nationalgridESO

Guidance Notes for Co-location of Different Technologies - Issue 2

June 2024

Foreword

These Guidance Notes have been prepared by the Electricity System Operator (ESO) to describe to Generators and other Users of the system how the Grid Code Compliance Processes is intended to work for the various configurations of co-located installations of different technologies.

These Guidance Notes are prepared solely for the assistance of prospective Generators connecting Power Stations directly to the National Electricity Transmission System or Large Power Stations to a User's System (eg. Embedded Large Power Stations connected to a Network Operator's System). In the event of dispute, the Grid Code and Bilateral Agreement documents will take precedence over these notes.

Generators in respect of Small and Medium Embedded Power Stations should contact the relevant Distribution Network Operator (DNO) for guidance.

These Guidance Notes are based on the Grid Code, Issue 6 Revisions 21 effective from the 4th of March 2024.

Definitions for the terminology used in this document can be found in the Grid Code.

The Engineering Compliance Manager (see contact details below) will be happy to provide clarification and assistance required in relation to these notes and on Grid Code compliance issues.

ESO welcomes comments including ideas to reduce the compliance effort while maintaining the level of confidence. Feedback should be directed to the ESO Engineering Compliance team at:

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Abbreviations

This section includes a list of the abbreviations that appear in this document.

Abbreviation	Description
BCA	Bilateral Connection Agreement
BM / BMU	Balancing Mechanism / Balancing Mechanism Unit
CUSC	Connection and Use of System Code
DNO	Distribution Network Operator
ECC	European Connection Conditions
ECP	European Compliance Processes
FON	Final Operational Notification
GB	Great Britain
ION	Interim Operational Notification
IET	Integral Equipment Test
Mod-app	Modification Application
NGESO	National Grid Electricity System Operator
NGET	National Grid Electricity Transmission
PC	Planning Code
POC	Point of Connection
RfG	Requirements for Generators (EU legislation)
TEP	Transmission Entry Point

1 Introduction

With the advances in technology, an increasing number of users are connecting sites to the GB electricity system using more than one type of plant or technology. This recent trend seeks to enhance the technical capability along with the commercial potential of the overall plant.

A co-located site would be one where Power Generating Modules belonging to different technologies and/or fuel type, including storage and non-embedded demand, are installed at the same site or Power Station and connected to the GB electricity system.

There are several ways in which different co-located technology projects can be developed. The purpose of this guidance document is to offer more clarity around the compliance process that will set the right expectations from the User, and thereby help to achieve relevant compliance prior to receiving ESO operational notifications.

2 Different Types of Connections to the Transmission System

There are two main connection types when connecting a new power station (and hence its associated power generating modules) to the transmission system:

2.1 Parallel Connection

A parallel connection is the one where the additional technology being co-located is connected directly to the transmission system at an existing or contracted connection site but with a new independent connection point, a representative example is depicted in Figure 2.1

A new independent connection point to the transmission network shall be considered where a developer intends to treat the new connecting unit as a new and separate Power Station. This would require a new connection application followed by a new Bilateral Connection Agreement (BCA) for such a connection. A condition of which would bind the User to meeting the requirements of the Connection and Use of System Code (CUSC) and Grid Code.

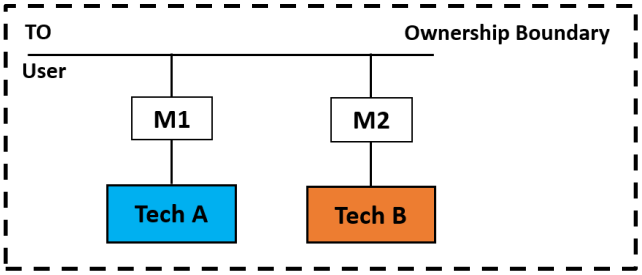

Figure 2.1 Parallel Connection

In some cases, as shown in Figure 2.2 a User may already own multiple bays in the transmission substation and decide to add new technology behind one bay. In such a case, the User would be required to undergo a ModApp, by which their existing BCA shall then be amended.

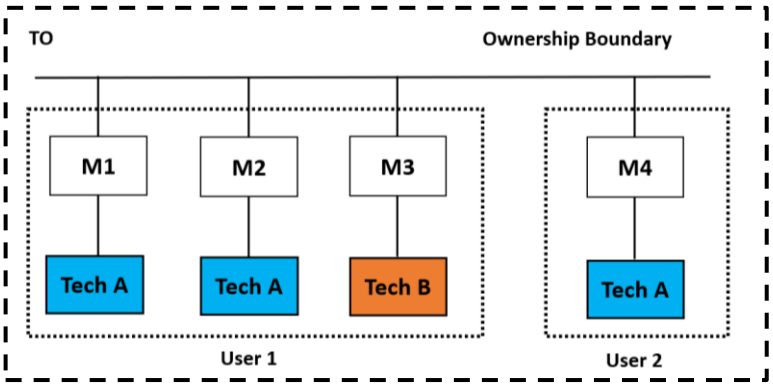

Figure 2.2 User with Multiple Bays

2.2 Consolidated Connection

A consolidated connection in this context is one where the new technology being co-located is connected to the transmission system behind an existing connection point at the existing (or contracted) connection site, such that there remains a single electrical connection to the transmission system. A representative example is shown in Figure 2.3. There are three types of configurations under a consolidated type of connection. These are described in the subsequent parts of this report.

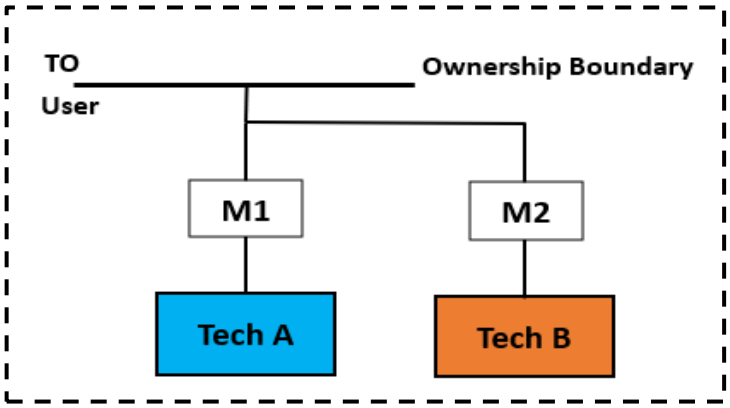

Figure 2.3 Consolidated Connection

2.2.1 Independently Controlled Configuration

In this configuration, the Power Station would comprise of a generating unit/demand unit along with the generating unit/demand unit of a different technology type, where the operation of both units is independent from each other. In other words, it is possible to have one generating unit running while the other component(s) of the Power Station (i.e., other generating/demand unit) is (are) switched off and vice versa.

Examples of such a configuration are as follows:

1. An existing User (with a FON) who wishes to install a new unit of a different technology type behind an existing connection point (see Figure 2.4).
2. A new User designing the site with multiple technologies that can operate independently of one another.

A Simple Independent Configuration is where there is a clear electrical separation of different technologies as can be seen in Figure 2.4. All the generating units of same technology type are grouped together and connected to the User's busbar at the POC with an independent electrical connection.

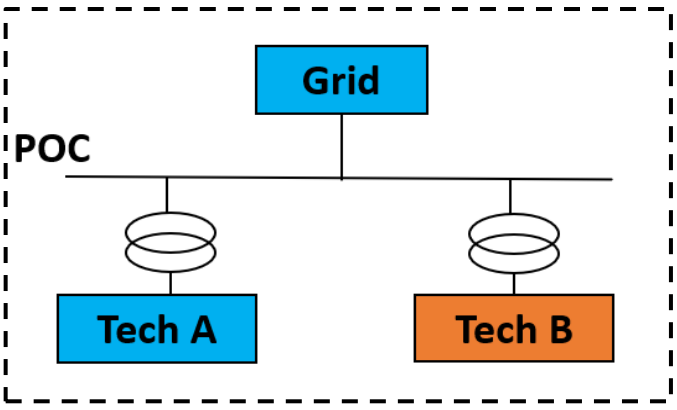

Figure 2.4 Simple Independent Configuration

Another configuration that has been gaining interest lately is a Complex Independently Controlled Configuration. In this configuration, the generating/demand units of different technology types are grouped together and electrically connected behind a common power transformer as can be seen in Figure 2.5 and Figure 2.6.

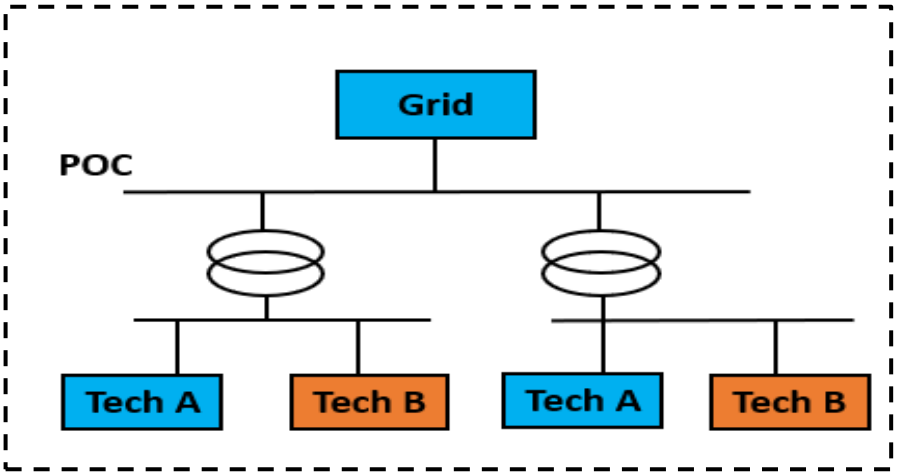

Figure 2.5 Complex Independent Configuration

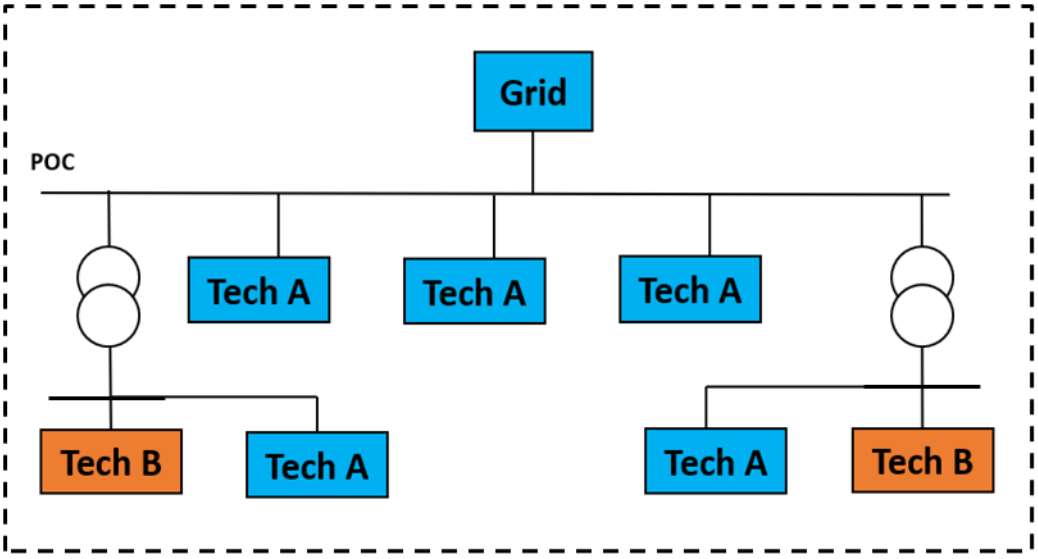

Figure 2.6 Complex Independent Configuration

2.2.2 Supplementary Controlled Configuration

A Configuration in which a Generating Unit or a demand Unit is linked to the operation of the generating unit/demand unit of a different technology and both modules cannot be independently controlled, is called a Supplementary controlled configuration. For example, as shown in Figure 2.7, the User installs Electricity Storage Modules to enhance the frequency response performance when modernizing an existing generating unit. In other words, the new generating unit supplements the performance of an existing generating unit, and cannot operate independently with it i.e., when the main component is off, the storage device should also be off.

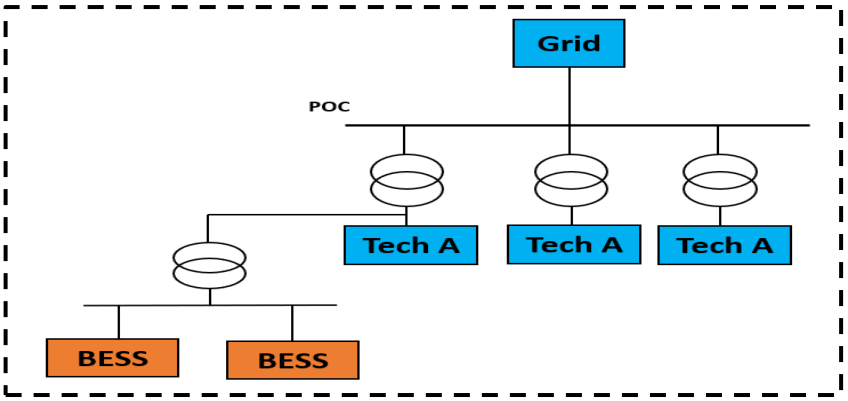

Figure 2.7 Supplementary Configuration

3 Compliance Process for Different Connections:

The objective of the compliance process remains the same regardless of different combinations of generating/demand units at a co-located site. The compliance process seeks to guarantee uniformity among all EU/GB Code Users by establishing minimum technical, design, and operational standards. This ensures consistency in connecting to the National Electricity Transmission System, thereby allowing the ESO to fulfil its statutory and Transmission License duties.

Please note, to comply with the planning code requirements of the Grid Code, users are required to provide to ESO validated model(s) which adequately represent the dynamic performance of their systems as demonstrated during the compliance process. For detailed recommendations and advice on the model(s) submission aimed at complying with PC.A.9 of the Grid Code, please refer to "Guidance Notes on Modelling Requirements – GC0141 Grid Code Modification" in Appendix A of this document.

3.1 Parallel Connection

If the connection of the new unit is to be a new Power Station with a separate Bilateral Connection Agreement, then a normal compliance process will be followed. The provisions contained in Grid Code ECP.5 to ECP.7 detail the process to be followed for the User's Plant and Apparatus to become operational. This includes the issue of three Operational Notifications: EON (Energisation Operation Notification), ION (Interim Operational Notification used for synchronising) and FON (Final Operational Notification demonstrating full compliance).

If the connection of the new unit is at an existing power station with an amendment of an existing BCA, then the compliance process in accordance with ECP.11.7 shall be followed. It is advisable that for a co-located connection, the Power Generating Modules of different technology and/or fuel type shall be classified into separate BM Units such that they can be separately instructible and controllable.

3.2 Consolidated Connection

For a consolidated connection the new Generating Unit or Power Park Module (also then being a separate BM Unit) will be grouped within the existing contracted or connected Power Station. A Modification Application will be required to review and potentially amend the existing Bilateral Connection Agreement prior to connection, and the compliance process will be determined depending on whether an independent or supplementary controlled configuration is implemented.

As per clause ECP.11.7 in the grid code, in the case of a co-located site, i.e., generating unit of different technology connected within a new or existing Power Station, The Company will accept demonstration of compliance at the Grid Entry Point or User System Entry Point (if embedded) through a combination of the capabilities of both generation units.

Generator Owners should however be aware that for the purposes of compliance, full Grid Code compliance should be demonstrated when, for example, unit A (technology A) is out of service and the remaining Power Generating Module (technology B) is in service, or unit A (technology A) is in service and the remaining Power Generating

Module (technology B) is out of service. Please refer to Appendix A for the detailed guidance on compliance requirements for each type of Power Generating Module.

3.2.1 Independently Controlled (Simple and Complex Configuration):

Independently Controlled Configuration can be classified into following cases:

A. One case is when an existing GB Code User decides to install new Generating Units of different technology behind an existing connection point in an independently controlled manner. The configuration is such that the two technologies can be operated both individually as well as in a combined mode. In such a case, the User shall undertake a modification application (Mod-App) to reflect such a change and amend the BCA to increase the Transmission Entry Capacity (TEC) (if applicable). There shall also be a new Appendix F (Site Specific Technical Requirements) describing the requirements for new Generating Units of different technology at a Co-located site. The customer shall provide a confirmation that Generating Units of different technology will be consolidated behind an existing connection point along with the existing assets where no substantial modification is made to existing Main Plant and Apparatus.

   There may be then two Appendix Fs, one for an existing Power Generating Module (which shall remain unchanged with respect to the Connection Conditions), and other for new Power Generating Module which will be with respect to European Connection Conditions. Hence, appropriate code requirements (GB or EU) will be followed as applicable, with the assumption that the components are sufficiently independent.

   Where an existing Power Generating Module has a FON, i.e., the User has already demonstrated full grid code compliance when it was first commissioned, the new Generating Units being co-located shall undergo full grid code compliance as an EU Code User as relevant and as applicable at the existing Connection Point. A reduced set of compliance simulations and onsite tests may be agreed between the User and The Company to assess the performance of the combined operation when both existing and newly added units are operating simultaneously in accordance with ECP.11.7 and ECP.A.6.1.1.

   The newly added Generating Units shall be required to submit the RMS and EMT models in accordance with Grid Code PC.A.9 as introduced through Grid Code modification GC0141. The Company may ask for the combined model of the power station that can be used for the validation of the combined performance of a co-located site at the PoC. If an existing Generating Unit or Power Park Module is a GB Code User or an EU Code User with a completion date before 1st September 2022, then the combined RMS model may be accepted such that the part of the model corresponding to existing plant may be encrypted (in accordance with the Connection Conditions and Planning Code) and part of the plant corresponding to new installation shall be unencrypted (in accordance with European Connection Conditions and updated Planning Code). The existing GB Code User will normally not be asked to submit unencrypted RMS and encrypted EMT Models as per PC.A.9 unless The Company identifies a need. In such a case, a discussion will be initiated where The Company shall work with the User to get the required model as per The Company's satisfaction.

B. Another case is when an existing EU Code User (with a FON) decides to install new Generating Units of different technology behind an existing connection point in an independently controlled manner. In such case, where existing Power Generating Module has already demonstrated full grid code compliance, the new Generating Units being co-located shall be required to undergo full grid code compliance as an EU Code User. A reduced set of compliance simulations and onsite tests may be agreed between the User and The Company to assess the performance of the combined operation when both existing and newly added units are operating simultaneously in accordance with ECP.11.7 and ECP.A.6.1.1.

C. Another case is when the site being co-located is a new site comprising of Generating Units/Demand Units that can be operated independently from each other. The new site would require a new BCA with two Appendix Fs, one for each technology type under the context of an EU Code User and the whole site would then be demonstrating compliance with respect to ECC/ECP.

   In this case, the compliance process in accordance with ECP.11.7 shall be followed for each technology individually as appropriate, and the compliance process would be a three staged process as follows:

   - **Stage 1: Technology A is only operational, and Technology B is out of service and the compliance will be assessed through full list of compliance tests and simulations as applicable.**

- **Stage 2: Technology B is only operational, and Technology A is out of service and the compliance will be assessed through a full list of compliance tests and simulations as applicable.**
- **Stage 3: Both units, Technology A and B are operating together, and the compliance will be assessed through a reduced set of compliance tests and simulations.**

Customers are encouraged to contact the relevant Compliance Engineer in the early compliance stage of the project to receive further clarifications on the detailed scope of the simulations and tests in the combined operation.

3.2.1.1 Operational Notifications

When the co-located assets of a power station comprising Power Generating Modules of different technologies are commissioned together i.e. different technologies being synchronised to the system at the same time, the Interim Operational Notification for such a power station would be issued by taking into account the proportion of the co-located assets being commissioned. For example, in the case of a consolidated co-located site where both PV and Electricity Storage Modules are commissioned together, there would be an obligation on the User to complete the voltage control tests before the 20% of the Power Park Module is synchronised to the network. The pre-20% voltage control test performance shall be demonstrated through a combination of co-located technology assets i.e. in this case, PV and Electricity Storage Modules operating together. The Interim Operational Notification will also limit the proportion of the Power Park Module which can be simultaneously synchronised to the Total System to 70% of Maximum Capacity of the Power Park Module (where it is greater or equal to 100MW) until the Generator has completed the frequency response tests (as detailed in ECP.A.6.3.1). These tests shall be demonstrated through a combination of co-located technology assets.

On the contrary, the co-located assets of a power station may be commissioned together but in a phased approach where Phase 1 involves commissioning of Power Generating Modules of one technology type and Phase 2 involves the commissioning of Power Generating Modules of another technology type, with both the stages concluding prior to The Company issuing Final Operational Notification. In this case, the Interim Operational Notification shall be issued first for Phase 1 which would allow the User to synchronise the Power Generating Modules in Phase 1 to the system. The limitation on the Interim Operational Notification for Phase 1 shall be with respect to the requirements of ECP.6.2 / ECP.6.3. When the Power Generating Modules in Phase 2 are ready to be synchronised, the existing Interim Operational Notification shall then be amended to reflect the applicable requirements of ECP.6.2 / ECP.6.3 for Phase 2. This includes completion of the 20% voltage control tests to be done in combination with the Power Generating Modules in Phase 1 (that are already synchronised) and the Power Generating Modules in Phase 2 (to be synchronised).

3.2.1.2 BM Units Registration

In case of a co-located site, the Power Generating Modules of different technology and/or fuel type shall be classified into separate BM Units such that they can be separately instructible and controllable. They may, however, share a common control point at the Point of Connection.

ECC.8.1 states the requirement for each Type C or Type D Power Generating Module to have a Mandatory Services Agreement (MSA) for both reactive capability and frequency response services. In case of co-located site, where different Power Generating Modules are split into separate BM Units, the reactive capability and frequency response capability for entering into an MSA can be agreed with respect to each BM Unit. Further guidance on configuration of standard or non-standard BM Units can be found on the Elexon website (refer to Balancing & Settlement Code).

3.2.2 Supplementary Controlled

When a User carries out a Substantial Modification as explained in this document, the User shall then amend the existing Bilateral Agreement accordingly. As per the Grid Code, such a User shall be then required to fulfil the latest GC requirements. For simplicity, if a GB Code User makes a Substantial Modification to their existing Main Plant and Apparatus after April 2019, they will then be treated as an EU Code User and hence caught by the latest requirements of the Grid Code.

The user shall confirm that the new technology added under this configuration will not be operating independently i.e., it will always be operating in combination with an existing site.

A

4 Appendices

Appendix A: Guidance Documents

This section details the list of guidance documents published on ESO website to provide further clarification around the compliance requirements for different Power Generating Modules.

- Guidance Notes for Electrical Storage (EU Code User)
- Guidance Notes for Power Park Module (GB Code User)
- Guidance Notes for Power Park Modules (EU Code User)
- Guidance Notes for Synchronous Generators (GB User)
- Guidance Notes for Synchronous Generators (EU Code User)
- Guidance Notes for Synchronous Condensers
- Guidance Notes on Modelling Requirements – GC0141 Grid Code Modification

Appendix B: Substantially Modifications Examples

This list states what modification can be classified as a substantial change.

Number	Example Details	This would be classified as 'new' because….	This would be classified as 'existing' because….	Other comments
1	Existing 20-year-old station comprising of synchronous generating units. Excitation and Governor systems to be replaced on a like for like basis	No	No material changes to performance – plant replaced with components of the same type and technology as when constructed.	ESO to be notified of change.
2	Existing Power Station site - old Generating Unit to be replaced with new Gas Turbines	Yes – There is a material change to the plant – a brand new unit is replacing the existing retired unit	No	ESO to be notified and treated in the same way as a new generating unit.
3	A 100MW wind farm comprises 50 x 2MW turbines. The wind turbines are to be replaced by 20 x 5MW turbines.	Yes – The turbines, control systems and performance are all using new plant even though the Grid Connection assets may remain largely unchanged.	No	ESO to be notified and treated in the same way as a new generating unit.
4	Generator Transformer replaced at an existing 40-year-old coal station with a grey spare	No	Plant is using technology of the same type when the station was built.	ESO would need to assess any alterations in performance if different from the original plant eg tap range.
5	Change of Generator Ownership – no change to plant	No	No material changes to plant	Bilateral Connection agreement to be updated using new terms where necessary (eg removal of MCUSA with CUSC)
6	An existing wind farm adds additional new turbines	New turbines would need to be Grid Code Compliant	Major issue is that the requirements are based on the module not each turbine. Additional issue is that if the wind farm is small and the additional turbines increase the size of the Power Station to Medium or Large. The new turbines would have to be RfG compliant, but questions remain as to how the existing Power Station should be treated.	Same issue as GB Code- Power Park Module extensions. Difficult to segregate turbine requirements from module requirements. Major issue would be for an old wind farm (pre-June 2005 without Grid Code requirements adding new turbines).

7	Small Power Station replants with a new bigger unit	Yes – There is a material change to the plant – a brand new unit is replacing the existing retired unit		Transfer from Small to Band C or D. Potentially more onerous requirements than previously but would effectively be treated in the same way as a new Generator.
8	Generator changes its TEC capacity or Connection Dates	Yes / No – depends on if Main Plant has been ordered. If main plant ordered no, if main plant not ordered and beyond Q2 2018 - yes		

Appendix C: Contacting National Grid

There are several different departments within National Grid that will be involved with this connection. The initial point of contact for the ESO will be your allocated Customer Connection Contract Manager for the Bilateral Agreement. If you are unsure of who your allocated Customer Connection Contract Manager is then the team can be contacted on box.ECC.Compliance@nationalgrideso.com.

For any correspondence relating to testing on the system following the Grid Code, the IET (Integral Equipment Test) process should be followed with notifications made to the '.Box.Tranreq' email address for England and Wales connections and '.Box.TR.Scotland' for all connections in Scotland.

Contact Address:

National Grid ESO, Faraday House, Warwick Technology Park, Gallows Hill, Warwick CV34 6DA

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