GUIDELINE NOTES
FOR NON EMBEDDED CUSTOMERS

SUBMISSION OF GRID CODE DATA

(Prepared by National Grid plc)

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NOTES

These Guidance Notes have been prepared by National Grid plc to assist Non-Embedded Customers provide the necessary submissions under the Grid Code. The Guidance Notes do not form part of either the Grid Code or the Master or Supplemental Agreements, and in case of ambiguity the Grid Code or Agreements (as appropriate) take precedence over these Guidance Notes.

DOCUMENT CHANGE CONTROL DETAILS

ISSUE No.	PUBLISHED	CHANGES MADE	APPROVED
Issue 10	April 2001	Modification to Schedule dates	P T Manning
Issue 11	March 2004	Major Revision	D Balasingam
Issue 12	April 2006	Update in accordance with Grid Code Issue 3 Revision 15	K.F. Dan
Issue 13	April 2007	Clarification of zero seq impedance reqmts. Contact details added.	K.F. Dan

CONTENT PAGE

1. INTRODUCTION

All non-embedded customers (**NEC**) should make a Grid Code (**GC**) Data Submission in 'week 24' (approximately the third week of June) each year. This submission should be in 4 parts:

1) Users System Data (Covering Schedule 5)

2) Demand data (Covering Schedule 10)

3) Connection Point Demand Data (Covering Schedule 11)

4) User System data (Covering Schedule 13)

General guidance on providing this data is given in this. Proformas for providing this data are located on National Grid's Industry Information website:

https://www.nationalgrid.com/uk/Electricity/Codes/gridcode/gridcodedocs/

Standard Planning Data and Detailed Planning Data are required for all existing and proposed non-embedded customers (CUSC contract accepted with connection dates within the succeeding seven financial years) and all connected projects in Week 24 of each year. A submission of Standard Planning Data is also requested from existing customers where a CUSC contract has not been signed in order that safe operation of the transmission System may be ensured (vis á vis fault infeed, transient performance and thermal loading)

2. USERS SYSTEM DATA (SCHEDULE 5)

2.1 Definitions

A User System contains all electrical plant and apparatus at all voltage levels. The GC divides it into three parts:-

(i) User's Supergrid Higher Voltage System.

Equipment operating above 200kV directly connected to the GB Transmission System (in practice this is all equipment operating at 275 or 400 kV).

(ii) User's Subtransmission Primary Voltage System.

This comprises all equipment operating at the next transformation level down from supergrid voltage.

(iii) The Remainder of the User System

This comprises all other equipment; limited data may be required depending on type of use.

2.2 Data Requirements

Requirements for User's system data are given in section PC.A.2 of the GC. The summary below considers each section in turn.

Single Line Diagram (PC.A.2.2.1)

NECs are asked to provide a Single Line Diagram showing the layout of their system. Note that phasing arrangements for overhead conductors operating at 400 or 275kV is required.

The Single Line Diagram is not the Operations Diagram referred to in the Connection Conditions; although in some cases the Operations Diagram can be used as a surrogate for the Single Line Diagram.

Where the NEC has auxiliary GTs, it would be helpful if the Single Line Diagram could show the normal point of connection of these machines. Where there are alternative connection points for such machines, this should also be shown.

Lumped System Susceptance (PC.A.2.3)

This data refers only to susceptance associated with significant demands. It is only likely to be of significance if there is a considerable demand (over 100 MW) associated with a large 132 kV cable network. Note that the susceptance of any 275 or 400 kV equipment is not to be provided here, but will be included in the submission made under PC.A.2.4 (see below).

Reactive Compensation Equipment (PC.A.2.4)

Please provide details of any reactive compensation equipment connected at 132 kV or

above. Short-Circuit Infeed (PC.A.2.5)

Requirements for data on fault infeeds are discussed in Section 5 (Fault Infeeds) below.

Three Winding Transformers

The GC requirements for data on transformers are, in most cases, sufficient for the needs of the Transmission Licensee. There are, however, a few cases when additional data is required in order to model transformer elements correctly. One such case is that of the three winding transformer, i.e. a transformer constructed with two secondary windings designed to carry load currents. The case of the transformer constructed as primary, secondary and tertiary is excluded from this category of three winding transformer.

For the three winding transformer, the following minimum data items are required:-

- Rating of each winding (e.g. 90/45/45)
- Voltage Ratio (e.g. 132/13/13)
- Winding Arrangement (e.g. YDD)
- Positive Sequence Impedance (See below)
- Zero Sequence Impedance (Note that for a YDD winding arrangement, a single value of zero sequence impedance is appropriate)
- Tap Changer Range
- Step Size
- Type (On Load/Off Circuit)
- Tapped Winding

The positive sequence impedance of the transformer should be provided in the form of an "equivalent T" representation for the maximum, minimum and nominal tap positions. The values of the "equivalent T" can be readily calculated form the standard test measurements made on the transformer.

The impedance values should be quoted as a percentage **on the same MVA base.** This base may be the LV windings (45MVA in the above case) or in the case where all three windings have different ratings, the test certificate measurements may have to be converted to a consistent MVA base **before** the "equivalent T" is evaluated.

The values for an “equivalent T" which is based on the terminals of the three windings designated H, L1 and L2 should be provided as outlined below.

		Z_H For The Equivalent T	Z_{L1} For The Equivalent T	Z_{L2} For The Equivalent T
Resistance	Max Tap Min Tap Nom Tap			
Reactance	Max Tap Min Tap Nom Tap			

MVA Base For The Values Given:_____MVA

Switchgear (PC.A.2.2.6)
User's Supergrid Voltage Connecting System Data (PC.A.2.2.2 to PC.A.2.2.4)

Earthing Arrangements (PC.A.2.2.5.1)

The Data is required on the electrical components shown on the Single Line Diagram. This comprises:

(i) all lines and cables at 275 or 400 kV and in Scotland also at 132kV.
(ii) all transformers with at least one voltage being 400 or 275 kV and in Scotland also at 132kV.
(iii) all circuit breakers at 400 or 275 kV and in Scotland also at 132kV.

Proforma for the return of this data is Schedule 5 of the DRC which is located on National Grid's Industry Information website:

https://www.nationalgrid.com/uk/Electricity/Codes/gridcode/gridcodedocs/

If the transformer is sited within the Transmission Licensee substation and connected to the Transmission Licensee system by less than 100m of overhead connection, a data return saying "overhead connection less than 100m" is acceptable.

Please note that, for switchgear, while the rated SC breaking current should be the symmetrical value, the rated SC making current should be the peak value.

3. DEMAND DATA (SCHEDULE 10)

The proforma for the submission of demand data are contained in Schedule 10 of the Data Registration Code (which can be accessed through the Grid Code website).

A Schedule 10 proforma is required to be completed by each User for each of the following three specified days (as stated in PC.A.4.2.1): -

a) The day on which the User's demand is predicted to peak

b) The day on which the GB Transmission System demand is predicted to peak

c) The day on which GB Transmission System demand is predicted to be minimum. The

predicted times and dates for b) and c) will be provided by NGET in Week 17 (PC.A.4.2.2).

Users should also use Schedule 10 to notify National Grid of its active energy data (PC.A.4.2.3), again for each of the three specified periods above.

Where a NEC has two or more connection points then separate submissions should be made for each point.

The GC asks for the effects of any reactive compensation and cable susceptance to be separated out and quoted separately (PC.A.4.3.2.(b)).

The demand profiles should represent the site demand of the Non-Embedded Customer including active and reactive power losses on the Non-Embedded Customer's system, where these are not negligible.

The Non-Embedded Customer should make whatever deduction from the demand profile it considers appropriate to allow for the running of any generating plant (PC.A.4.3.2(a)).

3.1 Notes relating to Schedule 10 submissions for the day on which the User's demand is predicted to peak

This should give the demand profile for the day of the User's peak active demand. The demand values given should be the maximum demand that in the User's opinion could reasonably be imposed on the GB Transmission System Transmission System.

If there is generation embedded within the NEC's system, then the demand value given above should be the net demand value, i.e. (gross demand – embedded generation). The amount of generation thus netted out should be given at the bottom line of the table.

The amount of embedded generation may vary day-to-day. On the day of User's peak demand may well be when that generation experiences low or zero availability (see section 3.4 below). Whatever the availability of the embedded generation may be, the amount of embedded generation used in deriving the net demand value should be shown on the bottom row.

In the case where the Connection Point consists of busbars, which are normally run in separate sections, please include a sketch to show details.

3.2 Notes relating to Schedule 10 submission for the day on which the GB Transmission System demand is predicted to peak

NGET has provided all Non-Embedded Customers with the day of the expected GB Transmission System peak demand. This date is not a prediction, it is when NGET would expect peak demand if average weather conditions pertained throughout the year. In reality, of course, the outturn peak demand is likely to be on a different date.

As in the case for the schedule 10 submission for the day of the User's peak Demand, the demand value given should be the net demand value, (i.e. gross demand minus embedded generation). The amount of generation thus netted out should be given at the foot of page 2 of Schedule 10. Similar remarks apply to that made on above for the submission for the day of the User's peak Demand in Paragraph 3.1 regarding availability of embedded generation

If Non-Embedded Customers predict demand at time of GB Transmission System peak by extrapolating the demand from the equivalent day on the previous year, the previous year's demand must be corrected to Average Cold Spell (ACS) weather conditions before the extrapolation is made. If your demand does not have a weather related element please add an appropriate note. If you cannot carry out the ACS calculation, then please give the uncorrected data and add an appropriate note.

If the Non-Embedded Customer considers that the day of the Connection Point peak demand is expected to coincide with the day of GB Transmission System peak demand, then the submissions for the day of the GB Transmission System peak demand and the day of the User's peak Demand will be identical.

3.3 Notes relating to Schedule 10 submission for the day on which GB Transmission System demand is predicted to be minimum

NGET has also provided all non-embedded customers with the day of expected GB Transmission System minimum demand. Similar remarks apply to these submissions as apply to the submission for the day of GB Transmission System **Peak** Demand.

3.4 Embedded Generation

Some non-embedded customers have generation embedded within their system, which is used to support Demand.

The demands quoted to NGET should represent the total unrestricted demand of the plant. According to GC (PC.A.4.2.4), the demands quoted should be those remaining after taking into account the output profile of all embedded small and medium power stations, customer generating plant and imports across embedded external interconnections. Please state, at the foot of each table, the amount of embedded generation (if any) that is present for the dates specified by NGET in week 17.

If the demands quoted have been derived differently, please advise the basis behind their derivation. In cases where doubt remains as to the data required, clarification may be sought from NGET System Technical Performance Group.

3.5 Notes relating to the provision of Active Energy Data under Schedule 10

The customer tariffs shown in Page 2, Schedule 10 of the GC are as follows.

LV1	Daytime Economy 7 or similar tariff energy consumed at 415V.
LV2	Nighttime Economy 7 or similar tariff energy consumed at 415V.
LV3	Units consumed at 415V other than LV1 and LV2.
HV	Units consumed at 11kV.
EHV	Units consumed at voltages above 11kV.
Traction	Railtrack or other electric railways.
Lighting	Public Lighting (effectively the unmetered element).

The above listing given in the GC is based on Network Operator submissions to Ofgem. NEC customers should give data only for those categories relevant to them. If the categories are not sufficient to cover all their energy consumption, other categories could be listed separately.

The Active Energy data should be net of output from embedded generation. This netted out energy from embedded generation should be shown in the bottom row of each Schedule 10 submission

4. CONNECTION POINT DEMAND DATA (SCHEDULE 11)

Proforma for the submission of Connection Point Demand data can again be found on the Grid Code website.

Data requested in Page 1, Schedule 11 of the GC should be provided by all NECs. Some of the data will be same as that in Schedule 10 however Schedule 11 requires power factor data as well (PC.A.4.3.1). Where separate submissions of reactive compensation or susceptance are made the demand power factor should be adjusted to take account of these effects so that the total effect of (demand power factor quoted & reactive compensation & susceptance) gives the correct reactive power demand at the Connection Point.

Data requested in Pages 2 and 3 of Schedule 11 of the GC regarding demand transfer capability and embedded generation need to be filled in only if the data is relevant to any particular NEC.

5. FAULT INFEED DATA (SCHEDULE 13)

The User System Data required is specified in the GC (PC.A.4) and summarised below. In brief the following is required:-

- Details of any of the NEC's system operating above 132kV.
- Any reactive compensation and susceptance inherent in the User's System

5.1 Short Circuit Infeeds

Schedule 13 contains the requirements for the provision of short-circuit infeed data, which should be provided as values at the NEC/GB Transmission System boundary. A copy of Schedule 13 of the DRC may be located on National Grid’s Industry Information website:

https://www.nationalgrid.com/uk/Electricity/Codes/gridcode/gridcodedocs/

Two values for the fault infeed are required; those at instant of fault, and after the subtransient component have died away. The former normally represents the sum of fault from generation and from induction motors; the latter from generation alone. In addition the minimum zero sequence source impedances and the X/R ratio should be provided.

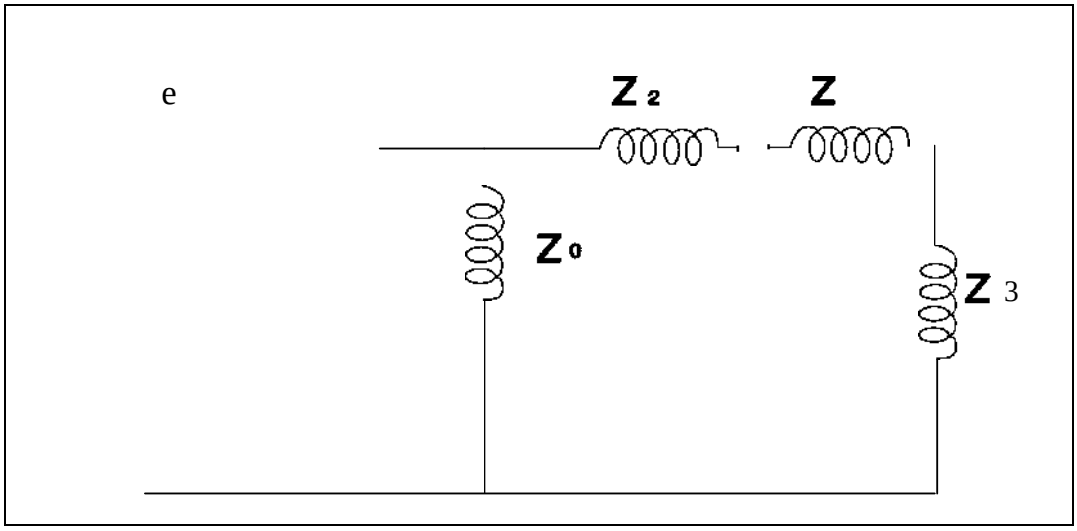
5.2 Zero Sequence Impedance

Zero sequence resistance and reactance values are requested in the schedule 13 tables. In the absence of better information, estimation of resistance and reactance values may be made by assuming that the X:R ratio is the same as for the positive phase sequence.

The minimum zero sequence impedance (both reactance and resistance) is only required if the User connection can supply zero sequence current to the GB Transmission System

The calculation of minimum zero sequence impedance will depend upon the transformers connecting the GB Transmission high voltage system (i.e. 400 or 275kV throughout GB and also 132kV in Scotland) to the Users primary voltage system, the earthing arrangements on the Users System and the interconnectivity between connection points at a single site.

If the transformer is 'star-star', the normal arrangement for station transformers, the minimum zero sequence impedance of the connection point can be derived by considering the following diagram:



where:

Z_o, Z_1, Z_2, are the zero sequence 'equivalent - T' model of the star-star transformer (see below for derivation).

Z_{E1} is **three times** the impedance of the connection between the HV star point and earth. Under normal circumstances, this will be zero as the HV system is solidly earthed.

Z_{E2} is **three times** the impedance of the connection between the LV star point and earth and will be zero if the star point is directly earthed and infinite if the 'star-point' is unearthed. This impedance should be calculated based on rated LV voltage.

Z_3 is the zero sequence impedance of the Users System connected to the LV of the transformer. Note that this value can be infinite if the Users System connected to the LV side of the transformer is unearthed. (This situation can arise if there is only 'delta' connected equipment or if 'star' connected equipment does not have the 'star point' earthed.

The zero sequence 'T' equivalent of the transformer can be derived from standard tests as follows:

	hv Windings	lv Windings	Neutrals	Tertiary (if present)	Test Voltage	NDC Reference
$Z_{OH-T//N}$	shorted	o/c	connected	closed	hv to neutral	197
$Z_{OL-T//N}$	o/c	Shorted	connected	closed	lv to neutral	202
$Z_{OL-H//T//N}$	shorted to neutral	Shorted	connected	closed	lv to neutral	207
$Z_{OH-L//T//N}$	shorted	Shorted To neutral	connected	closed	hv to neutral	212

o/c = open circuit
"shorted" means that the 3 terminals are shorted together
"shorted to neutral" means that the 3 terminals are shorted, and connected to neutral.
"closed" means that the 3 delta windings are connected together to give a continuous current path round all 3 phases.
"connected" means that the two neutrals are connected together.
"NDC Reference" is the reference in the old CEGB National Data Catalogue.

From these measurements, Z_O may be calculated as:

$$Z_O = \{Z_{OH-T//N} (Z_{OL-T//N} - Z_{OL-H//T//N})\}^{1}/_{2}$$

$$= \{Z_{OL-T//N} (Z_{OH-T//N} - Z_{OH-L//T//N})\}^{1}/_{2}$$

The two values are theoretically identical but will differ due to measurement error and an average value should be taken.

The values of Z_1 and Z_2 can now be calculated as:

$$Z_1 = Z_{OH-T//N} - Z_O$$

$$Z_2 = Z_{OL-T//N} - Z_O$$

Note that the effects of transformer taps are such that these impedances may vary. Users should select the tap position that gives the lowest zps impedances.

The minimum zero sequence impedance of this type of connection can now be calculated by considering Z_0, Z_1, Z_2, Z_3, $_{Ze1}$ ^{and} $_{Ze2}$ as a series parallel network.

6. CONTACT DETAILS

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