



DECISION PAPER

PROPOSED MODIFICATIONS TO THE TRANSMISSION CODE

12 SEPTEMBER 2024

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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 and operate installations on the transmission system.

2 Proposed modifications to the Transmission Code

- 2.1 Pursuant to Section 1.6 of the Transmission Code, EMA has sought representations on the proposed modifications to the Transmission Code to update and clarify the technical requirements relating to Energy Storage Systems (“ESS”), photovoltaic (PV) generation units, generating units, mitigation of single points of failure and cybersecurity.
- 2.2 We received feedback from four respondents by the closing of consultation on 2 October 2023.
- 2.3 EMA has since reviewed the feedback pertaining to the proposed modifications and our responses are detailed in [Annex 1](#).

3 EMA’s Decision

- 3.1 Taking into account the feedback received, EMA has decided to modify clauses of the Transmission Code as set out in [Annex 2](#). The proposed modifications will come into effect on 26 Sep 2024.

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EMA's Response to Written Representations

Modification Ref. No.	Clause	Public/ Industry	Comments	EMA's Response
TC/2023/1	1.3.1	SP Group	<p>SPPA:</p> <p>1. We wish to confirm that “solar PV” is not a “generating station”.</p> <p>2. We wish to clarify that where “generation facility” is referenced in the Transmission Code, it also applies to “solar PV”. This is to provide clarity on requirements related to solar PV.</p> <p>SPES:</p> <p>1. We would like to clarify that a generation facility should refer to the “solar PV system”. This is because solar PV is generally defined as semiconducting cells that convert sunlight into electrical energy, excluding the other electrical components of the system. Hence, we propose the following amendment for clarity:</p> <p>“solar photovoltaic system” or “solar PV system” means a <i>generation facility</i> that produces electricity by means of solar irradiance incident to semiconducting materials (i.e. solar cells)</p> <p>2. In addition, we wish to clarify whether there is a need to introduce a certain capacity cap in the definition of solar PV system to ensure that when the term is referenced to in the Transmission Code, it only applies to solar PV system with a certain capacity</p>	<p><u>Response on SPPA feedback:</u></p> <p>1. The new definition is revised to “solar photovoltaic generation facility” or “solar PV generation facility” which means a generation facility that produces electricity by means of solar irradiance incident to semiconducting materials (i.e. solar cells).</p> <p>To align with the new definition, “solar photovoltaic generating unit(s)” is amended to “solar photovoltaic generation facility” in TC/2023/19, TC/2023/20, TC/2023/21, TC/2023/22, TC/2023/23, TC/2023/24, TC/2023/25, TC/2023/26 and TC/2023/27.</p> <p>2. Requirements applicable to "generation facility" will apply to solar PV generation facilities, unless otherwise stated.</p> <p><u>Response on SPES feedback:</u></p> <p>1. Please see response above.</p> <p>2. The capacity threshold is specified in the clauses, where relevant.</p>

Modification Ref. No.	Clause	Public/ Industry	Comments	EMA's Response
			cap. Otherwise, the cap may need to be specifically mentioned in some clauses where relevant.	
TC/2023/2	1.3.1	SP Group	SPPA: We would like to confirm that Uninterruptible Power Supply (UPS) does not fall under this definition. This is because UPS is not used for or for the purposes connected with the production of electricity. Consequently, SPPG will not be required to include UPS in the ESS registry.	This definition will not be introduced.
TC/2023/3	1.3.1	SP Group	SPPA: 1. We would like to confirm that Uninterruptible Power Supply (UPS) does not fall under this definition. This is because UPS is not used for or for the purposes connected with the production of electricity. Consequently, SPPG will not be required to include UPS in the ESS registry. 2. We wish to confirm that "ESS" is not a "generating station", but that "ESS" is a "generation facility". As such, where "generation facility" is referenced in the Transmission Code, it also applies to "ESS". This is to provide clarity on requirements related to ESS.	1. UPS does not fall under this definition. 2. The ESS definition is revised for clarity. Please refer to Annex 2, TC/2023/3.
TC/2023/4	1.3.1	SP Group	SPPA: 1. We would like to clarify what is the minimum ESS capacity that can be considered to be centrally dispatchable. 2. We wish to confirm that a "generation facility" does not include a "centrally dispatchable Energy Storage	1. The capacity for centrally dispatchable ESS is tied to and specified under the Generation Registered Facility requirements, which are defined in the Market Rules. 2. With reference to the new definition in TC/2023/3, ESS is a generation facility.

Modification Ref. No.	Clause	Public/ Industry	Comments	EMA's Response
			System". This is to provide clarity on requirements related to centrally dispatchable Energy Storage System.	
TC/2023/5	4.1.1	SP Group	<p>SPPA:</p> <p>1. As SPPA does not require all the information listed in Appendix L, we propose that Appendix L not be submitted by the connection applicant to the Transmission Licensee, but to PSO directly.</p> <p>2. We wish to confirm that SPPA does not have to verify the information provided by the connection applicant in Appendix L or to ensure the connection applicant's continuous compliance with its obligations in this clause.</p>	<p>1. As ESS is a type of generation facility, the connection application process and submission of the information described in Appendix L to the Transmission Licensee is no different from the prevailing practice for generation facilities, which requires submission of the information described in Appendix C.</p> <p>2. Please see our response above.</p>
TC/2023/6	4.2.1	SP Group	<p>SPPA:</p> <p>Refer to comment in TC/2023/5</p>	Please refer to the response in TC/2023/5.
TC/2023/10	6.1.6	YTLPS	<p>Based on the consultation paper titled "Centralised Process to ensure sufficient generation capacity" dated 10 April 2023, the EMA has stated in Paragraph 7 that "All Gencos are also required (under the Transmission Code) to provide a notice period of at least 5 years to retire any licensed generation units, mainly the CCGTs."</p> <p>As such, we propose the following amendments to align with EMA's intent, which is targeted at the combined cycle gas turbine generating units for the Gencos to provide the specified notice period.</p>	<p>The Consultation Paper for the Centralised Process has been superseded by the Final Determination Paper published on 31st July 2023.</p> <p>Reference to the Final Determination Paper, this retirement requirement applies to any generating unit of a Generation Licensee. Moreover, the intent of this modification pertains to the notice period; the generating units for which it applies to remains unchanged.</p>

Modification Ref. No.	Clause	Public/ Industry	Comments	EMA's Response
			<p>The amendments are as shown below:</p> <p>a) Any Generation Licensee that intends to retire any of its combined cycle gas turbine generating units, shall submit a written request to the Authority for approval not later than 31 March of the year that is 5 years prior to the year of the intended retirement of the combined cycle gas turbine generating unit¹, and shall provide such information that the Authority requires to facilitate the Authority's decision in relation to whether to approve the retirement of the combined cycle gas turbine generating unit (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 Authority may, if it considers necessary or appropriate, approve the retirement of the combined cycle gas turbine generating unit subject to conditions.</p> <p>¹For example, if a Generation Licensee intends to retire any of its combined cycle gas turbine generating units in 1 Jan 2029 to 31 Dec 2029, he Generation Licensee shall submit a written request to the Authority not later than 31 March 2024.</p>	
TC/2023/11	6.11.2	SP Group	SDC and SPES:	This requirement is applicable only to generation facilities owned/managed by Generation Licensees that are connected to the transmission network.

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			<p>1. We wish to clarify if this clause applies only to generation facility owned/managed by Generation Licensees.</p> <p>Otherwise, it is not economically viable to impose this requirement on generating unit with capacity of less than 10MWac due to high investment costs.</p> <p>Furthermore, the generating unit of less than 10MW do not pose any technical and commercial threats on the electricity system if it fails to operate. Any distortion to the market is expected to be negligible as well.</p> <p>Such generating facility is also not required to be registered as Generation Registered Facility ("GRF") for dispatch by the PSO and settlement in the wholesale electricity market.</p> <p>Hence, EMA should give more flexibility to smaller generating unit to encourage adoption of Solar and ESS in Singapore's electricity market.</p> <p>2. We wish to clarify that this paragraph applies only to generating unit or facility that is connected to high voltage (1000V ac or 1500V dc).</p>	
TC/2023/14	6.12.3		<p>SPPA:</p> <p>1. Preferably, the data communication lines of the centrally dispatchable ESS should be connected to a transmission substation or 22kV source substation. It is not advisable to connect at downstream distribution</p>	<p>1. ESS owner selecting the location of ESS shall consider the reliability, redundancies, and accessibility to Transmission Licensee data communication lines to control centres of Power System Operator. In addition, the communication to the control centres shall be point-to-point connection.</p>

Modification Ref. No.	Clause	Public/ Industry	Comments	EMA's Response
			<p>substation due to data communication constraint from the ESS to control centres of Power System Operator.</p> <p>If we need to connect the power cables of the centrally dispatchable ESS to the distribution substation but the data communication lines is to be connected to the transmission substation, we need to consult with EMA on the work scope, the timeline and cost recovery.</p> <p>2. We would like to clarify if a “centrally dispatchable ESS” can be located outside of Singapore (e.g. energy import from outside Singapore).</p> <p>If a “centrally dispatchable ESS” can be located outside of Singapore, we wish to confirm that the Transmission Licensee’s terminal box will only be located at the point of common coupling (in the Transmission Licensee’s substation in Singapore).</p>	<p>The Transmission Licensee should advise the ESS owner on the feasibility of the proposed location for ESS connection during the consultation stage.</p> <p>2. The centrally dispatchable ESS can be located overseas. However, as the active power measured at point of common coupling (<i>i.e. substation in Singapore</i>) will be used by PSO’s Energy Management System (EMS) for AGC control, the Licensee responsible for the centrally dispatchable ESS shall ensure the ESS’s controllers located overseas will be able to respond to PSO’s Energy Management System (EMS) AGC’s control signals and transmit any other measurements as requested by PSO</p> <p>Transmission Licensee’s terminal box shall be located at the connection point, which is the Transmission Licensee’s substation in Singapore that is designated for overseas ESS connection. The Licensee responsible for the overseas ESS shall ensure the establishment of data communication connectivity between overseas and local termination box.</p>
TC/2023/17	6.12.7	SP Group	<p>SPES: We would like to confirm with EMA that the purpose of the amendment is to require connected person with solar photovoltaic system of installed capacity equal to or exceeding 1MWac to provide information to the PSO based on the installed capacity at each point of connection.</p>	<p>The purpose of the amendment is to provide clarity that the consideration is the installed capacity at each site and not the connection point. The modified text is revised for clarify. Please refer to Annex 2, TC/2023/17.</p>

Modification Ref. No.	Clause	Public/ Industry	Comments	EMA's Response
			<p>If yes, for the purpose of consistency with the rest of the Transmission Code, we would like to propose to amend the clause as below:</p> <p>“Connected person with solar photovoltaic system of installed capacity equal to or exceeding 1MWac <u>at each site and connected to the same connection point</u>, shall provide the Power System Operator with the following signals sampled and transmitted at 1 minute interval”</p>	
TC/2023/18	6.15.1	SP Group	<p>SDC:</p> <p>1. Please confirm the following understanding that this clause is only meant for centrally dispatchable ESS systems designated as CII.</p> <p>2. In addition, we wish to clarify whether a company, that owns centrally dispatchable ESS systems not designated at CII but interfaces with the power systems designated at CII, needs to also put in place adequate cyber security measures?</p>	<p>1. This clause is meant only for licensees who own installation(s) that is/are designated as Critical Information Infrastructure (CII)(s).</p> <p>2. While a licensee's system may not be designated as a CII, it is paramount to recognise that the absence of such a designation does not diminish the necessity for robust cybersecurity measures. In today's interconnected and digitally dependent world, all systems, regardless of their formal classification, are interlinked in various ways with critical information infrastructure and other critical systems. Even though the designation of CII carries its own set of regulatory requirements and priorities, it does not negate the need for comprehensive cybersecurity measures in all systems. Every organization, whether designated as CII or not, should prioritise cybersecurity to protect its own assets, the larger ecosystem, and the nation's overall security and resilience.</p>
TC/2023/19	C1	SP Group	<p>SPPA:</p> <p>We would like to clarify whether the proposed modification of revising the term “facility” in</p>	<p>We will retain the “site/facility” in TC/2023/19 and TC/2023/20 since one location may have multiple</p>

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			"site/facility" to "site/location" at TC/2023/17 should also apply to other modifications in this consultation paper, such as at TC/2023/19 and TC/2023/20.	connection points. After further review, we will amend the term to "site" at TC/2023/17.
TC/2023/20	C7.2	SP Group	SPPA: We propose to remove the phrase "(where applicable)" as the System Operation Manual is a document designed and maintained by the Energy Market Authority.	The System Operation Manual is one of the Market Manuals, referenced in the Market Rules, that all Market Participants (including SPPA/SPPG) are required to comply with where specific clauses are applicable to them. Hence, the phrase "(where applicable)" will remain.
TC/2023/21	F9.1	SP Group	SDC: We would like to propose that the requirement for the installation of high-resolution recorder should only apply to centrally dispatchable ESS <u>with capacity of more than 10MWac.</u> This is because the amount of energy injected/withdrawn by the ESS with capacity of less than 10MWac is limited, and thus do not pose any technical and commercial threats on the electricity system if it fails to operate. EMA should give more flexibility to ESS with capacity of less than 10MWac to encourage and facilitate adoption of ESS in Singapore's electricity market.	We will retain the phrasing because the capacity threshold for centrally dispatchable ESS is tied to and specified under the Generation Registered Facility requirements, which are defined in the Market Rules.
TC/2023/22	F10.1	SP Group	SPES: For ESS, we would like to propose that the "Neutral" pole to remain in contact when disconnecting the	The purpose of this clause is to ensure that the solar PV and ESS have the capability to disconnect from the transmission system if under or over voltage is detected. The clause also specifies the range of

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			remaining poles from the transmission system. i.e., Three Poles Neutral (TPN) Disconnecter.	abnormal operating voltages and the corresponding minimum holding time before disconnection and the maximum trip time allowable. The owner of the ESS shall ensure that the ESS is disconnected from the transmission system without compromising the reliability and security of the network.
TC/2023/23-27	F11.1, F12.1 & F12.1.1, F12.2 & F12.2.1, F12.3, F12.4	Keppel	Could EMA provide the study referenced in the proposed modifications for the recommended new requirements for solar PVs? Keppel would also like to clarify if the proposed code modifications will apply to existing solar generation facilities.	The proposed modifications for solar PVs are based on the practice in other utilities/jurisdictions (e.g. Energinet, EETC, National Grid, AEMO/AEMC, ENTSO-E, BDEW and EirGrid). The proposed modifications will apply for all new and/or future proposed modifications of existing solar generation facilities.
TC/2023/24	F12.1 & F12.1.1	SP Group	SPPA: In relation to F12.1.1(b), i. We wish to clarify whether this clause is applicable to solar PV energy imports from outside of Singapore. ii. If so, we propose that the reference voltage be taken at the point of common coupling (i.e. Transmission Licensee's substation in Singapore). This is because the importer has to comply with all the requirements in the Transmission Code at the point of common coupling.	EMA plans to conduct the industry consultation on the Transmission Code change required for electricity import after we have completed the current modification for solar PV and ESS. SPPA's comment will be taken into consideration when drafting the consultation paper for electricity import.
TC/2023/26	F12.3	SP Group	SPES: We would like to propose that the curtailment be carried out at an interval of 10% instead of 15% to ensure a gradual and smooth curtailment.	The proposed modifications are based on the practice in other utilities/jurisdictions (e.g. Energinet, EETC, National Grid, AEMO/AEMC, ENTSO-E, BDEW and

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				EirGrid). As such, we would retain the 15% interval as proposed.
TC/2023/27	F12.4	SP Group	<p>SPES: The requirement to reduce the MW output when system frequency is greater than 50.5Hz, and shall reach 0 MW when system frequency reaches 52Hz should not be imposed on solar photovoltaic generating unit with an aggregated installed capacity of less than 25MWac at each site/facility and connected to the same connection point.</p> <p>This is because such function is not available for smaller sized string inverters which are used for systems less than 25MWac.</p>	Based on the technical scan with other utilities/jurisdictions (e.g. Energinet, EETC, National Grid, AEMO/AEMC, ENTSO-E, BDEW and EirGrid), such function is also readily available for small size solar. Therefore, we will retain the phrasing.
TC/2023/29	H5.3	SP Group	<p>SPES: For accuracy purposes, we propose that MW and MVar values used for ESS be the gross values taken at the point of connection of the ESS with the transmission system (not before the ESS's step-up transformer).</p>	The point of connection of the ESS to the transmission system may entail the connection of other generating units and/or loads on the same site and therefore, does not reflect the actual gross output of the ESS. Gross MW and MVar measurements taken before the ESS's step-up transformer is necessary for AGC control and this requirement is similar to that for each Generation Registered Facility.
TC/2023/35	L1.2	SP Group	<p>SPPA: 1. We propose to remove the phrase "(where applicable)" as the System Operation Manual is a document designed and maintained by the Energy Market Authority.</p> <p>2. For clause (h) iii and (h) iv, we propose to redraft as below:</p>	<p>1. The System Operation Manual is one of the Market Manuals, referenced in the Market Rules, that all Market Participants (including SPPA/SPPG) are required to comply with where specific clauses are applicable to them. Hence, the phrase "(where applicable)" will remain.</p> <p>2. We will retain the same phrasing as it is essential for validation purposes of the dynamic model.</p>

Modification Ref. No.	Clause	Public/ Industry	Comments	EMA's Response
			<p><u>iii 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></p> <p><u>iv The parameters and models are considered validated when the computer simulation results match the site test results for their ESS. Simulation and site test results shall be overlaid on the same plots using the same scales. The method of site testing shall be designed to cover the linear and non-linear responses of ESS.</u></p>	
TC/2023/35	L1.2	YTLPS	<p>We would like to seek clarification on the timing that the models have to be provided. Is it acceptable: (a) generic models are sufficient during permission phase or (b) specific models need to be provided at commissioning.</p>	<p>As ESS is considered as a generation facility, this is no different from the existing generation connection process in Section 4 of the Transmission Code for the submission requirements.</p>
TC/2023/40	L2.3	YTLPS	<p>Regarding "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"</p> <p>We would like to clarify that in case the ESS is a Dedicated Facility which is part of a Generation Facility, is this requirement only for the period the Dedicated Facility ESS is on the grid? (<20% per minute ramp rate)</p>	<p>The proposed paragraph – "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" will be reviewed further. Therefore, this proposed paragraph will not be included in this round of modifications to the Code.</p>

Modification Ref. No.	Clause	Public/ Industry	Comments	EMA's Response
TC/2023/41	L4	SP Group	<p>SPES: We would like to clarify if the requirement for part (e) of this clause should be the same as that of F12.4.</p>	To clarify, F12.4 is the over frequency active power reduction requirement for solar PV, whereas L4(e) is the over frequency MW reduction for centrally dispatchable ESS. They are designed to be different.
TC/2023/42	K4	EMC	<p>Currently, the set of information submitted to CSA and EMA for Material Change submission are the same as the proposed changes.</p> <p>We would like to seek your understanding to align the change submission form to CSA Material Change Submission form (CII Information Record) for ease of maintenance of using a single form for submission to both EMA and CSA.</p>	<p>To clarify, EMA is not requiring an additional submission to EMA for material change. The current process for Licensees to submit the material change form to Cybersecurity Agency (CSA) and to copy EMA still remains. The proposed amendments to this clause is to reflect the existing process and requirements.</p> <p>To provide clarity and to distinguish between CII annual information update to EMA and Material Change submission to CSA (with EMA copied), we have amended the proposed modification to retain Appendix K4(b) in its entirety and to introduce Appendix K4(c) to cover the submission for material change. Please refer to Annex 2, TC/2023/42:</p>
TC/2023/43	I1.2	SP Group	<p>SPPA: We propose to amend the configuration of "Transformer Vector Group" to clearly specify the symbol of phase displacement.</p>	EMA will need to consult the industry on proposed modifications to the Transmission Code and requests that SPPA provide detailed justification for the proposed modification so that it may be considered for the next round of consultation.

Modification Ref. No.	Clause	Public/ Industry	Comments	EMA's Response
			<p>Transformers</p> <p>1) Transformer ratio 400/230kV 230/66kV 230/66kV 66/22kV</p> <p>2) Transformer Vector YyoNd11 YyoNd11 YyoNd11 Group YNad1 YNvn0d1 Yvn0+d</p> <p>2) Neutral grounding Solid grounding Solid grounding at 230kV side and through 19.5Ω Neutral resistor</p> <p style="padding-left: 150px;">grounding at 66kV side</p> <p style="padding-left: 150px;">Grounded through 6.5 Ω Neutral resistor grounding at 22kV side.</p>	

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 generation facility” or “solar PV generation facility” 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.	“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;	To include new definition for “energy storage unit”. This definition will not be introduced after further review.
TC/2023/3	1.3.1	New definition.	<u>“Energy Storage System” or “ESS” means a <i>generating facility</i> that has the ability to consume electricity from the transmission system, store the energy consumed, and later release the energy by supplying electricity to the transmission system;</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 registered with the Energy Market Company as a generation registered facility and is centrally dispatched;</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	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.	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.	To include the required information to be submitted by a connection applicant for an ESS connection.
TC/2023/6	4.2.1	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	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.	To include the required information to be submitted by a connection applicant for an ESS connection.

Modification Ref. No.	Clause	Original Text	Modified Text	Reasons
		Licensee in writing of any material additions or changes to the information submitted.		
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</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</p>	To include the required information to be submitted by a connection applicant for an ESS connection.

Modification Ref. No.	Clause	Original Text	Modified Text	Reasons
		applicable laws and regulations in the Republic of Singapore have been met;	regulations in the Republic of Singapore have been met;	
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 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.	For the commissioning of a <i>generation facility</i> , 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 <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	To include the required information to be submitted in Appendix L for ESS commissioning.

Modification Ref. No.	Clause	Original Text	Modified Text	Reasons
			given to the <u>Generation Licensee</u> or the <u>Licensee responsible for each centrally dispatchable ESS</u> .	
TC/2023/9	4.6.3	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.	Upon completion of the testing and commissioning of the <i>generation facility</i> <u>or centrally dispatchable ESS</u> , the <u>Generation Licensee</u> or the <u>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> .	To include the required information to be submitted in Appendix L for ESS commissioning.
TC/2023/10	6.1.6	(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	(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	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.

Modification Ref. No.	Clause	Original Text	Modified Text	Reasons
		<p>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><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><u>For example, if a <i>Generation Licensee</i> intends to retire any of its <i>generating units</i> in 1 Jan 2029 to 31 Dec 2029, the <i>Generation Licensee</i> shall submit a written request to the <i>Authority</i> not later than 31 March 2024.</u></p>	

Modification Ref. No.	Clause	Original Text	Modified Text	Reasons
TC/2023/11	6.11.2	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.	When connected to the <u><i>transmission network</i></u> , the <i>generation facility</i> , <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><i>auxiliary equipment and measuring instruments</i></u> shall be designed <u>and operated in</u> such <u>manner</u> 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 <u><i>Generation Licensees</i></u> submits with justifications the use of a different switchboard configuration for the <i>Power System Operator's</i> consideration.	To stipulate that the generation facility, auxiliary equipment and measuring instruments connected to the transmission network, should be designed and operated with no single point of failure that can cause outage of more than one generating unit.
TC/2023/12	6.12.1	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	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</i></u> responsible for each <u><i>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	To include Remote Terminal Unit requirements for centrally dispatchable ESS.

Modification Ref. No.	Clause	Original Text	Modified Text	Reasons
		<p>required includes status of <i>circuit breakers</i>, isolators, <i>earthing switches</i>, <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 taps and other quantities as specified by the <i>Power System Operator</i> are also required.</p>	<p>Appendix H. Facilities for remote control are required only for substations, <u><i>HVDC facilities</i></u> and <u><i>centrally dispatchable ESS</i></u>. Information required includes status of <i>circuit breakers</i>, isolators, <i>earthing switches</i>, <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 taps and other quantities as specified by the <i>Power System Operator</i> are also required.</p>	
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 <u><i>generating unit's</i></u> 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 <u><i>the Power System Operator's Energy Management System</i></u> as specified in Appendix H.</p>	<p>To include RTU's requirement for centrally dispatchable ESS in clause (b).</p>

Modification Ref. No.	Clause	Original Text	Modified Text	Reasons
			<p><u>(b) The Licensee responsible for each centrally dispatchable ESS shall provide the Remote Terminal Unit(s) for remote monitoring of its ESS's operating conditions, as well as facilities for automatic control of centrally dispatchable ESS's output from Power System Operator's Energy Management System as specified in Appendix H.</u></p>	
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</p>	<p>The <u><i>Transmission Licensee, Generation Licensee, and connected person</i></u> responsible for each <i>HVDC facility</i> and <u><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 <u>centres</u> 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 Licensee responsible for each centrally dispatchable ESS shall be responsible for the data communication lines from their centrally dispatchable ESS to the Transmission Licensee's termination box located in their centrally dispatchable ESS</u></p>	<p>To include communication equipment requirements for centrally dispatchable ESS.</p>

Modification Ref. No.	Clause	Original Text	Modified Text	Reasons
		<p>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 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.</p>	<p><u>facility</u>. The <u>connected person</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>Transmission Licensee's</u> termination box located in their <i>HVDC facility</i>. The <u>Generation Licensee</u> shall be responsible for the data communication lines from the <u>Generation Licensee's</u> equipment to the <u>Transmission Licensee's</u> termination box located in the <i>generating station's</i> switchhouse. The termination box, which shall be provided by the <u>Transmission Licensee</u>, shall also be used for termination of the <u>Transmission Licensee's</u> data communication lines. In the event of relocation of the termination box or diversion of the data communications lines, the <u>Licensee</u> 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 <u>Licensee or connected person</u> to divert the data communication lines at the affected <u>Licensee's or connected person'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.</p>	

Modification Ref. No.	Clause	Original Text	Modified Text	Reasons
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><i>Transmission Licensee, Generation Licensee, and connected person</i></u> responsible for each <i>HVDC facility</i> <u>and Licensee</u> responsible for each <u><i>centrally dispatchable ESS</i></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><i>Transmission Licensee, Generation Licensee, or connected person</i></u> responsible for each <i>HVDC facility</i> <u>or Licensee</u> responsible for each <u><i>centrally dispatchable ESS</i></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 provide the <i>Power System Operator</i> with the following signals sampled and transmitted at 1 minute intervals. <ul style="list-style-type: none"> • Active Power; and • Solar Irradiance Detailed requirements are stated in Section H4.3.	<i>Connected person</i> with solar photovoltaic system of installed capacity equal to or exceeding 1MWac at each site/ facility , shall provide the <u><i>Power System Operator</i></u> with the following signals sampled and transmitted at 1 minute intervals. <ul style="list-style-type: none"> • <u><i>Active Power</i></u>; and • Solar Irradiance Detailed requirements are stated in Section H4.3.	To clearly specify that the information to be provided to the <i>Power System Operator</i> is based on the installed capacity at each site where solar photovoltaic system is installed, instead of aggregated capacity across various sites. This requirement applies solar PV systems that may connect to different connection points but is

Modification Ref. No.	Clause	Original Text	Modified Text	Reasons
				essentially located at the same site. It does not apply to solar PV systems that is geographically distributed but is connected to a single connection point.
TC/2023/18	6.15.1	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.	The <i>Transmission Licensee, Generation Licensees, Wholesaler Licensees, Market Company Licensee</i> , and <i>connected person</i> responsible for each <i>HVDC and Licensee</i> responsible for each <i>centrally dispatchable ESS</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.	To include cyber security requirements for Critical Information Infrastructure involving ESS.
TC/2023/19	C1	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	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	Currently, solar photovoltaic systems are being setup in various configurations by entities who may not be a Generation Licensee or

Modification Ref. No.	Clause	Original Text	Modified Text	Reasons
		<p>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 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>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 and required to operate on <i>alternate fuel</i>). For <i>solar photovoltaic <u>generation facilities</u></i>, <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 solar photovoltaic generation facility</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>Wholesaler Licensee. This requirement is updated to provide clarify on the parties that shall provide the 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> or <i>connected person</i> responsible for <i><u>solar photovoltaic generation facilities</u></i> <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.</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>

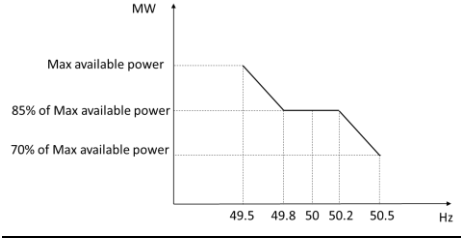
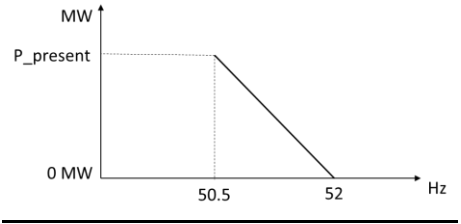
Modification Ref. No.	Clause	Original Text	Modified Text	Reasons
TC/2023/21	F9.1	<p>The high resolution recorder installed shall be suitable for both dynamic and transient recording. The recorder shall be able to set at minimum sampling rate of 50Hz and 1kHz for dynamic and transient recording respectively. The basic signal to be recorded / monitored includes, but not limited to, the following:</p> <p><i>For HVDC Facilities</i></p> <p>(a) <i>Active power (MW) and reactive power (MVar) flow at the point of connection of the HVDC facility with the transmission system</i></p> <p>(b) <i>HVDC substation busbar voltage (both DC and AC voltages) and frequency</i></p> <p>(c) <i>Circuit breaker and protection devices status</i></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 signals to be recorded / monitored includes, but is not limited to, the following:</p> <p><i>For HVDC Facilities</i></p> <p>(a) <i>Active power (MW) and Reactive power (MVar) flow at the point of connection of the HVDC facility with the transmission system</i></p> <p>(b) <i>HVDC substation busbar voltage (both DC and AC voltages) and frequency</i></p> <p>(c) <i>Circuit breaker and protection devices status</i></p> <p><u><i>For solar photovoltaic generation facility with an aggregated installed capacity of 25MWac or above at each site/facility and centrally dispatchable ESS.</i></u></p> <p>(a) <u>Dynamic Recording</u></p> <ul style="list-style-type: none"> • <u>Active Power (MW)</u> • <u>Reactive Power (MVar)</u> • <u>Voltage (kV)</u> • <u>Current (kA)</u> • <u>Frequency (Hz)</u> <p>(b) <u>Transient Recording</u></p> <ul style="list-style-type: none"> • <u>Voltage (kV)</u> • <u>Current (kA)</u> 	<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 and centrally dispatchable ESSs.</p>

Modification Ref. No.	Clause	Original Text	Modified Text	Reasons
TC/2023/22	F10.1	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.	The <u>solar photovoltaic generation facility</u> <i>generating unit</i> and <u>ESS</u> shall be capable of disconnecting from the <u>transmission system</u> if under or over voltage is detected at the <i>connected person's</i> incoming switchboard* or at the <i>generating unit</i> terminal.	To include ESS on the voltage operating range (table as shown in F10.1) to ensure power system reliability and stability.
TC/2023/23	F11.1	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 <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: (a) Frequency within 49.8Hz and 50.2Hz; (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.	<u>Solar photovoltaic generation facility</u> <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 <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: (a) Frequency within 49.8Hz <u>49.0Hz</u> and 50.2Hz; (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.	To update the reconnection requirements for solar photovoltaic generating unit based on the latest study conducted. By lowering the requirement on 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.
TC/2023/24	F12.1 & F12.1.1	F12.1 Reactive Power Output Control 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.	F12.1 Reactive Power Output Control Operation Modes F12.1.1 The <u>solar photovoltaic generation facility</u> <i>generating unit</i> <u>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>	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

Modification Ref. No.	Clause	Original Text	Modified Text	Reasons
		<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, V_n is nominal voltage, Q is actual feed-in <i>reactive power</i>, and P_n 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) 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></p>	<p>supply at the ac terminals of the inverter with the following <i>reactive power output control</i> <u>operation</u> modes.</p> <p>(a) Fixed Power Factor control mode where the <u><i>solar photovoltaic generation facility generating unit</i></u> shall operate at a 0.9 leading power factor, or otherwise specified by the <u><i>Transmission Licensee</i></u> or <i>Power System Operator</i>;</p> <p>(b) Q(V) <u>mode</u> according to local voltage control mode where the <u><i>solar photovoltaic generation facility generating unit</i></u> shall vary the <i>reactive power</i> output with <u>reference to</u> the voltage at the ac-side of the <u><i>solar photovoltaic generation facility's generating unit's</i></u> inverter(s), <u>at in accordance to</u> the characteristic curve as illustrated below. V is actual voltage measured at reference point, V_n is nominal voltage, Q is actual <u>feed-in <i>reactive power output</i></u>, and P_n 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>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>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>(dc) <u>Constant Q control mode where the solar photovoltaic generation facility generating unit shall be capable of changing its reactive power output, within its reactive power capability range, at the connection point</u> Connection Point upon receiving a <i>Reactive Power</i> control (Q) set-point signal from the Transmission Licensee or <i>Power System Operator</i>.</p> <p><u>The Transmission Licensee or Power System Operator will inform the solar photovoltaic generation facility of the reactive power operation mode to operate in and the corresponding reactive power setpoint.</u></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 generation facility with an aggregated installed capacity of 25MWac or above at each site/facility shall be designed with capability of controlling the active power supply measured at the connection point with the following active power operation modes.</u></p> <p><u>(a) Maximum Power Point Tracking mode where the solar photovoltaic generation facility shall operate its MW output at maximum available power.</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>(b) P limit mode where the solar photovoltaic generation facility shall operate its MW output at 1) active power setpoint if maximum available power of the solar photovoltaic generation facility is greater than or equal to the active power setpoint; 2) maximum available active power if maximum available active power of the solar photovoltaic generation facility is less than active power setpoint.</u></p> <p><u>The Transmission Licensee or Power System Operator will inform the solar photovoltaic generation facility of the active power operation mode to operate in and the corresponding active power setpoint.</u></p>	
TC/2023/26	F12.3	New clause.	<p><u>F12.3 Frequency Sensitive Operation Mode</u></p> <p><u>The solar photovoltaic generation facility with an aggregated installed capacity of 25MWac or above at each site/facility shall be designed with capability of frequency sensitive operation. In this mode of operation, the solar photovoltaic generation facility shall be capable of responding automatically to normal variation in the system frequency of ±0.5Hz by varying its active power output in accordance to the figure below. When the power system is in emergency operating state, the Power System Operator may direct solar</u></p>	<p>Frequency Sensitive Operation Mode is required of solar photovoltaic generating unit to ensure power system stability.</p>

Modification Ref. No.	Clause	Original Text	Modified Text	Reasons
			<p><u>photovoltaic generation facilities connected to the transmission system to activate in this operation mode.</u></p> 	
TC/2023/27	F12.4	New clause.	<p><u>F12.4 Over Frequency Active Power Reduction</u></p> <p><u>All solar photovoltaic generation facilities shall start to reduce its MW output when system frequency is` greater than 50.5Hz and shall reach 0 MW when system frequency reaches 52Hz. For avoidance of doubt, the solar photovoltaic generation facility shall continue to remain online within this frequency range, i.e. synchronised with the grid.</u></p> 	To include over frequency active power reduction requirement for solar photovoltaic generating unit to ensure power system stability.

Modification Ref. No.	Clause	Original Text	Modified Text	Reasons
			<p><u>When the power system is in emergency operating state, Power System Operator may direct solar photovoltaic generation facilities connected to the transmission system to disconnect from the transmission system.</u></p>	
TC/2023/28	H3.3	<p>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.</p>	<p>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 and Licensee</i> responsible for each <i>centrally dispatchable ESS</i> 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.</p>	To include communication requirement for ESS.
TC/2023/29	H5.3	<p>Measurements</p> <p>All measurements are represented by 16-bit values:</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</p>	<p>Measurements</p> <p>All measurements are represented by 16-bit values:</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</p>	To include data representation requirements for ESS.

Modification Ref. No.	Clause	Original Text	Modified Text	Reasons
		<p>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>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 ESS are gross values taken before the ESS 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 seconds. AGC parameters such as <i>generating unit</i> MW and MVar and</p>	<p>Response Requirements</p> <p>The following performance standards shall, on a continual basis, be achieved for all <u>Remote Terminal Unit (RTU)'s</u> 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 seconds. AGC parameters such as</p>	<p>To make clear that the response requirements are applicable to all facilities equipped with RTU.</p>

Modification Ref. No.	Clause	Original Text	Modified Text	Reasons
		<p>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><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</i>, Wholesaler Licensee, or <i>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.

Modification Ref. No.	Clause	Original Text	Modified Text	Reasons
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.
TC/2023/33	L1	New clause.	<u>Preliminary ESS Data to be Submitted for Consideration of Connection to the Transmission System</u> <u>Each Licensee responsible for ESS seeking 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>	To specify the data required of an ESS for consideration of connection to the transmission system.
TC/2023/34	L1.1	New clause	<u>General information of ESS</u> (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 storages (battery type, fly-wheel, etc.) and number of discrete units for each type.</u> (e) <u>Total power required for auxiliaries</u>	This clause specifies the list of general information required for the ESS.
TC/2023/35	L1.2	New clause.	<u>Technical information of ESS</u> (a) <u>Voltage at connection point</u> (b) <u>Maximum active power</u> i. <u>For supplying electricity to the transmission system</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
			<ul style="list-style-type: none"> ii. <u>For consuming electricity from the transmission system</u> (c) <u>State-of-charge (SoC) safety operation range</u> <ul style="list-style-type: none"> • <u>Minimum SoC (%)</u> • <u>Maximum SoC (%)</u> (d) <u>Energy storage capacity (MWh) degradation over the lifetime of ESS.</u> (e) <u>Round-trip efficiency.</u> (f) <u>Maximum Rate of MW Change Capability</u> <ul style="list-style-type: none"> • <u>supplying electricity to transmission system (MW/sec)</u> • <u>consuming electricity from transmission system (MW/sec)</u> (g) <u>Capability Curve:</u> <ul style="list-style-type: none"> • <u>Reactive Power Capability Curve</u> • <u>Factory test reports and field test result if any</u> (h) <u>Control design and dynamic models for centrally dispatchable Energy Storage System</u> <ul style="list-style-type: none"> i. <u>Functional description and block diagram showing transfer function of active power control and voltage regulation.</u> ii. <u>Dynamic models shall be provided to the Transmission Licensee and the Power System Operator (where applicable) in accordance with the requirements set forth in the System Operation Manual.</u> 	

Modification Ref. No.	Clause	Original Text	Modified Text	Reasons
			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 shall be overlaid on the same plots using the same scales.</u> v. <u>Commissioning tests or other field test results.</u>	
TC/2023/36	L1.3	New clause.	<u>ESS protection and step-up transformer</u> (a) <u>ESS protection – Functional description and settings including:</u> <ul style="list-style-type: none"> • <u>CT ratios</u> • <u>VT ratios</u> • <u>Settings</u> (b) <u>Step-up transformer</u> <ul style="list-style-type: none"> • <u>Rated MVA Capacity _____ MVA</u> • <u>Rated voltage</u> <ul style="list-style-type: none"> - <u>Primary _____ kV</u> - <u>Secondary _____ kV</u> • <u>Nominal _____ voltage _____ ratio, primary/secondary _____</u> • <u>Positive sequence impedance at</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>Maximum tap</u> _____ % - <u>Minimum tap</u> _____ % - <u>Nominal tap</u> _____ % • <u>Zero phase sequence impedance</u> _____ % • <u>Tap changer range</u> + _____ % - _____ % • <u>Tap changer step size</u> _____ % • <u>Tap changer type</u> on load / off load • <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> • <u>Report on predicted transformer energization performance including electromagnetic transient studies unless otherwise agreed with the PSO</u> <p><u>All data shall be provided in 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 to be connected to the transmission system shall provide the</u></p>	To include a section on information required for commissioning of an ESS.

Modification Ref. No.	Clause	Original Text	Modified Text	Reasons
			<u>information required in accordance with sections L2.1 to L2.3 of this Appendix.</u>	
TC/2023/38	L2.1	New clause.	<u>Date ESS is expected to be connected to the transmission system.</u>	To include the information to be provided when commissioning an ESS facility.
TC/2023/39	L2.2	New clause.	<u>Date ESS is expected to commence commercial operation.</u>	To include the information to be provided when commissioning an ESS facility.
TC/2023/40	L2.3	New clause.	<u>Commissioning Test Schedules: All test schedules to indicate date, time, and centrally dispatchable ESS's output profile as well as low / medium / high risks of ESS outage.</u> (a) <u>Primary Reserve Capability Tests with response in 2 seconds</u> (b) <u>Contingency Reserve Tests</u> (c) <u>Automatic Generation Control Tests</u> (d) <u>Reactive Power Capability Tests</u> (e) <u>Local Frequency Regulation Tests</u> (f) <u>Capacity Tests (Charging/Discharging Tests)</u> (g) <u>Others</u> <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>	To include the information to be provided when commissioning an ESS facility.

Modification Ref. No.	Clause	Original Text	Modified Text	Reasons
TC/2023/41	L3	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 shall be centrally dispatched and be designed to have the following capabilities except where the Licensees declare with technical justifications that certain capabilities are technically not possible and submit such request together with its supporting reasons for PSO consideration.</u></p> <p>(a) <u>Automatic Generation Control Capability</u></p> <p><u>All centrally dispatchable ESSs shall be designed to be capable of automatic control of ESS output from 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</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><u>manage the state-of-charge of centrally dispatchable ESS.</u></p> <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"> <li>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> <li>ii. <u>A frequency response droop of 1% or lower shall be set 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> <li>iii. <u>The state-of-charge shall be managed locally to be capable</u> 	

Modification Ref. No.	Clause	Original Text	Modified Text	Reasons
			<p><u>of providing primary reserve with response to full output measured at 2 seconds and to be sustained for the period of 9 minutes and 58 seconds, and must be verified through test stipulated in the System Operation Manual.</u></p> <p>(d) <u>Contingency Reserve Capability</u></p> <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 lower.</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</u></p>	

Modification Ref. No.	Clause	Original Text	Modified Text	Reasons
			<p><u>minute Capacity Limited Ramp Rate shall be not exceed 20% of the rated MW capacity of the ESS.</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 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 the Power System Operator.</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</u></p>	

Modification Ref. No.	Clause	Original Text	Modified Text	Reasons
			<p><u>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</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 etc. This monitoring capability shall include:</u></p> <ol style="list-style-type: none"> 1. <u>the direction of power flow and the state-of-charge of the ESSs;</u> 2. <u>Circuit Breaker & Switch Status;</u> 3. <u>ESS Remote (AGC) or Local Frequency Control Status;</u> 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> 	

Modification Ref. No.	Clause	Original Text	Modified Text	Reasons
			<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 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>	
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 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><u>c) <i>CII Owners</i> shall provide to the Cyber Security Agency (with the Authority copied) any material change to the design, configuration, security or operation of the critical information infrastructure ("CII") no</u></p>	Proposed modification to provide for <i>CII Owners</i> to update the Cyber Security Agency and the Authority on any material changes to <i>CII</i> .

Modification Ref. No.	Clause	Original Text	Modified Text	Reasons
			<p><u>later than 30 days after the change is made to the following:</u></p> <ul style="list-style-type: none"> • <u>Network architecture or topology of CII</u> • <u>Functionality of CII;</u> • <u>Application/Software Platforms of CII;</u> • <u>Outsource or insource of CII operation;</u> • <u>Addition or removal of CII's equipment/devices and/or cybersecurity components;</u> • <u>Key stakeholders responsible for cybersecurity of the CII.</u> 	
TC/2023/43	11.2	<p>Transformers</p> <p>1) 400/230 230/66k 230/66k Transfer kV √ √ mer ratio</p> <p>2) Yyond1 Yyond1 Yyond1 Transfer 1 1 1 mer Vector Group</p>	<p>Transformers</p> <p>1) 400/230 230/66k 230/66k Transfer kV √ √ mer ratio</p> <p>2) Yyo0nd Yyo0nd Yyo0nd Transfer 11 11 11 mer Vector Group</p>	<p>To amend the configuration of “Transformer Vector Group” to clearly specify the symbol of phase displacement. This proposed modification is being further reviewed. and will not be included in this round of modifications to the Code.</p>

Modification Ref. No.	Clause	Original Text	Modified Text	Reasons
		2) Solid Ground Neutral groundi ed groundi ng at through 230kV 6.5Ω side and Neutral through resistor 19.5Ω groundi Neutral ng at resistor 22kV groundi side. ng at 66kV side	2) Solid Ground Neutral groundi ed groundi ng at through 230kV 6.5Ω side and Neutral through resistor 19.5Ω groundi Neutral ng at resistor 22kV groundi side. ng at 66kV side	