GC0155

Clarification of Fault Ride Through Technical Requirements

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Background

This modification proposal is based on an alternative proposal (WAGCM2) to **GC0151** *'Grid Code Compliance with Fault Ride Through Requirements'* by Drax Power Ltd. It seeks to clarify the technical requirements for fault ride through capability set out in the Grid Code to improve consistency, accuracy and understanding and to help prevent non-compliance with the Grid Code.

Clarification of Fault Ride Through Requirements

Issue-

The way CC.6.3.15(a)(i) is written deals both with plant capability and actions to be taken during a fault, however, it does not clearly distinguish between either leading to confusion.

Proposed solution-

It is suggested that the current CC.6.3.15(a)(i) is split into two sections, one dealing with the required capability CC.6.3.15(a)(i)(a) and a second section CC.6.3.15(a)(i)(b) dealing with actions to be taken during a fault.

Plant Capabilities

Proposed solution-

The new section CC.6.3.15(a)(i)(a) will only deal with plant capabilities by clarifying that the plant has to be capable of riding through the worst fault that the network could impose which is a 3-phase short circuit at the connection point which lasts for up to 140ms.

Proposed Legal text

The words “be design to” will be added to section CC.6.3.15(a)(i)(a) as can be seen in the legal text in appendix 1.

Operating Requirements During a Fault

Issue-

The new section CC.6.3.15(a)(i)(b) will specify the actions to be taken if a fault occurs by requiring that plants ride through faults in the transmission system which can be cleared by the transmission system circuit breaker as shown in figure 2 below and by adding the following text as the introduction to the section

Proposed Legal text

(b) Each **Generating Unit**, **DC Converter**, or **Power Park Module** and any constituent **Power Park Unit** thereof and **OTSDUW Plant and Apparatus** shall remain transiently stable and connected to the **System** without tripping of any **Generating Unit**, **DC Converter** or **Power Park Module** and / or any constituent **Power Park Unit**, **OTSDUW Plant and Apparatus**, and for **Plant and Apparatus** installed on or after 1 December 2017, reactive compensation equipment, for any balanced and unbalanced fault where subjected to a voltage dip at either the **Onshore Grid Entry Point** or **Interface Point** as applicable where the voltage remains either on or within the envelope shown in figure CC.6.3.15(a)(i)(a) except where:

Operating Requirements During a Fault

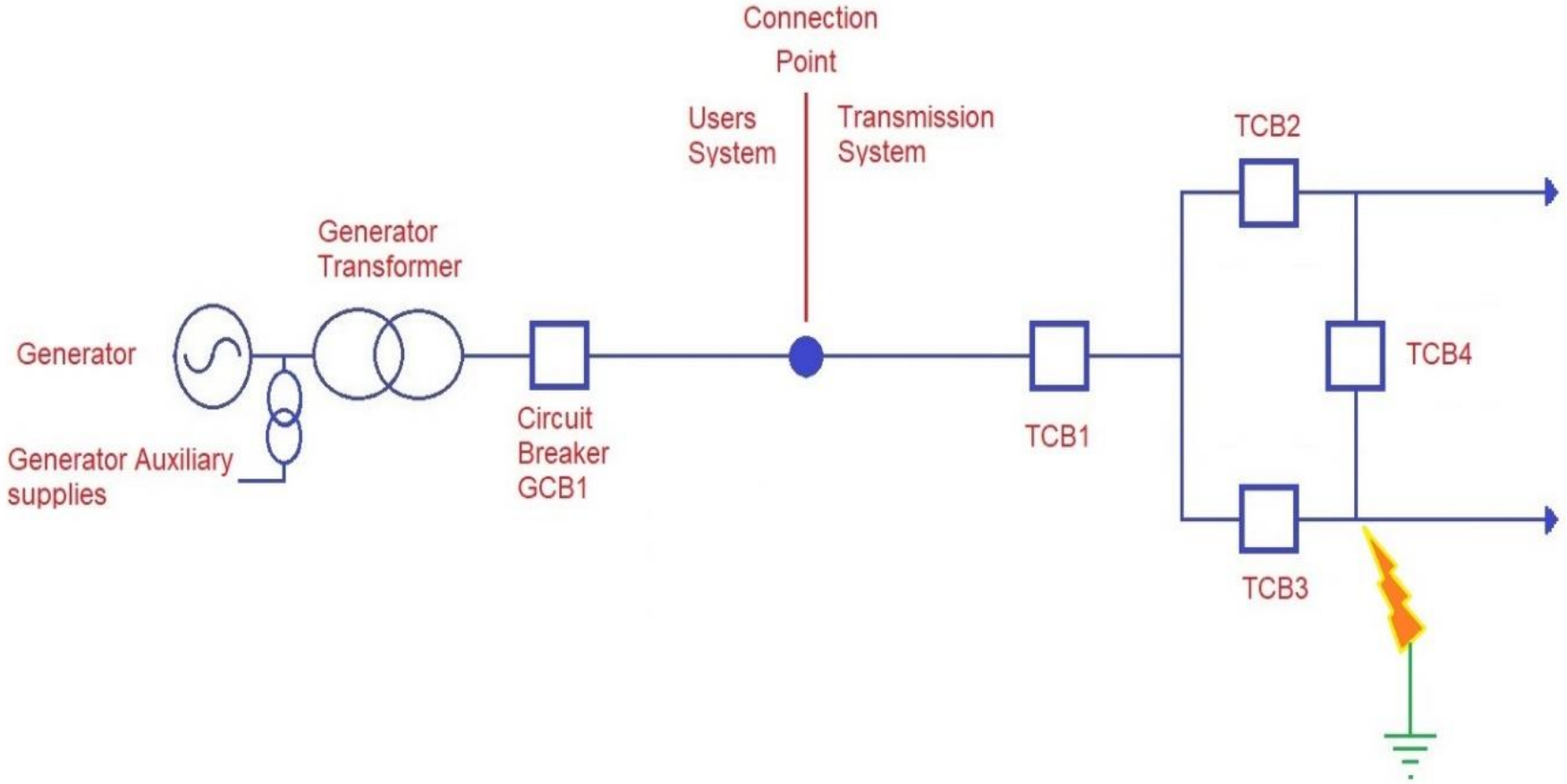

Figure 2 showing a fault which can be cleared by transmission system breakers TCB3 & 4

Operating Requirements During a Fault

Issue-

Whilst the introduction deals with plants riding through faults as it is currently drafted in the Grid Code, it is not clear what is supposed to happen where the plant's circuit breaker has to open to clear the fault.

There are concerns that the current text could be interpreted that the plant shall remain connected feeding the fault for 140ms which could lead to dangerous situations. It is clear this is not the intent, and that plant should trip during these circumstances.

It is proposed that the following subclauses are added to clarify each situation where tripping is permitted.

Subclause 1

If the fault is on the Generator's equipment then the Generator shall be required to trip to clear the fault from the transmission system as detailed in the proposed new section CC.6.3.15(a)(ii)(b)(i) (note that this is already permitted in the ECCs), as follows:-

Power Park Module and any constituent **Power Park Unit** thereof and **OTSDUW Plant and Apparatus** shall trip to clear the fault from the **Transmission System.** The protection schemes and settings should not jeopardise **Fault Ride Through** performance as specified in CC.6.3.15.1

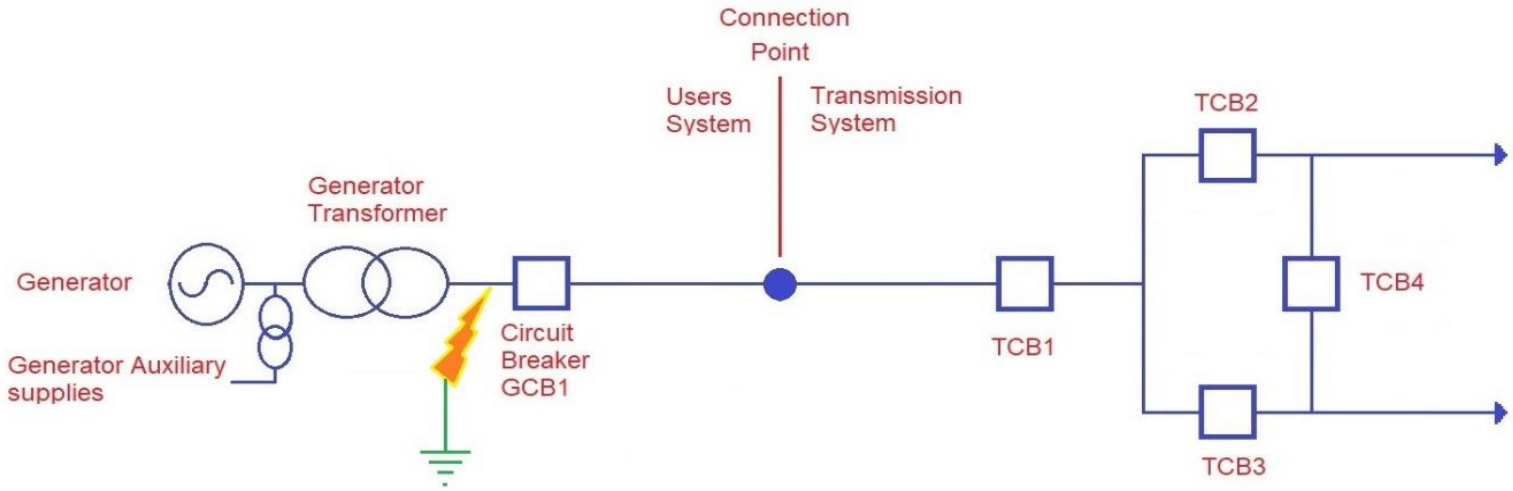

Figure 3 showing a fault which can only be cleared by generator breakers GCB1

Subclause 2

If the location of the fault on the network that means that the fault can only be cleared by operation of both Transmission and the Generator circuit breaker as shown in figure 4, again the Generator will be permitted to trip to clear the fault as detailed in the proposed new section CC.6.3.15(a)(i)(b)(ii) and ECC.6.3.15.8(vi)(i), as follows:-

the location of the fault means it cannot be fully cleared without tripping the of **Generating Unit**, **DC Converter**, or **Power Park Module** and any constituent **Power Park Unit** thereof and the **OTSDUW Plant** shall trip as required.

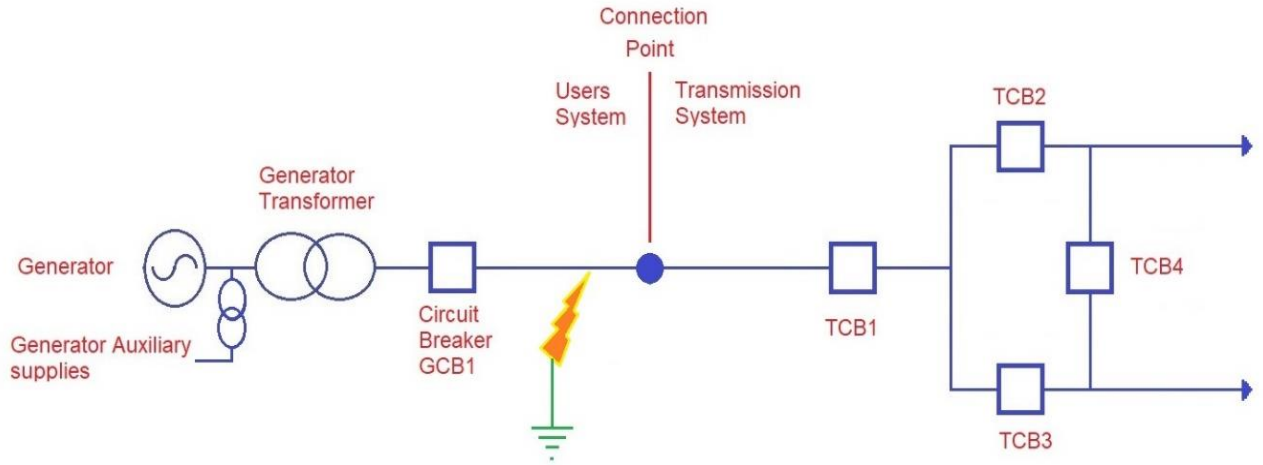

Figure 4 showing a fault which can only be cleared by generator breaker GCB1 & transmission circuit breaker TCB1

Subclause 3

if the location of the fault on the network means that the Generator will become islanded by the operation of the transmission circuit breakers as shown in figure 5 then it shall be permitted to trip as detailed in the proposed new sections CC.6.3.15(a)(ii)(b)(iii) and ECC.6.3.15.8(vi)(ii), as follows:-

clearance of the fault results in the **Generating Unit**, **DC Converter**, or **Power Park Module** or **OTSDUW Plant** becoming islanded and disconnected from the **Total System** and not supplying **Customers** (where CC.6.3.7(c)(i) applies), then the **Generating Unit**, **DC Converter**, or **OTSDUW Plants** shall be permitted to trip as required**.**

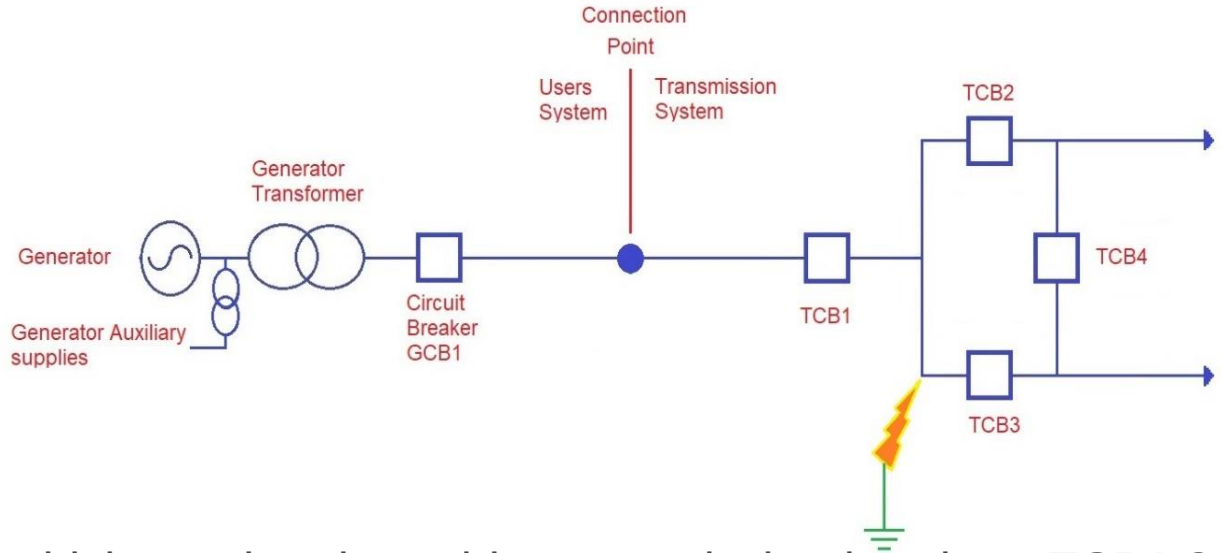

Figure 5 showing a fault which can be cleared by transmission breakers TCB1,2&3, however this results in the Generator being islanded from the main transmission system and needs to come off

Subclause 3

Also, if there are inter-trip arrangements with the TO or ESO in relation to protection schemes to prevent cascade overloading, etc then plants shall be required to trip as per these arrangements as detailed in the proposed new section CC.6.3.15(a)(i)(b)(iv & v) and ECC.6.3.15.8(iii & iv),as follows:-

the **Generating Unit**, **DC Converter**, or **Power Park Module** and any constituent **Power Park Unit** thereof and **OTSDUW Plant** is part of combined protection scheme with the **Transmission Operator**, then the **Generating Unit**, **DC Converter**, or **Power Park Module** and any constituent **Power Park Unit** thereof and **OTSDUW Plants** shall be permitted to trip as required**.**

the **Generating Unit**, **DC Converter**, or **Power Park Module** and any constituent **Power Park Unit** thereof and **OTSDUW Plant** is part of and intertrip scheme which is switched into service and triggered, then the **Generating Unit**, **DC Converter**, or **Power Park Module** and any constituent **Power Park Unit** thereof and **OTSDUW Plants** shall be permitted to trip as required**.**

Fault Current Injection

Issue-

The area of the current legal text which technically creates the biggest problem in relation to compliance are in sections CC.6.3.15 (a)(ii) and ECC.6.3.15.9.2.1(a)(i) which currently state “for which the voltage at the Grid Entry Point (or Interface Point in the case of OTSDUW Plant and Apparatus) is outside the limits specified in CC.6.1.4, each Generating Unit or Power Park Module or OTSDUW Plant and Apparatus shall generate maximum reactive current". If this requirement is drawn out on the figure 6 below where the current and voltage must always either be within the green shaded area or on the red line.

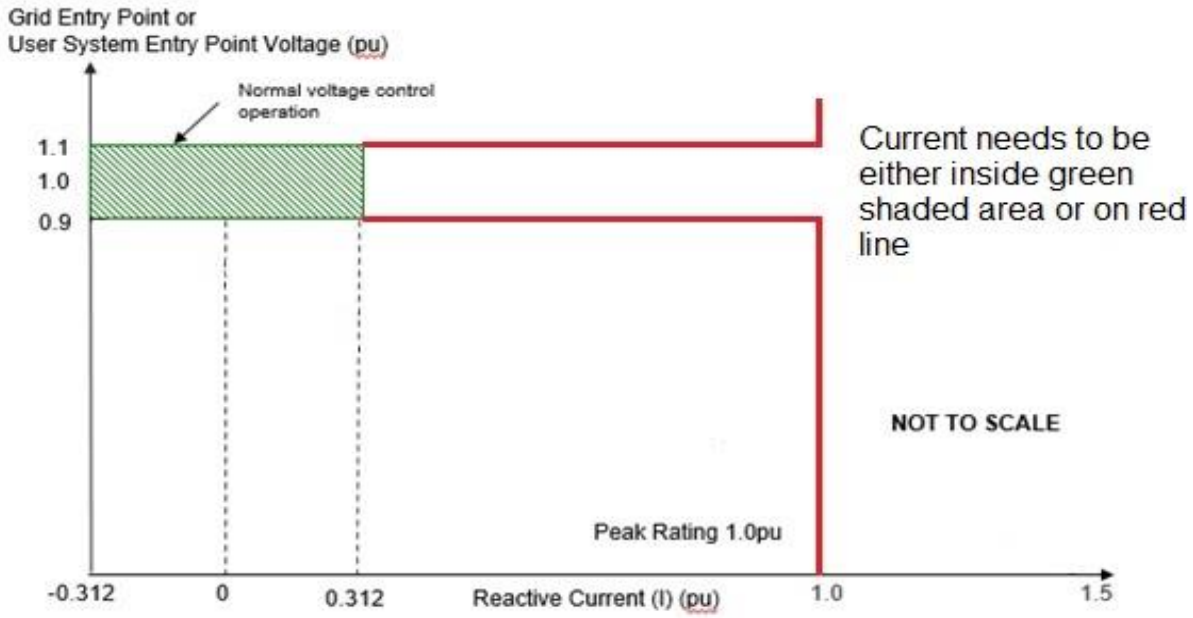

Figure 6 showing an interpretation of the existing legal text requiring the current to either be in the green box or on the red line

Fault Current Injection

Proposed Legal text

(iv) During the period of the fault as detailed in CC.6.3.15.1 (a) (i) for which the voltage at the **Grid Entry Point** (or **Interface Point** in the case of **OTSDUW Plant and Apparatus**) is outside the limits specified in CC.6.1.4, each **Generating Unit** or **Power Park Module** or **OTSDUW Plant and Apparatus** shall inject a reactive current above the heavy black line shown in Figure CC.6.3.15(b) without exceeding the transient rating limit of the **Generating Unit**, **OTSDUW Plant and Apparatus** or **Power Park Module** and / or any constituent **Power Park Unit** or reactive compensation equipment.

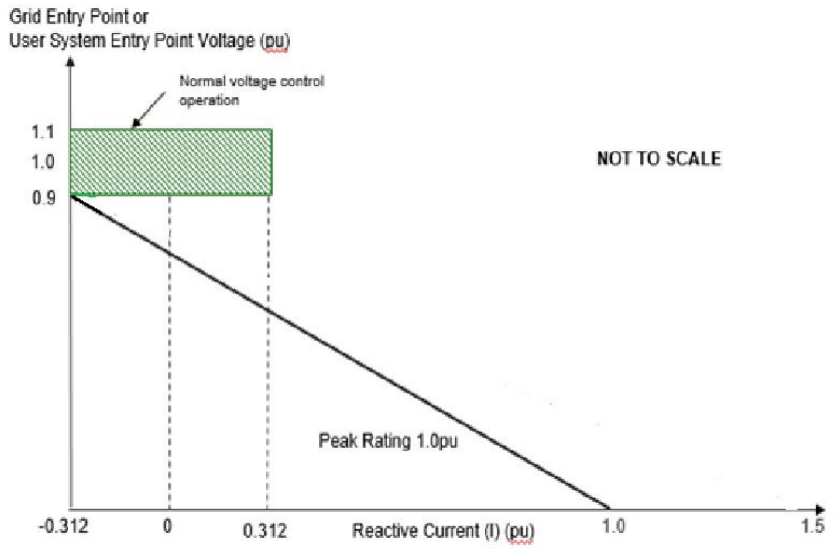

Figure 7 showing the proposed reactive current injection requirements, requiring the current to always remain above the black line

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Active Power Requirements- (solution required)

Issue-

Minimum active Power requirements after the fault has cleared because within CC.6.3.15.1 a) ii) it states:

(or within 0.5 seconds of restoration of the voltage at the **User System Entry Point** to 90% of nominal or greater if **Embedded**), Active Power output or in the case of OTSDUW Plant and Apparatus, Active Power transfer capability, shall be restored to at least 90% of the level available immediately before the fault. Once the Active Power output, or in the case of OTSDUW Plant and Apparatus, Active Power transfer capability, has been restored to the required level, Active Power oscillations shall be acceptable provided that:

- the total Active Energy delivered during the period of the oscillations is at least that which would have been delivered if the Active Power was constant

- the oscillations are adequately damped

Whilst this works in principle at higher loads, it does create an issue at lower loads if you consider a real event for a unit operating as a synchronous condenser in figure 8.

Active Power Requirements

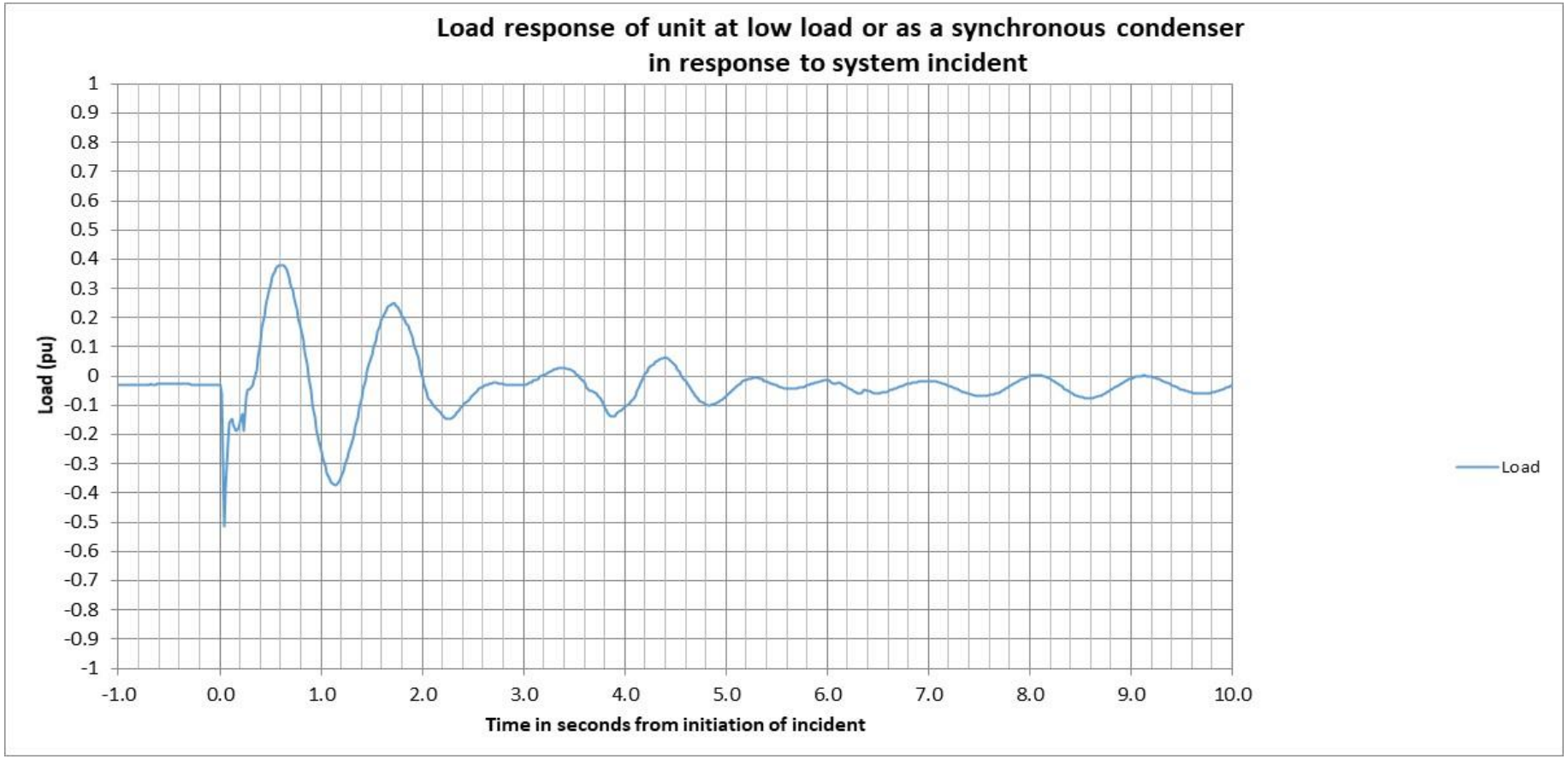

Figure 8 showing a typical active power response of a unit at low load to a fault

If you look at the initial load which is 0.02 pu then 90% of this small number you get a very small number, it is also difficult to see how a sensible compliance assessment can be carried out at these levels and it is hence suggested that under these circumstances the tolerance should be changed.

Voltage Protection Settings

Issue-

The Grid Code defines in detail the FRT requirements for voltage dips, it is silent on the requirement for Users or Network Operators to remain connected for transient over-voltages, particularly those that are expected to occur after the clearance of a fault.

Therefore it is possible, for example, that currently a Generator or Interconnector may successfully ride through a voltage dip, but trip when the fault is cleared as the resulting over-voltage transient is sufficiently high or sustained that it could trigger over-voltage protection that would ordinarily be expected to be fitted by the User (or Network Operator) to protect their equipment.

It is also possible a User site or Network Operator asset could ride through a low voltage fault but incorrectly configured protection settings result in the User site or Network Operator asset(s) tripping or de-loading.

Voltage Protection Settings

Proposed solution-

To provide further clarity to Users and Network Operators, it is proposed that wording along the following lines would be added to Section CC.6.3.15.3 and ECC.6.3.15.10 ('Other Fault Ride Through Requirements'):

- Users and Network Operators shall ensure voltage sensitive relays installed to protect the User's plant and / or apparatus or Network Operator's asset are configured such that they will not prevent correct operation of the Fault-Ride-Through capability of the User's equipment (or Network Operator's assets) against the relevant Voltage-Time curves. For example,
    - o Over-voltage protection shall be configured to be insensitive to transient overvoltages of at least 1.20pu for at least 0.5 seconds.
    - o Under-voltage protection shall be configured to be insensitive for transient undervoltages of below 0.8pu for at least 3 seconds