TRANSCO
شركة أبوظبي للنقل و التحكم
Abu Dhabi Transmission & Despatch Company

Addendum-2

Electricity Transmission Code (ver2, rev. 2 dated 30 June 2020) - Update to include Large Renewables and HVDC Requirements

Issue Date: 31 May 2021

Approved by Department of Energy

S.N	Code Reference Chapter/Section/Page	Statement per the Code (ETC ver.2 Rev.2 dated 30 June 2020)	Proposed Amendment/New Statement
1	Chapter-1, Glossary and Definitions	**Battery Storage** A type of energy storage power station that uses a group of batteries to store electrical energy	**Battery Storage** A type of energy storage power station that uses a group of batteries to store electrical energy/to provide electrical energy back to the network, which could be a part of **Power Park Module** as well as standalone installation.
2	Chapter-1, Glossary and Definitions	Not defined	**Harmonic Voltage Compatibility Level** A maximum level under which the power grid can operate normally considering the impact from nonlinear characteristics of equipment connected to the **Transmission System.** It represents a statistical measure of the overall condition of the **Power System** from a harmonic performance point of view.
3	Chapter-1, Glossary and Definitions	Not defined	**Harmonic Voltage Planning Level** Maximum allowable voltage harmonic level at a specific point of connection and is relevant for the determination of any new **User** apportion.
4	Chapter-1, Glossary and Definitions	Not defined	**Non-synchronous Generating Units** Generating units connected to network through power electronic inverters including **Power Park Modules** and **Battery Storage.**
5	Chapter-1, Glossary and Definitions	Not defined	**Limited Frequency Sensitive Mode** A mode whereby the operation of the **Non-synchronous Generating Unit** (**Power Park Modules and HVDC**) is frequency insensitive except when the **System Frequency** exceeds the predefined frequency threshold, from which point limited frequency response shall be provided. For **Non-synchronous Generating Units** (**Power Park Modules and HVDC**) operation in **Limited Frequency Sensitive Mode** would require **Limited Frequency Sensitive Mode – Over frequency (LFSM-O)** capability and **Limited Frequency Sensitive Mode – Underfrequency (LFSM-U)** capability.

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6	Chapter-1, Glossary and Definitions	Not defined	**Limited Frequency Sensitive Mode - Over frequency (LFSM-O)** A **Non-synchronous Generating Unit** (**Power Park Modules and HVDC**) operating mode which will result in **Active Power** output reduction in response to a change in **System Frequency** above a certain value.
7	Chapter-1, Glossary and Definitions	Not defined	**Limited Frequency Sensitive Mode - Underfrequency (LFSM-U)** A **Non-synchronous Generating Unit** (**Power Park Modules and HVDC**) operating mode which will result in **Active Power** output increase in response to a change in **System Frequency** below a certain value.
8	Chapter-1, Glossary and Definitions	Not defined	**Power Park Module** Multiple interconnected **Generating Units** (**PVGU** or **WTGU**) that have a common **Connection Point** and utilize renewable energy as the primary energy source.
9	Chapter-1, Glossary and Definitions	Not defined	**Power Purchase Agreement** An agreement between a **GENCO** and the **Procurer** covering the sale and purchase of Electricity.
10	Chapter-1, Glossary and Definitions	Not defined	**Synthetic Inertia** A facility or system service provided by a **Power Park Module** or **HVDC** system to replicate the effect of inertia of a **Synchronous Generating Unit** to a prescribed level of performance during a frequency deviation.
11	Chapter-1, Glossary and Definitions	Not defined	**Resource Following Ramp Rate** A ramp rate setting of **Power Park Modules** used during Start-Up and normal operation.
12	Chapter-1, Glossary and Definitions	Not defined	**Set-Point Ramp Rate** A ramp rate setting of **Power Park Modules, HVDC** and/or **Battery Storages** used for **Active Power** control during **AGC** control process.
13	Chapter-1, Glossary and Definitions	Not defined	**Frequency Response Ramp Rate**

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			A ramp rate setting of **Power Park Modules, HVDC** and/or **Battery Storages** used for **Primary Response** purpose.
14	Chapter-1, Glossary and Definitions	Not defined	**Compensating Ramp Rate** A ramp rate setting of **Battery Storages** that may be used to reduce the impact of **Active Power** ramps of the **Power Park Modules.**
15	Chapter-1, Glossary and Definitions	Not defined	**HVDC** High-Voltage Direct Current. A **Transmission System** to transfer power using direct current (**DC**).
16	Chapter-1, Glossary and Definitions	Not defined	**HVDC System** A **Transmission System** comprising all equipment to transmit power via **HVDC**, including **Converter Station**(s) and **HVDC** overhead line and/or cable systems.
17	Chapter-1, Glossary and Definitions	Not defined	**HVDC USER** An entity who owns/operates an **HVDC System** connected to **TRANSCO's** AC grid.
18	Chapter-1, Glossary and Definitions	Not defined	**AC/DC Converter** A facility to interface an AC system with a DC system; e.g. **HVDC Converter Station** and power-electronic converters used in **Power Park Modules.**
19	Chapter-1, Glossary and Definitions	Not defined	**System Short Circuit Ratio (SSCR)** A measure of AC system strength at an interconnection point. It is typically defined as the ratio of the rated power of a piece of equipment (e.g. **HVDC Converter Station**, **Power Park Module** or **Synchronous Generating Unit**) to the short circuit power at the point of interconnection.
20	Chapter-1, Glossary and Definitions	Not defined	**VSC - HVDC** **Voltage-Sourced Converter HVDC:** An **HVDC** topology using **Voltage-Sourced Converter** technology with forced-commutated valves.
21	Chapter-1, Glossary and Definitions	Not defined	**LCC - HVDC** **Line-Commutated Converter HVDC:** An **HVDC** topology using conventional thyristor-based valves.

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22	Chapter-1, Glossary and Definitions	Not defined	**Converter Station** A type of substation which forms the terminal equipment for a **HVDC** transmission line. It converts direct current (DC) to alternating current (AC) or the reverse.
23	Chapter-1, Glossary and Definitions	Not defined	**Voltage Sourced Converter** A type of **AC/DC Converter** technology based on Forced Commutated Valves such as IGBT (Insulated-Gate Bipolar Transistor).
24	Chapter-2, Planning Code Clause 2.3 Rated Parameters Data, Page 51	for each **AC/DC Converter** at a **AC/DC Converter Station** or **AC/DC Converter** connecting a **PVPS** or **WFPS**:	For each **AC/DC Converter** at a **HVDC Converter Station** or within **Power Park Module** connecting a **PVGU** or **WTGU.**
25	Chapter-2, Planning Code Clause 3.5 Short Circuit Contribution to Transmission System Page 52	To allow **TRANSCO** to model a **User System** with **Generating Unit(s)** and/or motor loads connected to it, a **User** is required to provide data, calculated in accordance with **Good Industry Practice**. The data should be provided for the condition of maximum short circuit infeed from that **User System** with all **Generating Units Synchronized** to that **User System**. The **User** must ensure that the pre-fault network conditions reflect a credible **System** operating arrangement …………………………… v) The **Active Power** being generated pre-fault by the **Power Farm** and by each **PVGU** and **WTGU**; vi) The **Power Factor** of the **Power Farm** and of each **PVGU** and **WTGU**.	To allow **TRANSCO** to model a **User System** with **Generating Unit(s)** and/or motor loads connected to it, a **User** is required to provide data, calculated in accordance with **Good Industry Practice**. The data should be provided for the condition of maximum short circuit infeed from that **User System** with all **Generating Units Synchronized** to that **User System** or with all **Power Park Modules** connected to that **User System** through **AC/DC Converter Station**. The **User** must ensure that the pre-fault network conditions reflect a credible **System** operating arrangement. ………………………… v) The **Active Power** being generated pre-fault by the **Power Park Module** and by each **PVGU** and **WTGU**; vi) The **Power Factor** of the **Power Park Module** and of each **PVGU** and **WTGU**.
26	Chapter-2, Planning Code Section 6 – Appendix C: System Model	**TRANSCO** will provide **Users** and potential **Users**, through the Emirates Water and Electricity Company or directly, with a complete listing of the data submitted and registered under the requirements of the **Electricity Transmission Code** and in addition the positive, negative and zero sequence data related to the **TRANSCO** transmission	**TRANSCO** will provide **Users** and potential **Users**, through the Emirates Water and Electricity Company or directly, with a complete listing of the data submitted and registered under the requirements of the **Electricity Transmission Code** and in addition the positive, negative and zero sequence data related to the **TRANSCO** transmission system and the dynamic model data corresponding to generators and other dynamic devices as determined by **TRANSCO** as necessary for the **User** to perform design verification studies.

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		system. This data will be validated by **TRANSCO** in accordance with **Good Industry Practice**.	Each connection between a **Generating Unit** and the **Transmission System** must be associated with the minimum **System Short Circuit Ratio** at the point of connection as determined by **TRANSCO** and specified within the **Connection and Interface Agreement, or Power (and Water) Purchase Agreement.** This data will be validated by **TRANSCO** in accordance with **Good Industry Practice**.
27	Chapter-2, Planning Code Section 5 – Appendix B: Simulation Models	Not Defined	**Simulation models** The **Power Park Module** or the **HVDC USER** shall provide the models that accurately represent the dynamic response of the plant. The model shall include all site specific protection, control and other parameter settings as applicable. Both RMS-type and EMT-type models shall be in software formats specified by **TRANSCO** (ex. PSS®E and PSCAD™/EMTDC™ formats, for RMS and EMT respectively). The models shall have the flexibility to change parameters and select options that **TRANSCO** will have access to with the field equipment. However, the model may be provided in 'closed (black-box)' form to protect proprietary information of the **Power Park Module** or **HVDC** Manufacturer that are included in the details of the model. The **HVDC** or **Power Park Module** shall provide the model validation and system compliance study results for review and agreement by **TRANSCO**. Those simulation studies shall be revised based on the actual system and **HVDC System** or **Power Park Module** tests and adhere to the requirements of the **Transmission System** and **HVDC** System or **Power Park Module** per the Technical Specifications, as well as the following requirements: For the purpose of dynamic simulations, the models provided shall contain at least, but not limited to, the following sub-models, depending on the existence of the mentioned components: (a) **HVDC** or **AC/DC** converter unit models; (b) AC component models; (c) DC system models; (d) Voltage and power controller; (e) Special control features if applicable (e.g. power oscillation damping (POD) function, sub-synchronous torsional interaction (SSTI) control); (f) Multi terminal control, if applicable; (g) **HVDC system** protection models as agreed between **TRANSCO** and the **HVDC USER**.

<table>
<tr><th>S.N</th><th>Code Reference Chapter/Section/Page</th><th>Statement per the Code (ETC ver.2 Rev.2 dated 30 June 2020)</th><th>Proposed Amendment/New Statement</th></tr>
<tr><td></td><td></td><td></td><td>The HVDC USER shall verify the models against the results of compliance tests carried out and a report of this verification shall be submitted to TRANSCO. The models shall then be used for the purpose of verifying compliance with the requirements of this code including, but not limited to, compliance simulations and used in studies for continuous evaluation in system planning and operation.

The HVDC USER shall submit HVDC recordings to TRANSCO, if requested, in order to compare the response of the models with these recordings.

Similarly, the owner/operator of the Power Park Modules shall submit the recordings to TRANSCO, if requested, in order to compare the response of the models with these recordings.</td></tr>
<tr><td>28</td><td>Chapter-3, Connection Conditions, Section-3 (SCOPE)

Pages 66</td><td>The Connection Conditions applies to TRANSCO and to the following Users:
i) GENCOs
ii) DISCOs
iii) Non-Embedded Customers
iv) Self-Supply Users
v) User System</td><td>The Connection Conditions applies to TRANSCO and to the following Users:
i) GENCOs (including Power Park Modules and Battery Storages)
ii) AC/DC (HVDC) Converter Station
iii) DISCOs
iv) Non-Embedded Customers
v) Self-Supply Users
vi) User System</td></tr>
<tr><td>29</td><td>Chapter-3, Connection Conditions, Section-6 (TECHNICAL, DESIGN AND OPERATIONAL CRITERIA) Clause 6.3.1</td><td>Frequency range for HVDC – Not specifically defined in the current version of ETC.</td><td>a) “The HVDC system shall be capable of staying connected to the Transmission System and remain operable within the System Frequency range 49 to 51Hz”. Decrease of output Active Power is permitted in the frequency range of 47 to 49.5 Hz. Any decrease of output Active Power occurring in the frequency range of 47 to 49.5 Hz should not be more than pro-rata with System Frequency.

b) “Minimum time period an HVDC System shall be able to operate for different frequencies deviating from a nominal value without disconnecting from the Transmission System is as follows:”

Table xxx1 Frequency ranges

<table><tr><th>Frequency Range</th><th>Requirement</th></tr><tr><td>47 - 47.5Hz</td><td>Operation for a period of at least 1 continuous minute is required each time the System Frequency is below 47.5Hz.</td></tr><tr><td>47.5 - 49Hz</td><td>Operation for a period of at least 90 continuous minutes is required each time the System Frequency is below 49Hz.</td></tr></table></td></tr>
</table>

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49 - 51Hz	Continuous operation is required. Any decrease of output power occurring in the frequency range of 47 to 49.5 Hz should not be more than pro-rata with **System Frequency.**
51- 51.5 Hz	Operation for a period of at least 90 continuous minutes is required each time the **System Frequency** is above 51 Hz. Decrease of output power is not permitted.
51.5 – 52 Hz	Operation for a period of at least 20 continuous minutes is required each time the **System Frequency** is above 51.5Hz. Decrease of output power is not permitted.
52 – 53 Hz	Operation for a period of at least 20 continuous seconds is required each time the **System Frequency** is above 52Hz. Decrease of output power is not permitted.

The proposed requirements for **HVDC** are depicted in the above Table xxx1 and Figure xxx1 below.

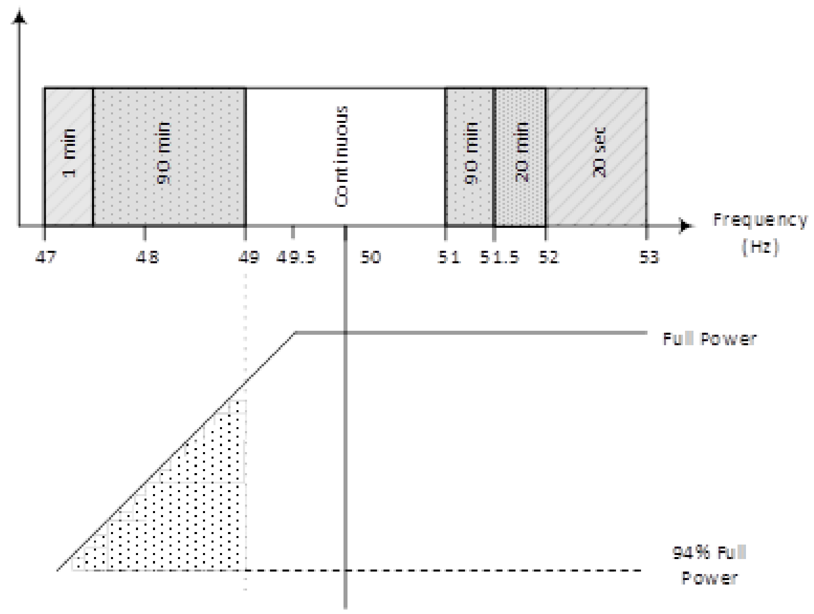

Figure xxx1 Expected withstand durations and expected real power capacity during system frequency deviations.

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			The **TRANSCO** may specify a maximum admissible **Active Power** output reduction from its operating point if the **System Frequency** falls within 49.5 Hz to 47 Hz. This reduction shall not be more than pro-rata with **System Frequency** (e.g. maximum reduction allowed at 47 % is 6% of the rated power). The **HVDC USER** shall communicate their technical duration capability (over and above what has been stated in Clause 6.3.1 above) to **TRANSCO** when the frequency is above 51.5 Hz. The protection settings of the **HVDC** equipment connecting to the **Transmission System** should not violate the frequency limits provided in Clause 6.3.1 Without prejudice to the requirements above, an **HVDC** system shall be capable of automatic disconnection at frequencies specified by **TRANSCO**.
30	Chapter-3, Connection Conditions, Section-6 (TECHNICAL, DESIGN AND OPERATIONAL CRITERIA) Clause 6.3.1		**TRANSCO** and **HVDC USER** may agree on wider frequency ranges or longer minimum times for operation if needed to preserve or to restore system security. If wider frequency ranges or longer minimum times for operation are economically and technically feasible, the **HVDC USER** shall not unreasonably withhold consent. This needs to be defined in the **Connection and Interface Agreement** between **TRANSCO** and the **HVDC USER**, while ensuring that all the Regulations required by the DoE are also met.
31	Chapter-3, Connection Conditions, Section-6 (TECHNICAL, DESIGN AND OPERATIONAL CRITERIA). Subsection 6.1.3.1 (Harmonic Distortion) Pages 68-69	**Harmonic Distortion** The **Electromagnetic Compatibility Levels** for harmonic distortion on the **Transmission System** from all sources under both **Planned Outage** and fault outage conditions, (unless abnormal conditions prevail) shall comply with the levels shown in the tables of Appendix F. Appendix F also contains planning levels which **TRANSCO** will apply to the connection of non-linear load to the **Transmission System**, which may result in harmonic emission limits being specified for these loads in the relevant **Connection Agreement**. **TRANSCO** shall apply planning criteria that will take into account the position of existing and	**Harmonic Distortion** The **Harmonic Voltage Compatibility Level** for harmonic distortion on the **Transmission System** from all sources under both **Planned Outage** and fault outage conditions, (unless abnormal conditions prevail) shall comply with the levels shown in the tables of Appendix F. Appendix F also contains **Harmonic Voltage Planning Level** which **TRANSCO** will apply for the determination of any new **User** apportion to the **Transmission System**, and which may result in harmonic emission limits, both in individual harmonic distortion as well as in **Total Harmonic Distortion** limits, being specified for these loads in the relevant **Connection and Interface Agreement.** A Harmonic Distortion caused by any new **User** will be calculated by **TRANSCO** and specified within **Connection and Interface Agreement**, according to the following equation:

<table>
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<tr><td></td><td></td><td>prospective Users' Plant and Apparatus in relation to harmonic emissions. Users must ensure that connection of distorting loads to their User Systems do not cause any harmonic emission limits specified in the Connection Agreement to be exceeded.</td><td>$$V_{hr}^{h} = \sqrt[\alpha]{(V_{pl}^{h})^{\alpha} - (V_{bg}^{h})^{\alpha}} \times k$$
Where:
V_{hr}^{h} - Max allowed contribution of new User for each harmonic order h
V_{pl}^{h} - the Harmonic Voltage Planning Level for harmonic h
V_{bg}^{h}- the measured background harmonic voltage distortion for harmonic h
k- Allotment factor which depends on number and the size (MVA rating) of Users connecting the electrical vicinity of point of connection and is exclusively under the TRANSCO discretion. TRANSCO will calculate the Allotment factor case by case, taking into consideration a harmonic planning margin.
α- Summation exponent as per the following table
<table><tr><th>Harmonic order</th><th>α</th></tr><tr><td>h<5</td><td>1</td></tr><tr><td>5<h<10</td><td>1.4</td></tr><tr><td>h>10</td><td>2</td></tr></table></td></tr>
<tr><td>32</td><td>Chapter-3, Connection Conditions, Section-6 (Technical, Design and Operational Criteria)
Subsection 6.2 (Plant and Apparatus Relating To User/TRANSCO Connection Site)
Clause 6.2.1
Page 70</td><td>General Requirements
The design of connections between the Transmission System and:
i) any Generating Unit, or
ii) any Distribution or User System
iii) Self-Supply User, or
iv) Non-Embedded Customers equipment;
shall be consistent with the Licence Standards</td><td>General Requirements
The design of connections between the Transmission System and:
i) any Generating Unit, or
ii) AC/DC (HVDC) Converter Station
iii) any Distribution or User System
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shall be consistent with the License Standards</td></tr>
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33	Chapter-3, Connection Conditions, Section-6 (Technical, Design and Operational Criteria) Subsection 6.2 (Plant and Apparatus Relating To User/TRANSCO Connection Site) Clause 6.2.2 GENCO/TRANSCO Connection Points Page 71	Not defined	**System Short Circuit Ratio** Each connection between a **Generating Unit** and the **Transmission System** must be associated with the minimum **System Short Circuit Ratio** at the point of connection as determined by **TRANSCO** and specified within the **Connection and Interface Agreement, or Power (and Water) Purchase Agreement.**
34	Chapter-3, Connection Conditions, Section-6 (Technical, Design and Operational Criteria) Subsection 6.3 (Generating Unit Requirements) Clause 6.3.1 Plant Performance Requirements Page 76	**Plant Performance Requirements** All **Synchronous Generating Units** with an **Apparent Power** rating of less than 1600 MVA must be capable of supplying **Rated MW** at any point between the limits 0.85 **Power Factor** lagging and **0.95 Power Factor** leading at the **Synchronous Generating Unit** terminals. **Synchronous Generating Units** with a rated **Apparent Power** of 1600 MVA or above shall supply rated power at 0.90 **Power Factor** lagging and 0.95 **Power Factor** leading at the **Synchronous Generating Unit** terminals. At **Active Power** output levels other than **Rated MW**, all **Synchronous Generating Units** must be capable of continuous operation at any point between the **Reactive Power** capability limits identified on the **Generator Performance Chart**. The **Short Circuit Ratio** of **Synchronous Generating Units** with an **Apparent Power** rating of less than 1600 MVA shall be not less than 0.5. The **Short Circuit Ratio** of **Synchronous Generating Units** with a rated **Apparent Power** of 1600 MVA or above shall be not less than 0.4. All **Non-Synchronous Generating Units** and **Power Farm Generating Units** must be capable of maintaining zero transfer of **Reactive Power** at the **Transmission Entry Point** at all **Active Power** output levels under steady state voltage conditions. For **Non-Synchronous Generating Units** and **Power Farm Generating Units** the steady state tolerance on **Reactive Power** transfer to and from the **Transmission System** expressed in MVAr shall be no greater than 5% of the **Rated MW**.	**Plant Performance Requirements** **Reactive power Capability** All **Synchronous Generating Units** with an **Apparent Power** rating of less than 1600 MVA must be capable of supplying **Rated MW** at any point between the limits 0.85 **Power Factor** lagging and **0.95 Power Factor** leading at the **Synchronous Generating Unit** terminals. **Synchronous Generating Units** with a rated **Apparent Power** of 1600 MVA or above shall supply rated power at 0.90 **Power Factor** lagging and 0.95 **Power Factor** leading at the **Synchronous Generating Unit** terminals. At **Active Power** output levels other than **Rated MW**, all **Synchronous Generating Units** must be capable of continuous operation at any point between the **Reactive Power** capability limits identified on the **Generator Performance Chart**. The **Short Circuit Ratio** of **Synchronous Generating Units** with an **Apparent Power** rating of less than 1600 MVA shall be not less than 0.5. The **Short Circuit Ratio** of **Synchronous Generating Units** with a rated **Apparent Power** of 1600 MVA or above shall be not less than 0.4. The **Power Park Module** as well as **Battery Storage** which is connected with the **System** through the **AC/DC converter station and HVDC** systems connected to **TRANCSO** AC system shall comply with the following plant performance requirements: ▪ The **Power Park Module, HVDC systems** as well as **Battery Storage** must be capable of maintaining zero transfer of **Reactive Power** at the **Transmission Entry Point** at all **Active Power** output levels under steady state voltage conditions. The steady state tolerance on **Reactive Power** transfer to and from the **Transmission System** expressed in MVAr shall be no greater than 5% of the Rated MW.

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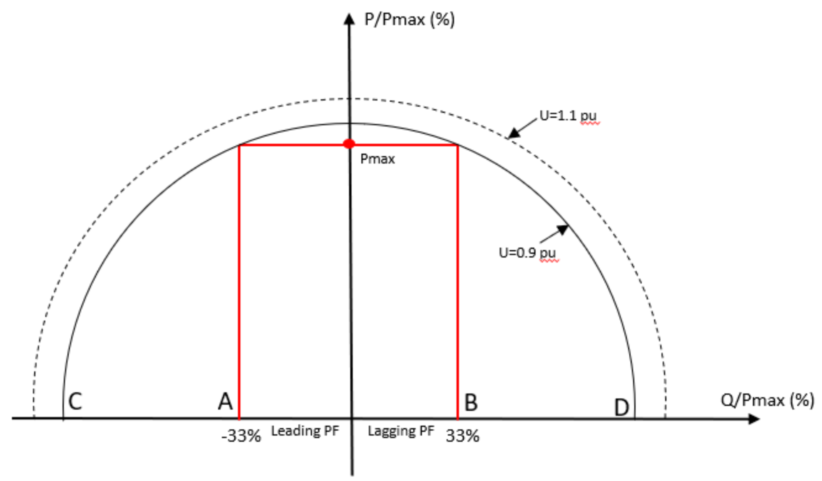
		All **Non-Synchronous Generating Units** and **Power Farm Generating Units** must be capable of supplying **Rated MW** output between the limits 0.95 **Power Factor** lagging and 0.95 **Power Factor** leading at the **Transmission Entry Point** (or **User System Entry Point,** if **Embedded**) subject to the paragraphs below and Figure 6.1. With all **Plant** in service, the **Reactive Power** limits defined at **Rated MW** at lagging **Power Factor** will apply at all **Active Power** output levels above 20% of the **Rated MW** as defined in **Figure 6.1**. With all Plant in service, the **Reactive Power** limits defined at **Rated MW** at leading **Power Factor** will apply at all **Active Power** output levels above 50% of the **Rated MW** output as defined in Figure 6.1. With all **Plant** in service, the **Reactive Power** limits will reduce linearly below 50% **Active Power** output as shown in Figure 6.1 unless the requirement to maintain the **Reactive Power** limits defined at **Rated MW** at leading **Power Factor** down to 20% **Active Power** output is specified in the Bilateral Agreement. These **Reactive Power** limits will be reduced pro rata to the amount of **Plant** in service. For the avoidance of doubt, all **Non-Synchronous Generating Units** and **Power Farm Generating Units** must be capable of providing, as a minimum, **Reactive Power** as defined in the "V" characteristic of Figure 6.1 bordered by the 0.95 leading and lagging **Power Factor** lines. Where the **Non-Synchronous Generating Units** and **Power Farm Generating Units** have an inherent capability to provide **Reactive Power** in accordance with the quadrilateral characteristic or TRANSCO has a system requirement for the **Non-Synchronous Generating Units** and **Power Farm Generating Units** to provide **Reactive Power** in accordance with the quadrilateral characteristic, TRANSCO will notify the **User** of this requirement and it shall be formalised in the in the Bilateral Agreement.	▪ The **Power Park Module, HVDC systems** as well as **Battery Storage** must allow the reactive power utilisation to the greatest possible extent, but at least as per P-Q capability diagram presented in Figure xxx2 where the **Reactive Power** capability at the **Transmission Entry Point** shall not be less than the ±33% of the rated power (that corresponds to the power factor of 0.95 leading/lagging) at: – Any level of **Active Power** output, including zero **Active Power** level – Any voltage at the connection point within the limits 0.9-1.1 p.u  **Figure xxx2: P-Q capability of the Non-synchronous Power Park Module and uni-directional HVDC** • Point A is equivalent to leading 0.95 **Power Factor** at Rated MW output • Point B is equivalent to lagging 0.95 **Power Factor** at rated MW output • Point C represents theoretical inverter limit (leading) at zero MW output • Point D represents theoretical inverter limit (lagging) at zero MW output (capability between A and C and between B and D may be required in separate bilateral agreement depend on the internal constraints, but it does not belong to standard capabilities) ▪ The **Battery Storage** must allow the reactive power utilisation to the greatest possible extent, but at least as per P-Q capability diagram presented in Figure xxx3. This maybe applicable to **HVDC systems** connecting two systems and required to be capable of bi-directional power flow.

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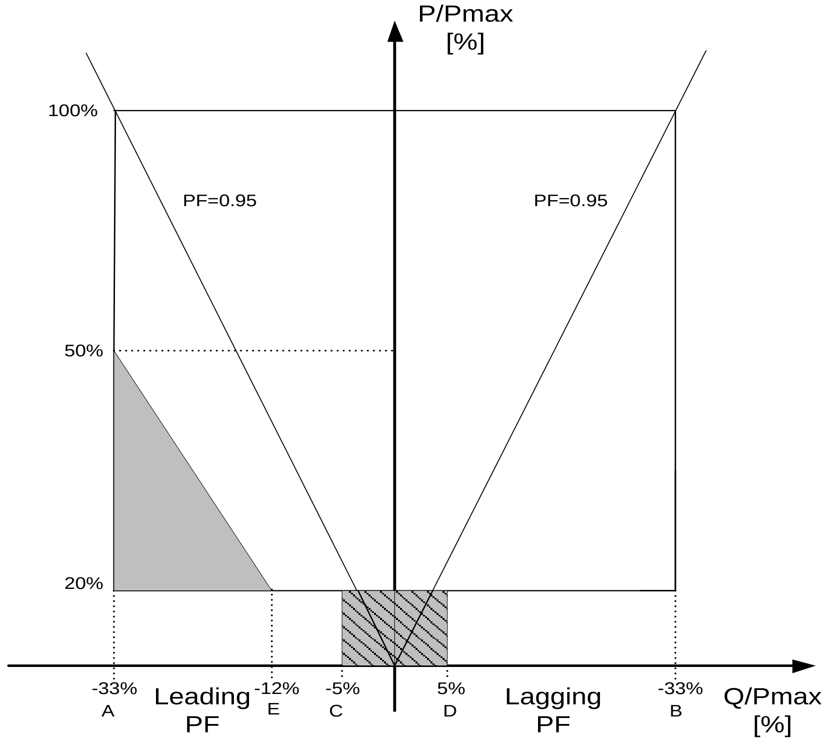
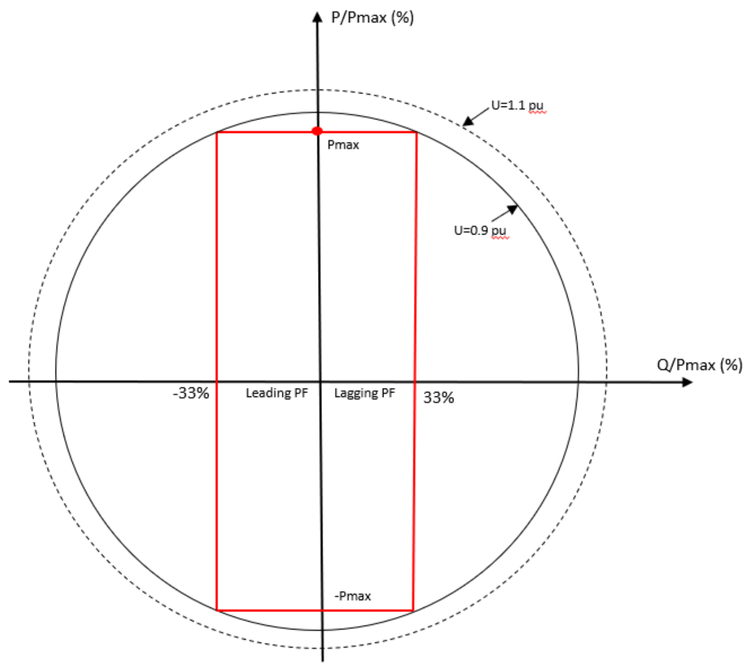
		 **Figure 6.1** Point A is equivalent (in MVAr) to: 0.95 leading **Power Factor** at **Rated MW** output Point B is equivalent (in MVAr) to: 0.95 lagging **Power Factor** at **Rated MW** output Point C is equivalent (in MVAr) to: -5% of **Rated MW** output Point D is equivalent (in MVAr) to +5% of **Rated MW** Point E is equivalent (in MVAr) to: -12% of **Rated MW** output Following frequency requirements are to be applicable for **Generating Units:** ……………… In respect to time constraints, intermittent source **Generating Units** are required to operate continuously within the range 47 – 53 Hz. When the **System Frequency** is within the range 47.00 Hz to 49.00 Hz and only for a **Generating Unit** which uses an **Intermittent Power Source**, the power output should not decrease by more than 5% of **Active Power** output (*compared to the **Active Power** output at 50.00 Hz).*	 Figure xxx3: P-Q capability of the Battery Storage and Bi-directional HVDC systems If the **Power Park Module, HVDC** or the **Battery Storage** is not capable of the level of performance established under previous paragraph, **Power Park Module, HVDC** as well as **Battery Storage** must install additional equipment connecting at the connection point, to provide the deficit of **Reactive Power** (supply and absorption), and such equipment is deemed to be part of the **Power Park Module**, **HVDC system** or **Battery Storage** System. The **HVDC USER** shall ensure that the **Reactive Power** of its **HVDC** converter station exchanged with the **Transmission System** at the **Connection point** is limited to the values specified by **TRANSCO**. The **Reactive Power** variation caused by the **Reactive Power** control operation mode of the **HVDC** system, shall not result in a voltage step exceeding the allowed value at the **Connection point**. **TRANSCO** shall specify this maximum tolerable voltage step value. Any exemption to the **Reactive Power** capability shall be agreed between **TRANCSO** and the **USER** and stated in a separate bilateral agreement. Following frequency requirements are to be applicable for **Generating Units:** ……………… In respect to time constraints, intermittent source **Generating Units** are required to operate continuously within the range 47 – 53 Hz. When the **System Frequency** is within the range 47.00 Hz to 49.00 Hz and only

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			for a **Generating Unit** of **Power Park Module**, the power output should not decrease by more than 5% of **Active Power** output (*compared to the **Active Power** output at 50.00 Hz).*
35	Chapter-3, Connection Conditions, Section-6 (Technical, Design and Operational Criteria) Subsection 6.3 (Generating Unit Requirements) Clause 6.3.1 Plant Performance Requirements, page 81	It is an essential requirement that the **Transmission System** must incorporate a **Black Start Capability**. This shall be achieved by agreeing a **Black Start Capability** at a number of strategically located **Power Stations**. For each **Power Station TRANSCO** shall state in the **Connection Agreement** whether or not a **Black Start Capability** is required.	**Black Start** It is an essential requirement that the **Transmission System** must incorporate a **Black Start Capability**. This shall be achieved by agreeing a **Black Start Capability** at a number of strategically located **Power Stations**. For each **Power Station TRANSCO** shall state in the **Connection Agreement** whether or not a **Black Start Capability** is required. **Black start** is not a mandatory service. If any **Generating Unit** (including non-synchronous) is able to provide **Black Start** service and wish to offer that service to the System operator, it will be specified within the **Power (and Water) Purchase Agreement** or **Ancillary Service** Agreement or any other Agreement. The following requirements shall apply: - **Generating unit** shall be capable of starting from shutdown without any external electrical energy supply within a time frame specified by **TRANSCO**. - **Generating unit** shall be able to synchronise within the frequency and voltage limits defined in ETC. - **Generating unit** shall be capable of automatically regulating dips in voltage caused by connection of demand. - **Generating unit** shall be capable of operating in **Normal Frequency Sensitive** mode. - **Generating unit** shall be capable of parallel operation of a few **Generating units** (including non-synchronous) within an isolated part of the **Total System**.
36	Chapter-3, Connection Conditions, Section-6 (Technical, Design and Operational Criteria) Subsection 6.3 (Generating Unit Requirements) Clause 6.3.1 Plant Performance Requirements Page 80	Not defined	All synchronous **Generating Units** shall be capable of withstanding any Rate Of Change Of Frequency up to 1 Hz/s without disconnection from the network The rate of change of frequency shall be measured over a sliding 500ms time period. All **Power Park Modules, HVDC** as well as **Battery Storages** shall be capable of withstanding any Rate Of Change Of Frequency up to 2.5 Hz/s without disconnection from the network. The rate of change of frequency shall be measured over a sliding 500ms time period. The requirements stated in Clause 6.3.1 above is the minimum requirement and **TRANSCO** may list additional requirements for specific connections if system studies indicate a need. Such requirements shall be specified in a **Connection and Interface Agreement** or **Power Purchase Agreement (PPA).**

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37	Chapter-3, Connection Conditions, Section-6 (Technical, Design and Operational Criteria) Subsection 6.3 (Generating Unit Requirements) Clause 6.3.2 Control Arrangements Page 82	**Control Arrangements** Each **Generating Unit ,** other than the **Steam Unit** within a **CCGT Module** where the steam turbine does not contribute initially to a system frequency change**,** must be capable of contributing to **Primary Control** by supplying **Active Power** to the **Transmission System** or the **Distribution** or **User System** if **Embedded** according to its **Primary and Secondary Response** capabilities as set out in the **Power and Water Purchase Agreement** or the **Connection Agreement**. The capability for contributing to **Secondary Control** (**AGC** and **LFC**) shall be as set out in the **Power and Water Purchase Agreement** or the **Connection Agreement**. The required participation shall be determined by **TRANSCO**.	**Control Arrangements** Each **Generating Unit** (including **Power Park Module, HVDC** and **Battery Storage**)**,** other than the **Steam Unit** within a **CCGT Module** where the steam turbine does not contribute initially to a system frequency change**,** must be capable of contributing to **Primary Control** by supplying **Active Power** to the **Transmission System** or the **Distribution** or **User System** if **Embedded** according to its **Primary and Secondary Response** capabilities as set out in the **Power and Water Purchase Agreement** or the **Connection and Interface Agreement**. The capability of **Generating Units** (including **Power Park Module), HVDC** and **Battery Storage** for contributing to **Secondary Control** (**AGC** and **LFC**) shall be as set out in the **Power and Water Purchase Agreement** or the **Connection and Interface Agreement**. The required participation shall be determined by **TRANSCO**.
38	Chapter-3, Connection Conditions, Section-6 (Technical, Design and Operational Criteria) Subsection 6.3 (Generating Unit Requirements) Clause 6.3.2.1 Generating Unit to have a Unit Controller Page 82	**Generating Unit to have a Unit Controller** Each **Generating Unit** must be fitted with a fast acting **Unit Controller** or equivalent control device capable of providing **Frequency** response under normal operational conditions in accordance with the Scheduling and Despatch Code. The control principle shall be in such a way that the **Generation Unit** output shall vary with rotational speed or frequency according to a proportional droop characteristic (**Primary Control**). The **Unit Controller** and any other superimposed control loop **(Load Control**, gas turbine temperature limiting control, etc.) shall contribute to the **Primary Control** according to the **Primary Response Performance Index** as set out in the **Power and Water Purchase Agreement** or the **Connection Conditions**. In the case of a **Power Farm** the **Unit Controller** or equivalent control device(s) may be on the whole **Power Farm** or on each individual Generating Unit **AC/DC Converter**. **Power Farm** units will only be expected to deliver response as per their **Power Purchase Agreement**. Superimposed **Load Control** loops shall have no negative impact on the steady state and transient performance of the **Unit Controller**.	**Generating Unit to have a Unit Controller** Each **Generating Unit** must be fitted with a fast acting **Unit Controller** or equivalent control device capable of providing **Frequency** response under normal operational conditions in accordance with the Scheduling and Despatch Code. The control principle shall be in such a way that the **Generation Unit** output shall vary with rotational speed or frequency according to a proportional droop characteristic (**Primary Control**). **Synchronous Generating Units** The **Unit Controller** and any other superimposed control loop **(Load Control**, gas turbine temperature limiting control, etc.) shall contribute to the **Primary Control** according to the **Primary Response Performance Index** as set out in the **Power and Water Purchase Agreement** or the **Connection Conditions**. Superimposed **Load Control** loops shall have no negative impact on the steady state and transient performance of the **Unit Controller**. The **Unit Controller** shall be sufficiently damped for both isolated and interconnected operation modes. Under all operation conditions, the damping coefficient of the **Unit Controller** shall be above 0.25 for speed droop settings above 3% for gas turbines and 5% for steam turbines. In the case of all **Generating Units** the **Frequency Control** device (or speed governor) deadband should be no greater than 0.04Hz (for the avoidance of doubt, ±0.02Hz). Under all system operation conditions, the **Synchronous Generating Unit** speed shall not exceed 106%.

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		The **Unit Controller** shall be sufficiently damped for both isolated and interconnected operation modes. Under all operation conditions, the damping coefficient of the **Unit Controller** shall be above 0.25 for speed droop settings above 3% for gas turbines and 5% for steam turbines. In the case of a **Power Farm** the speed droop should be equivalent of a fixed setting between 3% and 5% applied to each **WTGU** or **PVGU** in service. In the case of all **Generating Units** the **Frequency Control** device (or speed governor) deadband should be no greater than 0.04Hz (for the avoidance of doubt, ±0.02Hz). Under all system operation conditions, the **Synchronous Generating Unit** speed shall not exceed 106%. For generator oscillations with frequencies below 2 Hz, the Unit Load **Controller** shall have no negative effect on generator oscillation damping. The **Normalized Primary Response Characteristic** as defined by the **Primary Response Performance Index** shall be maintained under all operation conditions. Consequently, in the event that a **Generating Unit** becomes isolated from the System but is still supplying **Demand** the **Generating Unit** must be able to provide **Primary Control** according to the **Primary Response Performance Index**. All steam turbine **Generating Units** must be fitted with a **Unit Controller** which is designed and operated to the requirements of **IEC** 45. All Gas Turbine Units must be fitted with a **Unit Controller** capable of a power related speed droop characteristic of between 3% and 5%.	For generator oscillations with frequencies below 2 Hz, the Unit Load **Controller** shall have no negative effect on generator oscillation damping. The **Normalized Primary Response Characteristic** as defined by the **Primary Response Performance Index** shall be maintained under all operation conditions. Consequently, in the event that a **Generating Unit** becomes isolated from the System but is still supplying **Demand** the **Generating Unit** must be able to provide **Primary Control** according to the **Primary Response Performance Index**. All steam turbine **Generating Units** must be fitted with a **Unit Controller** which is designed and operated to the requirements of **IEC** 45. All Gas Turbine Units must be fitted with a **Unit Controller** capable of a power related speed droop characteristic of between 3% and 5%. **Non-synchronous Generating Units** A **Unit Controller** of each **Power Park Module or HVDC** must be capable of providing frequency response under the following modes: - **Normal Frequency Sensitive Mode** - **Limited Frequency Sensitive Mode - Over frequency** - **Limited Frequency Sensitive Mode - Under frequency** The **Unit Controller** or equivalent control device(s) may be on the **Power Park Module** or on each individual **AC/DC converter**. **Power Park Module or HVDC** will only be expected to deliver response as per their **Power Purchase Agreement**. A **Unit Controller** of each **Battery Storage** must be capable of providing frequency response under the **Normal Frequency Sensitive Mode.** The following shall apply for **Power Park Module, HVDC** (see Figure xxx4) and/or **Battery Storage** (see Figure xxx5) operating in **Normal Frequency Sensitive Mode**: - A **Frequency Deadband** of no greater than +/- 20mHz may be applied. The design, implementation and operation of the **Frequency Deadband** shall be agreed with the system operator prior to the **Commissioning.** - The **Active Power Frequency Response** shall be capable of having a **Governor Droop** between 3% and 5%. - In response to low frequency events, **Power Park Module, HVDC** and/or **Battery Storage** shall be capable of providing a power increase up to **Available Active Power**. Stable operation in response to low frequency events shall be ensured.

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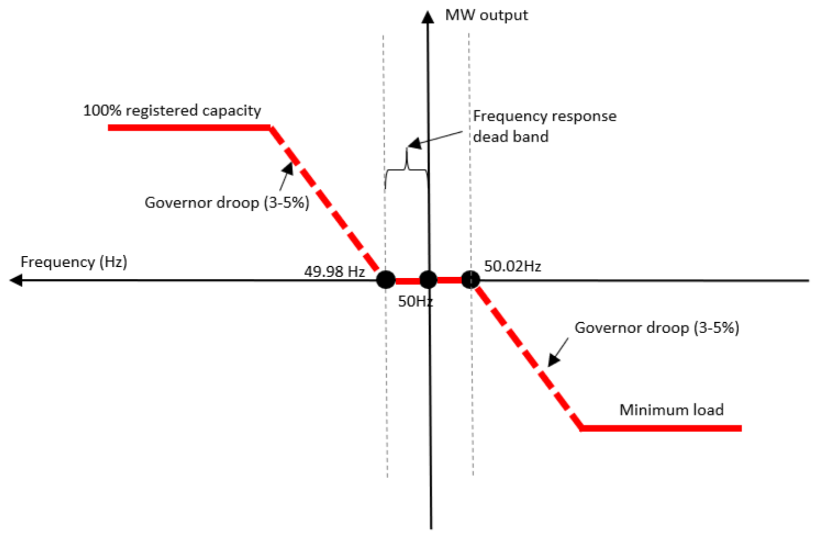
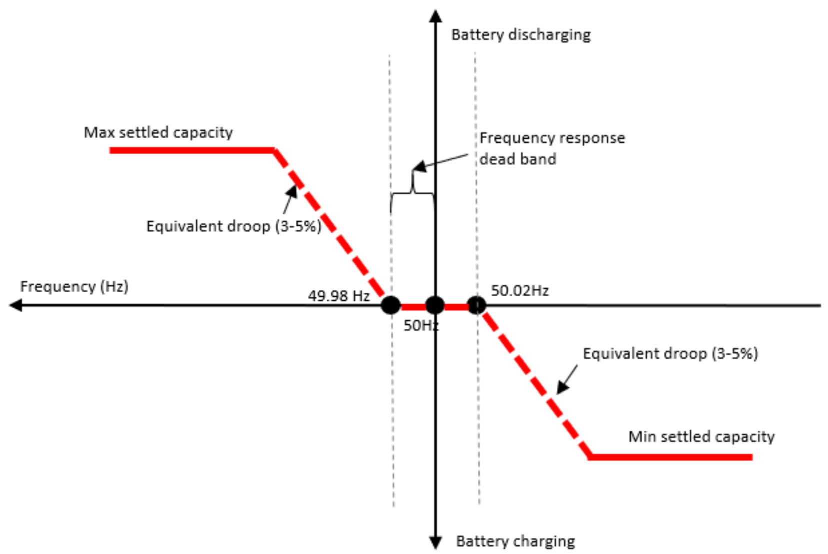
			 **Figure xxx4: Normal Frequency Sensitive Mode**  **Figure xxx5: Normal Frequency Sensitive Mode for Battery Storage** The following shall apply for **Power Park Module** or **HVDC** operating in **Limited Frequency Sensitive Mode – Over Frequency** (see Figure xxx6): - **Power Park Module** or **HVDC** shall be capable of providing **Active Power Frequency Response** when the **Transmission System Frequency** rises to or above threshold which should be set in range 50.2 – 50.5 Hz.

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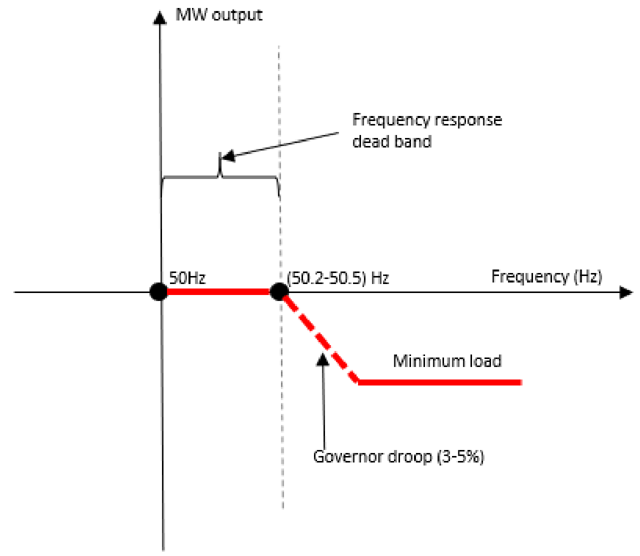
			- The **Active Power Frequency Response** shall be capable of having a **Governor Droop** between 3% and 5%. - **Power Park Module** or **HVDC** shall be capable of providing a power decrease down to **Minimum Load**. Stable operation shall be ensured. - **Power Park Module** or **HVDC** shall be capable of continuous stable operation when **MW Output** is reduced to **Minimum Load**. This response will prevail over any other **Active Power** control mode.  **Figure xxx6: Limited Frequency Sensitive Mode – Over Frequency** The following shall apply for **Power Park Module** or **HVDC** operating in **Limited Frequency Sensitive Mode – Under Frequency** (see Figure xxx7): - The mode should be activated under curtailed conditions (solar and/or wind). - **Power Park Module** or **HVDC** shall be capable of providing **Active Power Frequency Response** when the **System Frequency** falls to or below the threshold which should be set in range 49.5 – 49.98 Hz. - A **Frequency Deadband** of no greater than +/- 20mHz may be applied. The design, implementation and operation of the **Frequency Deadband** shall be agreed with the **TSO** prior to the **Commissioning.** - The **Active Power Frequency Response** shall be capable of having a **Governor Droop** between 3% and 5%. - **Power Park Module** or **HVDC** shall be capable of providing a power increase up to **Available Active Power**. Stable operation shall be ensured.

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			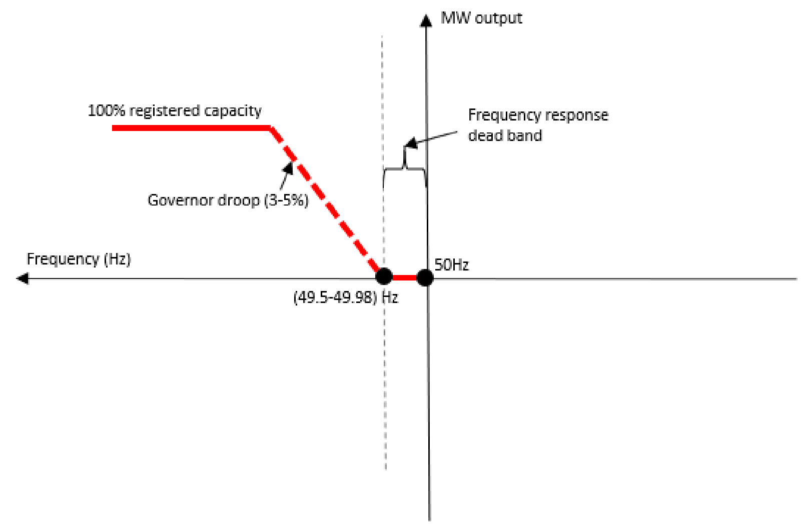 **Figure xxx7: Limited Frequency Sensitive Mode – Under Frequency** **Power Park Module, HVDC** and/or **Battery Storage** must ensure that: • The connection of the **Power Park Module, HVDC** and/or **Battery Storage** system shall not negatively impact the operation of other dynamic devices in its close vicinity. The stable operation shall be demonstrated through appropriate RMS (ex. PSS®E) and electromagnetic-transients-type (EMT) (ex. PSCAD/EMTDC) simulation tools. • The connection of the **Power Park Module, HVDC** and/or **Battery Storage** system shall not lead to unstable or poorly damped system conditions (commonly referred to as control interactions). • The connection of the **HVDC system** shall not result in transient and temporary over voltages that will impact existing generation, transmission and distribution equipment. • The connection of the **Power Park Module**, **HVDC** and/or **Battery Storage** shall not adversely impact the torsional oscillations (sub-synchronous torsional oscillations and interactions (SSO/SSTI). Regarding the sub-synchronous torsional interaction (SSTI) damping control, the **HVDC system** shall be capable of contributing to electrical damping at torsional oscillation frequencies. The SSTI studies shall be undertaken by the **HVDC USER**. The studies shall identify the conditions, if any, where SSTI exists and propose any necessary mitigation measures. Any necessary mitigating actions identified by the studies shall be reviewed by **TRANSCO**. The mitigating actions shall be undertaken by the **USER** as part of the connection of the new **HVDC system** or the **Power Park Module**. The **USER** shall provide all relevant data and models that allow such study to be performed to **TRANSCO**.

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			• The **Power Park Module, HVDC** and/or **Battery Storage** controls shall be equipped with inputs that can be used to facilitate power oscillation damping (POD) and sub-synchronous torsional interaction (SSTI) damping. Any other identified additional control facilities for oscillation damping shall be required by **TRANSCO** and shall be specified within **Connection and Interface Agreement.**
39	Chapter-3, Connection Conditions, Section-6 (Technical, Design and Operational Criteria) Subsection 6.3 (Generating Unit Requirements) Clause 6.3.2.2 Page 86	Not defined	**Ramping Control – Power Park Modules** The **Power Park Module** shall be capable of controlling the ramp rate of its **Active Power** output. There shall be three ramp rate capabilities**:** **1) Resource Following Ramp Rate** **2) Set-Point Ramp Rate** **3) Frequency Response Ramp Rate** The **Resource Following Ramp Rate** shall be used during Start-Up and normal operation. The **Set-Point Ramp Rate** shall be used for active power control during **AGC** control process**.** The **Resource Following Ramp Rate** and the **Set-Point Ramp Rate** shall be set each independently over a range up to 10% of registered capacity per minute**.** The **Frequency Response Ramp Rate** shall be the maximum possible ramp rate of the **Power Park Module** agreed with the **TRANSCO.** The **Power Park Module** shall operate the ramp rates with the following order of priority (high to low): **Frequency Response Ramp Rate**; **Set-Point Ramp Rate**; **Resource Following Ramp Rate.** The **Battery Storage** shall be capable of controlling the ramp rate of its **Active Power** output. There shall be three ramp rate capabilities**:** **1) Set-Point Ramp Rate** **2) Frequency Response Ramp Rate** 3) **Compensating Ramp Rate** The **Compensating Ramp Rate** may be used to reduce the impact **Active Power** ramps of the **Power Park Modules** The ramp rate settings may need to be changed from time to time depending on system needs. The **TRANSCO** shall give a prior notice, if change is required.

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			Ramping Control - HVDC Systems An **HVDC** system shall be capable of adjusting the ramping rate of **Active Power** variations within its technical capabilities in accordance with instructions sent by **HVDC USER** (or as requested by **TRANSCO**). In cases where fast modification of **Active Power** required (according to points (b) and (c) of paragraph below), this should supersede the ramp rate set for normal operation. a. An **HVDC System** shall be capable of adjusting the transmitted **Active Power** up to its maximum **HVDC** active power transmission capacity in each direction following an instruction from **TRANSCO**: • Shall specify a maximum and minimum power step size for adjusting the transmitted **Active Power**. This is determined based on system requirements (to maintain system security and stability), and **HVDC USER** shall comply with the request within the power ramping capacity of the **HVDC** system. • Shall specify a minimum **HVDC Active Power** transmission capacity for each direction, below which active power transmission capability is not requested. • Shall specify the maximum delay within which the **HVDC** system shall be capable of activating the adjustment of the transmitted **Active Power** upon receipt of request from **TRANSCO**. This delay shall not exceed 100 ms. b. **TRANSCO** shall specify how an **HVDC** system shall be capable of modifying the transmitted **Active Power** infeed in case of disturbances into one or more of the AC networks to which it is connected. If the initial delay prior to the start of the change is greater than 100 milliseconds from receiving the triggering signal sent by **TRANSCO**, it shall be reasonably justified by the **HVDC USER** to **TRANSCO**. c. **TRANSCO** may specify that an **HVDC** system be capable of fast **Active Power** reversal. The power reversal shall be possible from the maximum **Active Power** transmission capacity in one direction to the maximum **Active Power** transmission capacity in the other direction as fast as technically feasible. If the power reversal duration is greater than 2 seconds, **HVDC USER** shall demonstrate and obtain approval from the **TRANSCO** that longer power reversal times are required due to technical considerations. d. The **HVDC** system shall be equipped with control functions to support system **Frequency Control**. Upon receiving a signal, the **HVDC** system shall be capable of modulating the power output within 100 ms.

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			e. As applicable, the **HVDC** system shall be equipped with control functions enabling the **HVDC USER** (upon request from **TRANSCO**) to modify the transmitted **Active Power** for the purpose of cross-border balancing. If specified by **TRANSCO**, the control functions of an **HVDC system** shall be capable of taking remedial action including, but not limited to, stopping the ramping and blocking **FSM**, **LFSM-O**, **LFSM-U** and **Frequency Control**. The triggering and blocking criteria shall be specified by **TRANSCO**. The modalities of that notification shall be determined and agreed between the **HVDC USER** and **TRANSCO**. **Operational Robustness** The **HVDC** system, shall be capable of finding stable operation points with a minimum change in **Active Power** flow and voltage level, during and after any planned or unplanned change in the **HVDC** system or AC **Transmission System** to which it is connected. The **HVDC USER** shall ensure that the tripping or disconnection of an **HVDC** converter station, as part of any multi-terminal or embedded **HVDC** system, does not result in transients at the connection point beyond the limit specified by **TRANSCO**. The **HVDC** system shall withstand transient faults on HVAC lines in the network adjacent or close to the **HVDC system**. Such events shall not cause any of the equipment in the **HVDC system** to disconnect due to auto-reclosing of lines in the network. **Automatic Generation Control (AGC)** An **HVDC** System shall be designed to accept ramp up and ramp down signals from **AGC** controllers. The ramp rates shall be adjustable in a range specified by **TRANSCO** (determined based on system requirements and values specified within the technical capability of the **HVDC** system). An **HVDC** system shall be designed in such a way that its loss of **Active Power** injection in a synchronous area shall be limited to a value specified by **TRANSCO** for their respective load frequency control area, based on the **HVDC** system's impact on the **Power System**. Where an **HVDC** system connects two or more control areas, **TRANSCO** shall set a coordinated value of the maximum loss of **Active Power**, taking into account requirements for interconnected operation of the areas.

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S.N	Code Reference Chapter/Section/Page	Statement per the Code (ETC ver.2 Rev.2 dated 30 June 2020)	Proposed Amendment/New Statement
40	Chapter-3, Connection Conditions, Section-6 (Technical, Design and Operational Criteria) Subsection 6.3 (Generating Unit Requirements) Clause 6.3.2.2 Page 87	Not defined	**Synthetic Inertia** **Power Park Module and/or Battery Storage** being inherently incapable of contributing to the system inertia, may be required to provide **Synthetic Inertia** by supplying additional **Active Power** to the system in order to limit the Rate Of Change Of Frequency (RoCof) following the sudden system imbalance. A specific control setting, response characteristics, maximum response level will be specified within **Connection and Interface Agreement** or **Power Purchase Agreement** and justified with an appropriate study. If identified by **TRANSCO** as a requirement, the **HVDC** system shall be capable of providing **Synthetic Inertia** in response to frequency changes by rapidly adjusting the **Active Power** injected to or withdrawn from the AC network in order to limit the Rate Of Change Of Frequency.
41	Chapter-3, Connection Conditions, Section-6 (Technical, Design and Operational Criteria) Subsection 6.3 (Generating Unit Requirements) Clause 6.3.2 Control Arrangements Page 87	**Automatic Voltage Regulator** A continuous **Automatic Voltage Regulator** (**AVR**) acting on the excitation system is required to provide constant terminal voltage control of the **Synchronous Generating Unit** without instability over the entire operating range of the **Generating Unit**. Control performance of the voltage control loop shall be such that under isolated operation conditions the damping coefficient shall be above 0.25 for the entire operating range. The **Automatic Voltage Regulator (AVR)** shall have no negative impact on generator oscillation damping. In the case of a **Power Farm Generating Unit**, a continuously acting automatic control system is required to provide control of the voltage at the **Connection Point** without instability over the entire operating range of the **Power Farm** or **Generating Unit**. Any **Plant** or **Apparatus** used in the provision of such voltage control within a **Power Farm** may be located at the **WTGU** or **PVGU** terminals, an appropriate intermediate busbar or the **Connection Point**. When operating below 20% **Rated MW** the automatic control system may continue to provide voltage control utilising any available reactive capability The specific requirements for automatic excitation control facilities, including **Power System Stabilizers** where these are necessary for system reasons, shall be specified in the **Power and Water Purchase Agreement** or the **Connection and Interface**	**Automatic Voltage Regulator** A continuous **Automatic Voltage Regulator** (**AVR**) acting on the excitation system is required to provide constant terminal voltage control of the **Synchronous Generating Unit** without instability over the entire operating range of the **Generating Unit**. Control performance of the voltage control loop shall be such that under isolated operation conditions the damping coefficient shall be above 0.25 for the entire operating range. The **Automatic Voltage Regulator (AVR)** shall have no negative impact on generator oscillation damping. **Power Park Modules, HVDC** as well as **Battery Storages** shall be capable of providing automatic voltage control at the connection point by following control modes in normal operation: - **voltage control mode**, when the **Power Park Module, HVDC** or **Battery Storage** shall be capable of receiving the voltage setpoint within the range specified in clause 6.1.2 of the **ETC** (chapter 3) in steps no greater than 0.01 pu. Voltage control is ensured by continuous modulation of the **Reactive Power** output with the speed of response specified in **Connection and Interface Agreement** or any other Agreement. Voltage Regulation Set-point shall be operated with a deadband selectable in a range from zero to ±5% of reference 1 p.u. **Transmission System**.

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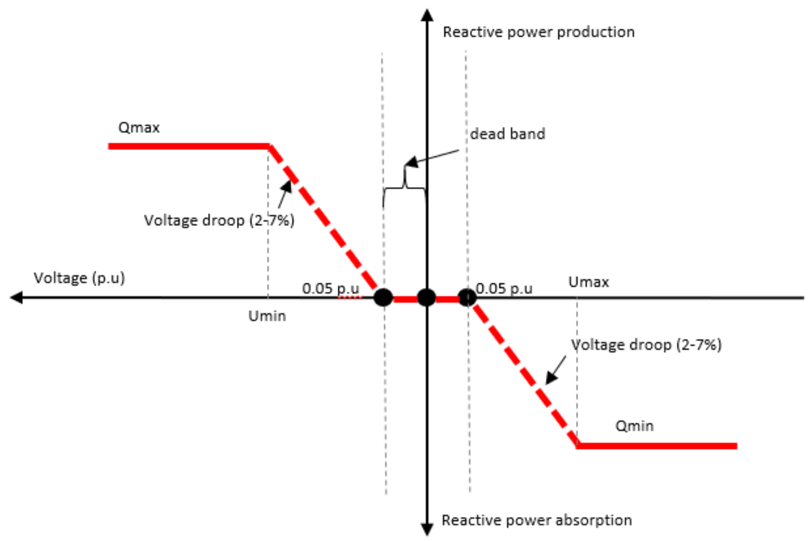
		Agreement. Operation of such control facilities shall be in accordance with the **Scheduling and Despatch Code**.	 **Figure xxx 8– Voltage control slope** - **reactive power control mode** when the **Power Park Module, HVDC** or **Battery Storage** shall be capable of receiving the **Reactive Power** setpoint anywhere in the reactive power range specified in clause 6.3.1 of the **ETC** (chapter 3), with setting steps no greater than 5 Mvar or 5 % (whichever is smaller) of maximum **Reactive Power**, controlling the **Reactive Power** at the Transmission Entry Point to an accuracy within ± 5 Mvar or ± 5 % (whichever is smaller) of the maximum **Reactive Power.** - **power factor control mode** when the **Power Park Module, HVDC** or **Battery Storage** shall be capable of receiving the **Power Factor** setpoint anywhere inside the mandatory or agreed **Reactive Power** capability region with setting steps no greater than 0.01 pu. The **Power Factor** shall be maintained within a tolerance of ± 0.5 %. The tolerance will be measured with reference to the maximum **Reactive Power** at the **Connection Point.** TRANSCO (i.e. System Operator) shall specify which of the above three control modes and associated setpoints is to apply. Any change of the control mode and the set point shall be implemented by the **Power Park Module, HVDC** or **Battery Storage** upon receipt of the appropriate signal from the **TRANSCO.** The specific requirements for automatic excitation control facilities, including **Power System Stabilizers** **(**Power Oscillation Damping controls**),** where these are necessary for system reasons, shall be specified in the **Power and Water Purchase Agreement** or the **Connection and Interface Agreement.** Operation of such control facilities shall be in accordance with the **Scheduling and Despatch Code.**

Addendum-2

Electricity Transmission Code (ver2, rev. 2 dated 30 June 2020) - Update to include Large Renewables and HVDC Requirements

Issue Date: 31 May 2021

Approved by Department of Energy

<table>
<tr><th>S.N</th><th>Code Reference Chapter/Section/Page</th><th>Statement per the Code (ETC ver.2 Rev.2 dated 30 June 2020)</th><th>Proposed Amendment/New Statement</th></tr>
<tr>
<td>42</td>
<td>Chapter-3, Connection Conditions, Section-6 (Technical, Design and Operational Criteria)

Subsection 6.3 (Generating Unit Requirements)

Clause 6.3.7 Fault Ride Through

Pages 89-90</td>
<td>Fault Ride Through

The following Fault Ride Through requirements are applicable to Generating Units (including for the avoidance of doubt WFPS, PVPS and AC/DC Converters):
i) During a 3 phase fault at 132, 220 or 400kV for 140msec the Generating Unit shall:
(a) Remain transiently stable and connected for all transmission phase voltages down to a minimum of zero;
(b) Generate the maximum possible reactive current without exceeding the transient rating limit of the Generating Unit; and
(c) Within 0.5 second following fault clearance and restoration of the transmission voltage to at least 90% of nominal, the Active Power output shall be restored to at least 90% of the level immediately available before the fault.

ii) In addition for voltage dips greater than 140msec in the vicinity of the Generating Unit, the Unit shall:
(a) Remain connected to the system for any dip-duration on or above the blue line of Figure 2 below;
(b) Supply active power to at least 90% of its pre-fault value within 1 second of restoration of the voltage to 90% of the nominal; and
(c) Retain Active Power output at least in proportion to the retained balanced transmission voltage.

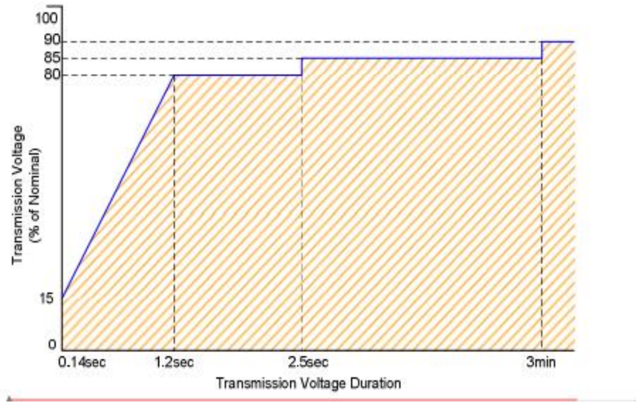


Figure 6.2. Voltage Duration Envelope</td>
<td>Fault Ride Through

The following Fault Ride Through requirements are applicable to Generating Units (including for the avoidance of doubt WTGU, PVGU, Battery Storages and AC/DC (HVDC) Converters):
(i) During a 3 phase fault at 132, 220 or 400kV for 140msec the Generating Unit shall:
(a) Remain transiently stable and connected for all transmission phase voltages down to a minimum of zero;
(b) Generate the maximum possible reactive current without exceeding the transient rating limit of the Generating Unit; and
(c) Within 0.5 second following fault clearance and restoration of the transmission voltage to at least 90% of nominal, the Active Power output shall be restored to at least 90% of the level immediately available before the fault.

(ii) In addition for voltage dips greater than 140msec in the vicinity of the Synchronous Generating Unit, the Unit shall:
(a) Remain connected to the system for any dip-duration on or above the blue line of Figure xxx9 below;
(b) Supply Active Power to at least 90% of its pre-fault value within 1 second of restoration of the voltage to 90% of the nominal; and
(c) Retain Active Power output at least in proportion to the retained balanced transmission voltage.

(iii) In addition for voltage dips greater than 140msec in the vicinity of the Power Park Module, HVDC, and/or Battery Storage, the Power Park Module, HVDC and Battery Storage shall:
a) Remain connected to the system for any dip-duration on or above the red dotted line of Figure xxx9 below;
b) Supply Active Power to at least 90% of its pre-fault value within 1 second of restoration of the voltage to 90% of the nominal; and
c) Inject the reactive current as fast as possible in proportion to the voltage dip or otherwise agreed with TRANSCO under the Connection and Interface Agreement.
d) Assign the priority to reactive current injection over the active current
e) Retain Active Power output to the extent of the remaining transient rated capacity after the Reactive Power is utilised.
f) be capable of providing its transient reactive response irrespective of the control mode in which</td>
</tr>
</table>

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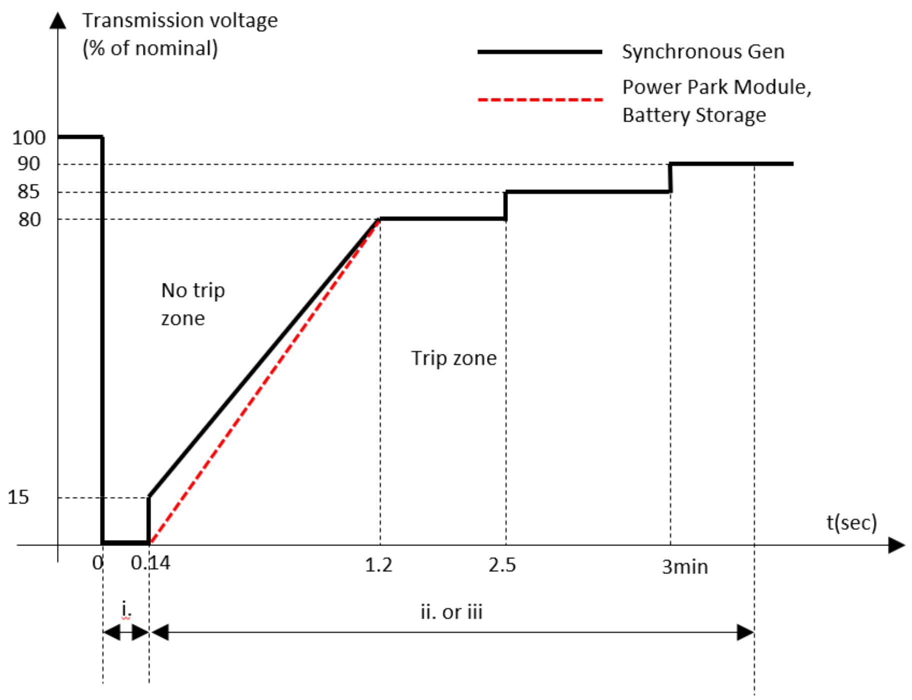
			it was operating at the time of the Voltage Dip**.** The **Power Park Module, HVDC** and **Battery Storage** shall revert to its pre-fault control mode and setpoint within 500ms of the voltage recovering to its normal operating range. g) Inject the inductive reactive current in case of over-voltages during the fault recovery.  Figure xxx9. Voltage Duration Envelope **Recovery from DC faults** **HVDC systems** with overhead line DC transmission shall be capable of auto-restarting from DC faults on the overhead line sections. The maximum time duration, number of auto-restart attempts and the restart voltage shall be specified by **TRANSCO**. Auto-restart is not applicable to **HVDC** systems with DC cables.

Addendum-2

Electricity Transmission Code (ver2, rev. 2 dated 30 June 2020) - Update to include Large Renewables and HVDC Requirements

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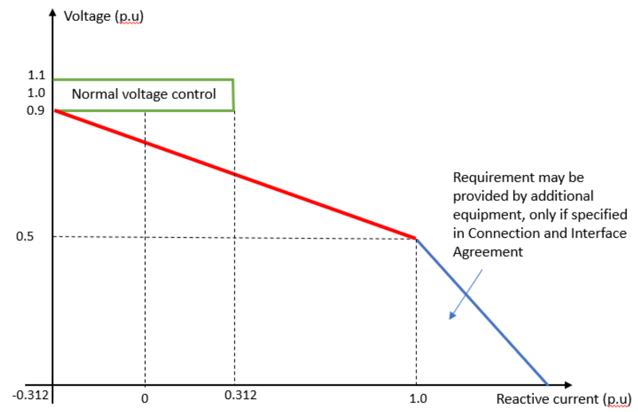
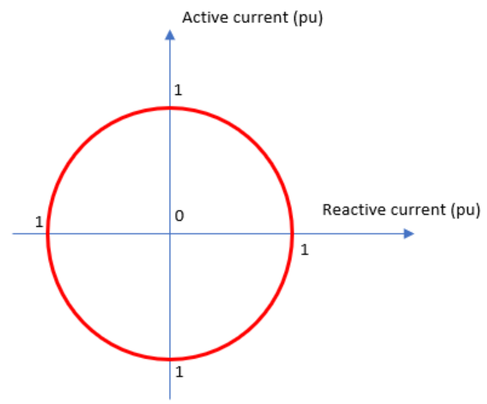
S.N	Code Reference Chapter/Section/Page	Statement per the Code (ETC ver.2 Rev.2 dated 30 June 2020)	Proposed Amendment/New Statement
43	Chapter-3, Connection Conditions, Section-6 (Technical, Design and Operational Criteria) Subsection 6.3 (Generating Unit Requirements) Clause 6.3.8 Dynamic Reactive Current Control Pages 90-91	Not defined	**Dynamic Reactive Current Control** In addition to the requirements from 6.3.2.2.(ETC) and 6.3.7.(ETC) and for any balanced fault which results in the voltage falling below the voltage levels specified in CC.6.1.2 at the point of connection, each **Non-synchronous Generating Unit (**including **Battery Storage** that connects to **Transmission System)** shall, as a minimum, be required to inject a reactive current above the heavy red line shown in Figure xxx10:  **Figure xxx10 – Dynamic reactive current for Generating Unit** (including **Battery Storage**) In addition, each non-synchronous **Generating Unit** (including **Battery Storage** that connects to **Transmission System**) shall be required to inject at least 2/3 of nominal reactive current, decreased by pre-fault level, in 60ms after the voltage dip, with 20ms of control response time. **HVDC** system shall be capable of injecting reactive current at its connection point if specified by **TRANSCO**. The amount of reactive current injection shall be specified by the **TRANSCO**. The fault conditions shall be identified, for instance, through the detection of a low voltage at the point of connection. The specific short circuit contribution shall be agreed as part of the connection process. **TRANSCO** may request the contribution of positive, negative and zero sequence currents depending on the requirements of fault detection near the Connection point. When a specific **HVDC** system is required to provide short circuit current contribution, the following parameters shall be defined as part of the connection process. • Voltage threshold for activation (e.g. 85 % - 90% of rated nominal voltage). • The characteristics (magnitude in relation to voltage dip) of the injected current in time domain ○ As a minimum, the reactive current injection shall be in proportion to the available voltage at the connection point.

S.N	Code Reference Chapter/Section/Page	Statement per the Code (ETC ver.2 Rev.2 dated 30 June 2020)	Proposed Amendment/New Statement
			○ The injected current shall utilize (up to) the full current rating of the **HVDC** system. • Allowable activation delays (20 ms - 40 ms : in order for ac protection systems to detect faults without undue delays). The fault current contribution compliance shall be verified through EMT simulations using a simplified AC network representation. The control priority shall be given to reactive current injection over the active, with any residual capability being supplied as active current. Under any faulted condition, a transient or steady state current must not exceed the maximum rated value (1.0 pu). See Figure xxx11.  **Figure xxx11 – Active/reactive current capability of inverters** Each equipment of **Non-Synchronous Generating Unit** (including **Battery Storage) and HVDC** should be designed to ensure a smooth transition between voltage control mode and **Fault Ride Through** mode.

Addendum-2

Electricity Transmission Code (ver2, rev. 2 dated 30 June 2020) - Update to include Large Renewables and HVDC Requirements

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S.N	Code Reference Chapter/Section/Page	Statement per the Code (ETC ver.2 Rev.2 dated 30 June 2020)	Proposed Amendment/New Statement
44	Chapter-3, Connection Conditions, Section-8 (Ancillary Services) Pages 97-98	**Part 2** 1) Provision of dedicated **Primary Response**; 2) **Frequency** control by means of **Demand** reduction; 3) **Black Start Capability**; 4) **Hot Standby**; 5) **Secondary Control** (**Automatic Generation Control (AGC)** of generating unit **Active Power** from the **Load Despatch Center** for Load Frequency Control (**LFC**) purposes); 6) **Reactive Power** supplied by means of synchronous or static compensators;	**Part 2** 1) Provision of dedicated **Primary Response**; 2) Provision of **Synthetic Inertia** 3) **Frequency** control by means of **Demand** reduction; 4) **Black Start Capability**; 5) **Hot Standby**; 6) **Secondary Control** (**Automatic Generation Control (AGC)** of generating unit **Active Power** from the **Load Despatch Center** for Load Frequency Control (**LFC**) purposes); 7) **Reactive Power** supplied by means of synchronous or static compensators;
45	Chapter-4, Operating Code "A", Section-2, page 111	**SCOPE** Operating Code 'A' **applies to** TRANSCO **and the following** Users: i) **GENCOs**; ii) **DISCOs**; iii) **Non-Embedded Customers;** iv) **Self-Supply Users;** v) **User System**; and vi) **Procurer** with respect to **External System Operators**	**SCOPE** Operating Code 'A' **applies to** TRANSCO **and the following** Users**:** i) **GENCOs (**including **Power Park Modules)**; ii) **Battery Storages** iii) **HVDC users** iv) **DISCOs**; v) **Non-Embedded Customers;** vi) **Self-Supply Users;** vii) **User System**; and viii) **Procurer** with respect to **External System Operators**
46	Chapter-4, Operating Code "A", Section-4.5	**DATA REQUIREMENTS** When requested initially under a **Power and Water Purchase Agreement** and thereafter in calendar week 48 in each calendar year, each **GENCO and each Self-Supply User** shall in respect of each of its **Generating Units** submit to **TRANSCO** in writing the **Generator Performance Chart** and the Generation Planning Parameters to be applied from the beginning of week 49 onwards, in the format indicated in Appendix A and Appendix B of this **Operating Code 'A'**. The Generation Planning Parameters shall be used by **TRANSCO** for **Operational Planning** purposes only and not in **Scheduling and Despatch**.	**DATA REQUIREMENTS** When requested initially under a **Power and Water Purchase Agreement** and thereafter in calendar week 48 in each calendar year, each **GENCO and each Self-Supply User** shall in respect of each of its **Generating Units** submit to **TRANSCO** in writing the **Generator Performance Chart** and the Generation Planning Parameters to be applied from the beginning of week 49 onwards, in the format indicated in Appendix A and Appendix B of this **Operating Code 'A'**. The Generation Planning Parameters shall be used by **TRANSCO** for **Operational Planning** purposes only and not in **Scheduling and Despatch**. In the case of a **Generating Unit** which is capable of firing on two different fuels, the **GENCO** must submit to **TRANSCO**, by separate written notifications, the Generation Planning Parameters in respect of each fuel, each clearly marked to indicate for which fuel it applies.

S.N	Code Reference Chapter/Section/Page	Statement per the Code (ETC ver.2 Rev.2 dated 30 June 2020)	Proposed Amendment/New Statement
		In the case of a **Generating Unit** which is capable of firing on two different fuels, the **GENCO** must submit to **TRANSCO**, by separate written notifications, the Generation Planning Parameters in respect of each fuel, each clearly marked to indicate for which fuel it applies. The **Generator Performance Chart** must be on a **Generating Unit** specific basis at the generator terminals, except in the case of **a Power Farm**, where it shall be on a **Power Farm** basis at the **Transmission Entry Point** or **Distribution System Entry Point** if **Embedded** and must include details of the generator transformer parameters (or, in the case of **a Power Farm** to the extent present, the main step-up transformer(s) or, otherwise, the step-up transformers that relate exclusively to the operation of each **WTGU** or **PVPS** therein) and demonstrate the limitation on **Reactive Power** capability of the **Transmission System** voltage at 3% above nominal. For each **Generating Unit** whose performance varies significantly with ambient temperature, the **Generator Performance Chart** shall show curves for at least two values of ambient temperature so that **TRANSCO** can assess the variation in performance over all likely ambient temperatures by a process of linear interpolation or extrapolation. One of these curves shall be for the ambient temperature at which the **Generating Unit** output equals its **Registered Capacity.** Examples of **Generator Performance Charts** for **Synchronous** and **Power Farm Generating Units** are shown in Appendix A. Each **GENCO** with a **WTGU**, **PVPS** or **CSTU** shall submit to **TRANSCO** in writing an **Intermittent Power Source** Planning Matrix. It shall be prepared on a best estimate basis relating to how it is anticipated the **WTGU**, **PVPS** or **CSTU** will be running and which shall reasonably reflect the operating characteristics of the relevant farm or module. The Planning Matrix must show the number of each **WTGU**, **PVPS** or **CSTU** expected to be available to generate, in the format indicated in Appendix E. The **Intermittent Power Source** Planning Matrix shall be accompanied by a graph showing the variation in MW output with **Intermittent Power Source** (e.g. MW versus wind speed or solar irradiation) for the relevant farm or module as the case may be.	The **Generator Performance Chart** must be on a **Generating Unit** specific basis at the generator terminals, except in the case of **a Power Farm**, where it shall be on a **Power Park Module** basis at the **Transmission Entry Point** or **Distribution System Entry Point** if **Embedded** and must include details of the generator transformer parameters (or, in the case of **a Power Park Module** to the extent present, the main step-up transformer(s) or, otherwise, the step-up transformers that relate exclusively to the operation of each **WTGU** or **PVGU** therein) and demonstrate the limitation on **Reactive Power** capability of the **Transmission System** voltage at 3% above nominal. For each **Generating Unit** whose performance varies significantly with ambient temperature, the **Generator Performance Chart** shall show curves for at least two values of ambient temperature so that **TRANSCO** can assess the variation in performance over all likely ambient temperatures by a process of linear interpolation or extrapolation. One of these curves shall be for the ambient temperature at which the **Generating Unit** output equals its **Registered Capacity.** Examples of **Generator Performance Charts** for **Synchronous** and **Power Park Module Generating Units** are shown in Appendix A. Each **GENCO** with a **WTGU**, **PVGU** or **CSTU** shall submit to **TRANSCO** in writing an **Intermittent Power Source** Planning Matrix. It shall be prepared on a best estimate basis relating to how it is anticipated the **WTGU**, **PVGU** or **CSTU** will be running and which shall reasonably reflect the operating characteristics of the relevant farm or module. The Planning Matrix must show the number of each **WTGU**, **PVGU** or **CSTU** expected to be available to generate, in the format indicated in Appendix E. The **Intermittent Power Source** Planning Matrix shall be accompanied by a graph showing the variation in MW output with **Intermittent Power Source** (e.g. MW versus wind speed or solar irradiation) for the relevant farm or module as the case may be. The **Intermittent Power Source** Planning Matrix will be used by **TRANSCO** for operational planning purposes only and not in connection with the operation of Scheduling and Despatch.

Addendum-2

Electricity Transmission Code (ver2, rev. 2 dated 30 June 2020) - Update to include Large Renewables and HVDC Requirements

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S.N	Code Reference Chapter/Section/Page	Statement per the Code (ETC ver.2 Rev.2 dated 30 June 2020)	Proposed Amendment/New Statement
		The **Intermittent Power Source** Planning Matrix will be used by **TRANSCO** for operational planning purposes only and not in connection with the operation of Scheduling and Despatch	
47	Chapter-4, Operating Code "A", Section-5.2.2 (Operating reserve), clause 5.2.2.4 on page 132	**Operating Reserve Determination** The amount of **Operating Reserve** required at any time will be determined by **TRANSCO** on annual basis having regard to the **Demand** levels, **Generating Plant** availability shortfalls and the greater of the largest secured loss of generation or loss of import from or sudden export across any **External Interconnections** against which, as a requirement of the **Licence Standards,** the **Transmission System** must be secured. **TRANSCO** will allocate the **Operating Reserve** to the various classes of **Generating Plant, to Self-Supply Users** or to an **External Interconnection** so as to fulfil the required levels of **Primary Reserve**, **Secondary Reserve** and **Tertiary Reserve**	**Operating Reserve Determination** The amount of **Operating Reserve** required at any time will be determined by **TRANSCO** on annual basis having regard to the **Demand** levels, **Generating Plant** availability shortfalls and the greater of the largest secured loss of generation or loss of import from or sudden export across any **External Interconnections** against which, as a requirement of the **License Standards,** the **Transmission System** must be secured. **TRANSCO** will allocate the **Operating Reserve** to the various classes of **Generating Plant, Battery Storage, to Self-Supply Users** or to an **External Interconnection** so as to fulfil the required levels of **Primary Reserve**, **Secondary Reserve** and **Tertiary Reserve.**
48	Chapter-4, Operating Code "A", Section-5.3 (Instructions of Operating Margin), on page 132	**Instruction of Operating Margin** **TRANSCO** will instruct sufficient individual **Generating Units** or **External Interconnection** transfer so as to fulfil in total the required levels of **Contingency Reserve** and **Operating Reserve** with the required levels of response.	**Instruction of Operating Margin** **TRANSCO** will instruct sufficient individual **Generating Units, Battery Storages** or **External Interconnection** transfer so as to fulfil in total the required levels of **Contingency Reserve** and **Operating Reserve** with the required levels of response.
49	Chapter-4, Operating Code "A", Section-11 on pages 142-143	**POWER FARMS** The following parameters are required in respect of each **Power Farm**: i) the minimum time to connect or reconnect the **Power Farm** (or part thereof) to the **Transmission System** following a **Despatch** instruction; ii) the minimum time to connect or reconnect the **Power Farm** (or part thereof) to the **Transmission System** automatically following a trip of the **Power Farm** (or part thereof) that does not cause damage to the **Power Farm** (or part thereof); iii) the maximum rate at which **Load** can be increased following connection of the **Power Farm** (or part thereof) to the **Transmission System**; and	**POWER PARK MODULES** The following parameters are required in respect of each **Power Park Modules**: i) the minimum time to connect or reconnect the **Power Park Module** (or part thereof) to the **Transmission System** following a **Despatch** instruction; ii) the minimum time to connect or reconnect the **Power Park Module** (or part thereof) to the **Transmission System** automatically following a trip of the **Power Park Module** (or part thereof) that does not cause damage to the **Power Park Module** (or part thereof); iii) the maximum rate at which **Load** can be increased following connection of the **Power Park Module** (or part thereof) to the **Transmission System**; and

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		iv) the minimum fault level or voltage at the Connection Point below which the Power Farm cannot be connected.	iv) the minimum fault level or voltage at the Connection Point below which the **Power Park Module** cannot be connected.
50	Chapter-4, Operating Code “A”, Section-12, on page 144	**PRIMARY RESPONSE CHARACTERISTICS** The **Primary Response Characteristic** shall be given for each **Generation Unit** for Various Generator Loading Conditions as defined in Table C.1	**PRIMARY RESPONSE CHARACTERISTICS** The **Primary Response Characteristic** shall be given for each **Generation Unit** or **Battery Storage** or **HVDC** for Various Loading Conditions as defined in Table C.1.
51	Chapter-4, Operating Code “A”, Section-13, on page 145	**PRIMARY CONTROLLER DROOP CHARACTERISTIC AND DEAD BAND** The **Primary Controller Droop Characteristic** and dead band shall be given for each **Generation Unit** for various generator loading conditions as defined in Table C.2:	**PRIMARY CONTROLLER DROOP CHARACTERISTIC AND DEAD BAND** The **Primary Controller Droop Characteristic** and dead band shall be given for each **Generation Unit or Battery Storage** or **HVDC** for various generator loading conditions as defined in Table C.2:
52	Chapter-4, Operating Code “A”, APPENDIX E, on page 147	**APPENDIX E - INTERMITTENT POWER SOURCE PLANNING MATRIX WIND POWER FARM POWER STATIONS** **PHOTOVOLTAIC POWER FARMS and CSTUs**	**APPENDIX E - INTERMITTENT POWER SOURCE PLANNING MATRIX WIND POWER PARK MODULES** **PHOTOVOLTAIC POWER PARK MODULES and CSTUs**
53	Chapter-5, Operating Code “B”, section 2, on page 149	**SCOPE** Operating Code 'B' **applies to** TRANSCO**, the Procurer the following** Users**:** i) **GENCOs**; ii) **DISCOs** iii) **Non-Embedded Customers**; iv) **Self-Supply Users**; and v) **User Systems**	**SCOPE** Operating Code 'B' **applies to** TRANSCO**, the Procurer the following** Users**:** i) **GENCOs (**including **Power Park Modules)**; ii) **Battery Storages** iii) **HVDC** iv) **DISCOs** v) **Non-Embedded Customers**; vi) **Self-Supply Users**; and

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			vii) **User Systems**
54	Chapter-5, Operating Code "B", Section-4 (CONTINGENCY PLANNING), clause 4.3 (Black Start) Page 141	Black Start requirement for HVDC not defined. Add inside Clause 4.3.1	**TRANSCO** may specify a **System Black Start** restoration capability from the **HVDC system**. In that case, the **HVDC** system shall be capable of operating in an isolated network in accordance with **Black Start** operation requirements. **TRANSCO** and the **HVDC USER** shall agree on the capacity and availability of the **Black Start** capability and any other operational procedures. The **HVDC** system shall also be able to synchronize with the AC system within the frequency limits and within the voltage limits specified. Wider frequency and voltage ranges may be specified by **TRANSCO** where needed in order to restore the AC Network security.
55	Chapter-5, Operating Code "B", Section-9 (Testing, Monitoring and Investigation), clause 9.4 (Procedure for testing) Page 180	Black Start Testing - Not defined	**Black Start Testing** a) The **TRANSCO** may require a **Generating Unit** (including **Power Park Module** and/or **Battery Storage**) with a **Black Start Station** to carry out a test (a "**Black Start Test**") on a **Generating Unit** or **Power Park Module, HVDC** and/or **Battery Storage** in a **Black Start Station** in order to demonstrate that a **Black Start Station** has a **Black Start** Capability. b) The **TRANSCO** may require a **Generating Unit** (including **Power Park Module** and/or **Battery Storage**) with a **Black Start Station** to carry out a **Black Start Test**, on each **Generating Unit** or **Power Park Module** and/or **Battery Storage**, which has **Black Start** capability, within such a **Black Start Station**, to demonstrate this capability at least once every three years, unless it can justify on reasonable grounds the necessity for more often tests. c) When the **TRANSCO** wishes a **Generating Unit** (including **Power Park Module, HVDC** and/or **Battery Storage**) with a **Black Start Station** to carry out a **Black-Start Test**, it shall notify the relevant **GENCO** at least 7 days prior to the time of the **Black Start Test** with details of the proposed **Black Start Test**. d) Detailed procedure for **Black Start Test** will be established jointly by **User** and **TRANSCO**.

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Issue Date: 31 May 2021

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S.N	Code Reference Chapter/Section/Page	Statement per the Code (ETC ver.2 Rev.2 dated 30 June 2020)	Proposed Amendment/New Statement
56	Chapter-5, Operating Code "B", Section-9 (Testing, Monitoring and Investigation), clause 9.4 (Procedure for testing) Page 181		**Ancillary Service Compliance** a) Compliance testing of mandatory **Ancillary Service** (Part I) shall be done once every three years, unless justified on reasonable grounds the necessity for more often tests. b) The tests shall include, but not limited to: - **Reactive Power** capability, - **Voltage control**, - **Frequency response**
57	Chapter-6, Scheduling and Despatch Code, Section-3 (Generation and desalination despatch) Page 198	**Generation and Desalination Despatch** sets out the procedure: i) to optimise the **Despatch** of **Generating Units** and **Desalination Units** such that the cost of procuring the required electricity and water to meet the demand is minimised; ii) to issue **Despatch** instructions to **GENCOs** in respect of their **Generating Units** and **Desalination Units**; iii) to issue exchange schedules to **External System Operators** in respect of transfers across **External Interconnections** in accordance with relevant Interconnection Agreements; iv) to issue exchange schedules to **Self-Supply Users** in respect of transfers across its **connection points** in accordance with relevant **PWPA** or **Connection and Interface Agreements**; v) to carry out a re-optimising **Scheduling** process as may be required in **TRANSCO** reasonable opinion; and vi) to issue instructions in relation to **Ancillary Services**. **Generating Units** powered by **Intermittent Power Sources** are not subject to **Despatch** unless they are equipped with appropriate energy storage facilities.	**Generation and Desalination Despatch** sets out the procedure: i) to optimise the **Despatch** of **Generating Units** and **Desalination Units** such that the cost of procuring the required electricity and water to meet the demand is minimised; ii) to issue **Despatch** instructions to **GENCOs** in respect of their **Generating Units** and **Desalination Units**; iii) to issue exchange schedules to **External System Operators** in respect of transfers across **External Interconnections** in accordance with relevant Interconnection Agreements; iv) to issue exchange schedules to **Self-Supply Users** in respect of transfers across its **connection points** in accordance with relevant **PWPA** or **Connection and Interface Agreements**; v) to carry out a re-optimising **Scheduling** process as may be required in **TRANSCO** reasonable opinion; and vi) to issue instructions in relation to **Ancillary Services**. vii) to issue instructions in relation to **Battery Storage** operational mode.

Addendum-2

Electricity Transmission Code (ver2, rev. 2 dated 30 June 2020) - Update to include Large Renewables and HVDC Requirements

Issue Date: 31 May 2021

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S.N	Code Reference Chapter/Section/Page	Statement per the Code (ETC ver.2 Rev.2 dated 30 June 2020)	Proposed Amendment/New Statement
58	Chapter-6, Scheduling and Despatch Code, Section-3 (Generation and desalination despatch), clause 3.2.4.4 (reactive power) Page 200	**Reactive Power** To ensure that a satisfactory **System** voltage profile is maintained and that sufficient **Reactive Power** reserves are maintained, **Despatch** instructions may include, in relation to **Reactive Power**: i) MVAr Output. The individual **MVAr** output from the **Generating Unit** onto the **Transmission System** at the **Transmission Entry Point** (or at the **Distribution System Entry Point** in the case of **Embedded Generating Plant**), namely on the HV side of the generator step-up transformer. In relation to each **Generating Unit**, where there is no HV indication, **TRANSCO** and the **GENCO** will discuss and agree equivalent **MVAr** levels for the corresponding LV indication. Where a **Generating Unit** is instructed to a specific **MVAr** output, the **GENCO** must achieve that output within a tolerance of ±1 **MVAr** (or such other figure as may be agreed with **TRANSCO**) by either: i) on load tap changing on the generator step-up transformer; or ii) adjusting the generator stator terminal voltage. Once this has been achieved, the **GENCO** will not tap again or adjust terminal voltage again without prior consultation with and the agreement of **TRANSCO**, on the basis that MVAr output will be allowed to vary with **System** conditions; **ii)** **MVAr** exchange on **connection points** to **Self-Supply User:** **TRANSCO** and **Self-Supply User** will discuss and agree **MVAr** level, based on which the **MVAr** outputs from the **Generating Units** will be despatched by **Self-Supply User** operator; iii) Target Voltage Levels. Target voltage levels to be achieved by the **Generating Unit** on the **Transmission System** at the **Transmission Entry Point** (or on the **Distribution System** at the **Distribution System Entry Point** in the case of **Embedded Generating Plant**), namely on the higher voltage side of the generator step-up transformer. Where a Generating Unit is instructed to a specific target voltage, the **GENCO** must achieve that target within a tolerance of ±1 kV (or such other figure as may be agreed with **TRANSCO**) by either: i) on load tap changing on the generator step-up transformer; or ii) adjusting the generator stator terminal voltage.	**Reactive Power** To ensure that a satisfactory **System** voltage profile is maintained and that sufficient **Reactive Power** reserves are maintained, **Despatch** instructions may include, in relation to **Reactive Power**: i) MVAr Output. The individual **MVAr** output from the **Generating Unit** onto the **Transmission System** at the **Transmission Entry Point** (or at the **Distribution System Entry Point** in the case of **Embedded Generating Plant**), namely on the HV side of the generator step-up transformer. In relation to each **Generating Unit**, where there is no HV indication, **TRANSCO** and the **GENCO** will discuss and agree equivalent **MVAr** levels for the corresponding LV indication. Where a **Generating Unit** is instructed to a specific **MVAr** output, the **GENCO** must achieve that output within a tolerance of ±1 **MVAr** (or such other figure as may be agreed with **TRANSCO**) by either: i. on load tap changing on the generator step-up transformer; or ii. adjusting the generator stator terminal voltage. iii. implementing the preferable control mode and set value for **Power Park Module, Battery Storage** or **HVDC** Once this has been achieved, the **GENCO** will not tap again or adjust terminal voltage again without prior consultation with and the agreement of **TRANSCO**, on the basis that MVAr output will be allowed to vary with **System** conditions; ii) **MVAr** exchange on **connection points** to **Self-Supply User:** **TRANSCO** and **Self-Supply User** will discuss and agree **MVAr** level, based on which the **MVAr** outputs from the **Generating Units** will be despatched by **Self-Supply User** operator; iii) Target Voltage Levels. Target voltage levels to be achieved by the **Generating Unit** on the **Transmission System** at the **Transmission Entry Point** (or on the **Distribution System** at the **Distribution System Entry Point** in the case of **Embedded Generating Plant**), namely on the higher voltage side of the generator step-up transformer. Where a Generating Unit is instructed to a specific target voltage, the **GENCO** must achieve that target within a tolerance of ±1 kV (or such other figure as may be agreed with **TRANSCO**) by either: i) on load tap changing on the generator step-up transformer; or ii) adjusting the generator stator terminal voltage. iii) implementing the preferable control mode and set value for **Power Park Module, Battery Storage** and **HVDC**.

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S.N	Code Reference Chapter/Section/Page	Statement per the Code (ETC ver.2 Rev.2 dated 30 June 2020)	Proposed Amendment/New Statement
		In relation to each **Generating Unit**, where there is no HV indication, **TRANSCO** and the **GENCO** will discuss and agree equivalent voltage levels for the corresponding LV indication.	In relation to each **Generating Unit**, where there is no HV indication, **TRANSCO** and the **GENCO** will discuss and agree equivalent voltage levels for the corresponding LV indication.
59	Chapter-6, Scheduling and Despatch Code, Section-4 (FREQUENCY CONTROL MANAGEMENT), clause 4.1 (introduction) Page 205	**Introduction** This section of the Scheduling and Despatch Code sets out the procedure which **TRANSCO** will use in relation to **Users** to direct **Frequency Control**. The **Frequency** of the **Transmission System** will be controlled by: i) automatic response from **Generating Units** operating in **Frequency Sensitive Mode**, including **Unit Controller** operation; ii) the manual Despatch of **Generating Units**; iii) **Generating Units** operating in **AGC** mode under a centralized acting integral **Secondary Controller**. iv) Response from **Self-Supply Users**; v) response from **External Interconnections**; and vi) **Demand Control**	**Introduction** This section of the Scheduling and Despatch Code sets out the procedure which **TRANSCO** will use in relation to **Users** to direct **Frequency Control**. The **Frequency** of the **Transmission System** will be controlled by: i) automatic response from **Generating Units,** and **Battery Storage** operating in **Frequency Sensitive Mode**, by **Unit Controller** operation; ii) automatic response from **Power Park Modules and HVDC** operating in **Frequency Sensitive Mode**, or Limited **Frequency Sensitive Mode (LFSM-O and/or LFSM-U)** by **Unit Controller** operation. iii) the manual Despatch of **Generating Units**; iv) **Generating Units** operating in **AGC** mode under a centralized acting integral **Secondary Controller**. v) Response from **Self-Supply Users**; vi) response from **External Interconnections**; and vii) **Demand Control**
60	Chapter-6, Scheduling and Despatch Code, Section-4 (FREQUENCY CONTROL MANAGEMENT), clause 4.2 (introduction) Page 207	**Frequency Sensitive Mode** Unless relieved of the obligation by **TRANSCO**, all Synchronous **Generating Units** and **Power Farms WTGU** shall operate at all times in **Frequency Sensitive Mode** (including, where applicable, with the **Unit Controller** in operation) which term means an automatic incremental or decremental generation response (**Primary Response**) to contain the initial **System Frequency** change together with a sustained generation response (**Secondary Response**) which can contribute to containing and correcting the **System Frequency** within the requirements for **Frequency Control. WTGU Power Farms** shall provide **Primary** and **Secondary Response** within the intermittent capability of their primary energy input, if required by **TRANSCO**.	**Frequency Sensitive Mode** Unless relieved of the obligation by **TRANSCO**, all Synchronous **Generating Units** shall operate at all times in **Frequency Sensitive Mode** (including, where applicable, with the **Unit Controller** in operation) **,** while **Power Park Modules and HVDC** shall operate in **Limited Frequency Sensitive Mode and/or Frequency Sensitive Mode,** which term means an automatic incremental or decremental generation response (**Primary Response**) to contain the initial **System Frequency** change together with a sustained generation response (**Secondary Response**) which can contribute to containing and correcting the **System Frequency** within the requirements for **Frequency Control. Power Park Modules** shall provide **Primary** and **Secondary Response** if required by **TRANSCO.**

Addendum-2

Electricity Transmission Code (ver2, rev. 2 dated 30 June 2020) - Update to include Large Renewables and HVDC Requirements

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S.N	Code Reference Chapter/Section/Page	Statement per the Code (ETC ver.2 Rev.2 dated 30 June 2020)	Proposed Amendment/New Statement
61	Chapter-6, Scheduling and Despatch Code, Section-4 (FREQUENCY CONTROL MANAGEMENT), clause 4.2.1 Page 207	**Generating Units, WTGU and PVPS in Primary Control Mode** A **System Frequency** induced change in **Active Power** output by the operation of the **Primary Controller** must not be countermanded by a **GENCO** except where it is done purely on safety grounds (relating to either personnel or plant) or, where necessary to ensure the integrity of the **Generating Plant**.	**Generating Units, Battery Storages and HVDC in Primary Control Mode** A **System Frequency** induced change in **Active Power** output by the operation of the **Primary Controller** must not be countermanded by a **GENCO or HVDC User** except where it is done purely on safety grounds (relating to either personnel or plant) or, where necessary to ensure the integrity of the **Generating Plant**.
62	Chapter-6, Scheduling and Despatch Code, Section-4 (FREQUENCY CONTROL MANAGEMENT), clause 4.2.2 Page 207	**Generating Units in AGC Control Mode** In accordance with the respective **Power and Water Purchase Agreement** a **Generating Unit** shall be able to operate in **AGC** mode with adjustable **Secondary Control** contribution factor. If the **System** frequency is at or above 51 Hz, or at or below 49 Hz the **AGC** mode should automatically be switched off.	**Generating Units, Battery Storages and HVDC in AGC Control Mode** In accordance with the respective **Power (and Water) Purchase Agreement** a **Generating Unit, Battery Storage** or **HVDC** shall be able to operate in **AGC** mode with adjustable **Secondary Control** contribution factor. If the **System** frequency is at or above 51 Hz, or at or below 49 Hz the **AGC** mode should automatically be switched off.
63	Chapter-6, Scheduling and Despatch Code, Section-4 (FREQUENCY CONTROL MANAGEMENT), clause 4.5 (TRANSCO despatch instructions) Page 206	**TRANSCO Despatch Instructions** **TRANSCO** will issue **Despatch** instructions to regulate the **Frequency** of the **Total System** to meet the requirements of **Frequency Control**. **TRANSCO** will issue **Despatch** instructions as to which **Generating Unit** shall participate in **Secondary Control** by means of **AGC** mode activation and participation factor settings.	**TRANSCO Despatch Instructions** **TRANSCO** will issue **Despatch** instructions to regulate the **Frequency** of the **Total System** to meet the requirements of **Frequency Control**. **TRANSCO** will issue **Despatch** instructions as to which **Generating Unit** shall participate in **Secondary Control** by means of **AGC** mode activation and participation factor settings. **TRANSCO** will issue Despatch instructions as to which frequency control mode is to be set to **Power Park Modules, HVDC** and **Battery Storage.**