Voltage Control and Fault Ride Through
(Paper by NGET to GCRP)

Introduction

This paper is presented to both the STC and Grid Code review panels to present NGET interpretation of two Power Park Module performance requirements. The performance requirements relate to:

(i) the availability of reactive capability to provide voltage control; and,
(ii) the current infeed from voltage control plant for fault ride through.

Voltage control requirements from static plant

Grid Code Connection Conditions (CC) 6.3.6 requires that all generators should be capable of contributing to voltage control by continuous changes of reactive power. The required reactive capability is described in CC6.3.2 whilst CC6.3.8 and associated CC Appendices detail the performance requirements. STC section K has equivalent requirements for offshore transmission systems.

For Power Park Modules the requirements in both codes are defined at the connection point to allow the owner/developer maximum flexibility in delivering the service. In practice the reactive power can be supplied by Wind Turbine Generators (WTG's), Static Synchronous Compensators (Statcoms), Static Var Compensators (SVC's), switched shunt capacitors and reactors or a combination of these plant items ("hybrid").

A common "hybrid" system uses a Statcom together with one of more mechanically switched capacitors and/or reactors to provide the Power Park Module reactive capability and voltage control. The Statcom is capable of rapid changes to reactive power and may use a short term overload capability to cover the delay in operation of the mechanically switched devices. With correct consideration of the rating of the Statcom and design of the switched components such systems have demonstrated compliance with the Grid Code.

However, two issues have come to light in relation to the switching of the shunt devices

(i) the time taken to charge the operating mechanism of the circuit breaker may be a significant.
(ii) after switching a shunt capacitor out of service there may be a significant delay while the capacitor is discharged before the plant can be switched into service again

Both issues mean that the shunt device is unavailable if called upon twice or more in a short time. Where this period of unavailability cannot be accommodated by the short term capability of the Statcom there is a shortfall in the reactive capability available to control the system voltage. In the worst cases found so far the time delay before full reactive capability is restored exceeds 10 minutes.

Given that bad weather such as strong winds and lightning crossing an area lead to multiple faults with circuits switching out and automatic reclosing in periods less than 10 minutes, National Grid believes that unavailability of the full reactive capability puts system security at risk and that capability should always be available. National Grid interprets the requirement to mean that the reactive output can be varied at any

time to any point on the characteristic to provide the voltage control and reactive support.

Following identification of the issue, NGET has surveyed all sites with hybrid systems to establish the depth of the problem and also made enquiries with manufacturers to identify performance enhancements. Discussion with manufacturers indicate that full availability of reactive capability at all times can be achieved with larger rated Statcoms or thyristor switching of shunt devices.

However, this presents a significant change which can not be accommodated within current sites built or under construction. Within the current site designs there are options to increase performance such that the switch recharge time less than 15 seconds and the capacitor discharges in less than 2 seconds. This is repeatable without restriction. National Grid believes that with this performance and a limited number of sites, the system can be managed with little additional risks to supply security.

Hence, the National Grid approach will be:

- Sites with completion date prior to 1 January 2013 and have a performance such that switch recharge time (close-open-close) less than 15 seconds and capacitor discharge time less than 2 seconds will be accepted.
- Sites with completion date prior to 1 January 2013 and have longer unavailability will be asked to seek a derogation.
- Sites with a completion date after 1 January 2013 will be required to have no unavailability of reactive capability.

Fault Ride Through

The requirements for Generators to ride through faults on the supergrid system were added to the Grid Code (CC.6.3.15) in 2005 as part of the amendment package to address the growth of renewable generation. Equivalent text was migrated into the STC Section K ready for the “go-active” of offshore transmission networks.

When referring to the requirement to provide maximum reactive current during a fault the Grid Code places this requirement on the power park module. The Grid Code further qualifies this requirement by stating “without exceeding the transient rating limit of power park module and/or constituent power park unit. The equivalent wording in STC (K.3.1.1(b)) states “….During the period of the fault as detailed in 3.1.1 (a) each Offshore Transmission System shall generate maximum reactive current without exceeding the transient rating limit at the Interface Point”. Hence the STC definitely requires fault current from voltage control plant while it is only implied as part of the Power Park Module under the Grid Code.

In recent compliance discussions relating to offshore projects, National Grid has become aware that some static compensation plant has been designed to trip or block at relatively high system voltages (e.g. 70%). The loss of reactive support through current generation at such times is not desirable for stable voltage control and could lead to voltage collapse. As wind turbine generators using the same convertor technology can operate down to 0 volts, National Grid posed this question to manufacturers.

The response is that 0 connection volts operation is only possible where there is an energy source on the “secondary” side of the convertor to supply losses and current.

In a static compensator the losses and charging current have to come from the connection side so 0 volts is not possible. Discussions with the three main manufacturers currently supplying equipment to wind farms has given the following conditions as technically feasible:

Fault Type	Voltage at the HV of the Statcom transformer (pu)
3 Phase	0.15
Phase to Phase	0.4
Single Phase	0.0

Hence, the National Grid approach will be to accept static compensation plant which has these characteristics and will consider bringing forward a change to both the Grid Code and STC to clarify the issue if required.

Recommendation

The Grid Code Review Panel and STC Panel are asked to:

i) note the interpretation of the requirements for reactive power change and reactive current generation.

ii) Consider if any changes are required to either the grid code or/and the STC