Amendment-3 (dated:19.04.2024) to RFP Documents for "Transmission System under Provision of Dynamic Reactive Compensation at KPS1 and KPS3" through tariff based competitive bidding process.

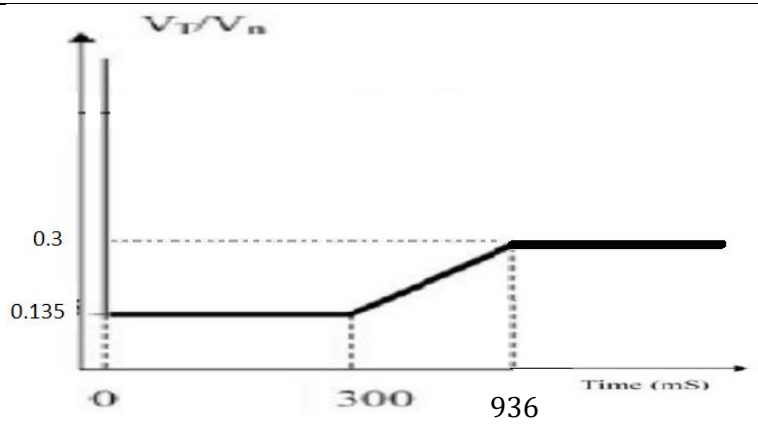
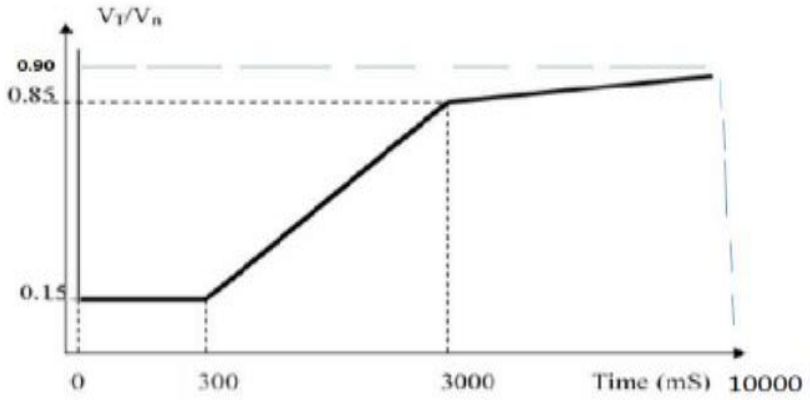
Sl. No.	Clause No.	Existing Clause	New/Revised Clause
1.	RFP Specific Technical Requirements for STATCOM Clause no. A.8.9	**A.8.9 Coupling Transformer** The TSP shall provide single-phase coupling transformers to operate as 3- phase bank with one unit as a common spare for stepping down the voltage from 400 kV system to a suitable medium voltage value as required. Common spare transformer unit shall be provided with necessary auxiliary arrangements for replacing any one of the faulty phase units without physically shifting the transformer.	**A.8.9 Coupling Transformer** The TSP shall provide single-phase coupling transformers to operate as 3- phase bank with one unit as a common spare **(cold spare)** with necessary auxiliary arrangements for stepping down the voltage from 400 kV system to a suitable medium voltage value as required for replacing any one of the faulty phase units without physically shifting the transformer.
2.	RFP Specific Technical Requirements for STATCOM Clause no. A.3	**A.3 Scope of work for STATCOM** …… …… The scope of work with regard to the works associated with the STATCOM at KPS1 shall comprise of ±1X300 MVAr Modular Multi-level Voltage Source Converter (MMC-VSC) based STATCOM along with 1x125 MVAr MSC (Mechanically Switched Capacitors) and 2x125 MVAr MSR (Mechanically Switched Reactors) in each 400kV Bus Sections i.e Bus Section-1 & Bus Section-2. The scope of work with regard to the works associated with the STATCOM at KPS3 shall comprise of ±1X300 MVAr Modular Multi-level Voltage Source Converter (MMC-VSC) based STATCOM along with 1x125 MVAr MSC (Mechanically	**A.3 Scope of work for STATCOM** ……. ……. The scope of work with regard to the works associated with the STATCOM at KPS1 shall comprise of ±1X300 MVAr Modular Multi-level Voltage Source Converter (MMC-VSC) based STATCOM along with 1x125 MVAr MSC (Mechanically Switched Capacitors) and 2x125 MVAr MSR (Mechanically Switched Reactors) in each 400 kV Bus Sections i.e Bus Section-1 and Bus Section-2. The scope of work with regard to the works associated with the STATCOM at KPS3 shall comprise of ±1X300 MVAr Modular Multi-level Voltage Source Converter (MMC-VSC) based STATCOM along with 1x125 MVAr MSC

Sl. No.	Clause No.	Existing Clause	New/Revised Clause
		Switched Capacitors) and 2x125 MVAr MSR (Mechanically Switched Reactors) in Bus Section-1. The TSP shall be responsible for complete installation of STATCOM station along with the substation works as specified in the complete scope of work. …… ……	(Mechanically Switched Capacitors) and 2x125 MVAr MSR (Mechanically Switched Reactors) in Bus Section-1. **STATCOM can either be Single/ multiple units. Minimum size of a unit allowed is 150 – 200 MVAr. TSP shall ensure that there are no coordination issues between multiple STATCOM branches of STATCOM station. Further complete Dynamic range for STATCOM may also be installed based on appropriate studies instead of combination of VSC with MSC/MSR technology. Minimum MV bus voltage is to be decided by OEMs.** The TSP shall be responsible for the complete installation of STATCOM station along with the substation works as specified in the complete scope of work. …… ……
3.	RFP Specific Technical Requirements for STATCOM Clause no. **A.6.2.1.6**	**A.6.2.1.6 Damping of Power Oscillations** The STATCOM shall provide necessary damping to power oscillations by modulating its output in its entire range based on the measured rate of change of power/frequency at the 400kV bus. The damping controller would track local area oscillations as well as wide area oscillations and control would include several loops each focused on different frequencies.	**A.6.2.1.6 Damping of Power Oscillations** The STATCOM shall provide necessary damping to power oscillations by modulating its output in its entire range based on the measured rate of change of power/frequency at the 400 kV bus. The damping controller would track local area oscillations as well as wide area oscillations and control would include several loops each focused on different frequencies. **TSP shall ensure the damping of oscillation during the entire license period including the pre–commissioning period as per relevant standards. (e.g. IEEE 1052).**

Sl. No.	Clause No.	Existing Clause	New/Revised Clause
4.	RFP Specific Technical Requirements for STATCOM Clause no. A.3	**A.3 Scope of work for STATCOM** …… …… TSP shall carry out a detailed study on prevailing system conditions before interconnection of the STATCOM to assess the performance of the STATCOM. Parameters tuning to avoid any adverse impact on the grid with integration of the STATCOM shall also be identified and implemented at this stage. TSP shall carry out tuning of Power Oscillation damping (POD) along with an interaction study with nearby HVDC/FACTS controllers. …….. …….	**A.3 Scope of work for STATCOM** …… …… TSP shall carry out a detailed study on prevailing system conditions before interconnection of the STATCOM to assess the performance of the STATCOM. Parameters tuning to avoid any adverse impact on the grid with integration of the STATCOM shall also be identified and implemented at this stage. TSP shall carry out tuning of Power Oscillation damping (POD) along with an interaction study with nearby HVDC/FACTS controllers. **TSP shall ensure interconnection study at the time of commissioning and shall also be responsible for tuning the POD during the license period as per relevant standards (e.g. IEEE 1052).** …….. …….
5.	RFP Specific Technical Requirements for STATCOM Clause no. A.8.4	**A.8.4 STATCOM Station Fault Recording System** An integrated Transient Fault Recording (TFR) System shall be supplied, installed and commissioned. This shall include trigger level settings for analog signal, etc subject to review and comment. Disturbance and event recording facilities are required for local monitoring of the STATCOM following a disturbance on the power system or the STATCOM System. The following inputs are required:	**A.8.4 STATCOM Station Fault Recording System** An integrated Transient Fault Recording (TFR) System shall be supplied, installed and commissioned. This shall include trigger level settings for analog signal, etc subject to review and comment. Disturbance and event recording facilities are required for local monitoring of the STATCOM following a disturbance on the power system or the STATCOM System. The TFR shall be GPS synchronized. The following inputs

Sl. No.	Clause No.	Existing Clause	New/Revised Clause
		• All analog signals (output signals) • All digital signals (control outputs, status indications, commands, alarms, and trip indications). Internal STATCOM Station control signals/variables to be selectable. • The accuracy of the TFR for event inputs shall be at least 100 μs (sampling rate of minimum 10 kHz). • The TFR shall have provision for remote access and retrieval of recorded information onto a PC. For this purpose, a communication link to the substation LAN shall be implemented. • The remote software application for data retrieval shall be included.	are required: • All analog signals (output signals) **including 3-ph & sequence values of voltage, current.** • All digital signals (control outputs, status indications, commands, alarms, and trip indications). Internal STATCOM Station control signals/variables to be selectable. • The accuracy of the TFR for event inputs shall be at least 100 μs (sampling rate of minimum 10 kHz). • The TFR shall have provision for remote access and retrieval of recorded information onto a PC. For this purpose, a communication link to the substation LAN shall be implemented. • The remote software application for data retrieval shall be included. • **There shall be multiple channels to view 3-ph and sequence values of voltage, current.** • **TFR file shall be viewable in any open source software.**
6.	Specific Technical Requirements for Communication Specific Requirement	**Specific Requirement for Phasor Measurement Units (PMUs)** TSP shall supply, install and commission required No. of Phasor Measurement Units (PMUs) PMUs at all the locations under the scope of TSP as per CEA (Technical Standards for Construction of Electrical Plants and Electric Lines) Regulations, 2022 (with latest amendment if any), and Latest applicable Regulations, Standards, Guidelines issued time to time. These PMUs shall be provided with GPS clock and LAN switch and shall connect with	**Specific Requirement for Phasor Measurement Units (PMUs)** TSP shall supply, install and commission required No. of Phasor Measurement Units (PMUs) at all the locations under the scope of TSP **under this RFP** as per CEA (Technical Standards for Construction of Electrical Plants and Electric Lines) Regulations, 2022 (**along with all amendments if any**), and **all the** applicable Regulations, Standards,

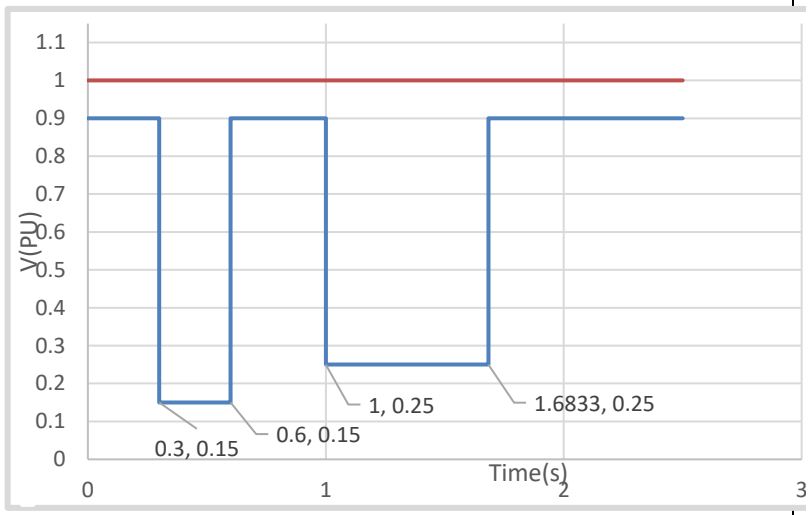
Sl. No.	Clause No.	Existing Clause	New/Revised Clause
	for Phasor Measurement Units (PMUs)	LAN switch of control room of respective substations/ generating stations with Fibre Optic cable. These PMUs shall be connected with the FOTE at Substation/ generating stations for onwards data transmission to the PDC (Phasor Data Concentrator) located at respective RLDC. Configuration work in existing PDC at RLDC for new PMU integration shall be done by respective RLDC, however all the necessary support in this regard shall be ensured by TSP. The maintenance of all the PMUs and associated equipment shall be the responsibility of TSP.	Guidelines issued time to time. **TSP shall also supply, install and commission required No. of Phasor Measurement Units (PMUs) on HV side of coupling transformer at each STATCOM station and integrate with PDC.** These PMUs shall be provided with GPS clock and LAN switch and shall connect with LAN switch of control room of respective substations/ generating stations with Fibre Optic cable. These PMUs shall be connected with the FOTE at Substation/ generating stations for onwards data transmission to the PDC (Phasor Data Concentrator) located at respective RLDC. Configuration work in existing PDC at RLDC for new PMU integration shall be done by respective RLDC, however all the necessary support in this regard shall be ensured by TSP. The maintenance of all the PMUs and associated equipment shall be the responsibility of TSP.
7.	**Power System Characteristic of STATCOM**	*The STATCOMs shall remain connected to the grid and shall be able to operate at rated reactive power capability when voltage at the interconnection point, on any or all phases dips up to the level depicted by the thick lines in the following curve (for specified time):* VT : Actual Voltage; Vn: Nominal Voltage	***For STATCOMs near RE complex:*** *The STATCOMs shall remain connected to the grid and shall be able to operate at rated reactive power capability when voltage at the interconnection point, on any or all phases dips up to the level depicted by the thick lines in the following curve (for specified time):* VT : Actual Voltage; Vn: Nominal Voltage

Sl. No.	Clause No.	Existing Clause	New/Revised Clause
			
8.	**A.6.1** **STATCOM Station Ratings**	……. ……. d) The STATCOM Station should continue to inject reactive power during temporary under voltage down to 54kV (0.135pu) (considering margin of 10% below 0.15p.u. which is the LVRT limit specified for RE generating stations) for the duration 0.3sec (Point C) and STATCOM behavior for voltages above 0.135 pu shall be as specified under section A.5 above, which also specifies operation at under voltage down to 120kV (0.3pu) for the duration 5sec; the STATCOM system may be tripped (or blocked) if the under voltage persists for time beyond limits specified under section A.5 above. ……. …….	……. ……. d) The STATCOM Stations **near RE Complex shall** continue to inject reactive power during temporary under voltage down to **60 kV (0.15 pu)** for the duration 0.3 sec (Point C) and STATCOM behavior for voltages above **0.15** pu shall be as specified under section A.5 above, which also specifies operation at under voltage down to 120 kV (0.3 pu) for the duration 5 sec; the STATCOM system may be tripped (or blocked) if the under voltage persists for time beyond limits specified under section A.5 above. **The STATCOM Stations (other than RE Complex) shall continue to inject reactive power during temporary under voltage down to 120 kV (0.3 pu) (Point-C) for the duration 5 sec; the STATCOM system may be tripped (or blocked) if the under voltage persists for time beyond limits**

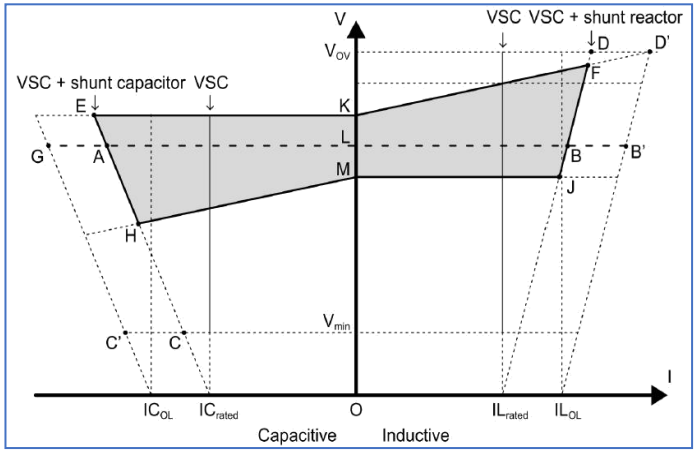
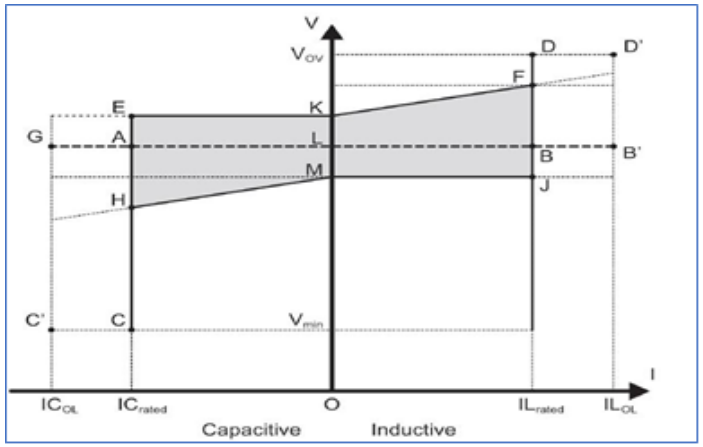
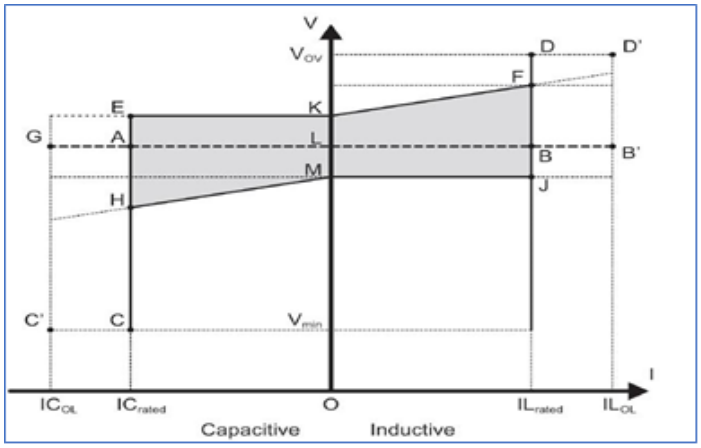
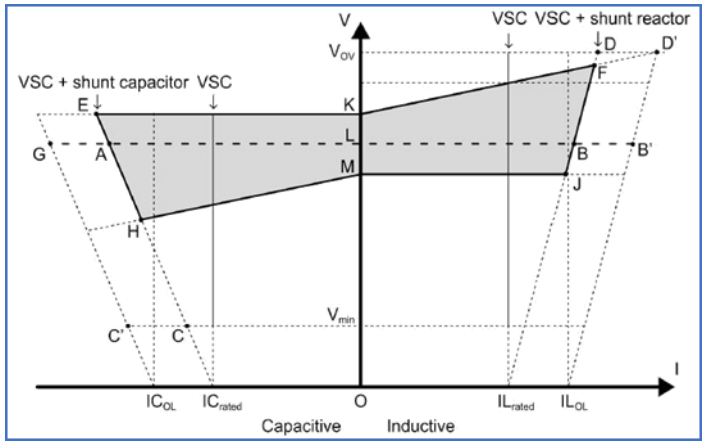
<table>
<tr><th>Sl. No.</th><th>Clause No.</th><th>Existing Clause</th><th>New/Revised Clause</th></tr>
<tr><td></td><td></td><td></td><td>specified under section A.5 above.
……..
……..</td></tr>
<tr><td>9.</td><td>A.6.1
STATCOM Station Ratings</td><td>…….
…….
e) The STATCOM should continue to absorb reactive power during temporary over voltages in a controlled manner as per the following.
<table><tr><th>Temporary Overvoltage</th><th>Duration</th></tr><tr><td>up to 600 kV (1.5 pu)</td><td>10 seconds</td></tr><tr><td>up to 704 kV (1.76 pu)</td><td>100 milli sec</td></tr><tr><td>up to 800 kV (2.0 pu)</td><td>50 milli sec</td></tr></table>STATCOM Station may be tripped if the respective temporary over voltages as mentioned above persists for more than its respective mentioned duration.
…….
…….</td><td>…….
…….
e) The STATCOM shall continue to absorb reactive power during HVRT Conditions in a controlled manner as per the following.
<table><tr><th>Nominal Voltage (pu)</th><th>Minimum time for rema connected to the Grid</th></tr><tr><td>V > 1.50</td><td>Instantaneous trip</td></tr><tr><td>1.50 ≥ V > 1.30</td><td>100 milli seconds</td></tr><tr><td>1.30 ≥ V > 1.10</td><td>10 seconds</td></tr><tr><td>V ≤ 1.10</td><td>Continuous</td></tr></table>STATCOM Station may be tripped if the respective temporary over voltages as mentioned above persists for more than its respective mentioned duration.
…….
…….</td></tr>
<tr><td>10.</td><td>A.6.2.1 STATCOM Station Functions and</td><td>A.6.2.1.1 Voltage Control mode (Automatic and Manual)
Control of the positive sequence component of the fundamental frequency voltage in steady state and dynamic operation, with slope in the range as specified at clause 6.1 c) above.</td><td>A.6.2.1.1 Voltage Control mode (Automatic and Manual)
Control of the positive sequence component of the fundamental frequency voltage in steady state at POI , with slope in the range as specified at clause 6.1 c) above.</td></tr>
</table>

Sl. No.	Clause No.	Existing Clause	New/Revised Clause
	Applications		**There shall be following provisions in STATCOM System to operate in Voltage Control Mode:** **a) To adjust the reference voltage for changes by Grid operator.** **b) To adjust the value of reactive power droop in pu to provide a stable, coordinated and dynamic response.** c) **To adjust the voltage dead band with a minimum magnitude of ±0.05 pu**
11.	**A.6.2.1 STATCOM Station Functions and Applications**	**A.6.2.1.2 Fixed Reactive Power Mode** In this mode, the reactive power output of the STATCOM as well as switching of MSRs and MSCs, should be manually controlled, by direct operator action. This feature is normally utilized for testing purpose.	**A.6.2.1.2 Fixed Reactive Power Mode** **In this mode, the STATCOM system shall maintain a specified constant reactive power output at the POI under continuous / steady state operating region. The target reactive power level and mode (injection or absorption) shall be specified by the Grid operator. There shall be a provision to adjust the reactive power set point. The dynamic response of the STATCOM system to any changes in reactive power shall be positively damped with a damping ratio of 0.3 or better.**
12.	**A.9.6** **Software simulation models**	…… …… **b) Transients model**. TSP should provide a detailed STATCOM transients model for use in PSCAD. The model detail should be appropriate and complete for the transient response calculation of the STATCOM system. All appropriate control features for	…… …… **b) Transients model**. TSP should provide a detailed STATCOM transients model for use in PSCAD. The model detail should be appropriate and complete for the transient response calculation of the STATCOM system. All

Sl. No.	Clause No.	Existing Clause	New/Revised Clause
		such analysis will be modeled, and necessary documentation on the theory and use of model should be provided. Further, a generic model, benchmarked to detailed STATCOM transient model, shall also be furnished for distribution. PSS/E files may be used for developing RTDS files/ models. For simulation of STATCOM in PSS/E file (load flow & dynamic) and PSCAD/EMTP-RV (Transient) model for STATCOM is required for study. TSP will share STATCOM models with CEA, CTU & Grid-India along with detailed documentation for above study purposes and simulations. For PSS/E, both Generic & User-defined models shall be shared by the TSP with the CEA, CTU & Grid-India. Generic model response shall be benchmarked with user-defined model to the extent possible by the TSP. Generic models can be shared by the CEA, CTU & Grid-India with the concerned stakeholders e.g. STUs etc. For User Defined model, confidentiality shall be maintained by the CEA, CTU & Grid-India. For PSCAD/EMTP-RV, User Defined model shall be provided by the TSP for which confidentiality shall be maintained by the CEA, CTU & Grid-India.	appropriate control features for such analysis will be modeled, and necessary documentation on the theory and use of model should be provided. Further, a generic model, benchmarked to detailed STATCOM transient model, shall also be furnished for distribution. PSS/E files may be used for developing RTDS files/ models. For simulation of STATCOM in PSS/E file (load flow & dynamic) and PSCAD (Transient) model for STATCOM is required for study. TSP will share STATCOM models with CEA, CTU and Grid-India along with detailed documentation for above study purposes and simulations. For PSS/E, both Generic and User-defined models shall be shared by the TSP with the CEA, CTU and Grid-India. Generic model **(PSS/E)** response shall be benchmarked with user-defined model **(PSS/E & PSCAD)** to the extent possible by the TSP. Generic models can be shared by the CEA, CTU and Grid-India with the concerned stakeholders/**external party(ies)** e. g. STUs etc. **on need basis**. For User Defined model, confidentiality shall be maintained by the CEA, CTU and Grid-India. For PSCAD, User Defined model shall be provided by the TSP for which confidentiality shall be maintained by the CEA, CTU and Grid-India. **Both UDM (PSCAD & PSS/E) and Generic model (PSSE) shall be provided by OEMs to CEA/CTU/GRID-INDIA without any NDA (Non-Disclosure Agreement)**
13.	**STATCOM Contingency**		**<u>To be added at the end of contingency list</u>** **STATCOM Station shall be capable of ride through for**

Sl. No.	Clause No.	Existing Clause	New/Revised Clause
	Cases		**multiple voltage dips within pre-defined time window as per following curve:** 
14.	**A.9.7** **Factory tests of controls**	…… …… a) The TSP should perform factory simulator system tests for integrated control and protection system to ensure the proper operation of the same. The control system should be connected to a digital simulator with adequate representation of the electrical network for various conditions. The STATCOM system controller needs to be representative of control functions, including basic controllers but inclusive of supplementary controls, firing controls, and protective functions integrated into the controllers. ……	…… …… a) The TSP should perform factory simulator system tests for integrated control and protection system to ensure the proper operation of the same. The control system should be connected to a digital simulator with adequate representation of the electrical network for various conditions. The STATCOM system controller needs to be representative of control functions, including basic controllers but inclusive of supplementary controls, firing controls, and protective functions integrated into the controllers. **TSP shall submit the FAT (factory acceptance test) reports of STATCOM controls to**

Sl. No.	Clause No.	Existing Clause	New/Revised Clause
		……	**CTU/RLDC.** …… ……
15.	**A.6.8.5** **Leakage distances**	**A.6.8.5 Leakage distances** The Creepage/leakage distance across insulation shall be determined by the TSP and shall be adequate to ensure that under conditions of heavy pollution, the probability of a flashover of an insulator does not exceed one in 15 years. However, the leakage distance for all AC insulators for outdoor installation shall not be less than 25 mm/kV of the maximum operating phase to earth rms voltage at the insulator. The leakage distance of equipment connected to 400 kV systems shall not be less than 10500 mm. Specific creepage distance for outdoor bushings, insulator strings and long rod insulators shall be a minimum 31 mm/kV.	**A.6.8.5 Leakage distances** The Creepage/leakage distance across insulation shall be determined by the TSP and shall be adequate to ensure that under conditions of heavy pollution, the probability of a flashover of an insulator does not exceed one in 15 years. However, the leakage distance for all AC insulators for outdoor installation shall not be less than **31 mm/kV** of the maximum operating phase to earth rms voltage at the insulator. The leakage distance of equipment connected to 400 kV systems shall not be less than **13020** mm. Specific creepage distance for outdoor bushings, insulator strings and long rod insulators shall be a minimum 31 mm/kV.

Sl. No.	Clause No.	Existing Clause	New/Revised Clause
16.	**A.6** **STATCOM Station Characteristic**	 **Figure-2: VI Curve of the VSC Portion**  **Figure-3: VI Curve of the STATCOM Station**	 **Figure-2: VI Curve of the VSC Portion**  **Figure-3: VI Curve of the STATCOM Station**

Sl. No.	Clause No.	Existing Clause	New/Revised Clause
17.	A.6.7.1	The TSP must guarantee the total losses of STATCOM Station, be less than 1% of the reactive power output individually at its inductive limit (STATCOM+MSRs) and capacitive limit (STATCOM+MSCs) for the cumulative highest reactive power output of STATCOM Station at PCC with the worse combination of manufacturing tolerances. For the purpose of total loss measurements, it should be assumed that the ambient temperature is 20 °C, the PCC voltage is 1 per unit, and the slope setting is 1%. The STATCOM system may not operate under these conditions, but they provide a common base.	The TSP must guarantee the total losses of STATCOM Station **will** be less than 1% of the reactive power output individually at its inductive limit (STATCOM+MSRs) and capacitive limit (STATCOM+MSCs) for the cumulative highest reactive power output of STATCOM Station at PCC with the worse combination of manufacturing tolerances **for the Option-1 to 4 as provided in clause A.3. In case of Option 5 as provided in clause A.3 i.e. +425/-550 MVAR STATCOM without MSC and MSR, the TSP must guarantee the total losses of STATCOM Station will be less than 1.5% of the reactive power output individually at its inductive limit and capacitive limit for the cumulative highest reactive power output of STATCOM Station at PCC with the worse combination of manufacturing tolerances.** For the purpose of total loss measurements, it should be assumed that the ambient temperature is 20 °C, the PCC voltage is 1 per unit, and the slope setting is 1%. The STATCOM system may not operate under these conditions, but they provide a common base.