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Transmission Planning Criteria Position Paper

Fault Ride Through

Apparent Inconsistency between Grid Code and the Transmission Planning Criteria

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Table of Contents

1. Introduction 3
2. Background into Apparent Inconsistency 3
3. Legislative background 4
4. Transmission Planning Criteria Outline 5
5. Output of the Transmission Planning Criteria 5
6. Transmission Planning Criteria - Dynamic Criteria 5
7. Grid Code Outline 6
8. Discussion on the apparent inconsistency between TPC and GC 6
9. Summary 7

1. Introduction

A Grid Code working group was established in May 2010 to review the appropriate requirements for Fault Ride Through. This has arisen following a number of recent interactions with generators and EirGrid with respect to fault ride through. In addition, the recent Facilitation of Renewables studies has indicated the importance of this capability in coping with high penetrations of windfarms on the operation of the power system.

One of the deliverables of this working group was an EirGrid paper on the apparent inconsistency in fault clearance times between the Grid Code and the Transmission Planning Criteria. This paper is written to satisfy that deliverable. It seeks to outline the reasons why the standards in both are different, appropriate for the purposes of each and clarifies that there is no apparent inconsistency between the Grid Code and Transmission Planning Criteria with respect to fault ride through requirements. In addition, the consideration of what is appropriate or not in terms of Fault Ride Through requirements and their intended uses in the Grid Code is the subject of another deliverable of the working group and is not discussed within this document.

2. Background into Apparent Inconsistency

The purpose and intent of this section is to give an outline of the Transmission Planning Criteria and the Grid Code standards in relation to fault ride through.

A question has been raised regarding the apparent anomaly between the Grid Code (GC) and the Transmission Planning Criteria (TPC) in regards the fault ride through capability of generators. More specifically, Grid Code (Version 3.4) Clause CC 7.3.1.1 (h), under the headings of 'Generators' and 'Specific Design and Performance Standards', states that generators as a minimum requirement must

> *'remain synchronised during and following **Voltage** dips at the **HV** terminals of the **Generator Transformer** of 95% of nominal **Voltage** (5% retained) for duration 0.2 seconds and Voltage dips of 50% of nominal Voltage (i.e. 50% retained) for duration of 0.6 seconds.'*

The TPC states that

> *'the strength of the system shall be such as to maintain stability following a three-phase zero impedance line-end fault'. It shall be assumed that the fault is correctly cleared by primary protection and that line reclosing is in operation where appropriate.'*

The TPC also states that

> *'Pole slipping, even for a short time, is unacceptable.'*

Clause CC.10.1 of the Grid Code that states a maximum clearance time of:

- 120 milliseconds for the 110 kV system;
- 100 milliseconds for the 220 kV system; and
- 80 milliseconds for the 400 kV system

These fault clearance times relate to faults located on the user side and are not systematically related to transmission network protection schemes.

The statements in the GC ask a generator to ride through faults, without loss of synchronism (e.g. pole slip or unit tripping) for up to 200ms. The TPC requires a generator to remain synchronised following a fault up to primary protection time, for example in the order of 100 ms at 220 kV. Is this difference an anomaly?

3. Legislative background

EirGrid is a regulated business by statute and licence. Statutory Instrument (SI) 445 of 2000 sets the function of the Transmission System Operator (TSO). Under regulation 8(1)(d) (iii) of the SI, EirGrid has a statutory obligation to carry out the TSO functions in accordance with the conditions in the TSO licence.

- Condition 16 paragraph 2 of the TSO licence relates to the Transmission Planning Criteria and it states that Eirgrid is responsible for the following:

"The Licensee shall be responsible for operating, ensuring the maintenance of and, if necessary, developing the transmission system in accordance with the Transmission System Security and Planning Standards."

- Condition 30 paragraph 1 of the TSO licence states that Eirgrid must comply with:

"The Licensee, in consultation with electricity undertakings liable to be materially affected thereby, shall adopt and at all times have in force and shall implement and comply with a Grid Code in accordance with the provisions of Section 33 (Preparation of a Grid Code and a Distribution Code) of the Act."

The Transmission Planning Criteria and the Grid code are linked through Clause PC.7.1 in the Grid Code which specifies the Transmission Planning Criteria as the standard to be applied in planning the development of the Transmission System. Users and the TSO are bound by the clauses of the Grid Code.

The law, through S.I. 445, the TSO licence and the obligations in the Grid Code (in particular PC 7.1) obligate EirGrid to plan the transmission system according to the TPC. The TSO is also obligated to be bound and comply with the Grid Code. The Commission for Energy Regulation (CER) has the authority to direct the TSO to not follow the current code or standard.

Similarly Generators are through licence obliged to comply, in so far as applicable, with the Grid Code. In this respect Generators are obliged to design, construct and operate a power plant in full compliance with the GC unless they have sought and have approved an appropriate derogation.

4. Transmission Planning Criteria Outline

The Transmission Planning Criteria (TPC) is a distinct set of standards, independent from those of the Grid Code, that are used in the assessment of statutory infrastructural investment (i.e. investment determined and approved by regulation and not necessarily determined by market investment decisions) in the transmission system. These criteria are a statement of the acceptable level of reliability of the transmission network having regard to the cost of enhancement and the consequences of inadequate capacity. The resulting standard has been found to deliver an acceptable compromise between the cost of development of the system and the reliability of the service delivered.

In accordance with general international practice, these criteria are deterministic. Criteria are defined and measured in terms of system performance including thermal loadings, voltage, dynamic stability and short circuit levels. Prediction of system performance is based on simulation, rather than actual test.

5. Output of the Transmission Planning Criteria

The criteria outline the standard for the implementation of transmission planning with the focus on transmission system performance and security. The function of transmission planning as stated in the TPC is as follows:

> *'The specific function of transmission planning is to ensure the co-ordinated development of a reliable, efficient and economical system for the transmission of electricity for the long-term benefit of transmission users,'*

The output of this function ensures a flexible transmission system that will allow the economic scheduling of generation and the facilitation of power flows resulting from these dispatches. The TPC does not test the performance of an individual item or plant but instead presides over system conditions that may influence the stability and flexibility of the system as a whole.

The general approach in transmission planning is that reliability and system integrity should be maintained for the more likely combinations of events, and less likely combinations of events should be contained and not lead to widespread blackouts. Accordingly, the TPC also details the combinations of events on the system that must be considered in transmission planning and their acceptable consequences.

6. Transmission Planning Criteria - Dynamic Criteria

The objective of the Transmission Planning Dynamic Criteria is to assess whether the transmission system as a 'whole' is able to maintain synchronism during severe system faults and for that reason the dynamic standards are focused on preserving the stability and security of the bulk system and not any particular item or technology. During a planning connection study, the defined scenarios are used to highlight deviations from the TPC triggered by the system modification for the user's connection. Hence, the dynamic criteria contained within the TPC are used as a connection impact assessment and not for the governance and maintenance of the stability of individual generators.

7. Grid Code Outline

The Grid Code is a regulated industry agreement that states the obligations and rights for system users and the TSO who operate and use the transmission system. The Grid Code standards apply from the submission of an application through commissioning of the generator on through the continued real time operation of the unit for the life cycle of the plant. The standards outline the performance capability required from unit. Given that a generator is likely to experience a wide range of operating conditions through the life cycle, the standards required for a unit to be able to operate are invariably wider than the combination of events used in the TPC. In addition there are other standards in the GC that are not explicitly considered in the TPC including for example ramping capability, reserve and frequency control.

8. Discussion on the apparent inconsistency between TPC and GC

Fault clearance times are a major consideration in relation to the TPC and the GC standards due to the potential influence on generator and transmission system transient stability. The TPC takes into consideration the actual protection at a location and assumes that system faults are cleared by primary protection. This is a prudent assumption given that the alternative of considering back-up protection with longer fault durations would lead to increased infrastructural investment above current levels. EirGrid believes that the use of primary protection for the analysis of statutory infrastructure investment is appropriate, efficient and has demonstrated to be successful since at least 1998 when the current TPC were adopted.

As outlined earlier, the TPC also states that '*pole slipping, even for a short time, is unacceptable*'. This clause ensures that the transmission system is developed in a manner that will not result in a generator pole-slipping for the specified TPC scenarios. Pole-slipping of a single generator could trigger the cascading of other connected generators and damage to the system.

Finally, transmission system planning studies in Ireland have shown that when considering a range of options for a transmission system upgrade, there is little improvement in the fault ride through capability of generators triggered by different statutory investment solutions. In essence the dynamic stability at a given location, based on EirGrid's experience to date on the Irish transmission system, is more dominated by the generator characteristics than individual items of network. As a result, the use of transmission infrastructural investment as a means of improving generator fault ride through capabilities at a location has proven to be ineffective and could lead to inefficient investment on the system. EirGrid acknowledges that during operational or maintenance switching the fault level in a particular location could be significantly reduced. These situations require greater flexibility and capability than those that may be encountered in the planning time scale.

In contrast the Grid Code Clause 7.3.1.1(h) describes a standard that a unit has to meet in day to day operation for the life of the plant. It is appropriate that this standard allows for a greater capability than used in TPC as it has to accommodate real time operation over many years and countless operation scenarios.

The TPC are designed to determine future statutory network investment. The GC is used to give technical standards clarity to investment determined by market forces. The purpose of both is fundamentally different. It is fully appropriate that with respect to fault ride through capability and dynamic stability that the clauses require different standards. There is no inconsistency between the TPC and GC in this regard.

9. Summary

- The TPC is the means of identifying the need for statutory investment in the transmission system while considering a cost, reliability and efficiency balance;
- The GC outlines the day-to-day rules for the operation of the transmission system and all aspects relating to the use of connected Plant (and/or Apparatus) and the necessary capabilities that the Plant (and/or apparatus) must provide;
- The GC and the TPC are designed for distinct and different purposes;

Therefore it is appropriate that the GC and the TPC have different standards with respect to FRT;

- In EirGrid's opinion if the network was planned to cover all operational situations i.e. to the GC standard, this would lead to unnecessary and unjustifiable infrastructure;
- If the GC FRT standard was set to that of the TPC in the event a protection relay did not operate correctly there is a potential to cause a cascade failure and in addition;
- In EirGrid's opinion the stability of the power system could be materially compromised if generation is designed to an FRT of primary protection time;

Therefore given the resulting impacts above, it is not appropriate that the TPC and the GC FRT clauses are the same.