



CONSULTATION PAPER FOR PROPOSED MODIFICATIONS TO THE TRANSMISSION CODE

Closing date for submission of representations:
2 Oct 2023, 5 p.m.

4 SEP 2023

ENERGY MARKET AUTHORITY
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1 Introduction

- 1.1. The Transmission Code sets out the rights and obligations of the Transmission Licensee, together with the rights and obligations of users of the transmission system. The Transmission Code also sets out the technical requirements to be met by those who seek to connect to and operate installations in the transmission system.

2 Proposed modifications to the Transmission Code

- 2.1. Pursuant to Section 1.6 of the Transmission Code, EMA seeks representations on the proposed modifications to the Transmission Code as set out in Appendix 1.
- 2.2. The proposed modifications are to provide updates and clarity to the technical requirements relating to Energy Storage Systems (“ESS”), photovoltaic (PV) generation units, generating units, mitigation of single points of failure and cybersecurity.

3 Invitation to submit representations

- 3.1. EMA invites written representations on the proposed modifications to the Transmission Code as set out in Appendix 1.
- 3.2. Please send your written representations by e-mail to:

EMA_ES@ema.gov.sg

Alternatively, you may send your written representations by post/fax to the following address:

*Electricity System Department
Energy Infrastructure Division
Energy Market Authority
991G Alexandra Road, #01-29
Singapore 119975.
Fax: (65) 6 835 8020*

Please use the form set out in Appendix 2 for your representations.

- 3.3. Anonymous representations will not be considered.
- 3.4. All representations must be in writing and must reach EMA by 5 pm on 2 Oct 2023.
- 3.5. EMA will acknowledge receipt of all submitted representations electronically. Please contact Mr Vincent Siow at 6376 7525 or Mr Yeo Eng Houw at 6376 7786 if you have not received an acknowledgement of your submitted representation

within two business days. EMA reserves the right to make public all or any part of any representation and/or to disclose the identity of the party who made the representation. Where a respondent considers any part of his representation to be confidential, he shall clearly mark and place such part of his representation as an annex.

- 3.6. This Consultation Paper shall constitute notice of the proposed modifications to the Transmission Code set out in Appendix 1, for the purpose of Section 1.6 of the Transmission Code.

~ End ~

Table 1: Proposed Modifications to the Transmission Code

Modification Ref. No.	Clause	Original Text	Modified Text	Reasons
TC/2023/1	1.3.1	New definition.	<u>“solar photovoltaic” or “solar PV” means a <i>generation facility</i> that produces electricity by means of solar irradiance incident to semiconducting materials (i.e. solar cells);</u>	To include new definition for “solar photovoltaic” or “solar PV”.
TC/2023/2	1.3.1	New definition.	<u>“energy storage unit” means a <i>generating unit</i> that has the ability to store energy and later release the energy, and that is used for, or for purposes connected with, the production of electricity;</u>	To include new definition for “energy storage unit”.
TC/2023/3	1.3.1	New definition.	<u>“Energy Storage System” or “ESS” means one or more <i>energy storage units</i>, including its associated equipment such as switchgears, transformers, and all auxiliary equipment;</u>	To include new definition for “Energy Storage System” or “ESS”.
TC/2023/4	1.3.1	New definition.	<u>“centrally dispatchable Energy Storage System” means an <i>Energy Storage System</i> that is centrally dispatched and under Automatic Generation Control (AGC);</u>	To include new definition for “centrally dispatchable Energy Storage System”.

Modification Ref. No.	Clause	Original Text	Modified Text	Reasons
TC/2023/5	4.1.1	<p>A <i>connection applicant</i> applying to connect its <i>generation facility</i> to the <i>transmission system</i> or modify its existing <i>generation facility</i> connected to the <i>transmission system</i> is required to submit a formal application through an <i>authorised person</i>, together with the <i>application fee</i> payable, to the Transmission Licensee. The application shall contain the information described in Appendix C. After having submitted the application, the <i>connection applicant</i> shall promptly notify the Transmission Licensee in writing of any subsequent material additions or changes to the information submitted.</p>	<p>A <i>connection applicant</i> applying to connect its <i>generation facility</i> to the <i>transmission system</i> or modify its existing <i>generation facility</i> connected to the <i>transmission system</i> is required to submit a formal application through an <i>authorised person</i>, together with the <i>application fee</i> payable, to the <u>Transmission Licensee</u>. The application shall contain the information described in Appendix C <u>and/or Appendix L, where applicable</u>. After having submitted the application, the <i>connection applicant</i> shall promptly notify the <u>Transmission Licensee</u> in writing of any subsequent material additions or changes to the information submitted.</p>	<p>To include the required information to be submitted by a connection applicant for an ESS connection.</p>
TC/2023/6	4.2.1	<p>A <i>connection applicant</i> applying to connect its consumer <i>installation</i> to the <i>transmission system</i> or modify its existing consumer <i>installation</i> connected to the <i>transmission system</i> is required to submit a formal application through an <i>authorised person</i>, together with the <i>application fee</i> payable, to the Transmission Licensee. The application shall contain the information described in Appendix B (and Appendix C, where applicable). After having submitted the application, the <i>connection applicant</i> shall promptly notify the Transmission Licensee in writing of any material additions or changes to the information submitted.</p>	<p>A <i>connection applicant</i> applying to connect its consumer <i>installation</i> to the <i>transmission system</i> or modify its existing consumer <i>installation</i> connected to the <i>transmission system</i> is required to submit a formal application through an <i>authorised person</i>, together with the <i>application fee</i> payable, to the <u>Transmission Licensee</u>. The application shall contain the information described in Appendix B <u>and/or Appendix C and/or Appendix L, where applicable</u>. After having submitted the application, the <i>connection applicant</i> shall promptly notify the <u>Transmission Licensee</u> in writing of any material additions or changes to the information submitted.</p>	<p>To include the required information to be submitted by a connection applicant for an ESS connection.</p>

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TC/2023/7	4.4.1	<p>The <i>connection application</i> shall, no less than 14 <i>business days</i>, prior to the date on which the <i>energisation</i> of the <i>service connection</i> is to take place:-</p> <p>(a) complied fully with the safety requirements of this <i>Code</i>;</p> <p>(b) complied fully with the technical requirements of this <i>Code</i> and shall, in particular, have submitted the data and information stipulated in Appendix B and/or Appendix C and/or Appendix D, where applicable;</p> <p>(c) submitted to the Transmission Licensee a written request for approval to <i>energise</i> the <i>service connection</i> and the proposed date of <i>energisation</i>;</p> <p>(d) submitted to the Transmission Licensee a written confirmation that the <i>installation</i> to be connected to the <i>transmission system</i> for which <i>connection</i> is sought conforms fully with the requirements of the <i>Connection Agreement</i>; and</p> <p>(e) submitted to the Transmission Licensee a written confirmation that it has obtained all necessary authorisations for the construction and operation of the <i>installation</i> in accordance with the provisions of all applicable laws and regulations in the Republic of Singapore have been met;</p>	<p>The <i>connection application</i> shall, no less than 14 <i>business days</i>, prior to the date on which the <i>energisation</i> of the <i>service connection</i> is to take place:-</p> <p>(a) complied fully with the safety requirements of this <i>Code</i>;</p> <p>(b) complied fully with the technical requirements of this <i>Code</i> and shall, in particular, have submitted the data and information stipulated in Appendix B and/or Appendix C and/or Appendix D <u>and/or Appendix L</u>, where applicable;</p> <p>(c) submitted to the <u>Transmission Licensee</u> a written request for approval to <i>energise</i> the <i>service connection</i> and the proposed date of <i>energisation</i>;</p> <p>(d) submitted to the <u>Transmission Licensee</u> a written confirmation that the <i>installation</i> to be connected to the <i>transmission system</i> for which <i>connection</i> is sought conforms fully with the requirements of the <i>Connection Agreement</i>; and</p> <p>(e) submitted to the <u>Transmission Licensee</u> a written confirmation that it has obtained all necessary authorisations for the construction and operation of the <i>installation</i> in accordance with the provisions of all applicable laws and regulations in the Republic of Singapore have been met;</p>	To include the required information to be submitted by a connection applicant for an ESS connection.
TC/2023/8	4.6.1	For the commissioning of a <i>generation facility</i> , the Generation Licensee shall submit to the <i>Power System Operator</i> , 14 <i>business days</i> in advance from the date its new/repowered <i>generating facility</i> is scheduled for synchronisation to the <i>power</i>	For the commissioning of a <i>generation facility</i> <u>or centrally dispatchable ESS</u> , the <u>Generation Licensee or Licensee responsible for each centrally dispatchable ESS</u> shall submit to the <i>Power System Operator</i> , 14 <i>business days</i> in advance from the date its new/repowered	To include the required information to be submitted in Appendix L for ESS commissioning.

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		<p><i>system</i>, a tentative commissioning tests program including those tests listed in Appendix C (giving details of the schedules and the test to be carried out at various load levels) for on-load commissioning of its new/repowered <i>generating facility</i>. A final version of the commissioning program shall be established one week before the commencement of the commissioning. The <i>Power System Operator</i> shall have the authority to re-schedule any of the required tests to minimise system risk and the reason for such re-scheduling shall be given to the Generation Licensee.</p>	<p><i>generating facility or centrally dispatchable ESS</i> is scheduled for synchronisation to the <i>power system</i>, a tentative commissioning tests program including those tests listed in Appendix C <u>and/or Appendix L, where applicable</u> (giving details of the schedules and the test to be carried out at various load levels) for on-load commissioning of its new/repowered <i>generating facility or centrally dispatchable ESS</i>. A final version of the commissioning program shall be established one week before the commencement of the commissioning. The <i>Power System Operator</i> shall have the authority to re-schedule any of the required tests to minimise system risk and the reason for such re-scheduling shall be given to the <u>Generation Licensee or the Licensee responsible for each centrally dispatchable ESS</u>.</p>	
TC/2023/9	4.6.3	<p>Upon completion of the testing and commissioning of the <i>generation facility</i>, the Generation Licensee shall submit and update the <i>Power System Operator</i> with the final site setting of the <i>generation facility</i>, as well as the testing and commissioning reports as set forth in Appendix C.</p>	<p>Upon completion of the testing and commissioning of the <i>generation facility</i> <u>or centrally dispatchable ESS</u>, the <u>Generation Licensee or the Licensee responsible for each centrally dispatchable ESS</u> shall submit and update the <i>Power System Operator</i> with the final site setting of the <i>generation facility</i> <u>or centrally dispatchable ESS</u>, as well as the testing and commissioning reports as set forth in Appendix C <u>and/or Appendix L, where applicable</u>.</p>	<p>To include the required information to be submitted in Appendix L for ESS commissioning.</p>

Modification Ref. No.	Clause	Original Text	Modified Text	Reasons
TC/2023/10	6.1.6	<p>(a) Any <i>Generation Licensee</i> that intends to retire any of its <i>generating units</i>, shall submit a written request to the <i>Authority</i> for approval not later than 60 months prior to the date of the intended retirement of the <i>generating unit</i>, and shall provide such information that the <i>Authority</i> requires to facilitate the <i>Authority's</i> decision in relation to whether to approve the retirement of the <i>generating unit</i> (including whether to approve the same subject to conditions), taking into consideration the protection of the interests of consumers with regard to the security, reliability, availability and continuity of supply of electricity. The <i>Authority</i> may, if it considers necessary or appropriate, approve the retirement of the <i>generating unit</i> subject to conditions.</p> <p>(b) No <i>Generation Licensee</i> shall retire any of its <i>generating units</i>, unless it has obtained the written approval of the <i>Authority</i> and complied with all conditions of approval of the <i>Authority</i> under section 6.1.6(a). For the avoidance of doubt, a <i>Generation Licensee</i> is deemed not to have obtained the <i>Authority's</i> approval under section 6.1.6(a) if the <i>Generation Licensee</i> fails to comply with any condition of approval of the <i>Authority</i> under section 6.1.6(a).</p>	<p>(a) Any <i>Generation Licensee</i> that intends to retire any of its <i>generating units</i>, shall submit a written request to the <i>Authority</i> for approval not later than 60 months <u>31 March of the year that is 5 years</u> prior to the date <u>year</u> of the intended retirement of the <i>generating unit</i>¹, and shall provide such information that the <i>Authority</i> requires to facilitate the <i>Authority's</i> decision in relation to whether to approve the retirement of the <i>generating unit</i> (including whether to approve the same subject to conditions), taking into consideration the protection of the interests of consumers with regard to the security, reliability, availability and continuity of supply of electricity. The <i>Authority</i> may, if it considers necessary or appropriate, approve the retirement of the <i>generating unit</i> subject to conditions.</p> <p>(b) No <i>Generation Licensee</i> shall retire any of its <i>generating units</i>, unless it has obtained the written approval of the <i>Authority</i> and complied with all conditions of approval of the <i>Authority</i> under section 6.1.6(a). For the avoidance of doubt, a <i>Generation Licensee</i> is deemed not to have obtained the <i>Authority's</i> approval under section 6.1.6(a) if the <i>Generation Licensee</i> fails to comply with any condition of approval of the <i>Authority</i> under section 6.1.6(a).</p> <p>¹ For example, if a <i>Generation Licensee</i> intends to retire any of its <i>generating units</i> in <u>1 Jan 2029 to 31 Dec 2029</u>, the <i>Generation Licensee</i> shall submit a written request to the <i>Authority</i> not later than <u>31 March 2024</u>.</p>	<p>To ensure that the annual Request for Proposal for new generation capacity accounts for existing generation capacity that would be retiring in the year that the new generation capacity is to be delivered.</p>

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TC/2023/11	6.11.2	<p>The <i>generating unit's</i> step-up transformers and <i>generating unit's</i> switchboard (or switchgear) for connecting the <i>high voltage</i> side of the <i>generating unit's</i> step-up transformers and the associated switching and protection/control equipment shall be designed such that no single failure/<i>outage</i> shall cause simultaneous <i>outage</i> of two or more <i>generating units</i> connected to the switchboard. All switchboards shall be designed in accordance with Appendix I1.4, unless the Generation Licensees submit with justifications the use of a different switchboard configuration for the <i>Power System Operator's</i> consideration.</p>	<p>The <u><i>generation facility</i></u> including its associated <u>equipment</u>, <i>generating unit's</i> step-up transformers, and <i>generating unit's</i> switchboard (or switchgear) for connecting the <i>high voltage</i> side of the <i>generating unit's</i> step-up transformers and the associated switching, and protection/control equipment, <u>auxiliary equipment and measuring instruments</u> shall be designed <u>and operated</u> in such manner that no single failure/<i>outage</i> shall cause simultaneous <i>outage</i> of two or more <i>generating units</i>. connected to the switchboard. All switchboards shall be designed in accordance with Appendix I1.4, unless the Generation Licensees submit with justifications the use of a different switchboard configuration for the <i>Power System Operator's</i> consideration.</p>	<p>To stipulate that the generation facility including its associated equipment, auxiliary equipment and measuring instruments, should be designed and operated with no single point of failure that can cause outage of more than one generating unit.</p>
TC/2023/12	6.12.1	<p>The Transmission Licensee, Generation Licensee and <i>connected person</i> responsible for each <i>HVDC facility</i> shall provide the <i>Remote Terminal Unit(s)</i> at their substations, switchhouses or <i>HVDC facilities</i>, which shall provide the <i>Power System Operator</i> with remote monitoring, control and data acquisition of the equipment in the substation, switchhouse or <i>HVDC facility</i> as set out in Appendix H. Facilities for remote control are required only for substations and <i>HVDC facilities</i>. Information required includes status of <i>circuit breakers</i>, isolators, <i>earthing</i> switches, <i>protection systems</i>, ancillary equipment and other devices or equipment as specified by the <i>Power System Operator</i>. Measurements of power flow, <i>frequency</i>, voltages, transformer</p>	<p>The <u><i>Transmission Licensee</i></u>, <u><i>Generation Licensee</i></u>, and <i>connected person</i> responsible for each <i>HVDC facility</i> <u>and <i>Licensee responsible for each centrally dispatchable ESS</i></u> shall provide the <i>Remote Terminal Unit(s)</i> at their substations, switchhouses, or <i>HVDC facilities</i> <u>or <i>centrally dispatchable ESS</i></u>, which shall provide the <i>Power System Operator</i> with remote monitoring, control and data acquisition of the equipment in the substation, switchhouse, or <i>HVDC facility</i> <u>or <i>centrally dispatchable ESS</i></u> as set out in Appendix H. Facilities for remote control are required only for substations, <u><i>centrally dispatchable ESS</i></u> and <i>HVDC facilities</i>. Information required includes status of <i>circuit breakers</i>, isolators, <i>earthing</i> switches, <i>protection systems</i>, ancillary equipment and other devices or equipment as specified by the</p>	<p>To include Remote Terminal Unit requirements for ESS.</p>

Modification Ref. No.	Clause	Original Text	Modified Text	Reasons
		taps and other quantities as specified by the <i>Power System Operator</i> are also required.	<i>Power System Operator</i> . Measurements of power flow, <i>frequency</i> , voltages, transformer taps and other quantities as specified by the <i>Power System Operator</i> are also required.	
TC/2023/13	6.12.2	<p>The Generation Licensee shall provide the <i>Remote Terminal Unit(s)</i> for remote monitoring of their <i>generating units'</i> output and operating conditions as well as facilities for automatic control of generating unit's output from <i>Power System Operator's Energy Management System</i> as specified in Appendix H.</p> <p>(a) The Transmission Licensee and <i>connected person</i> responsible for each <i>HVDC facility</i> shall provide the <i>remote terminal unit(s)</i> for remote monitoring of their <i>HVDC facilities'</i> operating conditions, as well as facilities for automatic control of <i>HVDC facilities'</i> from <i>Power System Operator's Energy Management System</i> as specified in Appendix H.</p>	<p>The <u><i>Generation Licensee</i></u> shall provide the <i>Remote Terminal Unit(s)</i> for remote monitoring of their <i>generating units'</i> output and operating conditions as well as facilities for automatic control of generating unit's output from <i>Power System Operator's Energy Management System</i> as specified in Appendix H.</p> <p>(a) The <u><i>Transmission Licensee</i></u> and <i>connected person</i> responsible for each <i>HVDC facility</i> shall provide the <i>remote terminal unit(s)</i> for remote monitoring of their <u><i>its HVDC facilities'</i></u> operating conditions, as well as facilities for automatic control of <u><i>its HVDC facilities'</i></u> from <i>Power System Operator's Energy Management System</i> as specified in Appendix H.</p> <p>(b) The <u><i>Licensee</i></u> responsible for each <u><i>centrally dispatchable ESS</i></u> shall provide the <u><i>Remote Terminal Unit(s)</i></u> for remote monitoring of their <u><i>ESS's operating conditions, as well as facilities for automatic control of centrally dispatchable ESS's output</i></u> from <i>Power System Operator's Energy Management System</i> as specified in Appendix H.</p>	To include RTU's requirement for ESS in clause (b) .

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TC/2023/14	6.12.3	<p>The Transmission Licensee, Generation Licensee, and <i>connected person</i> responsible for each <i>HVDC facility</i> shall provide all the equipment at their respective site, including the communication equipment. The Transmission Licensee shall provide data communication lines from the computer room in the control centers of the <i>Power System Operator</i> to the transmission substation, <i>HVDC facility</i> and <i>generating station</i> switchhouses as specified by the <i>Power System Operator</i> for the purposes of real-time power system monitoring and control. The <i>connected person</i> responsible for each <i>HVDC facility</i> shall be responsible for the data communication lines from their <i>HVDC facility</i> to the Transmission Licensee's termination box located in their <i>HVDC facility</i>. The Generation Licensee shall be responsible for the data communication lines from the Generation Licensee's equipment to the Transmission Licensee's termination box located in the <i>generating station's</i> switchhouse. The termination box, which shall be provided by the Transmission Licensee, shall also be used for termination of the Transmission Licensee's data communication lines. In the event of relocation of the termination box or diversion of the data communications lines, the Licensee that initiates the relocation or diversion shall bear all the costs necessary for the relocation or diversion including the costs incurred by any other affected Licensee to divert the data communication</p>	<p>The <u><i>Transmission Licensee</i></u>, <u><i>Generation Licensee</i></u>, <u>and <i>connected person</i></u> responsible for each <i>HVDC facility</i> <u>and <i>Licensee</i></u> responsible for each <u><i>centrally dispatchable ESS</i></u> shall provide all the equipment at their respective site, including the communication equipment. The <u><i>Transmission Licensee</i></u> shall provide data communication lines from the computer room in the control centers of the <i>Power System Operator</i> to the transmission substation, <i>HVDC facility</i>, <u><i>centrally dispatchable ESS</i></u> and <i>generating station</i> switchhouses as specified by the <i>Power System Operator</i> for the purposes of real-time power system monitoring and control. <u>The <i>Licensee</i></u> responsible for each <u><i>centrally dispatchable ESS</i></u> shall be responsible for the data communication lines from their <u><i>centrally dispatchable ESS</i></u> to the <u><i>Transmission Licensee's</i></u> termination box located in their <u><i>centrally dispatchable ESS</i></u> facility. The <u><i>connected person</i></u> responsible for each <i>HVDC facility</i> shall be responsible for the data communication lines from their <i>HVDC facility</i> to the <u><i>Transmission Licensee's</i></u> termination box located in their <i>HVDC facility</i>. The <u><i>Generation Licensee</i></u> shall be responsible for the data communication lines from the <u><i>Generation Licensee's</i></u> equipment to the <u><i>Transmission Licensee's</i></u> termination box located in the <i>generating station's</i> switchhouse. The termination box, which shall be provided by the <u><i>Transmission Licensee</i></u>, shall also be used for termination of the <u><i>Transmission Licensee's</i></u> data communication lines. In the event of relocation of the termination box or diversion of the data communications lines, the <u><i>Licensee</i></u> that</p>	<p>To include communication equipment requirements for centrally dispatchable ESS.</p>

Modification Ref. No.	Clause	Original Text	Modified Text	Reasons
		lines at the affected Licensee's end caused by the relocation or diversion. All the equipment at the site shall be equipped with battery backup of at least 4-hour operation time. In addition, the AC power shall also be backed up by the standby generator at the site, if the site is equipped with such a facility.	initiates the relocation or diversion shall bear all the costs necessary for the relocation or diversion including the costs incurred by any other affected <u>Licensee</u> to divert the data communication lines at the affected <u>Licensee's</u> end caused by the relocation or diversion. All the equipment at the site shall be equipped with battery backup of at least 4-hour operation time. In addition, the AC power shall also be backed up by the standby generator at the site, if the site is equipped with such a facility.	
TC/2023/15	6.12.4	The Transmission Licensee, Generation Licensee, and <i>connected person</i> responsible for each <i>HVDC facility</i> seeking to conduct any work on their <i>remote terminal unit</i> must submit to the <i>Power System Operator</i> for approval a written proposal that clearly states the nature, purpose and duration of the work.	The <u>Transmission Licensee</u> , <u>Generation Licensee</u> , and <u>connected person</u> responsible for each <i>HVDC facility</i> and <u>Licensee</u> responsible for each <u>centrally dispatchable ESS</u> seeking to conduct any work on their <i>remote terminal unit</i> must submit to the <i>Power System Operator</i> for approval a written proposal that clearly states the nature, purpose and duration of the work.	To include RTU requirements for ESS facility.
TC/2023/16	6.12.5	The Transmission Licensee, Generation Licensee, or <i>connected person</i> responsible for each <i>HVDC facility</i> shall submit to the <i>Power System Operator</i> a test report of the commissioning of the <i>remote terminal unit</i> .	The <u>Transmission Licensee</u> , <u>Generation Licensee</u> , or <u>connected person</u> responsible for each <i>HVDC facility</i> <u>or Licensee</u> responsible for each <u>centrally dispatchable ESS</u> shall submit to the <i>Power System Operator</i> a test report of the commissioning of the <i>remote terminal unit</i> .	To include RTU requirements for ESS facility.
TC/2023/17	6.12.7	<i>Connected person</i> with solar photovoltaic system of installed capacity equal to or exceeding 1MWac at each site/facility, shall	<i>Connected person</i> with solar photovoltaic system of installed capacity equal to or exceeding 1MWac at each site/ facility location,	To clearly specify that the information to be provided to the Power System Operator

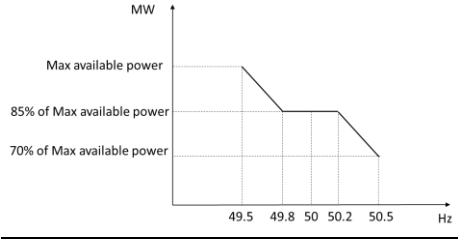
Modification Ref. No.	Clause	Original Text	Modified Text	Reasons
		<p>provide the Power System Operator with the following signals sampled and transmitted at 1 minute intervals.</p> <ul style="list-style-type: none"> • Active Power; and • Solar Irradiance <p>Detailed requirements are stated in Section H4.3.</p>	<p>shall provide the <u>Power System Operator</u> with the following signals sampled and transmitted at 1 minute intervals.</p> <ul style="list-style-type: none"> • <u>Active Power</u>; and • Solar Irradiance <p>Detailed requirements are stated in Section H4.3.</p>	<p>is based on the installed capacity at each site or location where solar photovoltaic system is installed, instead of aggregated capacity across various sites or locations.</p>
TC/2023/18	6.15.1	<p>The <i>Transmission Licensee, Generation Licensees, Wholesaler Licensees, Market Company Licensee</i> and <i>connected person</i> responsible for each <i>HVDC facility</i> shall put in place adequate cyber security measures to ensure that designated <i>Critical Information Infrastructures (CIIs)</i> are properly maintained, operated and secured, so as not to compromise, or cause any adverse impact, to the <i>security, reliability</i> and stability of the power system including interruption of electricity supply or electricity generation due to inadvertent system or equipment failure, human error or through malicious actions of other parties.</p>	<p>The <i>Transmission Licensee, Generation Licensees, Wholesaler Licensees, Market Company Licensee</i>, <u>and <i>Licensee</i></u> responsible for each <i>HVDC</i> <u>and <i>Licensee</i></u> shall put in place adequate cyber security measures to ensure that designated <i>Critical Information Infrastructures (CIIs)</i> are properly maintained, operated and secured, so as not to compromise, or cause any adverse impact, to the <i>security, reliability</i> and stability of the power system including interruption of electricity supply or electricity generation due to inadvertent system or equipment failure, human error or through malicious actions of other parties.</p>	<p>To include cyber security requirements for Critical Information Infrastructure involving ESS.</p>
TC/2023/19	C1	<p>Each <i>Generation Licensee</i> or <i>Wholesaler Licensee</i> responsible for the <i>generation facility</i>, with the exception of solar photovoltaic systems, and seeking connection to the <i>transmission system</i> shall provide the information required in accordance with the format set forth in C.1.1 to C.1.3 of this Appendix for both primary and <i>alternate fuel</i> (for <i>generating units</i> that</p>	<p>Each <i>Generation Licensee</i> or <i>Wholesaler Licensee</i> responsible for the <i>generation facility</i>, with the exception of solar photovoltaic systems, and seeking connection to the <i>transmission system</i> shall provide the information required in accordance with the format set forth in C.1.1 to C.1.3 of this Appendix for both primary and <i>alternate fuel</i> (for <i>generating units</i> that are capable of operating</p>	<p>Currently, solar photovoltaic systems are being setup in various configurations by entities who may not be a Generation Licensee or Wholesaler Licensee. This requirement is updated to provide clarify on the parties that shall provide the</p>

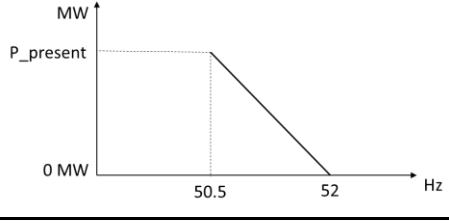
Modification Ref. No.	Clause	Original Text	Modified Text	Reasons
		<p>are capable of operating and required to operate on <i>alternate fuel</i>). For solar photovoltaic <i>generating unit</i>, the <i>Generation Licensee</i> or <i>Wholesaler Licensee</i> shall provide the information required in accordance with the format set forth in C7 of this Appendix.</p>	<p>and required to operate on <i>alternate fuel</i>). For solar photovoltaic <i>generating unit</i>, the <i>Generation Licensee</i> or <i>Wholesaler Licensee</i> shall provide the information required in accordance with the format set forth in C7 of this Appendix. <u>This requirement is also applicable to the <i>connected person's</i> solar photovoltaic <i>generating unit(s)</i> with an aggregated installed capacity of 10MWac or above at each site/facility and connected to the same <i>connection point</i>.</u></p>	<p>information required in Appendix C7.</p>
TC/2023/20	C7.2	<p>Each <i>Generation Licensee</i> or <i>Wholesaler Licensee</i> responsible for solar photovoltaic <i>generating unit(s)</i> with an aggregated installed capacity of 10MWac or above at each site/facility, and seeking connection to the <i>transmission system</i> shall provide to the <i>Transmission Licensee</i> and the <i>Power System Operator</i> (where applicable) a dynamic simulation model that fulfils the requirements set forth in the System Operation Manual.</p>	<p>Each <i>Generation Licensee</i> or <i>Wholesaler Licensee</i> responsible for solar photovoltaic <i>generating unit(s)</i> with an aggregated installed capacity of 10MWac <u>25MWac</u> or above at each site/facility, and seeking connection to the <i>transmission system</i> shall provide to the <i>Transmission Licensee</i> and the <i>Power System Operator</i> (where applicable) a dynamic simulation model that fulfils the requirements set forth in the System Operation Manual. <u>This requirement is also applicable to the <i>connected person's</i> solar photovoltaic <i>generating unit(s)</i> with an aggregated installed capacity of <u>25MWac</u> or above at each site/facility and connected to the same <i>connection point</i>.</u></p>	<p>To reduce regulatory burden, dynamic simulation model is only required for PV generating unit(s) with an aggregated installed capacity of 25MWac or above.</p>
TC/2023/21	F9.1	<p>The high resolution recorder installed shall be suitable for both dynamic and transient recording. The recorder shall be able to set at minimum sampling rate of 50Hz and 1kHz for dynamic and transient recording respectively. The basic signal to be recorded</p>	<p>The high resolution recorder installed shall be suitable for both dynamic and transient recording. The recorder shall be able to set at minimum sampling rate of 50Hz and 1kHz for dynamic and transient recording respectively. The basic signal to be recorded / monitored includes, but not limited to, the following:</p>	<p>To include the type of signals to be provided by high resolution recorder for solar photovoltaic generating units with an aggregated installed capacity of 25MWac or above at each site/facility</p>

Modification Ref. No.	Clause	Original Text	Modified Text	Reasons
		<p>/ monitored includes, but not limited to, the following:</p> <p>For HVDC Facilities</p> <p>(a) Active power (MW) and reactive power (MVar) flow at the point of connection of the HVDC facility with the transmission system</p> <p>(b) HVDC substation busbar voltage (both DC and AC voltages) and frequency</p> <p>(c) Circuit breaker and protection devices status</p>	<p>For HVDC Facilities</p> <p>(a) Active power (MW) and Reactive power (MVar) flow at the point of connection of the HVDC facility with the transmission system</p> <p>(b) HVDC substation busbar voltage (both DC and AC voltages) and frequency</p> <p>(c) Circuit breaker and protection devices status</p> <p><u>For solar photovoltaic generating units with an aggregated installed capacity of 25MWac or above at each site/facility and centrally dispatchable ESS.</u></p> <p>(a) Dynamic Recording</p> <ul style="list-style-type: none"> • <u>Active Power (MW)</u> • <u>Reactive Power (MVar)</u> • <u>Voltage (kV) at connection point</u> • <u>Current (kA) at connection point</u> • <u>Frequency (Hz)</u> <p>(b) Transient Recording</p> <ul style="list-style-type: none"> • <u>Voltage (kV) at connection point</u> • <u>Current (kA) at connection point</u> 	<p>and centrally dispatchable ESSs.</p>
TC/2023/22	F10.1	<p>The solar photovoltaic <i>generating unit</i> shall be capable of disconnecting from the transmission system if under or over voltage is detected at the <i>connected person's</i> incoming switchboard* or at the <i>generating unit</i> terminal.</p>	<p>The <u>solar photovoltaic generating unit and ESS</u> shall be capable of disconnecting from the transmission system if under or over voltage is detected at the <i>connected person's</i> incoming switchboard* or at the <i>generating unit</i> terminal.</p>	<p>To include voltage operating range (table as shown in F10.1) for ESS to ensure power system reliability and stability.</p>
TC/2023/23	F11.1	<p>Solar photovoltaic <i>generating unit</i> and other <i>generating unit</i> connected to the <i>distribution network</i> that is disconnected due to section F6.2 or section F10.1, may reconnect to the</p>	<p><u>Solar photovoltaic generating unit</u> and other <i>generating unit</i> connected to the <i>distribution network</i> that is disconnected due to section F6.2 or section F10.1, may reconnect to the</p>	<p>To update the reconnection requirements for solar photovoltaic generating unit based on the latest study</p>

Modification Ref. No.	Clause	Original Text	Modified Text	Reasons
		<p><i>transmission system</i> 1 minute after the voltage and frequency at its <i>connection point</i> have recovered and remained within the ranges listed as follows:</p> <p>(a) Frequency within 49.8Hz and 50.2Hz;</p> <p>(b) <i>Transmission network</i> voltage within $\pm 3\%$ of the nominal value or <i>distribution network</i> voltage within $\pm 6\%$ of the nominal value.</p>	<p><i>transmission system</i> 1 minute after the voltage and <i>frequency</i> at its <i>connection point</i> have recovered and remained within the ranges listed as follows:</p> <p>(a) <i>Frequency</i> within 49.8Hz <u>49.0Hz</u> and 50.2Hz;</p> <p>(b) <i>Transmission network</i> voltage within $\pm 3\%$ of the nominal value or <i>distribution network</i> voltage within $\pm 6\%$ of the nominal value.</p>	<p>conducted. By lowering the lower end of the frequency range from 49.8Hz to 49.0Hz, it will help bring solar PV generating units back to the power system earlier to provide support in times of contingencies.</p>
TC/2023/24	F12.1 & F12.1.1	<p>F12.1 Reactive Power Output Control</p> <p>F12.1.1 The solar photovoltaic <i>generating unit</i> shall be designed with capability of controlling the <i>reactive power</i> supply at the ac terminals of the inverter with the following <i>reactive power</i> output control modes.</p> <p>(a) Fixed Power Factor control mode where the solar photovoltaic <i>generating unit</i> shall operate at a 0.9 leading power factor, or otherwise specified by the Transmission Licensee or <i>Power System Operator</i>;</p> <p>(b) Q(V) according to local voltage control mode where the solar photovoltaic <i>generating unit</i> shall vary the <i>reactive power</i> output with the voltage at the ac-side of the solar photovoltaic <i>generating unit's</i> inverter(s), at the characteristic curve as illustrated below. V is actual voltage measured at reference point, Vn is nominal voltage, Q is actual feed-in <i>reactive power</i>, and Pn is nameplate <i>active power</i> rating of inverter;</p>	<p>F12.1 Reactive Power Output Control Operation Modes</p> <p>F12.1.1 The <u>solar photovoltaic generating unit with an aggregated installed capacity of 25MWac or above at each site/facility</u> shall be designed with capability of controlling the <i>reactive power</i> supply at the ac terminals of the inverter with the following <i>reactive power output control operation</i> modes.</p> <p>(a) Fixed Power Factor control mode where the <u>solar photovoltaic generating unit</u> shall operate at a 0.9 leading power factor, or otherwise specified by the <u>Transmission Licensee</u> or <i>Power System Operator</i>;</p> <p>(b) Q(V) according to local voltage control mode where the <u>solar photovoltaic generating unit</u> shall vary the <i>reactive power</i> output with the voltage at the ac-side of the <u>solar photovoltaic generating unit's</u> inverter(s), at the characteristic curve as illustrated below. V is actual voltage measured at reference point, Vn is nominal voltage, Q is actual feed-in <i>reactive</i></p>	<p>To reduce the regulatory burden on solar PV system owners, EMA has assessed that the reactive power operation mode is applicable for solar PV with an aggregated installed capacity of 25MWac or above. In addition, the Q(P) control for solar PV system is no longer required based on the latest study conducted.</p>

Modification Ref. No.	Clause	Original Text	Modified Text	Reasons
		<p>(c) Q(P) according to actual feed-in <i>active power</i> where the solar photovoltaic <i>generating unit</i> shall vary its operating power factor with the <i>active power</i> output exceeds 50% of its rated <i>active power</i> capacity. P is actual feed-in <i>active power</i>; and</p> <p>(d) Q control mode where the solar photovoltaic <i>generating unit</i> shall be capable of changing its <i>reactive power</i> output, within its <i>reactive power</i> capability range, at the <i>Connection Point</i> upon receiving a <i>Reactive Power</i> control (Q) set-point signal from the Transmission Licensee or <i>Power System Operator</i>.</p>	<p><i>power</i>, and Pn is nameplate <i>active power</i> rating of inverter;</p> <p>(c) Q(P) according to actual feed-in <i>active power</i> where the solar photovoltaic <i>generating unit</i> shall vary its operating power factor with the <i>active power</i> output exceeds 50% of its rated <i>active power</i> capacity. P is actual feed-in <i>active power</i>; and</p> <p>(d) <u>c</u>) Q control mode where the <u>solar photovoltaic</u> <i>generating unit</i> shall be capable of changing its <i>reactive power</i> output, within its <i>reactive power</i> capability range, at the <i>Connection Point</i> upon receiving a <i>Reactive Power</i> control (Q) set-point signal from the Transmission Licensee or <i>Power System Operator</i>.</p>	
TC/2023/25	F12.2 & F12.2.1	New title and new clause.	<p><u>F12.2 Active Power Operation Modes</u></p> <p><u>F12.2.1 The solar photovoltaic generating unit with an aggregated installed capacity of 25MWac or above at each site/facility shall be designed with capability of operating the active power supply at the connection point with the following active power operation modes.</u></p> <p><u>(a) Maximum Power Point Tracking mode where solar photovoltaic generating unit shall operate its MW output at maximum available power.</u></p> <p><u>(b) P limit mode where solar photovoltaic generating unit shall operate its MW output at 1) P setpoint if maximum available power of solar photovoltaic generating unit is greater than or</u></p>	Active power operation modes is required for solar photovoltaic generating unit to ensure power system stability.

Modification Ref. No.	Clause	Original Text	Modified Text	Reasons
			<p><u>equal to the active power setpoint; 2) maximum available power if maximum available power of solar photovoltaic generating unit is less than active power setpoint.</u></p>	
TC/2023/26	F12.3	New clause.	<p><u>F12.3 Frequency Sensitive Mode</u></p> <p><u>The solar photovoltaic generating unit with an aggregated installed capacity of 25MWac or above at each site/facility shall be designed with capability of Frequency sensitive mode. In this mode, solar photovoltaic generating unit shall operate its MW output capable of responding automatically to the variation in the system frequency of ± 0.5Hz. When the power system is in emergency operating state, Power System Operator may direct those solar photovoltaic units connected to the transmission system to activate this mode and to operate as stipulated in the figure below.</u></p> 	<p>Frequency Sensitive Mode are required for solar photovoltaic generating unit to ensure power system stability.</p>
TC/2023/27	F12.4	New clause.	<p><u>F12.4 Over Frequency Active Power Reduction</u></p> <p><u>All solar photovoltaic generating unit shall start to reduce its MW output when system frequency</u></p>	<p>To include over frequency active power reduction requirement for solar photovoltaic generating unit</p>

Modification Ref. No.	Clause	Original Text	Modified Text	Reasons
			<p>is` greater than 50.5Hz, and shall reach 0 MW when system frequency reaches 52Hz. For avoidance of doubt, the <i>solar photovoltaic generating unit</i> shall continue to remain online within this frequency range, i.e. synchronise with the grid.</p>  <p>For the avoidance of doubt, when the power system is in emergency operating state, <i>solar photovoltaic generating units</i> may be requested to be disconnected from the <i>transmission system</i>.</p>	to ensure power system stability.
TC/2023/28	H3.3	It is the responsibility of the <i>Transmission Licensee, Generation Licensee, Wholesaler Licensee</i> and <i>connected person</i> responsible for each <i>HVDC facility</i> to provide all the equipment at the remote site. The communication equipment shall include encryption devices to ensure secure communication on the communication lines. These encryption devices shall be of the same make and model as the devices installed at the PSO control centres.	It is the responsibility of the <i>Transmission Licensee, Generation Licensee, Wholesaler Licensee, and connected person</i> responsible for each <i>HVDC facility</i> <u>and Licensee responsible for each centrally dispatchable ESS</u> to provide all the equipment at the remote <u>their respective</u> site. The communication equipment shall include encryption devices to ensure secure communication on the communication lines. These encryption devices shall be of the same make and model as the devices installed at the PSO control centres.	To include communication requirement for ESS.
TC/2023/29	H5.3	Measurements All measurements are represented by 16-bit values:	Measurements All measurements are represented by 16-bit values:	To include data representation requirements for ESS.

Modification Ref. No.	Clause	Original Text	Modified Text	Reasons
		<p>(a) Range values are –32767 to +32767 or 0 to 65535.</p> <p>(b) For substations, <i>HVDC facilities</i> and switchhouses, power flowing out is positive. For <i>generating units</i>, power flowing out is considered positive.</p> <p>(c) MW and MVar values for <i>generating units</i> are gross values taken before the <i>generating unit</i> step up transformer.</p> <p>(d) MW and MVar values for <i>HVDC facility</i> are gross values taken at the <i>point of connection</i> of the <i>HVDC facility</i> with the <i>transmission system</i>.</p> <p>(e) MW, V and A values on the DC side of each <i>HVDC pole</i>.</p>	<p>(a) Range values are –32767 to +32767 or 0 to 65535.</p> <p>(b) For substations, <i>HVDC facilities</i> and switchhouses, power flowing out is positive. For <i>generating units</i>, power flowing out is considered positive.</p> <p>(c) MW and MVar values for <i>generating units</i> are gross values taken before the <i>generating unit</i> step up transformer.</p> <p>(d) MW and MVar values for <i>HVDC facility</i> are gross values taken at the <i>point of connection</i> of the <i>HVDC facility</i> with the <i>transmission system</i>.</p> <p>(e) MW, V and A values on the DC side of each <i>HVDC pole</i>.</p> <p>(f) <u>MW and MVar values for <i>ESS</i> are gross values taken before the <i>ESS's</i> step-up transformer.</u></p>	
TC/2023/30	H7.2	<p>Response Requirements</p> <p>The following performance standards shall, on a continual basis, be achieved for all telemetry requirements:</p> <p>(a) Any change in the status in the field shall be reported spontaneously to the <i>EMS</i> within 1 seconds of the change.</p> <p>(b) All measurements shall be updated periodically. With the exception of AGC parameters, the updating cycle shall be 10</p>	<p>Response Requirements</p> <p>The following performance standards shall, on a continual basis, be achieved for all <u><i>Remote Terminal Unit (RTU)</i></u>'s telemetry requirements:</p> <p>(a) Any change in the status in the field shall be reported spontaneously to the <i>EMS</i> within 1 seconds of the change.</p> <p>(b) All measurements shall be updated periodically. With the exception of AGC parameters, the updating cycle shall be 10</p>	To make clear that the response requirements are applicable to all facilities equipped with RTU.

Modification Ref. No.	Clause	Original Text	Modified Text	Reasons
		<p>seconds. AGC parameters such as <i>generating unit</i> MW and MVar and busbar <i>frequency</i> shall be updated every 2 seconds.</p> <p>(c) AGC pulses from the <i>EMS</i> to the <i>generating units</i> are transmitted every 4 seconds.</p>	<p>seconds. AGC parameters such as <i>generating unit</i> MW and MVar and busbar <i>frequency</i> shall be updated every 2 seconds.</p> <p>(c) AGC pulses from the <i>EMS</i> to the <i>generating units</i> are transmitted every 4 seconds.</p>	
TC/2023/31	H9	<p>Testing and Commissioning</p> <p>The following requirements are needed for testing and commissioning:</p> <p>(a) To facilitate AGC testing, a mechanism (software or hardware) is needed to isolate the AGC signals from the turbine control.</p> <p>(b) Copies of all commissioning tests are to be submitted.</p> <p>(c) The <i>Transmission Licensee, Generation Licensee, Wholesaler Licensee</i> or <i>connected person</i> responsible for each <i>HVDC facility</i> shall have qualified personnel on site during commissioning to confirm and verify all data sent to the <i>EMS</i>.</p> <p>Copies of all final as-built drawings, parameters and data are to be submitted.</p>	<p>Testing and Commissioning <u>of a Facility's AGC Interface</u></p> <p>The following requirements are needed for testing and commissioning <u>of a facility's AGC interface</u>:</p> <p>(a) To facilitate AGC testing, a mechanism (software or hardware) is needed to isolate the AGC signals from the turbine <u><i>generating unit</i></u> control.</p> <p>(b) Copies of all commissioning tests are to be submitted.</p> <p>(c) The <i>Transmission Licensee, Generation Licensee, Wholesaler Licensee, or connected person</i> responsible for each <i>HVDC facility</i> <u>or Licensee</u> responsible for each <u><i>centrally dispatchable ESS</i></u> shall have qualified personnel on site during commissioning to confirm and verify all data sent to the <i>EMS</i>.</p> <p>Copies of all final as-built drawings, parameters and data are to be submitted.</p>	To include testing and commissioning requirement for ESS.
TC/2023/32	Appendix L	New appendix.	<u>APPENDIX L ENERGY STORAGE SYSTEM REQUIREMENTS</u>	This new appendix specifies the requirements for Energy Storage Systems.

Modification Ref. No.	Clause	Original Text	Modified Text	Reasons
TC/2023/33	L1	New clause.	<p><u>Preliminary ESS Data to be Submitted for Consideration of Connection to the Transmission System</u></p> <p><u>Each Licensee responsible for ESS who seek connection to the transmission system shall provide the information required in accordance with the format set forth in L1.1 to L1.3 of this Appendix.</u></p>	To specify the data required of an ESS for consideration of connection to the transmission system.
TC/2023/34	L1.1	New clause	<p><u>General information of ESS</u></p> <p>(a) <u>Name of the ESS</u> (b) <u>Total power rating (MW)</u> (c) <u>Total storage capacity (MWh)</u> (d) <u>Brief description of the configuration of the ESS including types of storage (battery type, fly-wheel, etc.) and number of discrete units.</u> (e) <u>Total power required for auxiliaries</u></p>	This clause specifies the list of general information required for the ESS.
TC/2023/35	L1.2	New clause.	<p><u>Technical information of ESS</u></p> <p>(a) <u>Voltage at connection point</u> (b) <u>Maximum instantaneous power output in MW</u> i. <u>For supplying energy to the transmission system</u> ii. <u>For absorbing energy from the transmission system</u> (c) <u>State-of-charge (SoC) safety operation range</u></p> <ul style="list-style-type: none"> • <u>Minimum SoC (%)</u> • <u>Maximum SoC (%)</u> 	To include new clauses which specify the list of technical information required for each ESS.

Modification Ref. No.	Clause	Original Text	Modified Text	Reasons
			<p>(d) <u>Energy storage capacity (MWh) degradation over the lifetime of ESS.</u></p> <p>(e) <u>Round-trip efficiency.</u></p> <p>(f) <u>Maximum Rate of MW Change Capability</u></p> <ul style="list-style-type: none"> • <u>supplying to transmission system (MW/sec)</u> • <u>absorbing from transmission system (MW/sec)</u> <p>(g) <u>Capability Curve:</u></p> <ul style="list-style-type: none"> • <u>Reactive Power Capability Curve</u> • <u>Factory Test Reports and field test result if any</u> <p>(h) <u>Control design and dynamic models for centrally dispatchable Energy Storage System</u></p> <ol style="list-style-type: none"> i. <u>Functional description and block diagram showing transfer function of MW control and Voltage Regulation.</u> ii. <u>Dynamic models shall be provided to the Transmission Licensee and the Power System Operator (where applicable) that fulfils the requirements set forth in the System Operation Manual.</u> iii. <u>Dynamic models shall be submitted in PSSE format (i.e. user defined model with source code in flecs format or standard library model). The parameters and models shall be validated via site tests for their ESS. The method of testing shall be designed to cover the linear and non-linear responses of ESS.</u> iv. <u>The parameters and models are considered validated when the computer simulation results match the site test results. Simulation and site test results</u> 	

Modification Ref. No.	Clause	Original Text	Modified Text	Reasons
			<p><u>shall be overlaid on the same plots using the same scales.</u></p> <p>v. <u>Commissioning tests or other field test results.</u></p>	
TC/2023/36	L1.3	New clause.	<p><u>ESS protection and step-up transformer</u></p> <p>(a) <u>ESS protection – Functional description and settings including:</u></p> <ul style="list-style-type: none"> • <u>CT ratios</u> • <u>VT ratios</u> • <u>Settings</u> <p>(b) <u>step-up transformer</u></p> <ul style="list-style-type: none"> • <u>Rated MVA Capacity</u> _____ MVA • <u>Rated voltage</u> <ul style="list-style-type: none"> - <u>Primary</u> _____ kV - <u>Secondary</u> _____ kV • <u>Nominal</u> _____ <u>voltage</u> _____ <u>ratio,</u> <u>primary/secondary</u> • <u>Positive sequence impedance at</u> <ul style="list-style-type: none"> - <u>Maximum tap</u> _____ % - <u>Minimum tap</u> _____ % - <u>Nominal tap</u> _____ % • <u>Zero phase sequence impedance</u> _____ % • <u>Tap changer range</u> + _____ % - _____ % <hr/> <ul style="list-style-type: none"> • <u>Tap changer step size</u> _____ % • <u>Tap changer type on load / off load</u> • <u>Winding connection and Vector Group</u> • <u>Magnetizing curve</u> • <u>Earthing resistor of transformer (if any)</u> <ul style="list-style-type: none"> - <u>At Primary side</u> - <u>At Secondary side</u> 	To include new clauses which specify the list of protection and step-up transformer information required for each ESS.

Modification Ref. No.	Clause	Original Text	Modified Text	Reasons
			<ul style="list-style-type: none"> • <u>Report on predicted transformer energization performance including electromagnetic transient studies</u> <p><u>All the data shall be provided in Rated MW Capacity and Rated MVA Capacity base, respectively.</u></p>	
TC/2023/37	L2	New clause.	<p><u>Commissioning Test Schedule</u></p> <p><u>Each Licensee responsible for centrally dispatchable ESS who seek connection to the transmission system shall provide the information required in accordance with sections L2.1 to L2.3 of this Appendix.</u></p>	To include a section on information required for commissioning of an ESS.
TC/2023/38	L2.1	New clause.	<p><u>To provide the date where ESS is expected to be connected to the transmission system.</u></p>	To include the information to be provided when commissioning an ESS facility.
TC/2023/39	L2.2	New clause.	<p><u>To provide the date where ESS is expected to commence commercial operation.</u></p>	To include the information to be provided when commissioning an ESS facility.
TC/2023/40	L2.3	New clause.	<p><u>To provide the Commissioning Test Schedules. All test schedules to indicate date, time, and unit's output profile as well as low / medium / high risks of ESS outage.</u></p> <p>(a) <u>Primary Reserve Capability Tests with response in 2 seconds.</u></p> <p>(b) <u>Contingency Reserve Tests</u></p> <p>(c) <u>Automatic Generation Control Tests</u></p> <p>(d) <u>Reactive Power Capability Tests</u></p> <p>(e) <u>Local Frequency Regulation Tests</u></p>	To include the information to be provided when commissioning an ESS facility.

Modification Ref. No.	Clause	Original Text	Modified Text	Reasons
			<p>(f) <u>Capacity Tests (Charging/Discharging Tests)</u></p> <p>(g) <u>Others</u></p> <p><u>For avoidance of doubt, if unspecified, the per minute ramp rate shall be controlled within 20% of the MW capacity of the Generation Registered Facility due to the potential effect on power system stability.</u></p>	
TC/2023/41	L4	New clause.	<p><u>Centrally Dispatchable Energy Storage System Unit Minimum Capability Requirements</u></p> <p><u>All ESSs registered with the Energy Market Company as generation registered facility (analogous to an AGC generating unit) shall be centrally dispatched and designed to have the following minimum capabilities.</u></p> <p>(a) <u>Automatic Generation Control Capability</u></p> <p><u>All centrally dispatchable ESSs shall be designed to be capable of providing regulation reserve via Automatic Generation Control; and controlled and monitored by the Power System Operator's EMS.</u></p> <p>(b) <u>State-of-Charge Management Capability</u></p> <p><u>The state-of-charge shall be managed locally to ensure the centrally dispatchable ESS operates safely. For the avoidance of doubt, Power System-Operator shall not be the party to manage the state-of-charge of centrally dispatchable ESS.</u></p>	To include the operational capability requirements for ESS facilities registered for centrally dispatch.

Modification Ref. No.	Clause	Original Text	Modified Text	Reasons
			<p>(c) <u>Primary Reserve Capability with 2 second response</u></p> <p><u>The centrally dispatchable ESS shall be designed to have the capability of providing quick response to frequency deviations. This quick response, when required, will supersede any other ESS's controls. The primary reserve with 2 second response shall have the following characteristics.</u></p> <ul style="list-style-type: none"> i. <u>A deadband of ±0.20 Hz around nominal system frequency shall be used to prevent the centrally dispatchable ESS from providing quick response from 49.80 Hz to 50.20 Hz.</u> ii. <u>A frequency response droop of 1% or smaller shall be used to ensure full centrally dispatchable ESS's output for a frequency deviation of 0.50 Hz (49.30 Hz system frequency). The droop response shall be enabled as long as the centrally dispatchable ESS is still connected to the transmission system.</u> iii. <u>The state-of-charge shall be managed locally to be capable of providing primary reserves with response to full output in 2 seconds and last for a minimum of 10 minutes.</u> <p>(d) <u>Contingency Reserve Capability</u></p>	

Modification Ref. No.	Clause	Original Text	Modified Text	Reasons
			<p>i. <u>The centrally dispatchable ESS must be capable of providing contingency reserve up to its Rated MW Capacity within 10 minutes and shall be verified through test stipulated in the System Operation Manual.</u></p> <p>(e) <u>Over Frequency MW Reduction</u></p> <p><u>The centrally dispatchable ESS shall start to reduce its MW output when system frequency is greater than 50.20Hz with droop of 1% or smaller.</u></p> <p>(f) <u>Capacity Limited Ramp Rate</u></p> <p><u>Capacity Limited Ramp Rate describes the manner in which the centrally dispatchable ESS shall control its active power (charging/discharging) as it approaches the limits of its energy capacity (State-of-Charge). The per minute Capacity Limited Ramp Rate shall be within 20% of the MW capacity of the Generation Registered Facility.</u></p> <p>(g) <u>Protective Relay Systems</u></p> <p><u>The protective relay systems for the centrally dispatchable ESS should be adequate to prevent equipment damage for contingencies occurring both within the centrally dispatchable ESS and outside the centrally dispatchable ESS on the transmission system. The Licensee</u></p>	

Modification Ref. No.	Clause	Original Text	Modified Text	Reasons
			<p><u>responsible for each centrally dispatchable ESS shall be responsible for the operation and maintenance of each protective relay system within the centrally dispatchable ESS. Reference is given in Appendix F.</u></p> <p>(h) <u>Performance Monitoring Facility</u></p> <p><u>The Licensee responsible for each ESS shall provide, install, and maintain at its own cost high-resolution recorder(s) for monitoring and assessment of performance by PSO.</u></p> <p><u>The requirements of high-resolution recorder(s) are given in Appendix F. The Licensee responsible for each centrally dispatchable ESS, upon receiving notification from PSO, shall furnish such records/data in softcopy via email in the format as specified in Appendix F9.2(g) within 24 hours.</u></p> <p>(i) <u>Remote Monitoring and Automatic Control</u></p> <p><u>The Licensee responsible for each centrally dispatchable ESS shall make provision at their facility for remote monitoring of the ESS's output and switchhouse equipment loading and operating conditions. This monitoring capability shall include:</u></p> <ol style="list-style-type: none"> <u>1. the direction of power flow and the state-of-charge of the ESSs;</u> <u>2. Circuit Breaker & Switch Status;</u> <u>3. ESS Remote (AGC) or Local Frequency Control Status;</u> 	

Modification Ref. No.	Clause	Original Text	Modified Text	Reasons
			<p>4. <u>Converter Fault Status;</u> 5. <u>Battery System Fault Status;</u> 6. <u>Controller Fault Status;</u> 7. <u>RTU Communication Fault Status,</u> 8. <u>Intake Voltage (kV), Frequency,</u> 9. <u>Facility gross active & reactive power,</u> 10. <u>AGC Pulse (Control Point),</u> 11. <u>Aggregated Auxiliary Load,</u> 12. <u>Energy Charged & Discharge and</u> 13. <u>Any other measurements or status as required by PSO.</u></p> <p><u>Provisions shall also be made for automatic control of the centrally dispatchable ESS's output from the Power System Operator's EMS. Refer Section 6.12 for the requirement on Remote Monitoring and Automatic Generation Control.</u></p> <p>(j) <u>Self-start capability</u></p> <p><u>The centrally dispatchable ESS shall be designed to have the self-start capability using power conversion system to supply its own auxiliary loads up to rated MW capacity and maintain the operation up to the grid connection point, subject to the remaining energy leftover at that point in time.</u></p> <p>(k) <u>Local Frequency Regulation</u></p> <p><u>The centrally dispatchable ESS shall be designed to have local frequency regulation capability.</u></p>	

Modification Ref. No.	Clause	Original Text	Modified Text	Reasons																								
TC/2023/42	K4	<p>(b) <i>CII Owners</i> shall provide updated copy of <i>CII's</i> network diagram and asset inventory lists annually or as and when there are changes to the network equipment in machine readable PDF format showing the following information but not limited to;</p> <ul style="list-style-type: none"> • Hostname; • IP address of the equipment/devices. 	<p>(b) <i>CII Owners</i> shall provide updated copy of <i>CII's</i> network diagram, and asset inventory lists annually or as and when there are changes to the network equipment and <u>any material change to the design, configuration, security or operation of the <i>CII</i> no later than 30 days after the change is made.</u> These are to be provided in machine readable PDF format showing the following information but not limited to;:</p> <ul style="list-style-type: none"> • Hostname; • IP address of the <u><i>CII's</i></u> equipment/devices;: • <u>Functionality of <i>CII</i>;</u> • <u>Application/Software Platforms of <i>CII</i>;</u> • <u>Outsource or insource of <i>CII</i> operation;</u> • <u>Addition or removal of <i>CII's</i>' equipment/devices and/or cybersecurity components;</u> • <u>Key stakeholders responsible for cybersecurity of the <i>CII</i>.</u> 	To provide clarity that <i>CII Owners</i> shall provide the material change carried out in the <i>CII</i> no later than 30 days after the change is made.																								
TC/2023/43	I1.2	<p>Transformers</p> <table border="0"> <tr> <td>1) Transformer ratio</td> <td>400/230kV</td> <td>230/66kV</td> <td>230/66kV</td> </tr> <tr> <td>2) Transformer Vector Group</td> <td>Yyond11</td> <td>Yyond11</td> <td>Yyond11</td> </tr> <tr> <td>2) Neutral grounding</td> <td>Solid grounding</td> <td>Solid grounding at 230kV side and through 19.5Ω Neutral resistor</td> <td>Grounded through 6.5 Ω Neutral resistor grounding at 22kV side.</td> </tr> </table>	1) Transformer ratio	400/230kV	230/66kV	230/66kV	2) Transformer Vector Group	Yyond11	Yyond11	Yyond11	2) Neutral grounding	Solid grounding	Solid grounding at 230kV side and through 19.5Ω Neutral resistor	Grounded through 6.5 Ω Neutral resistor grounding at 22kV side.	<p>Transformers</p> <table border="0"> <tr> <td>1) Transformer ratio</td> <td>400/230kV</td> <td>230/66kV</td> <td>230/66kV</td> </tr> <tr> <td>2) Transformer Vector Group</td> <td>Yyeond11</td> <td>Yyeond11</td> <td>Yyeond11</td> </tr> <tr> <td>2) Neutral grounding</td> <td>Solid grounding</td> <td>Solid grounding at 230kV side and through 19.5Ω Neutral resistor</td> <td>Grounded through 6.5 Ω Neutral resistor grounding at 22kV side.</td> </tr> </table>	1) Transformer ratio	400/230kV	230/66kV	230/66kV	2) Transformer Vector Group	Yye o nd11	Yye o nd11	Yye o nd11	2) Neutral grounding	Solid grounding	Solid grounding at 230kV side and through 19.5Ω Neutral resistor	Grounded through 6.5 Ω Neutral resistor grounding at 22kV side.	To amend the configuration of “Transformer Vector Group” to clearly specify the symbol of phase displacement.
1) Transformer ratio	400/230kV	230/66kV	230/66kV																									
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Modification Ref. No.	Clause	Original Text	Modified Text	Reasons
		grounding at 66kV side	grounding at 66kV side	

Representations on the Proposed Modifications to the Transmission Code

Name: _____

Designation: _____

Company: _____

Email: _____

Role (Generation Licensee/ Retailer/ Consumer):

Submission Date: _____ (dd/mm/yy)

Modification Ref. No.	Section	Comments