically most remote service termination (or main, where no service exists) must ensure that there is sufficient phase to neutral fault current available to cause LV circuit fuse operation within 100 milliseconds. Therefore the design requirement is:

- To end of service 250 milli-ohms
- To end of main, where no service exists, 200 milli-ohms

3.13 Prospective Short Circuit Current at LV Busbars of Distribution Substation

- Design Maximum 25 kA
- All equipment to be capable of withstanding 36 kA

3.14 Prospective Short Circuit Current at Service Termination

The maximum design PSCC at the electrically nearest LV single-phase service termination to any substation shall not normally exceed 16kA. For a three-phase service the design PSCC shall not normally exceed 27kA.

Values of PSCC up to 46kA can be experienced for connections made directly to solidly interconnected LV networks such as those found in the central London area, for such networks prior GTC approval is required.

Further guidance on the determination of PSCC can be obtained from ENA ER P25 for single phase and ENA ER P26 for three phases.

3.15 LV Generator Connections

GTC has a requirement to provide means of connecting temporary LV 3 phase generation to the LV fuse cabinets at HV/LV substations and free standing LV Pillars. Please refer GTC's Appendix for G81-Part 2: Material Specification GE-CIC-ES-0064 for further details.

3.16 Calculation of Demand

Data for calculation of demand is determined by the program and is dependent upon the number of connections and the designer's estimate of annual unit consumption. The table below indicates the classifications of properties used by GTC and gives typical unit consumptions. However, Watt per square metres calculations as per CIBSE standards or any other alternative calculation method requires prior GTC approval.

3.16.1 ADMDs (kW) WinDebut curve/units (After Diversity Maximum Demands)

Type	Day	Night	Curve	Day	Night
1/2 Bed Gas C/h	1.2	0.3	URLC	3500	0
3 Bed Gas C/h	1.5	0.3	URLC	4400	0
4 Bed Gas C/h	1.8	0.5	URMC	5800	0
5+ Bed Gas C/h	2.4	0.5	URHC	7500	0
1/2 Bed Other C/h	1.5	2	ESEVEN	3500	2000
3 Bed Other C/h	1.9	2.5	ESEVEN	4400	2500
4 Bed Other C/h	2.1	3	ESEVEN	5800	3000
5+ Bed Other C/h	3.1	3.5	ESEVEN	7500	3500
E7 1 Heater / W/h	2.2	5.13	ESEVEN	5500	5000
E7 2 Heater / W/h	2.5	7.56	ESEVEN	5700	7500
E7 3 Heater / W/h	2.8	9.99	ESEVEN	6000	10000
E7 4 Heater / W/h	3.4	12.42	ESEVEN	7500	12000
15kW Boiler	4.5	16.2	ESEVEN	10300	16000
19kW Boiler	5.7	19.8	ESEVEN	12000	18800

3.17 Services

GTC does not employ or accept looped services connections for non-street lighting installations. Up to a maximum of four single phase service cables; or one three phase and one single phase service cables shall be installed in one service joint. Overall phase balance should be considered as part of the design function. It is permissible to loop in sideways **not** in the main road up to 3 street lighting cut outs from the same single phase service cable.

A single branch from any direct service to customer's electrical installation is permitted for services to street lighting columns.

3.18 Service Entry Requirements

On new housing developments the preferred method of service entry to a customer's electrical installation is via a duct (with draw-wire) and a hockey stick to an outdoor meter cabinet, complying with: NJUG Volume 2: Guidelines on the Positioning of Underground Utilities Apparatus; and ENATS 12-24 standard.

Looped services shall not be used. The normal service will be a 35mm² single phase CNE cable with a 100amp cut out installed at the customer's termination.

The provision of brick or block behind the outdoor meter cabinet may not be possible in timber framed buildings. The wall behind the service/metering equipment must be fitted with a steel sheet (min. 1mm thick) bonded to the cut-out PME terminal. This is to protect persons drilling through the wall from electric shock. For further guidance, see Internal Metering Point document - Appendix 4 of GTC's operational procedure GE-DPR-OP-0043.

In certain circumstances an internal termination position may be agreed. This will be due to circumstances dictated by the style or positioning within the property.

Where this is undertaken GTC will give special dispensation to provide this type of service. Under these circumstances the service termination MUST be mounted on class 'O' fire retardant chipboard to BS 476, Part 6.

3.19 Equipment Ratings

The network shall be designed so that the proposed equipment/cables are suitable for use at the rating of that part of the distribution system to which they are connected.

LV mains cable ratings shall be suitable for maximum load conditions – usually winter cyclic rating. A de-rating factor shall be applied if mains cable is laid in ducts longer than 15 metres. Two or more duct lengths can be used on a section provided there are no more than 30 metres of duct in any 250 metre cable section and a minimum of 10 metres separation between each duct length.

3.20 Maximum Number of Connected Customers per Feeder and per Substation

LV radial circuits shall normally have no more than 80 connected customers. Based on a 5 way LV Distribution cabinet/pillar, this would result in a maximum of 400 customers per unit substation. Any changes to this standard due to sound technical reasons require prior GTC approval from the authorising manager.

3.21 Supplies to Multi-Occupied Buildings

Supplies to Multi-Occupied Buildings shall be designed in accordance with ENA Engineering Recommendation G87, GTC's documents *GE-TGI-IG-0015 Technical Guidelines-Electricity* and *GE-DPR-OP-0043 Electricity-Design Criteria Testing Requirements*.

3.22 LV Protection

The network shall be designed to provide short-circuit protection over the whole length of the circuit up to the service cut out and allow for the cyclic overload rating of the circuit.

LV fuses shall be sized such that the minimum pre-arcing I^2t of any upstream fuse must exceed the total I^2t of any downstream fuses whilst ensuring discrimination with the transformer HV protection.

3.23 Underground Cables - Criteria for HV and LV Cables

Cables as laid out in the GTC's Appendix for *G81-Part 2: Material Specification GE-CIC-ES-0064* only will be used, applying the following factors:

- Continuous ratings in accordance with ENATS or manufacturers' specifications
- Soil thermal resistivity g = 1.2°C metres per Watt
- Ground ambient temperatures 15°C
- Maximum conductor temperatures in accordance with ENATS or manufacturers' specifications

- Definition of cyclic ratings in accordance with IEC 853: group derating factors in accordance with ERA 69-30
- Ducts – maximum lengths without de-rating 15m
- All road crossings shall be ducted
- Appropriate number of spare ducts shall be installed in the road crossings
- Ducts shall be smooth bore twin walled black polyethylene or red PVC duct by prior approval from GTC's authorising Manager, manufactured to ENA Technical Standard 12-24
- The installations of underground cable to NJUG's recommendations

3.24 Unmetered Supplies

GTC will provide unmetered supplies in the following circumstances, in line with 'The Electricity Unmetered Supplies Regulation':

- The load is of a predictable nature
- The load is below 500watts

The type of installation which can be unmetered includes street lighting under solar cell control, street signs, bollards, surveillance cameras and traffic monitoring systems etc.

Reference should be made to the Elexon list to determine whether an item of street furniture can be given an unmetered supply.

Normally this type of supply will be provided to an installation which will be adopted and maintained by the Local Street lighting Authority but in some cases it will be acceptable to provide unmetered supplies to privately owned installations provided certain conditions are met.

3.24.1 Private street lighting installations and unmetered supplies by GTC

Where the street lighting of a private development will not be adopted by the local authority but is **generally similar in layout and location** to a normal adoptable scheme.

- The lighting will be controlled by either solar cell or time switch (i.e. predictable consumption)
- The location will be accessible 24 hours/day
- The equipment will be within normal servicing distance of existing or proposed mains cables or services

The supplies can, subject to a formal agreement with the management company, be unmetered.

In such cases normal route of main services will be provided – see Options 1, 2 and 3 as following.

3.24.2 Where GTC cannot provide unmetered supplies

Supplies to private cable networks for the list below cannot be provided with unmetered supplies:

- Car Park Lighting
- Electric Gates
- Lighting within gated developments incorporating, for example, low level up lighters
- Footway bollards etc
- All types of installations which can be broadly categorised as landlords supplies with indeterminate or variable loads. All supplies of the above type will be metered. The normal arrangement would be for the developer to provide a suitable service pillar or kiosk to GTC requirements for security and size, located in a secure accessible position with 24 hr access.

GTC will provide a standard metered service to supply the private equipment or cable network.

3.24.3 Design of Street Lighting Schemes

GTC will provide services to street lamps and service pillars (for road signs and similar street furniture) where these are within the site and near to the distribution cables. These connections will be subject to full details of the street lighting design, equipment specification and lighting loads shall be supplied by the developer.

There are three main options in providing electricity supplies to street lighting installations which are outlined below.

3.24.3.1 Option 1: Route of Main Connections

Where an LV main is present, the lighting columns shall be individually serviced using standard 35mm² hybrid service cable.

The length of the individual service cable should not normally exceed 29m and up to this service length the standard design parameters of GTC low voltage networks will ensure that the loop impedance to the end of the service will not exceed 250 milli-ohms. The Windebut study of the proposed network shall include the furthest points of the mains cable network and if there will not be domestic service connections nearby a token load shall be added at the furthest point to ensure that the loop impedance at that point will be within normal limits. This will ensure that the main fuse controlling the circuit will clear within 100 seconds.

Roadside signs, bollards and miscellaneous street furniture shall normally be supplied from the nearest lighting column using a Titan 2 cut-out with a sub fuse rated at 6amps and standard 35mm² service cable. If the nearest column is more than 30m from the required supply point to the street furniture a mini pillar shall be installed. This will have a normal street lighting service installed with a fuse rating of 6amps.

If longer service lengths will be necessary to supply individual remote columns the loop impedance of the most remote run shall be calculated to ensure that the substation or supply pillar fuse will clear correctly and will be within the limits of Table 1. The controlling fuse should clear a fault on the main or service within 100 seconds.

To determine the loop impedance at the end of the street lighting service first find the loop impedance in milliohms at the proposed joint position from WinDebut. Then add the loop impedance of the proposed service cable: if using standard 35mm² service cable (Length (m) x 1.751) milliohms.

The sum of impedance (1) at the proposed joint position and loop impedance (2) of proposed service cable must not exceed the values in Table 1 for the size of LV fuse controlling the mains cable to ensure fault clearance in 100 seconds.

Table 1.

LV Fuses to BS 88 Pt.5	Max Loop Impedance (1 + 2) 100 sec clearance
630 amps	120 milliohms
400 amps	190 milliohms
315 amps	270 milliohms
200 amps	450 milliohms

3.24.3.2 Option 2: Extension of Main using 3Phase 35mm² Cable

When the street lighting installation extends beyond the limits of housing and the distances are greater than the limits of option 3, it will be necessary to extend the GTC cable network to provide secure street lighting supplies. This shall be carried out using 3 phase 35mm² cable. This cabling must be included on the WinDebut study to determine the maximum loop impedance at the furthest point of the extended network. If the loop impedance will remain within the limits of Table 1 for the fuse size proposed on the particular network the criteria of 100 second fault clearance will be achieved and the proposed lighting columns can then be connected by individual short services as in option 1. Street lighting load shall be balanced across all three phases with adjacent columns connected to different phases.

If the loop impedance at the furthest column exceeds the limits of Table 1, it will be necessary to sub fuse the section of the extended network which exceeds the limits of Table 1. This can be achieved by installing a mini-pillar at a convenient point on the route and installing a 3 phase cut out to supply the remote section of the circuit. The sub fuse size will depend on the street lighting load and the loop impedance and a suitable fuse can be selected from Table 2.

Table 2

Street lighting Fuses to BS88 Part 1&2	Max Loop Impedance (100 sec) in Ohms
25 amps	3.27
20 amps	3.86
16 amps	6.07
10 amps	9.66
6 amps	19.32
Note: based on max. curves in BS 7654	

3.24.3.3 Option 3: Looping of Additional Columns

Up to 3 additional lighting columns could be looped from the final route of main connected column without sub-fusing provided the loop impedance of the furthest column will be within the limits of Table 1 for mains fuse clearance. If the loop impedance will exceed Table 1 values a sub fuse will be used to control the looped columns. This will be installed in the control column using a Titan 2 cut out which has the option of a second fused out feed. The sub fuse size will be selected from Table 2 to allow for the calculated loop impedance of the furthest column. Normally a 6amp fuse will be used.

3.24.3.4 Earthing Requirements

Extended cable networks for street lighting shall be designed in the same way as a normal network with neutral earthing electrodes installed at the furthest point on the network. Individual columns where a PME service will be provided will not need an electrode if the main will have one installed beyond the service position; as per the normal arrangement for domestic services. Every column will be earthed. If columns will be looped as in option 3, an electrode will be installed at the furthest column and it will be connected to the supply neutral using 16mm² copper earthing conductor.

3.24.3.5 Supplies to Private Networks with Unpredictable Power Consumption

These installations will always require metering and the standard method of supply would be via an approved service pillar or supply kiosk. Normally the developer would supply a suitable unit which would need to comply with GTC requirements for security and size and be located in an accessible position for meter reading. A standard 35mm² services shall be installed.

3.24.3.6 Supplies to Traffic Lights, Roundabouts or Traffic Islands

Where supplies shall be required for traffic signs, bollards, traffic lights, street lighting columns sited on roundabouts or similar situations, GTC will provide a service into a supply pillar provided by the developer from which private cable will supply the particular installation. Normally such installations will be metered.

4. DESIGN APPROVAL DOCUMENT

This information shall be provided to GTC as part of the design approval process.

4.1 Design

- Site drawing to minimum of 1/500 scale and not to 1/750,showing plot numbers and layout, cable routes and sizes, ducts, substation location, link boxes location, proposed meter positions (including grouped), phase connections, landlord connections and any temporary building supplies required. In addition highway/footway to be adopted by local authority should also be clearly indicated.
- Phasing of development, housing schedule and type of heating/demand
- Number of customers and connections on each circuit and phase
- Maximum load on each circuit (A)
- Fuse size selected for each circuit (A)
- Maximum voltage regulation at end of mains and electrically most remote service termination/cut out (as % of declared voltage 230V) for each circuit
- Maximum earth loop impedance at electrically most remote service termination/cut out
- Design maximum PSCC at electrically nearest service terminations
- Details of voltage fluctuations due to any proposed pumps/motors on site
- A Designer's Statement and, where appropriate, a Design Risk Assessment detail potential risks and how the risks have been mitigated in the Design
- A Substation Risk Assessment as required by the ESQC Regulations
- Computer model print out for validation
- HV single line diagram
- Upstream DNO point of connection, design approval documents and associated correspondence
- Indicative route of upstream DNO cables
- Details of way leave requirements and substation lease requirements
- Details of provisions made for future load growth
- Name of designer and date of design
- A record of any assumptions made
- Details of any Special Engineering Difficulties (e.g. Bridge crossings, rail crossings etc)
- Details of Metering as required by the GTC LDSO Database for meter registration

4.2 Requirements for motors

- No of Motors
- Motor Size (kW)
- Motor Connection Voltage
- No of Phases
- Duty Cycle as number of starts per hour
- Method of Starting
- Starting Current (Amps)
- Full Load Current (Amps)

4.3 Small Scale Distribution Generation (SSEG) Up to 16 A per phase

The design shall be assessed and approved as directed under ENA Engineering Recommendation G83.

4.4 Details of Other Generations Sources

Other forms of generation will require separate site-specific approval in line with ENA Engineering Recommendation G59. This can be a chargeable activity based upon the complexity of the generation scheme, using an external consultant, what impact it has on the upstream network and subject to upstream DNO design approval.

4.5 Witness tests of SSEG units 50kW and above

GTC will normally require to witness tests of installations of 50 kW and above. However, GTC reserves the right to witness tests of installations below 50kW. GTC normally charges for this activity.

The following supplementary information shall be required prior to adoption of any networks by GTC:

4.6 Switchgear

- Manufacturer
- Serial number
- Year of manufacture
- The manufacturer's stipulations for its inspection and maintenance
- Type
- Normal Ratings
- Fault Ratings
- Transformer protection details
- Ring or radial connection

- HV cable type, size and termination
- Protection Relay Settings
- Switch Label

4.7 Transformer

- Manufacturer and Specification
- Serial number of the transformer
- Year of manufacture of the transformer
- The manufacturer's stipulations for its inspection and maintenance
- Rating of transformer (kVA)
- Voltage ratio and number of tap positions with % steps
- Impedance Z%
- Vector Group
- Design PSCC at LV bus bar (kA)
- Iron losses (W) and Copper losses (W)
- Design maximum load (kVA)

4.8 LV Distribution Fuse Cabinet – transformer mounted

- Manufacturer/Type
- Details of the outgoing LV feeders
- Bus bar rating
- Outgoing ways
- MDI range/CT ratio
- Cable sizes connected

4.9 Earthing

- Earthing Arrangement
- Substation site identified as "Hot" or "Cold"
- Details of PME or Non PME earthing
- Location of Earth Spikes

4.10 Cable types and specification to be used

- HV Mains cables
- LV Mains cables
- Service Cables

Additional information requirements may be detailed in G81 Part 3: Installation and Records appendix to Framework for new low voltage housing development installations.

Appendix 1

Recommended Setting for EA Technology's 'WinDebut' Computer Program

Design Parameter	WinDebut Setting
Fusing	ON
Fusing value	1.05
Fault level (MVA)	250
Design voltage (volts)	240
Minimum length of cable (m)	50
Minimum % of cable (%)	10
Incremental taper length (m)	5
Capitalised cost of losses (£/kW)	0
Network modelled?	No services
Resistance R (mΩ) (ELI)	200
Maximum day volt drop	5%
Maximum night volt drop	5%
Transformer minimum rating required	BS7735
Losses	Simple
Excess Regulation	On
Maximum day outside temp (ºC)	8
Minimum night outside temp (ºC)	4
Transformer selection group	315/500/800/1000 kVA
Cable selection group correct	95/185/300
1 or 2 Bed Property (Gas Heated) Profile URLC (0 – 4500)	3500 Units
3 Bed Property (Gas Heated) Profile URLC (0–4500)	4400 Units
4 Bed Property (Gas Heated) Profile URMC (4501–6000)	5800 Units
5+ Bed Propert (Gas Heated) Profile URHC (6001-7500)	7500 Umits
Customer profile URHC (7500+)	Appropriate to installed Load
Customer profile ESEVEN	Appropriate to installed Load

Note: Generally, these are the recommended settings but other settings may be applied where agreed with GTC on a site-specific basis, where local constraints are imposed by the Upstream DNO network's supply characteristics.

1. Provision of earth-loop impedance test results