Fault Ride Through
RfG - Compliance

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ENTSO-E Requirements for Large Directly Connected Synchronous Generating Units

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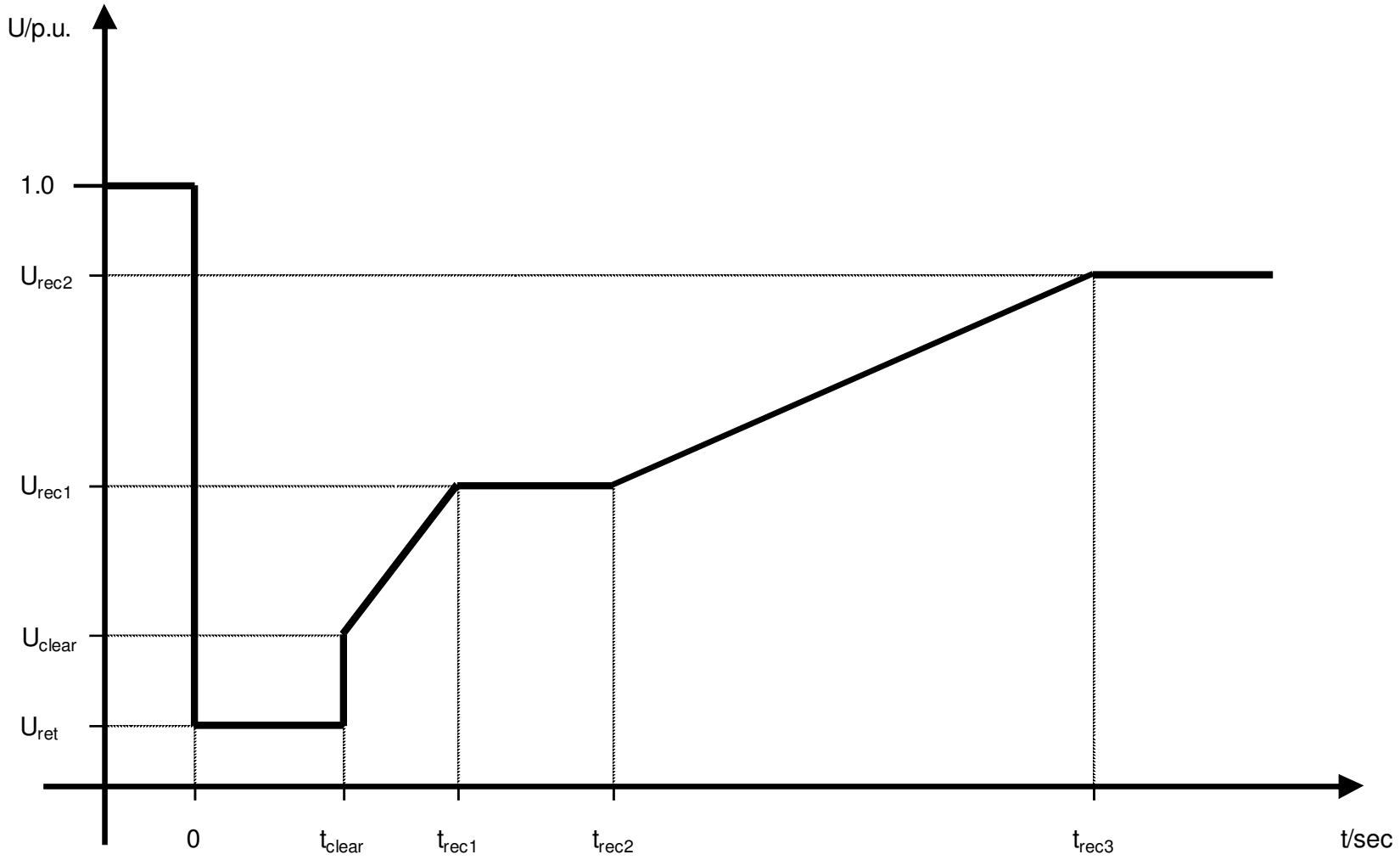
- Article 9 (3), Article 11 (3) and Article 12 (3)(a)
  - Power Generating Module shall be capable of staying connected to the network and continuing stable operation after the power system has been disturbed by secured faults in accordance with a voltage against time profile at the Connection Point for fault conditions on the Network defined by the Relevant Network Operator.
  - The voltage against time profile shall be expressed by a lower limit of the course of the phase to phase voltages on the Network Voltage level at the Connection Point during a symmetrical fault, as a function of time before, during and after the fault.

ENTSO-E RfG - Fault Ride Through Requirements – Voltage Against Time Profile – Figure 3



Interpretation of Voltage against time profile

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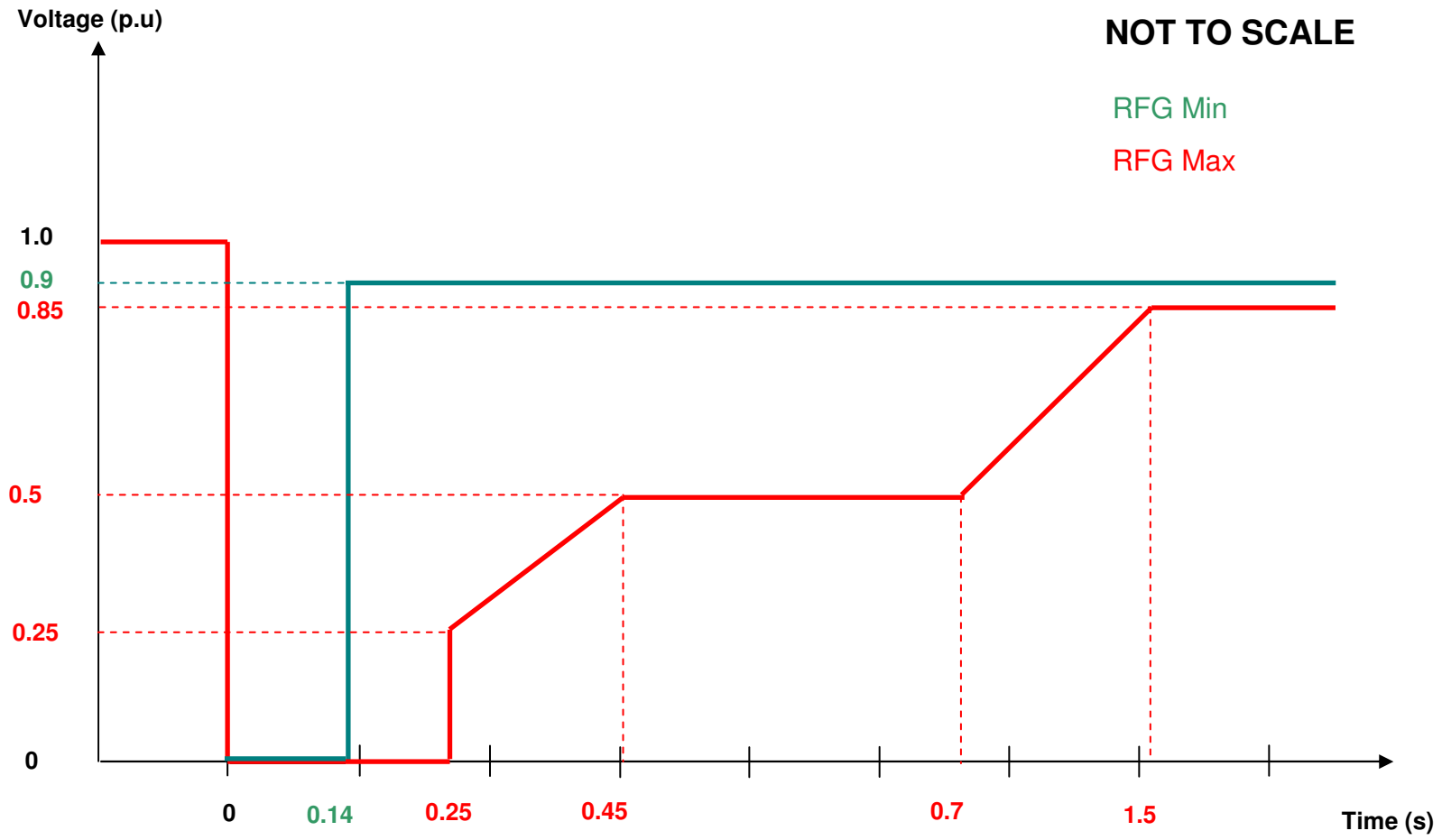
- Figure 3 defines the Fault Ride Through profile of a Power Generating Module (Synchronous and Asynchronous). The diagram represents the lower limit of a voltage-against time profile by the voltage at the Connection Point, expressed by the ratio of its actual value and its nominal value in per unit before, during and after a fault. Uret is the retained voltage at the connection point during a fault, tclear is the instant when the fault has been cleared. Urec1, Urec2, trec1, trec2 and trec3 specify certain points of lower limits of voltage recovery after fault clearance.

ENTSO-E RfG - Voltage Against Time Profile

Type D Synchronous Power Generating Modules Table 7.1



Additional Requirements (1)

- Each TSO shall define and make publically available whilst respecting the provisions of Article 4(3) defining the pre fault and post fault conditions for fault ride through capability in terms of:-
  - Conditions for the calculation of the pre-fault minimum short circuit capacity at the Connection Point
  - Conditions for pre-fault Active and Reactive Power operating point of the Power Generating Module at the Connection Point and Voltage at the Connection Point
  - Conditions for the calculation of the post fault minimum short circuit capacity at the Connection Point

Additional Requirements (2)

- Upon request by a Power Generating Facility Owner a Relevant Network Operator shall provide the pre-fault and post fault conditions to be considered for fault ride through capability as an outcome of the calculations at the Connection Point as defined in subparagraph 3 regarding.
  - The pre fault minimum short circuit capacity at each Connection Point expressed in MVA;
  - The pre-fault operating point of the Power Generating Module expressed in Active Power output and Reactive Power output at the Connection Point and Voltage at the Connection Point and
  - The Post – Fault minimum short circuit capacity at each Connection Point expressed in MVA.
  - Alternatively generic values for the above conditions derived from typical cases may be provided by the Relevant Network Operator.
  - The Fault Ride Through capabilities in the case of asymmetrical faults shall be defined by each TSO while respecting the provisions of Article 4(3)
  - The TSO shall define (subject to Article 4(3)) the magnitude and time for Active Power recovery of the Generating Unit
  - The Power Generating Module shall be capable of remaining connected to the Network and continuing stable operation when the course of the phase to phase voltages on the Network Voltage level at the Connectionn Point during a symmetrical fault given the pre-fault and post fault conditions according to Article 9(3) (a) points 3) and 4), remains above the lower limit defined in Article 9(3) (a) point 2) unless the protection scheme for internal electrical faults requires he disconnection of the Power Generating Module from the Network.

Compliance - Overview

- Operational Notification process applied similar to current GB arrangements
- Type D Power Generating Modules to include
  - Energisation Operational Notification
  - Interim Operational Notification
  - Final Operational Notification
- Article 30 (3)
  - Itemised Statement of Compliance
  - Detailed Technical Data
  - Equipment Certificates where relied on as as part of statement of compliance
  - Simulation models as specified by Article 10(6)(c)
  - Studies demonstrating expected steady state and dynamic performance.

Compliance – Testing / Simulation

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- Testing
  - No on site testing would be required for fault ride through performance and there is no requirement for manufacturer test results (Synchronous Plant only)
- Simulations
  - Studies required to demonstrate fault ride through capability requirements as defined in Article 9(3)(a) and 11(3) (a)
  - Simulation is deemed passed provided compliance with Article 9(3)(a) and 11(3) (a) is demonstrated
  - The Power Generating Module shall demonstrate its capability to simulate post fault active power recovery in accordance with the requirements of Article 12(3)(a)

Implementation (1)

- RfG curently still in the Comitology phase and not expected to be finalised until the end of 2014.
- The RfG could therefore still be subject to change
- A combined Grid Code / Distribution Code working group has been established to develop implementation options.
- The Compliance process is not expected to change significantly under RfG but the fault ride through requirements defined under Articles 9, 11 and 12 will have an impact on the simulation studies carried out.

Assumed Implementation Options?

- Network Conditions would be expected to be published in the Electricity Ten Year Statement and / or Bilateral Agreement – eg pre and post fault conditions for the minimum short circuit capacity at the Connection Point
- Range of Operating points (ie pre fault real and reactive power) defined in the Grid Code - Compliance Provisions
- Pre and Post fault minimum short circuit capacity defined in the Bilateral Agreement
- National Grid will provide additional information as requested by the Generator under Article 9(3) and 11(3).

Compliance

- Range of fault conditions to be assessed – voltage against time curves to be determined through study work
- Ability of Generator to ride through pre - defined set of faults and restore active power in accordance with requirements
- Voltage against time curves, active power recovery and pre and post fault generator operating point to be defined globally.
- Pre and post fault system strength at the connection point would need to be specified on a site specific basis. General details on overall system strength could be specified in the Electricity Ten Year Statement but more specific cases under outage conditions would need to be specified in the Bilateral Agreement.

Summary

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- RfG currently progressing through the comitology phase and therefore the requirements could still be subject to change
- Compliance process broadly expected to be in line with current GB Grid Code though more detailed simulation studies required
- There will be no requirement for testing – all fault ride through compliance will be demonstrated through simulations.
- The majority of requirements would be expected to be specified in the Grid Code globally other than site specific requirements such as pre and post fault system strength.

Discussion

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