Grid Code Review Panel – Issue Assessment Proforma

Protection

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Summary
This paper seeks to progress two protection issues which were first brought to the attention of the GCRP in 2008. The first issue refers to clarification of the wording associated with fault clearance times in CC.6.2.2.2.2(a) and CC.6.2.3.1.1(a). The second relates to Generator Back-Up Protection defined within CC.6.2.2.2.2(b). The paper proposes that consideration of these issues is restarted and progressed to an Industry Workshop.

Users Impacted
High
Directly connected Generators or directly connected Network Operators / Non Embedded Customers and directly connected DC Converter Stations
Medium
None identified
Low
None Identified

Description & Background
These issues were first raised at GCRP in 2008. In November 2009, National Grid informed the Panel that an informal Workgroup had been established to bring transparency to fault clearance and Back-up Protection issues specified in the Grid Code. In March 2009 a survey was issued to Generators in order to identify their current arrangements used for protection. The issue was raised again at the GCRP in July 2012 with proposed changes to the legal text of the Grid Code. This was followed by further proposals being made by DNOs and individuals on the proposed changes to the legal text. However, this issue is still unresolved as none of the proposals were taken forward. The purpose of this paper is to restart the process from its previous position as at the last discussion. The proposed legal text as submitted by NGET to the industry at the time of the last discussions has been added to the Appendices to ensure transparency of the whole process. CC.6.2.2.2.2(a) and CC.6.2.3.1.1 (a) relate to the fault clearance times associated with directly connected Generators or directly connected Network Operators / Non Embedded Customers respectively. The concern is that the wording of the paragraphs is unclear implying that National Grid will require a fault clearance time not faster than: • 80ms at 400kV, • 100ms at 275 kV and • 120ms at 132 kV and below

but at the same time the Grid Code states that *"this shall not prevent the User or NGET having faster fault clearance times"*.

The last sentence in italics is believed to cause confusion as it could currently imply that a faster fault clearance time could be specified in the Bilateral Connection Agreement. This is not the intention of the wording which is effectively designed to set out that if the Bilateral Connection Agreement (BCA) states a figure of 80ms at 400kV there would be nothing to stop the Generator having a faster fault clearance time than this if so desired and likewise it would not prevent NGET from having a faster fault clearance time than 80ms on its own plant and apparatus. In either case, this would meet the Grid Code requirement.

The second issue relates to the use of the term “faster/slower” or “less than/greater than” in CC.6.2.2.2.2 (a) and CC.6.2.3.1 (a). There has been some concern that the use of the existing terms of “faster/slower” are misleading and the terms “less than/greater than” may be more appropriate. As a result, National Grid proposes to amend the Grid Code such that the wording provides greater User clarity regarding the intention of the provisions thus avoiding unnecessary confusion.

Grid Code provision CC.6.2.2.2.2(b) requires the installation of Back-up Protection by all Generators and National Grid. The provision provides that in the event of fault clearance times not being met by the Generator’s Main Protection system (within the relevant fault clearance times – CC.6.2.2.2.2(a)), then their Back-up Protection should be activated within a specific timeframe. The provisions specify that both National Grid’s and the Generator’s Back-up Protection systems should be co-ordinated to provide the appropriate level of discrimination.

A review of CC.6.2.2.2.2(b) has indicated that the current wording of the provisions does not provide for adequate discrimination between National Grid and Generator protection systems, where two Main Protections and one Back-up Protection have been installed on the Generator’s system. This is the result of inappropriate fault clearance times being specified for the Generator’s protection system which are not reflective of National Grid’s fault clearance times and therefore it is not possible to coordinate the two Back-up Protections such that they provide adequate discrimination.

The consequences of this are that in the event of a fault on the Generators HV connections, failure of both Main Protections provided by the Generator would mean that the Generators Back-Up Protection would operate within 800ms from fault inception. During this time, the Back-Up Protection on National Grid’s system would operate (typically within 500ms) which would result in the loss of the busbar and could (under certain configurations) result in the loss of the entire substation and circuits remote from that substation. There is also a risk that demand and generation could be lost which in the latter case could exceed 1800MW. By re-grading the settings this risk can be eliminated.

Proposed Solution

The proposal is to restart this issue from its previous position and progress it to an industry workshop to understand if the previously proposed legal text is sufficiently robust.

If approved at the workshop, the necessary changes to the legal text will be progressed via an industry consultation. If industry experts are not in agreement, then further discussion at the GCRP and re-establishment of the workgroup will be required.

The previously proposed legal text to address the issues described above is available in the attached Appendices.

Assessment against Grid Code Objectives
(i) to permit the development, maintenance and operation of an efficient, coordinated and economical system for the transmission of electricity; The previously proposed changes would permit the operation of an efficient Transmission System by removing any confusion within the Grid Code requirements in facilitating the operation of protection systems so as to cause the minimum loss to the Transmission System. ***(ii) to facilitate competition in the generation and supply of electricity (and without limiting the foregoing, to facilitate the national electricity transmission system being made available to persons authorised to supply or generate electricity on terms which neither prevent nor restrict competition in the supply or generation of electricity);*** The proposed changes are neutral to this objective. ***(iii) subject to sub-paragraphs (i) and (ii), to promote the security and efficiency of the electricity generation, transmission and distribution systems in the national*** With the clauses in the Grid Code clarified, it will remove any possible confusion regarding the operation of protection systems and promote a more secure transmission system ***(iv) to efficiently discharge the obligations imposed upon the licensee by this license and to comply with the Electricity Regulation and any relevant legally binding decisions of the European Commission and/or the Agency.*** The proposed changes are neutral to this objective.

Impact & Assessment
Impact on the National Electricity Transmission System (NETS) The proposed changes will not have an adverse impact on the Transmission System. ***Impact on Greenhouse Gas Emissions*** The proposed changes will not have a material impact on Greenhouse Gas Emissions. ***Impact on core industry documents*** None identified at this time. ***Impact on other industry documents*** None identified at this time.

Supporting Documentation	
Have you attached any supporting documentation	YES
If Yes, please provide the title of the attachment:	Appendix A and B

Recommendation
The Grid Code Review Panel is invited to: Progress this issue to Industry workshop

Appendix A – NGET Proposed Grid Code Changes

CC.6.2.2 Requirements at Connection Points or, in the case of OTSDUW at Interface Points that relate to Generators or OTSDUW Plant and Apparatus or DC Converter Station owners

CC.6.2.2.1 Not Used.

CC.6.2.2.2 Generating Unit, OTSDUW Plant and Apparatus and Power Station Protection Arrangements

CC.6.2.2.2.1 Minimum Requirements

Protection of Generating Units (other than Power Park Units), DC Converters, **OTSDUW Plant and Apparatus** or Power Park Modules and their connections to the **National Electricity Transmission System** shall as a minimum ~~must~~ meet the ~~minimum~~ requirements given below. These are necessary to reduce to a practical minimum the impact on the **National Electricity Transmission System** of faults on **OTSDUW Plant and Apparatus** circuits or circuits owned by Generators or DC Converter Station owners.

CC.6.2.2.2.2 Fault Clearance Times

(a) The fault clearance time~~s~~ for faults on the Generator's or DC Converter Station owner's equipment directly connected to the **National Electricity Transmission System** or **OTSDUW Plant and Apparatus** and for faults on the **National Electricity Transmission System** directly connected to the Generator or DC Converter Station owner's equipment or **OTSDUW Plant and Apparatus**, from fault inception to the circuit breaker arc extinction, shall be set out in each ~~accordance with the~~ **Bilateral Agreement**. The fault clearance time~~s~~ specified in ~~accordance with~~ the **Bilateral Agreement** shall not be shorter ~~faster~~ than the minimum levels specified below:

(i) 80~~mS~~ ms at 400kV

(ii) 100~~mS~~ ms at 275kV

(iii) 120~~mS~~ ms at 132kV and below

but this shall not prevent ~~a~~ the **User** from selecting fault clearance times on its Plants and Apparatus which are shorter than specified in the **Bilateral Agreement** nor shall it prevent **NGET** or a **Generator** in respect of **OTSDUW Plant and Apparatus** ~~having~~ from selecting shorter ~~faster~~ fault clearance times on their ~~its~~ own **Plant** and **Apparatus**.

~~Slower~~ Longer fault clearance times may be specified in ~~accordance with~~ the **Bilateral Agreement** for faults on the **National Electricity Transmission System**. ~~Slower~~ Longer fault clearance times for faults on the **Generator** or **DC Converter Station** owner's equipment or **OTSDUW Plant and Apparatus** may be agreed with NGET in accordance with the terms of the **Bilateral Agreement** but only if **System** requirements, in **NGET's** view, permit. The probability that the fault clearance times stated ~~in accordance~~ in the **Bilateral Agreement** will be exceeded by any given fault, must be less than 2%.

(b) For the event that the above fault clearance times are not met as a result of failure to operate on the **Main Protection System(s)** provided, the **Generators** or **DC Converter Station** owners or **Generators** in the case of **OTSDUW Plant and Apparatus** shall, except as specified below, provide Independent **Back-Up Protection**. **NGET** will also provide **Back-Up Protection** and ~~these~~ **NGET and the User's** **Back-Up Protections** will be co-ordinated so as to provide **Discrimination**.

On a **Generating Unit** (other than **Power Park Units**), **DC Converter** or **Power Park Module** or **OTSDUW Plant and Apparatus** connected to the **National Electricity Transmission System** ~~where only one **Main Protection** is provided to clear faults on the **HV Connections** within the required fault clearance time~~, the Independent **Back-Up Protection** provided by the **Generators** (including in respect of **OTSDUW Plant and Apparatus**) and **DC Converter Station** owners shall operate to give a fault clearance time of no ~~slower~~ longer than 300 ms at the minimum infeed for normal operation for faults on the **HV Connections**. ~~On **Generating Units** (other than **Power Park Units**), **DC Converters** or **Power Park Modules** or **OTSDUW Plant and Apparatus** connected to the **National Electricity Transmission System** at 400 kV and 275 kV where two **Main Protections** are provided and on **Generating Units** (other than **Power Park Units**), **DC Converters** or **Power Park Modules** or **OTSDUW Plant and Apparatus** connected to the **National Electricity Transmission System** at 132 kV and below, the **Back-Up Protection** shall operate to give a fault clearance time of no slower than 800 ms in England and Wales or **Offshore** and 300 ms in Scotland at the minimum infeed for normal operation for faults on the **HV Connections**.~~ For avoidance of doubt, the requirement to provide an **Independent Back Up Protection** will be satisfied where the **Main Protection** ~~System~~ includes ~~two or more **Main Protections** of which one is~~ an **Independent Main Protection.**

Not withstanding the paragraph above, a **Generating Unit (**other than a **Power Park Unit), DC Converter** or **Power Park Module,** with a **Completion Date** before 1st January 2009 and connected to the **National Electricity Transmission System** in England and Wales at 400 kV, 275 kV or 132 kV, may have two **Independent Main Protections** ~~and~~ and a **Back-up Protection** which shall operate to give a fault clearance time of no longer than 800ms at the minimum infeed for normal operation for faults on the **HV Connections.**

Generators' (including in respect of **OTSDUW Plant and Apparatus**) and **DC Converter Station** owners' with **Back-Up Protection** or **Independent Protection** will also be required to withstand, without tripping, the loading incurred during the clearance of a fault on the **National Electricity Transmission System** by breaker fail **Protection** at 400kV or 275kV or of a fault cleared by **Back-Up Protection** where the **Generator** (including in the case of **OTSDUW Plant and Apparatus**) or **DC Converter** is connected at 132kV and below. This will permit **Discrimination** between **Generator** or **DC Converter Station** owners' **Back-Up Protection** or **Generator** or **DC Convertor Station** owners' **Independent Backup Protection** and the **Back-Up Protection** provided on the **National Electricity Transmission System** and other **Users' Systems**.

(c) When the **Generating Unit** (other than **Power Park Units**), or the **DC Converter** or **Power Park Module** or **OTSDUW Plant and Apparatus** is connected to the **National Electricity Transmission System** at 400kV or 275kV, and in Scotland and **Offshore** also at 132kV, and a circuit breaker is provided by the **Generator** (including in respect of **OTSDUW Plant and Apparatus**) or the **DC Converter Station** owner, or **NGET**, as the case may be, to interrupt fault current interchange with the **National Electricity Transmission System**, or **Generator's System**, or **DC Converter Station** owner's **System**, as the case may be, circuit breaker fail **Protection** shall be provided by the **Generator** (including in respect of **OTSDUW Plant and Apparatus**) or **DC Converter Station** owner, or **NGET**, as the case may be, on this circuit breaker. In the event, following operation of a **Protection** system, of a failure to interrupt fault current by these circuit-breakers within the **Fault Current Interruption Time**, the circuit breaker fail **Protection** is required to initiate tripping of all the necessary electrically adjacent circuit-breakers so as to interrupt the fault current within the next 200 ms.

(d) The target performance for the **System Fault Dependability Index** shall be not less than 99%. This is a measure of the ability of **Protection** to initiate successful tripping of circuit breakers which are associated with the faulty item of **Apparatus**.

CC.6.2.3.1 Protection Arrangements for Network Operators and Non-Embedded Customers

CC.6.2.3.1.1 **Protection** of **Network Operator** and **Non-Embedded Customers User Systems** directly supplied from the **National Electricity Transmission System**, shall as a minimum ~~must~~ meet the minimum requirements referred to below:

Fault Clearance Times

(a) The fault clearance times for faults on **Network Operator** and **Non-Embedded Customer** equipment directly connected to the **National Electricity Transmission System**, and for faults on the **National Electricity Transmission System** directly connected to the **Network Operator's** or **Non-Embedded Customer's** equipment, from fault inception to the circuit breaker arc extinction, shall be set out in ~~accordance with~~ each **Bilateral Agreement**. The fault clearance time~~s~~ specified in ~~accordance with~~ the **Bilateral Agreement** shall not be ~~faster~~ shorter than the minimum levels specified below:

(i) 80~~mS~~ ms at 400kV

(ii) 100~~mS~~ ms at 275kV

(iii) 120~~mS~~ ms at 132kV and below

but this shall not prevent ~~a~~ the **User** from selecting fault clearance times of its **Plant** and **Apparatus** which are shorter than specified in the **Bilateral Agreement** nor **NGET** from selecting shorter ~~having a faster~~ fault clearance times on its own **Plant** and **Apparatus.**

~~Slower~~ Longer fault clearance times may be specified in accordance with the **Bilateral Agreement** for faults on the **National Electricity Transmission System**. ~~Slower~~ Longer fault clearance times for faults on the **Network Operator** and **Non-Embedded Customers** equipment may be agreed with NGET in accordance with the terms of the **Bilateral Agreement** but only if **System** requirements in **NGET's** view permit. The probability that the fault clearance times stated in ~~accordance with~~ the **Bilateral Agreement** will be exceeded by any given fault must be less than 2%.

Proposed Changes to Glossary and Definitions

Independent Back-Up Protection	A **Back-Up Protection** which utilises a different type of relay and different current transformers (CTs) from the **Main Protection** such that it can operate autonomously in the event of any failure of the **Main Protection**.
Independent Main Protection	A **Protection** system which, ~~where~~ comprises of two or more **Main Protections** ~~exist~~, in which each **Main Protection** utilise~~s~~ a different type of relay and different current transformers (CTs) from any other ~~such that the~~ **Main Protection~~s~~** such that it will ~~can~~ operate autonomously ~~from each other~~ in the event of any failure.

Appendix B – DNO Proposed Grid Code Changes

CC.6.2.3.1 Protection Arrangements for Network Operators and Non-Embedded Customers

CC.6.2.3.1.1 **Protection** of **Network Operator** and **Non-Embedded Customers' User Systems** directly ~~supplied from~~ connected to the **National Electricity Transmission System**, shall as a minimum, meet the following requirements ~~must meet the minimum requirements referred to below~~:

Fault Clearance Times

(a) The fault clearance times for faults on **Network Operator** and **Non-Embedded Customer** equipment directly connected to the **National Electricity Transmission System**, and for faults on the **National Electricity Transmission System** directly connected to the **Network Operator's** or **Non-Embedded Customer's** equipment, from fault inception to the circuit breaker arc extinction, shall be set out in ~~accordance with~~ each **Bilateral Agreement**. The fault clearance time~~s~~ specified in accordance with the **Bilateral Agreement** shall not be ~~faster~~ shorter than:

(i) 80m~~S~~s at 400kV

(ii) 100m~~S~~s at 275kV

(iii) 120m~~S~~s at 132kV and below

but this shall not prevent ~~a~~ the **User** from selecting a fault clearance time for faults on its **Plant** and **Apparatus** which is ~~faster~~ shorter than that specified in the **Bilateral Agreement** nor shall it prevent **NGET** from selecting a fault clearance time for faults on its **Plant** and **Apparatus** which is ~~faster~~ shorter than specified in the **Bilateral Agreement** ~~having a faster fault clearance time~~.

For the purpose of establishing the protection requirements in accordance with CC6.2.3.1.1 only, the **Network Operator** and **Non- Embedded Customer** equipment directly to the **GB Transmission System** shall be interpreted as being the low voltage busbars at a **Grid Supply Point**, irrespective of their actual ownership. Situations where there are no low voltage busbars at a **Grid Supply Point** shall be considered on their merits.

A ~~fault clearance time~~ fault clearance time ~~s slower~~ longer than that stated in (i), (ii) or (iii) above may be specified in ~~accordance with~~ the **Bilateral Agreement** for faults on the **GB Transmission System**. A fault clearance time ~~fault clearance times slower~~ longer than that stated in (i), (ii) or (iii) above for faults on the **Network Operator** and **Non- Embedded Customers** equipment may be specified ~~agreed~~ in ~~accordance with~~ the ~~terms of the~~ Bilateral Agreement but only if System requirements in NGET's view permit. The probability that the fault clearance times stated in accordance with the Bilateral Agreement will be exceeded by any given fault must be less than 2%.

(b)

(i) For the event of failure of the **Protection** systems provided to meet the above fault clearance time requirements, **Back-Up Protection** shall be provided by the **Network Operator**, ~~or~~ **Non-Embedded Customer** and **NGET** as will be required to ensure a backup clearance for any fault affected by the above failure~~as the case may be~~.

(ii) **NGET** will ~~also~~ provide **Back-Up Protection**, which will result in a fault clearance time slower than that specified for the **Network Operator** or **Non-Embedded Customer Back-Up Protection** so as to provide **Discrimination**.

(iii) For connections with the **GB Transmission System** at 132kV and below, it is normally required that the **Back-Up Protection** on the **GB Transmission System** shall discriminate with the **Network Operator** or **Non-Embedded Customer's Back-Up Protection**.

(iv) For connections with the **GB Transmission System** at 400kV or 275kV, the **Back-Up Protection** will be provided by the **Network Operator** or **Non-Embedded Customer**, as the case may be, with a fault clearance time not slower than ~~300mS~~ 300ms for faults on the **Network operator's** or **Non-Embedded Customer's Apparatus**.

(v) Such **Protection** will also be required to withstand, without tripping, the loading incurred during the clearance of a fault on the **GB Transmission System** by breaker fail **Protection** at 400kV or 275kV. This will permit **Discrimination** between **Network Operator** or **Non-Embedded Customer**, as the case may be, **Back-Up Protection** and **Back-Up Protection** provided on the **GB Transmission System** and other **User Systems**. The requirement for and level of **Discrimination** required will be specified in the **Bilateral Agreement**.

(c)

(i) Where the **Network Operator** or **Non-Embedded Customer** is connected to the **GB Transmission System** at 400kV or 275kV, and in Scotland also at 132kV, and a circuit breaker is provided by the **Network Operator** or **Non-Embedded Customer**, or **NGET**, as the case may be, to interrupt the interchange of fault current with the **GB Transmission System** or the **System** of the **Network Operator** or **Non-Embedded Customer**, as the case may be, circuit breaker fail **Protection** will be provided by the **Network Operator** or **Non-Embedded Customer**, or **NGET**, as the case may be, on this circuit breaker.

(ii) In the event, following operation of a **Protection** system, of a failure to interrupt fault current by these circuit-breakers within the **Fault Current Interruption Time**, the circuit breaker fail **Protection** is required to initiate tripping of all the necessary electrically adjacent circuit-breakers so as to interrupt the fault current within the next 200 ms.

(d) The target performance for the **System Fault Dependability Index** shall be not less than 99%. This is a measure of the ability of **Protection** to initiate successful tripping of circuit breakers which are associated with the faulty items of **Apparatus.**