सत्यमेव जयते

भारत सरकार/ Government of India
विद्युत मंत्रालय/ Ministry of Power
केन्द्रीय विद्युत प्राधिकरण/ Central Electricity Authority
ग्रिड प्रबंधन प्रभाग/ Grid Management Division
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सं.: 12/एक्स/एस.टी.डी.(सी.ओ.एन.एन)/जी.एम./2023/ 44 दिनांक: ~~.12.2023~~ 20/12/2023

विषय: दिनांक 27.10.2023 (शुक्रवार) को पूर्वाह्न 11:30 बजे आईएसटीएस में नए स्टेटकॉम संबंधित मुद्दों पर चर्चा करने के लिए आयोजित बैठक का कार्यवृत्त ।

Subject: Minutes of Meeting held on 27.10.2023 (Friday) at 11:30 AM to discuss w.r.t. new STATCOMs proposed to be installed at ISTS sub-stations – reg.

दिनांक 27.10.2023 को पूर्वाह्न 11:30 बजे आयोजित बैठक के कार्यवृत्त आपकी जानकारी एवं आवश्यक कार्यवाही हेतु संलग्न है।

यह पत्र सक्षम अधिकारी द्वारा अनुमोदित है।

Please find enclosed the minutes of the meeting held on 27.10.2023 at 11:30 AM.

It is issued on approval of Competent Authority.

संलग्नक: यथोपरि।

20/12/2023
(चन्द्र प्रकाश)
(मुख्य अभियन्ता)

बैठक के सभी प्रतिभागियों को ई-मेल द्वारा प्रेषित ।

Minutes of Meeting held on 27.10.2023 (Friday) at 11:30 AM to discuss requirement w.r.t. new STATCOMs proposed to be installed at ISTS sub-stations – reg.

A meeting was held on 27.10.2023 (Friday) at 11.30 P.M. with the participants from GRID India, Central Transmission Utility of India Limited (CTUIL), Power Grid Corporation of India Ltd. (PGCIL) and STATCOM OEMs to discuss operational Issues w.r.t. features for the proposed STATCOMs at ISTS. The list of the participants is enclosed at **Annexure-I**.

2. Deputy Director (GM), CEA summarized the participants about the previous meetings held in the same subject wherein the Grid-India and CTUIL proposed the necessary changes required in RfP or regulations for future STATCOMs. Subsequently, STATCOM OEMs were made to present their view on the requirements proposed w.r.t future STATCOMs. Accordingly, this meeting has been called to discuss the requirement that can be fulfilled by OEMs and the necessary changes needed in RfP for the future STATCOMs.

3. The requirements proposed by the GRID – India & CTUIL were put one-by-one for discussion and the comments/ inputs on the same by the OEMs and PGCIL are compiled at **Annexure-II.**

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Annexure-I

List of participants in the meeting on 27/10/2023 at 11:30 AM

Central Electricity Authority (CEA)

1. Sh. Chandra Prakash, Chief Engineer (Grid Management)
2. Sh. Pankaj Kumar Verma, Deputy Director (PSE&TD)
3. Sh. Himalaya Shubham, Deputy Director (Grid Management)
4. Sh. Sandeep Kumar, Deputy Director (Grid Management)
5. Sh. Dhruv Kawat, Assistant Director (Grid Management)
6. Sh. Bhavesh Mahawar, Assistant Director (PSE&TD)

Grid-India

1. Sh. Surajit Banerjee
2. Sh. Ebin Mathew, Manager
3. Sh. Priyam Jain, Manager

Central Transmission Utility of India Limited (CTUIL)

1. Sh. Ajay Kumar, Asstt. Manager

POWERGRID

1. Sh. S.J. Lahiri, CGM
2. Sh. Gautam Sharma, DGM
3. Sh. K. Deepak, Manager

Representative from STATCOM OEMs

1. Siemens Ltd
2. Hitachi-Energy India Ltd
3. Hyosung T&D
4. GE T&D

Annexure-II

S. No.	Topic	OEM Recommendation/Remark				POWERGRID Remark	CTUIL/ GRID India Remark	Recommendation of the Sub-committee
		HITACHI	**HYOSUNG**	**SIEMENS**	**GE**			
1.	Redundancy in Coupling Transformer: a. Hot/Cold Spare.	It is possible to provide both Hot and Cold spare. Most of the STATCOM/SVC projects globally with spare transformer are designed with Cold spare. However, Hot spare will shorten the outage time. Such solutions will also require separate protection including surge Arresters, Surge Capacitors. Further the spare unit will have protections enabled to monitor the healthiness. It is also important to specify how spare transformer to be envisaged, with disconnectors or with bolted links. Bolted links are the commonly used solutions globally, since the allowed scheduled outages are around 1outage/year. Bolted links can be shifted to alternate/spare transformer during such outages.	- OEM recommend to go for cold standby - As far as OEM is concern, we were not able to find any reference of hot-standby transformer except Indian STATCOM Projects.	Cold Spare preferred. No ref. of hot spare available for sharing. They have operating experience since 2018 and no failure is reported in coupling Transformers.	Cold Spare preferred	Cold Spare preferred. No problem faced till date with the coupling Transformers.	Hot spare preferred. However, if cold spare is provided then it should be possible to take the spare in service within a short time frame as specified in the TS.	Cold Spare is recommended with no physical movement of spare unit.
2.	STATCOM Branch: a. Single/Multiple units. b. Highest Rating of single unit. c. Interaction between STATCOM Units of same STATCOM Station. d. Requirement of Complete Dynamic Solution or STATCOM with MSR/MSC at RE Complex.	a. Single unit of higher rating. Due to advancement in semi-conductor technology, it is possible to use	a. Single/multiple both are OK. b. Upto 800 MVAR installed. Rating between 150MVAR to 350	a. Single/multiple both are OK. b. 1x400MVAR unit (Project Name: Orchard Substation STATCOM, Client: LS Power	a. Single/multiple both are OK. b. 1x300MVAR unit c. No coordination issues if the	a. Single/multiple both are OK. b. Depends on OEM capability. c. No coordination issues envisaged.	a. The size of the single unit of higher rating should be such that grid is able to survive n-1 of STATCOM	It can either be Single/ multiple units. Minimum size of a unit allowed is 150 – 200 MVAr. OEMs shall ensure that there are no

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		single VSC branch for large converters. Such solution will provide optimized design: • Reduced footprint • Better RAM performance due to minimized equipment. • Less maintenance required. • Less Complex control system. • No risk for interaction between STATCOM units of same STATCOM station. b. 1x400MVAR unit c. No such possibility for Station designed with single VSC branch. d. Identify dynamic rating (as VSC) & Steady state rating (as MSR/MSC) of STATCOM Station at the time of planning studies. Studies shall also define the number of STATCOM Stations required and the rating of each STATCOM station shall be	MVAR is common. c. No coordination issues. d. Complete Dynamic is preferred (in such case no need of CB in MV yard and it's not feasible to meet guaranteed loss clause of 1% at capacitive/reactive full load output.).	Grid California Award: 2020, expected commissioning: 2024). c. No coordination issues confirmed. e. Complete Dynamic is preferred (in ~~such~~ case of single branch of STATCOM / STATCOM Station no need of CB in MV yard).	STATCOMs are of same make. d. Complete Dynamic is preferred (in such case no need of CB in MV yard).	d. Both Complete VSC solution and separation of Steady state MVAr requirement as MSC/MSR/Bus Reactors are OK. However, MVAr from MSC/MSR/Bus Reactor may not be considered in dynamic requirement of STATCOM Station.	operating at rated capacity b. The size of the single unit shall factor in the expected fault level and SCR at the bus where interconnection is planned. c. Likely coordination issue between multiple STATCOM units to be identified and addressed during design studies. d. In case of current based switching logic of MSC/MSR, only dynamic solution without any mechanically switched device is preferred.	coordination issues between multiple STATCOM branches of STATCOM station. Further complete Dynamic range for STATCOM may be installed based on appropriate studies instead of combination of VSC with MSC/MSR technology. **VSC is preferred worldwide as per the references given by the OEMs.** **With VSC technology, there is no need for circuit breaker on the MV side.** **Minimum MV bus voltage is to be decided by OEMs.** **Losses in the VSC to be restricted to 1.5% instead of 1% in case of VSC with MSCs and MSRs.**

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		optimized based on operational performance, losses, total cost.						
3.	MSC/MSR Branch a. Switching logic (Voltage/Current based) b. Independent mode of operation of MSR/MSC c. Switch in/out voltage & time delay shall be kept configurable in large range {typical: (0.1 sec to 30 sec)}	a. Combination of control with Current based (for VSC+MSR/MSC control) & Voltage based (for MSC/MSR only) is suggested. MSC/MSR switching is based on availability of VSC in two operating modes: i. Switching of MSC/MSR, when STATCOM unit is available. ii. Switching of MSC/MSR, when STATCOM is not available. When STATCOM unit is available, it is suggested to use the VSC current based switching as recommended by IEEE1052-2018, clause 8.2.1.c.2 where we can adopt slow and fast switching methodology. Based on the setting levels of	a. Either Voltage or current based control are OK, but it needs to be specified in RfP. b. Not recommended. c. Achievable but required range needs to be defined in RfP. However, OEM recommend to avoid MSC/MSR at MV side i.e. in parallel to STATCOM branch. As far as OEM is concerned, we were not able to find any reference of MSC/MSR (at MV-Side) with STATCOM except Indian STATCOM Projects.	a. Either Voltage or current based control are OK, but it needs to be specified in RfP. b. Not recommended. In case of requirements of independent operation, it is preferred to Install MSC & MSR on HV side. c. Achievable but required range needs to be defined in RfP.	a. Either Voltage or current based control are OK, but it needs to be specified in RfP. b. Not recommended c. Achievable but required range needs to be defined in RfP.	a. Rather to specify the switching logic, we must specify the operation requirement of STATCOM in RfP in terms of dead band, droop characteristics etc. b. Not recommended. c. Achievable but required range needs to be defined in RfP.	a. Voltage based b. Required c. Programmable /Configurable voltage & time delay settings in a large range (say 5 to 10% of nominal voltage, 0.1sec to 30 sec for time delay) is required. The maximum number of switching of MSC/MSR in a day shall be specified in RfP. The maximum allowable rest time between successive switching of MSC/MSR also shall be specified.	**Only complete dynamic STATCOM based on appropriate studies is recommended for the proposed new STATCOMs.** However, in case of STATCOM with MSC/ MSR, the existing specifications may be followed.

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		slow/fast, MSC/MSR can be switched-In or Switched-out accordingly to extend the dynamic reserve from VSC. When VSC is not available switching of MSC/MSR will be based on voltage. b. Achievable, However, voltage step during MSC/MSR switching need to be checked with simulations and level of voltage variation will depend on the network strength. The requirements have to be defined in technical specification. c. Achievable with reference to fast/slow switching defined in IEEE1052-2018. The requirement need to be defined in technical specification.						
4.	LVRT Threshold value shall be coordinated with that of RE plant	Achievable to inject rated current if the voltage in all three phases goes below a level, but not greater than 0.135 pu.	Achievable. However, the LVRT and HVRT duration as per NERC PRC-024-2 document is given below in **Table 1**.	Achievable for 1-ph/3-ph faults. Not achievable for 2-ph faults which have less probability.	Achievable.	Acceptable if OEM can achieve the same. However, POWERGRID recommends for further studies if the requirement of IBR (at RE generation)	LVRT requirement shall be higher than that of IBR at RE generator. STATCOM system may give all possible assistance at times of	In the LVRT, the threshold value shall be coordinated with that of RE plant as per the CEA (Technical Standards for Connectivity to the Grid) Regulations i.e.

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						needs to be complied for STATCOM connected at Grid Level (since STATCOM PCC is grid bus voltage and not generator bus voltage)	short term low voltage and high voltage. Illustrative time sequence diagrams providing concurrent voltage and current values versus time duration should be provided in RfP.	the curve shown in **Figure 1** may be followed for STATCOM installed at ISTS near RE complexes. **For locations other than RE complexes 0.3 pu for 5 sec may be taken as the lower limit.** LVRT curve shows the minimum time to remain connected and deliver rated reactive power support. Further, as shared by OEMs, globally 0.3 p.u. is taken as the LVRT threshold value and rarely 0.2 p.u. based on the site specific conditions.
5.	HVRT a. Maximum continuous operating voltage shall be coordinated with RE plant (i.e., 1.1 pu). b. Coordination with Stage-2 Over Voltage line settings at PCC. c. Sample curve of HVRT	Achievable. It is recommended that the HVRT profile shall be same as IBR's. If the HVRT profile to be considered for FACTS applications is higher than IBR's, the same cannot be higher than the HVDC HVRT profile.	Achievable. However, the LVRT and HVRT duration as per NERC PRC-024-2 document is given in **Table 1** below.	Achievable. No change is required in Technical Specification for HVRT.	Achievable.	Acceptable if OEM can achieve the same. However, the operating V-I curve of STATCOM station need to be coordinated with the HVRT requirement.	a. Required b. Required Studies must be performed by the OEM with proper model representation of the STATCOM system to determine the maximum overvoltage and duration to which the system and its components will be subjected and designed for. The overvoltage profile could be higher and of a longer duration than	HVRT requirement need to be aligned with CEA (Technical Standards for connectivity to the Grid) Regulations ensuring proper coordination with operating range of STATCOM Station. The HVRT limits shall be as given in **Table 2**. HVRT Table shows the minimum time to remain connected deliver rated reactive power support.

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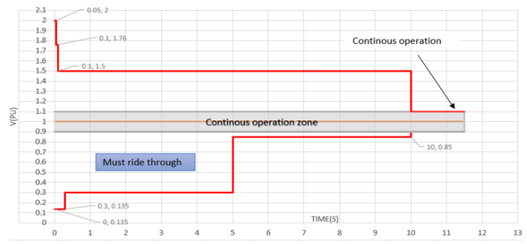
	Table 1 Voltage ride through requirements at POI/PCC Voltage range (pu) at POI/PCC (1pu = 400kV, L-L rms) / Minimum ride through time (Seconds) Switching over-voltages: Upto 2.5pu — Few milliseconds Temporary over voltages LVRT Conditions: V < 0.90 — 10 seconds; V < 0.30 — 05 seconds; V < 0.135 — 300 milliseconds HVRT Conditions: V > 2.0 — 50 milliseconds; V > 1.76 — 100 milliseconds; V > 1.50 — 10 seconds; V > 1.10 — Continuous  Figure 1 STATCOM Station Voltage ride through characteristics						obtained from the system studies conducted by the user. In this case, the STATCOM system should not be allowed to block or trip. Therefore, the STATCOM shall be designed to operate at rated capacity upto the over voltage profile as derived from studies. Further there should be suitable margins (in voltage as well as time delay settings) c. Required	As per the details shared by OEMs, the STATCOMs installed worldwide, the HVRT setting is taken as 1.3 p.u. and in some projects it is 1.5 p.u based on the site specific conditions.
6.	Multiple Fault ride through (MFRT) a. Capability required and shall match requirement of IBR recommended by IEEE 2800-2022. This shall include: i. The STATCOM **<u>may trip/block for more than four deviations of the voltage at the POI/PCC upto 50%</u>** of the nominal voltage outside of the continuous operation region within any 10sec period. ii. The STATCOM **<u>may trip/block for more than two individual deviations of the voltage at the POI/PCC below 50%</u>** of the nominal voltage within any 10sec period. b. Sample Curve for MFRT	Achievable. The contingency case that represents the MFRT scenario shall be defined in the list of contingencies as part of technical specification. Further, it is recommended that bidder shall demonstrate the performance of STATCOM unit for specified MFRT profile.	As far as OEM is concern, we were not able to find any reference of this clause "Multiple Ride through" in global specifications However, OEM confirm that we can meet the MFRT condition provided.	Achievable. However, the requirement needs to be specified as proper contingency cases in RfP. The limitations of the mechanically switched branches have been clearly mentioned in MSC/ MSR switching logic. Before defining a number of fault events for Mechanically Switched feeders in the RfP, the benefit of these feeders during the fault events should be investigated. Especially during an under voltage event, the contribution of a capacitor bank for voltage support is only miniscule. To	Achievable. However, the requirement needs to be specified as proper contingency cases in RfP. Limitations well described.	Acceptable if OEM can achieve the same. However, POWERGRID recommends for further studies on the requirement of such MFRT requirements since these are applicable for IBR generators only and not recommended for grid connected STATCOMs in any standards. In case it is found required, such MFRT needs to be specified as proper contingency cases with details like duration of fault, time intervals between multiple faults, etc.	MFRT capability is required based on some latest events observed at RE complex.	Further study need to be done to confirm the requirement along with contingency cases. Hence, the existing specifications may be followed. The contingency list to be provided in RfP document by CTU and Grid-India. The OEM shall provide the compliance for these each contingency case.

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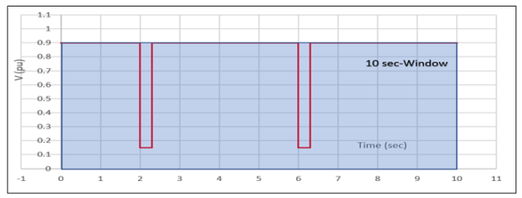
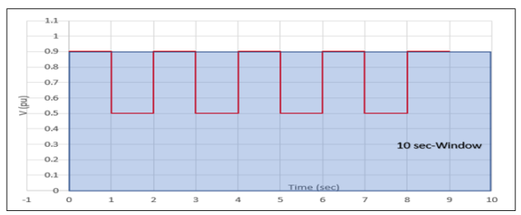
	 Figure 2 Multiple ride through requirements for voltage less than 0.5pu  Figure 3 Multiple ride through requirements for voltage above 0.5pu			achieve successful ride through in case of multiple voltage dips, it is recommended to achieve required swing range using VSC branches only.				
7.	Following functionality required in STATCOM with user settable range: a. Fixed 'Q' Control b. Voltage Control with following configurable parameters i. Vref ii. Dead band (at least ±0.05pu) iii. Droop iv. PID Controller gain	Achievable. It is recommended to include the definition of dead band in the technical specification.	Achievable.	Achievable but range of all configurable parameters need to be specified in RfP.	Achievable but range of all configurable parameters and definition of dead band need to be specified in RfP.	Acceptable if OEM can achieve the same.	Specified functionalities are required and need to be defined in RfP as given in IEEE standard 1052 , section *Control Objectives*	Relevant clauses shall be prepared by CTU based on relevant standards. OEMs shall provide these functionality in the proposed STATCOMs. CTU to provide the same in the RfP documents for TBCB projects.
8.	Response time a. ≤30msec required for step change of STATCOM reference voltage. b. Between Actual Voltage at PCC & Q injected by STATCOM (for slow oscillating bus voltage).	a. Achievable. It is recommended to refer to IEEE1052-2018 for the step response definition. Validation of step response shall be done based on Thevenin equivalent. b. Instantaneous response for voltage can be achieved with the GRID	a. Achievable. b. Provide the required characteristic response curve to check and confirm.	a. Achievable. a. Provide the required characteristic response curve to check and confirm.	a. Achievable b. Provide the required characteristic response curve to check and confirm.	a. Acceptable. b. Provide the required characteristic response curve to check and confirm. It is recommended that the response between V & Q is highly dependent on network configuration, frequency of voltage oscillations, etc. Tuning is possible only if these	a. Acceptable if achieved. b. OEM may provide the best possible response that they can design & achieve between V & Q for their respective STATCOMs.	Existing specification may be continued i.e. response time of less than or equal to 30 msec may be complied with by the OEMs.

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		FORMING CONTROL, which will also give faster response for Q. However, no response time is defined in IEEE for Q.				parameters are defined in RfP.		
9.	Interconnection Study for STATCOM: a. Damping of oscillations required that may arise due to interaction between several active controllers in the network. b. Detailed interaction study may be carried out by OEM/TSP before STATCOM commissioning and parameter tuning may be done. c. POD tuning after interaction study with nearby HVDC/FACTS controllers d. Sharing of all necessary information (including control inputs, device models, etc.) with any future TSP. e. Possibility of new STATCOM in same substation (i.e., same bus or other bus section with existing STATCOM of different make. Operation in coordinated manner with different make.	a. Based on the interaction study for STATCOM, the STATCOM control system can be provided with damping controller. Further, possible need of exchange of signals between active controllers (FACTS/HVDC) will also be identified based on interaction study. It is recommended to adopt the Grid Forming control functionality for STATCOM to achieve instantaneous response. Such controller is also expected to give less interactions with other devices. b. Agreed, the same requirement shall be included in specification. Further the detailed models	a. The oscillations can be categorized as follows, A) Low frequency oscillation (Power oscillation): Interactions between generator rotors B) Sub-synchronous oscillation (SSO): - SSTI (sub-synchronous torsional interactions) : Interactions between steam turbine generator and power electronics devices - SSR (sub-synchronous resonance) : Interactions between generator and series capacitor (compensator) - SSCI (sub-synchronous control interactions) :	a. Network models, reproducing real-life oscillations are needed, to carry out any 'Control/Parameter tuning etc.' with the STATCOM. b. All interaction studies may be done by TSO itself. c. The contingency cases which involve the power oscillations should be highlighted in RFP, where POD can be tuned to damp such oscillations. d. The requirement of necessary information including list of signals should be clearly specified in the RFP. e. At present there is no such reference available. This solution may be available in future considering the communication	a. Network models, reproducing real-life oscillations are needed, to carry out any 'Control/Parameter tuning etc.' with the STATCOM. b. All interaction studies may be done by TSO itself. c. The contingency cases which involve the power oscillations should be highlighted in RFP, where POD can be tuned to damp such oscillations. All POD studies may be done by the TSO itself. d. The requirement of necessary information including list of signals should be clearly specified in the RFP. e. Possible, but some level of details needed of the existing STATCOM.	a., b. & c. Detailed model of existing FACTS/HVDC/IBRs devices in the vicinity is required for interconnection study, controller tuning, POD tuning, etc. It is recommended that all interaction studies may be done by TSO itself. d. Acceptable if OEMs agree. e. Not recommended due to proprietary nature of controller.	Requirements specified need to be fulfilled for proper operation. Following studies may be added further: i. Study of response time and of the STATCOM system's behaviour and contribution to the system's recovery from faults. ii. Interaction Studies to evaluate the interaction of the STATCOM controls with the other nearby control systems, including high-voltage direct current (HVDC) controls, generator controls, and controls of other flexible ac transmission systems (FACTS) devices	(a) TSP shall ensure the damping of oscillation during the entire licence period including the pre – commissioning period as per relevant standards. (e.g., IEEE 1052) (b) & (c) TSP shall ensure interconnection study at the time of commissioning and shall also be responsible for tuning the POD during the licence period as per relevant (e.g., IEEE 1052) (d) & € Regarding operational issues observed by the Grid-India during the operation of the STATCOMs, the same shall be brought before Member (GO&D), CEA to be examined by GM Division in consultation with all the stakeholders and

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		and controllers shall be supplied by TSO together with the contract. c. The scenarios and Contingency cases for POD study to be defined in technical specification along with PSS/E model files. d. The list of signals that shall be exchanged or coordinated between two TSPs shall be clearly specified in the technical specification. The OEM can only take the responsibility of exchange of signals of their own STATCOM. e. Acceptable. It is recommended to include the requirements in the technical specification for future STATCOM and the possible need of exchange of signals (Vref, gain, slope, Master/Slave, etc.)	Interactions between power electronics devices To damp the oscillations described above, STATCOM must be located between the components causing the interactions. It will be also need to be verified whether STATCOM causes additional SSTI and SSCI b. The interactions on which STATCOM has effects are just SSTI and SSCI. c. As described above, Power oscillation is different from SSCI. POD controller will be designed and implemented separately from SSOD controller. d. PSCAD/EMTDC model including all control functions will be submitted to CTU/CEA/POSOCO/POWERGRID e. Integration with other make STATCOM at same substation bus is “Not Possible".	interface between two stations being done via existing network with available protocol like IEC 61850,104 etc.				suggest remedial; measures in a time bound manner.

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10.	Transient Fault Recorder (TFR) a. Multiple channels to view 3-ph & sequence values of voltage, current. b. TFR file shall be able to open in open source software.	Achievable. a. The number of channels for TFR to be defined in the technical specification. b. In the technical specification it shall be mentioned that the TFR file shall be in Comtrade format.	Achievable.	Achievable.	Achievable.	Acceptable if OEM can achieve the same.	a. Required. b. Required.	Suitable clauses in technical specifications (RfP) shall be incorporated for the installation of TFR.
11.	Availability of PMU a. PMU required at HV side of coupling transformer at each STATCOM Station and integrate with PDC.	Achievable. The requirement of PMU shall be included in technical specifications	Achievable but requirement need to be mentioned in RfP.	Achievable but requirement need to be mentioned in RfP.	Achievable but requirement need to be mentioned in RfP.	Acceptable.	Required.	Suitable clauses in technical specifications (RfP) shall be incorporated for the installation of PMU.
12.	Sharing validated dynamic model of STATCOM a. UDM model (RMS & EMT) of STATCOM to be provided to CEA/CTU/GRID-INDIA without any NDA (Non-Disclosure Agreement) b. Generic Model matching with UDM response shall also be provided however, without NDA.	a. The User defined models cannot be shared without an NDA, since the models include the OEMs IP. b. Generic models can be shared without NDA.	OEM has no objection in sharing both Generic model and UDM as per of project delivery. Grey/Black box model can be shared without NDA.	a. UDM model (RMS & EMT) of STATCOM to be provided to CEA/CTU/GRID-INDIA without any NDA (Non-Disclosure Agreement) These models can be made available if it is contractually agreed to treat these models confidentially, as in the example of Ramgarh/ Fatehgarh-iii STATCOM packages. In case of newer features / technologies in STATCOM such as active filter, Frequency Stabilisation, Grid Following function etc. required, NDA is requested, considering these	Only Generic Model can be provided and Project specific model can be provided at project stage.	OEM recommendation may be acceptable. However, in case generic model is required, level of closeness with UDM/FAT response may be specified in RFP.	Both UDM & Generic model is required. UDM model shall remain within CEA/CTU/GRID-INDIA, however, generic models shall be shared externally on need basis.	Both UDM and Generic model may be provided by OEMs to CEA/CTU/GRID-INDIA without any NDA (Non-Disclosure Agreement) UDM model shall remain with CEA/ CTU/ Grid-India and not be shared with any external party. OEMs shall ensure that the generic models are as close as possible with UDM for the purpose of the carrying the requisite analysis. CTUIL shall ensure the same. Further, generic models shall be shared externally on

S. No.	Topic	OEM Recommendation/Remark				POWERGRID Remark	CTUIL/ GRID India Remark	Recommendation of the Sub-committee
		HITACHI	HYOSUNG	SIEMENS	GE			
				being state of the art technologies. b. Generic Model matching with UDM response shall also be provided however, without NDA, no problem for RMS model, generic transient models is not possible. Above is generally followed approach globally with TSPs / TSOs.				need basis with the other stakeholders.

Ride Through Duration

High Voltage Ride Through		Low Voltage Ride Through	
Voltage (pu)	**Time (second)**	**Voltage (pu)**	**Time (second)**
≥ 1.200	**Instantaneous trip**	**< 0.45**	**0.15**
≥ 1.175	**0.20**	**< 0.65**	**0.30**
≥ 1.15	**0.50**	**< 0.75**	**2.00**
≥ 1.10	**1.00**	**<0.90**	**3.00**

Table 1: HVRT and LVRT limits as per NERC PRC- 024-2 document

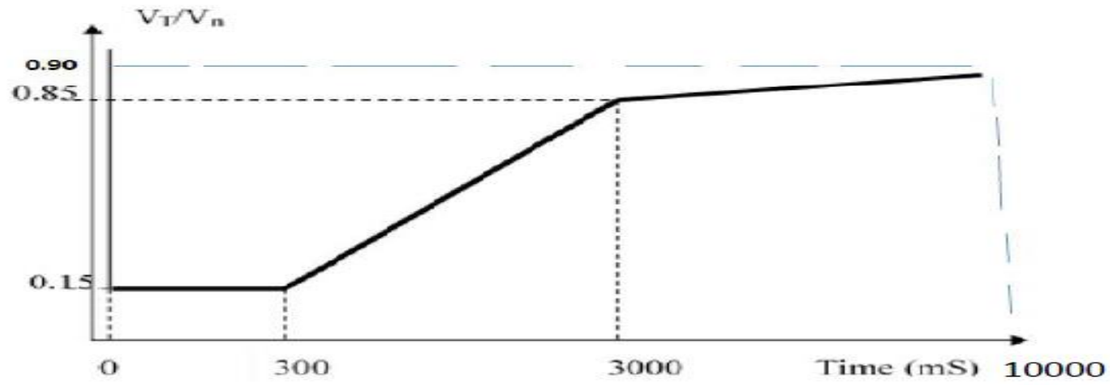

Figure 1: LVRT Curve as per CEA (Technical Standards for Connectivity to the Grid) Regulations for STATCOM

(Voltages in the curve is the HV side voltages)

Over voltage (pu)	**Minimum time to remain connected**
V > 1.50	Instantaneous trip
1.50 ≥ V > 1.30	100 milli seconds
1.30 ≥ V > 1.10	10 seconds
V ≤ 1.10	Continuous

Table 2: HVRT Limits recommended for new STATCOMs