Sl. no.	Clause No.	Existing Clause	New/Revised Clause
1.	ANNEXURE C Specific Technical Requirements for Synchronous Condenser **Clause 1 Introduction** RFP & TSA	..... The SynCon Station may consist of multiple identical synchronous condenser units, each operating in parallel and connected to the 400 kV HV bus (PCC), as per the design and space available. The design shall ensure compliance with grid code requirements, and the provision of inertia and fault current to support reliable and stable system operation.	..... The SynCon Station may consist of multiple identical synchronous condenser units, each operating in parallel and connected to the 400 kV HV bus (PCC), as per the design and space available. **The minimum size of a syncon unit shall be 100 MVAr.** The design shall ensure compliance with grid code requirements, and the provision of inertia and fault current to support reliable and stable system operation.
2.	ANNEXURE C Specific Technical Requirements for Synchronous Condenser **Clause 1.2 APPLICABLE STANDARDS** RFP & TSA	Unless otherwise specified herein, the plant shall be in accordance with the latest edition and amendments of Indian Electricity Grid Code (IEGC), CEA Technical Standards, appropriate International Electrotechnical Commission (IEC) and Institute of Electrical and Electronics Engineers (IEEE) standards **operative at the Reference Date**. In particular, the plant shall comply with the following Standards (as applicable):	Unless otherwise specified herein, the plant shall be in accordance with the latest edition and amendments of Indian Electricity Grid Code (IEGC), CEA Technical Standards, appropriate **Indian Standard (IS),** International Electrotechnical Commission (IEC) and Institute of Electrical and Electronics Engineers (IEEE) standards **and their amendment thereof**. In particular, the plant shall comply with the following Standards (as applicable): .....
3.	ANNEXURE C Specific Technical Requirements for Synchronous Condenser **Clause 2.1 System Studies and Compliance** RFP & TSA	... SynCon unit shall be designed to operate at rated MVAr capacity upto an ambient temperature of 40° C. Beyond ambient temperature of 40o C, TSP shall provide the derating curve, however, derating rate shall not be more than 1% of rated MVAr per degree Centigrade. There shall not be any impact on rated Short circuit current and Inertia due to increase in ambient temperature beyond 40o C. OEM/TSP shall submit temperature to MVAr derating curves (continuous & time limited). The SynCon shall be designed to support grid operation within a voltage range of ±10% and a frequency range of 47.5 Hz to **52 Hz** at the PCC.	... SynCon unit shall be designed to operate at rated MVAr capacity upto an ambient temperature of 40° C. Beyond ambient temperature of 40° C, TSP shall provide the derating curve, however, derating rate shall not be more than 1% of rated MVAr per degree Centigrade. There shall not be any impact on rated Short circuit current and Inertia due to increase in ambient temperature beyond 40° C. OEM/TSP shall submit temperature to MVAr derating curves (continuous & time limited). The SynCon shall be designed to support grid operation within a voltage range of ±10% and a frequency range of 47.5 Hz to **52.5 Hz** at the PCC.

<table>
<tr><th>Sl. no.</th><th>Clause No.</th><th>Existing Clause</th><th>New/Revised Clause</th></tr>
<tr><td>4.</td><td>ANNEXURE C

Specific Technical Requirements for Synchronous Condenser

Clause no. 2.1.2 Steady state operation study

RFP & TSA</td><td>.....
In addition to above following study shall also be carried out.

1) Open circuit and short-circuit characteristics tests
2) Negative sequence impedance tests.

Following test as indicated in "IEEE 115-Guides for Test Procedures for Synchronous Machines" shall also be carried out.
<table>
<tr><th>Test No.</th><th>Test Name</th><th>Purpose / Determination</th><th>Key Reference (IEEE 115-2019)</th></tr>
<tr><td>1</td><td>Visual & Mechanical Inspection</td><td>Verify nameplate data, connections, physical condition, alignment, cooling system, bearing, and mechanical integrity.</td><td>Clause 6.1</td></tr>
<tr><td>2</td><td>Insulation Resistance & Polarization Index</td><td>Measure stator and field insulation condition using a megger test (1 min and 10 min readings).</td><td>Clause 6.2</td></tr>
<tr><td>3</td><td>Measurement of DC Resistance</td><td>Determine stator winding resistance (per phase) and field winding resistance for copper loss calculation.</td><td>Clause 6.3</td></tr>
<tr><td>4</td><td>No-Load Saturation Curve (Open-Circuit Characteristic, OCC)</td><td>Plot generated voltage vs. field current at rated speed — defines excitation requirements and saturation.</td><td>Clause 7.1</td></tr>
<tr><td>5</td><td>Short-Circuit Characteristic (SCC)</td><td>Plot armature current vs. field current at rated speed with terminals shorted — used with OCC to compute synchronous reactance.</td><td>Clause 7.2</td></tr>
<tr><td>6</td><td>Synchronous Impedance and Reactance Determination</td><td>From OCC and SCC — obtain per-phase synchronous reactance Xs = Eoc/Isc.</td><td>Clause 7.3</td></tr>
<tr><td>7</td><td>Zero Power Factor (ZPF) or Potier Test</td><td>For large machines — determine leakage reactance and field current for rated voltage at full-load condition.</td><td>Clause 7.4</td></tr>
<tr><td>8</td><td>Load (Performance) Test</td><td>Operate under various loads and power factors to measure</td><td>Clause 8.1</td></tr>
</table></td><td>.....

<u>In addition to above, following test as per relevant International Standard shall also be carried out.</u>

<u>(a) No-Load Saturation Curve (Open-Circuit Characteristic, OCC)-Plot generated voltage vs. field current at rated speed — defines excitation requirements and saturation.</u>

<u>(b) Short-Circuit Characteristic (SCC)- Plot armature current vs. field current at rated speed with terminals shorted — used with OCC to compute synchronous reactance.</u>

<u>(c) Excitation System Performance Test (Steady-State)-Measure field current, voltage, and reactive power under rated voltage conditions.</u>

<u>(d) V-Curve (for Synchronous Condenser)-Plot stator current vs. field current at constant terminal voltage; determines stability margin and reactive power range.</u>

<u>(e) Reactive Capability Curve Test (for Condenser)-Determine leading and lagging VAR capability vs. field current and stator current limits.</u>

<u>TSP shall also submit Negative sequence impedance value.</u></td></tr>
</table>

Sl. no.	Clause No.	Existing Clause				New/Revised Clause
				efficiency, voltage regulation, and temperature rise.		
		9	Efficiency Test (Direct or Indirect)	Compute efficiency using segregation of losses or input–output method.	Clause 8.2	
		10	Temperature Rise Test	Verify compliance with permissible temperature rise limits under rated load conditions (stator, rotor, bearings).	Clause 8.3	
		11	Excitation System Performance Test (Steady-State)	Measure field current, voltage, and reactive power under rated voltage conditions.	Clause 9.1	
		12	Field Discharge and De-excitation Check	Confirm safe decay of field energy upon trip or fault.	Clause 9.2	
		13	Magnetic Balance / Unbalanced Loading Test	Verify current and voltage symmetry among phases.	Clause 10.1	
		14	Loss Segregation Tests	Separate core loss, friction & windage, and stray-load losses for efficiency evaluation.	Clause 8.2.3	
		15	Voltage Regulation Test (Calculated)	From OCC and SCC, determine regulation under various power factors using synchronous impedance or Potier method.	Clause 7.3.2	
		16	Armature Reaction Test	Assess effect of armature current on main field under lagging/leading conditions.	Clause 7.5	
		17	Open-Circuit and Short-Circuit Ratio Tests (SCR)	Compute short-circuit ratio (SCR = field current for rated voltage / field current for rated short-circuit current).	Clause 7.6	
		18	V-Curve (for Synchronous Condenser)	Plot stator current vs. field current at constant terminal voltage; determines stability margin and reactive power range.	Clause 8.4	
		19	Reactive Capability Curve Test (for Condenser/Generator Mode)	Determine leading and lagging VAR capability vs. field current and stator current limits.	Clause 8.5	

<table>
<tr><th>Sl. no.</th><th>Clause No.</th><th>Existing Clause</th><th>New/Revised Clause</th></tr>
<tr><td>5.</td><td>ANNEXURE C

Specific Technical Requirements for Synchronous Condenser

Clause no. 5 Power System Requirements

RFP & TSA</td><td>Table 2
<table><tr><th>Sl. n.</th><th>Power System Characteristic</th><th>Value</th><th>Unit</th></tr><tr><td>9.</td><td>Maximum continuous ac system frequency</td><td><u>52</u></td><td>Hz</td></tr><tr><td>...</td><td>.....</td><td>.....</td><td>.....</td></tr><tr><td>...</td><td>.....</td><td>.....</td><td>.....</td></tr><tr><td>36</td><td>Sound pressure level (SPL) when measured at approximately 1 m distance from the Synchronous condenser surface during normal operation at rated ratings & ambient conditions.</td><td><u>≤95</u></td><td><u>dB</u></td></tr><tr><td>37</td><td>.....</td><td>.....</td><td>.....</td></tr></table></td><td>Table 2
<table><tr><th>Sl. n.</th><th>Power System Characteristic</th><th>Value</th><th>Unit</th></tr><tr><td>9.</td><td>Maximum continuous ac system frequency</td><td><u>52.5</u></td><td>Hz</td></tr><tr><td>...</td><td>.....</td><td>.....</td><td>.....</td></tr><tr><td>36</td><td>Sound pressure level (SPL) when measured at approximately 1 m distance from the Synchronous condenser surface during normal operation at rated ratings & ambient conditions.</td><td><u>≤ 90</u></td><td><u>dB (A)</u></td></tr><tr><td>37</td><td>.....</td><td>.....</td><td>.....</td></tr></table></td></tr>
<tr><td>6.</td><td>ANNEXURE C

Specific Technical Requirements for Synchronous Condenser

Clause 6.2 Voltage and Frequency

RFP & TSA</td><td>...
The following ranges of voltage and frequency are applicable:
..
6) Maximum continuous frequency of <u>52 Hz</u>
7) Minimum continuous frequency of 47.5 Hz.

The synchronous condenser unit shall be capable of withstanding frequency variation and maintain continuous uninterrupted operation for frequency ranges of 47.5 Hz to <u>52 Hz</u> within a voltage range of ±10%. Further, the Synchronous Condensers Unit shall be capable of unrestricted and uninterrupted continuous operation for the following frequency ranges.

Table: Frequency Variations Withstand Requirements for Unrestricted Operation
<table><tr><th>Sl. No.</th><th>Frequency Range (Hz)</th><th>Duration</th></tr><tr><td>...</td><td>...</td><td>..</td></tr><tr><td>5.</td><td>51 to <u>52</u></td><td>5 Minutes</td></tr></table>
...

The SynCon Station shall continue to absorb reactive power during HVRT Conditions in a controlled manner as per the following for symmetrical and asymmetrical cases:</td><td>...
The following ranges of voltage and frequency are applicable:
..
6) Maximum continuous frequency of <u>52.5 Hz</u>
7) Minimum continuous frequency of 47.5 Hz.

The synchronous condenser unit shall be capable of withstanding frequency variation and maintain continuous uninterrupted operation for frequency ranges of 47.5 Hz to <u>52.5 Hz</u> within a voltage range of ±10%. Further, the Synchronous Condensers Unit shall be capable of unrestricted and uninterrupted continuous operation for the following frequency ranges

Table: Frequency Variations Withstand Requirements for Unrestricted Operation
<table><tr><th>Sl. No.</th><th>Frequency Range (Hz)</th><th>Duration</th></tr><tr><td>...</td><td>...</td><td>..</td></tr><tr><td>5.</td><td>51 to <u>52.5</u></td><td>5 Minutes</td></tr></table>
...

<u>The SynCon Station shall continue to absorb reactive power (rated reactive power up to 1.1 p.u., and inherent reactive</u></td></tr>
</table>

Sl. no.	Clause No.	Existing Clause	New/Revised Clause
		... The SynCon Station shall remain connected to the grid and shall be able to operate at rated reactive power capability at PCC when the applicable voltage at the interconnection point dips up to the level depicted by the thick lines in the following curve (for specified time): ...	**power beyond 1.1 p.u.) during HVRT Conditions as per the following Table-3.** ... **The SynCon Station shall continue to inject reactive power (rated reactive power down up to 0.9 p.u., and inherent reactive power below 0.9 p.u.) during LVRT Conditions as per the following Curve (Figure-3) for the specified time.** ...
7.	ANNEXURE C Specific Technical Requirements for Synchronous Condenser **Clause 6.3 Continuous Ratings** RFP & TSA	... 4) The Synchronous Condensers Units shall be capable of continuous uninterrupted operation for system frequencies in the ranges of 47.5 Hz to **52 Hz**. ...	... 4) The Synchronous Condensers Units shall be capable of continuous uninterrupted operation for system frequencies in the ranges of 47.5 Hz to **52.5 Hz**. ...
8.	ANNEXURE C Specific Technical Requirements for Synchronous Condenser **Clause no. 7 Short Circuit Contribution** RFP & TSA	The Synchronous condenser unit for project /substation shall be able to supply a short circuit power (Short-circuit power must be calculated according to **IEEE 551-2006**, using saturated sub-transient reactance and transformer impedance). ...	The Synchronous condenser unit for project /substation shall be able to supply a short circuit power (Short-circuit power must be calculated according to **IEC 60909-0:2016**, using saturated sub-transient reactance and transformer impedance). ...

Sl. no.	Clause No.	Existing Clause	New/Revised Clause
9.	ANNEXURE C Specific Technical Requirements for Synchronous Condenser **Clause no. 8.5 Damper Winding** RFP & TSA	A low resistance damper winding made of full-length copper rods or copper rotor wedges shall be provided on all the poles to dampen rotor oscillations. They shall be short circuited at the ends by a completely connected ring on either side. The damper windings shall be strong enough to withstand all the electrical and mechanical stresses occurring during operation. ...	A low resistance damper winding made of full-length copper rods or copper rotor wedges shall be provided on all the poles to dampen rotor oscillations. They shall be short circuited at the ends by a completely **electrically** connected ring on either side. The damper windings shall be strong enough to withstand all the electrical and mechanical stresses occurring during operation. ...
10.	ANNEXURE C Specific Technical Requirements for Synchronous Condenser **Clause no. 8.8 Instrumentation** RFP & TSA	All temperature sensors shall be Resistance Temperature Detectors (RTDs) of duplex type and be wired to a terminal box with shielded cables	All temperature sensors shall be Resistance Temperature Detectors (RTDs) of **preferably duplex type (alternatively suitable nos. of single element RTDs with spares in place of duplex RTDs are also acceptable)** and be wired to a terminal box with shielded cables.
11.	ANNEXURE C Specific Technical Requirements for Synchronous Condenser **Clause no. 8.8.2 Rotor winding** RFP & TSA	Rotor winding temperature shall be measured using the resistance method as per IEC 60034-1. Sufficient number (at least 12) of Duplex RTDs shall be provided, distributed as per OEM design to monitor the temperature.	Rotor winding temperature shall be measured using either the resistance method **or through RTDs** as per IEC 60034-1. **In case of RTDs,** Sufficient number (at least 12) **of preferably duplex type RTDs (alternatively suitable nos. of single element RTDs with spares in place of duplex RTDs are also acceptable)** shall be provided, distributed as per OEM design to monitor the temperature.

<table>
<tr><th>Sl. no.</th><th>Clause No.</th><th>Existing Clause</th><th>New/Revised Clause</th></tr>
<tr><td>12.</td><td>ANNEXURE C

Specific Technical Requirements for Synchronous Condenser

Clause no. 8.10 Bearings

RFP & TSA</td><td>.....

The <u>contractor</u> shall ensure complete protection, control, and measurement for the bearing's safety and diagnosis, consisting of RTDs, at least one triple element per bearing, to monitor bearing metal temperature.</td><td>.....

The <u>TSP</u> shall ensure complete protection, control, and measurement for the bearing's safety and diagnosis, consisting of RTDs, at least one triple element <u>(or two dual element)</u> per bearing, to monitor bearing metal temperature.</td></tr>
<tr><td>13.</td><td>ANNEXURE C

Specific Technical Requirements for Synchronous Condenser

Clause 8.14.2 Shaft Current online Monitoring of Synchronous condenser

RFP & TSA</td><td>A low-voltage ring type current transformer in a parted form of construction shall be used for measurement of shaft current. The current transformers design shall be suitable for the intended installation location (i.e. ambient conditions). Thus, the shaft current relay shall detect a transient current in the synchronous condenser shaft.</td><td><u>A suitable shaft current online monitoring of Synchronous Condenser shall be provided to detect transient current in the synchronous condenser shaft.</u></td></tr>
<tr><td>14.</td><td>ANNEXURE C

Specific Technical Requirements for Synchronous Condenser

Clause no. 16.3 Protection Functions</td><td>B. Step Up Transformer Protection Functions

<table><tr><th>Function</th><th>Main A</th><th>Main B</th></tr><tr><td><u>Biased Differential</u></td><td>Y</td><td>Y</td></tr><tr><td>Overcurrent Protection</td><td>Y</td><td>Y</td></tr><tr><td>Over fluxing Protection</td><td>Y</td><td>Y</td></tr><tr><td><u>Low Side Neutral Voltage Displacement Protection</u></td><td>Y</td><td>Y</td></tr></table></td><td>B. Step Up Transformer Protection Functions

<table><tr><th>Function</th><th>Main A</th><th>Main B</th></tr><tr><td><u>Steep-up transformer differential protection (87T)</u></td><td>Y</td><td>Y</td></tr><tr><td><u>Restricted earth fault protection</u></td><td><u>Y</u></td><td><u>Y</u></td></tr><tr><td>Overcurrent Protection</td><td>Y</td><td>Y</td></tr><tr><td>Over fluxing Protection</td><td>Y</td><td>Y</td></tr><tr><td><u>Back-up earth fault protection on Step-up transformer HV neutral (51NGT)</u></td><td>Y</td><td>Y</td></tr></table></td></tr>
</table>

<table>
<tr><th>Sl. no.</th><th>Clause No.</th><th>Existing Clause</th><th>New/Revised Clause</th></tr>
<tr><td></td><td>RFP & TSA</td><td>
<table>
<tr><td>Buchholz Protection</td><td>Y</td><td>N</td></tr>
<tr><td><u>Explosion Vent Protection</u></td><td>N</td><td>Y</td></tr>
<tr><td>LV Winding Temperature Protection</td><td>N</td><td>Y</td></tr>
<tr><td>HV Winding Temperature Protection</td><td>Y</td><td>N</td></tr>
</table>
C. Unit Transformer Protection Functions (Auxiliary Transformers)
<table>
<tr><th>Function</th><th>Main A</th><th>Main B</th></tr>
<tr><td><u>HV High set Overcurrent Protection</u></td><td>Y</td><td>Y</td></tr>
<tr><td><u>HV Overcurrent Protection</u></td><td>Y</td><td>Y</td></tr>
<tr><td><u>Overfluxing Protection</u></td><td>Y</td><td>Y</td></tr>
<tr><td>Buchholz Protection</td><td>Y</td><td>N</td></tr>
<tr><td><u>Explosion Vent Protection</u></td><td>N</td><td>Y</td></tr>
<tr><td>LV Winding Temperature Protection</td><td>Y</td><td>N</td></tr>
<tr><td>HV Winding Temperature Protection</td><td>N</td><td>Y</td></tr>
</table>
</td><td>
<table>
<tr><td>Buchholz Protection</td><td>Y</td><td>N</td></tr>
<tr><td><u>Pressure relief valve (PRV) Protection</u></td><td>N</td><td>Y</td></tr>
<tr><td>LV Winding Temperature Protection</td><td>N</td><td>Y</td></tr>
<tr><td>HV Winding Temperature Protection</td><td>Y</td><td>N</td></tr>
<tr><td><u>Oil temperature Protection (49)</u></td><td><u>Y</u></td><td><u>Y</u></td></tr>
</table>
C. Unit Transformer Protection Functions
<table>
<tr><th>Function</th><th>Main A</th><th>Main B</th></tr>
<tr><td><u>Restricted earth fault protection (64)</u></td><td><u>Y</u></td><td><u>Y</u></td></tr>
<tr><td><u>Instantaneous over current protection (50)</u></td><td>Y</td><td>Y</td></tr>
<tr><td><u>IDMT over current protection (51)</u></td><td>Y</td><td>Y</td></tr>
<tr><td><u>Back up Earth Fault Protection</u></td><td>Y</td><td>Y</td></tr>
<tr><td>Buchholz Protection</td><td>Y</td><td>N</td></tr>
<tr><td><u>Pressure relief valve (PRV) Protection</u></td><td>N</td><td>Y</td></tr>
<tr><td>LV Winding Temperature Protection</td><td>Y</td><td>N</td></tr>
<tr><td>HV Winding Temperature Protection</td><td>N</td><td>Y</td></tr>
<tr><td><u>Oil temperature Protection (49)</u></td><td><u>Y</u></td><td><u>Y</u></td></tr>
</table>
</td></tr>
<tr><td>15.</td><td>ANNEXURE C

Specific Technical Requirements for Synchronous Condenser

Clause no. 12.1 General Requirements

RFP & TSA</td><td>
<u>Table-3</u>
<table>
<tr><th>Sl. No.</th><th>Description</th><th>Unit</th><th>Technical Parameters</th></tr>
<tr><td>1.16</td><td>Bushing</td><td></td><td></td></tr>
<tr><td></td><td>.....</td><td></td><td>.....</td></tr>
<tr><td>vii)</td><td>Tan delta of bushings</td><td></td><td></td></tr>
<tr><td></td><td>HV</td><td>%</td><td>Refer Note 2</td></tr>
<tr><td></td><td>MV</td><td>%</td><td>Refer Note 2</td></tr>
<tr><td></td><td>...</td><td></td><td>...</td></tr>
</table>
</td><td>
<u>Table-4</u>
<table>
<tr><th>Sl. No.</th><th>Description</th><th>Unit</th><th>Technical Parameters</th></tr>
<tr><td>1.16</td><td>Bushing</td><td></td><td></td></tr>
<tr><td></td><td>.....</td><td></td><td>.....</td></tr>
<tr><td>vii)</td><td>Tan delta of bushings#</td><td></td><td></td></tr>
<tr><td></td><td>HV</td><td>%</td><td rowspan="2"><u>≤ 0.5</u></td></tr>
<tr><td></td><td>MV</td><td>%</td></tr>
<tr><td></td><td>...</td><td></td><td>...</td></tr>
</table>
<u># Tan δ value of OIP/RIP/RIS condenser bushing shall be 0.005 (max.) in the temperature range of 10°C to 40°C. If tan delta is measured at a temperature beyond above mentioned</u>
</td></tr>
</table>

Sl. no.	Clause No.	Existing Clause	New/Revised Clause
			limit, necessary correction factor as per IEEE shall be applicable. The measured Tan δ value at site should not exceed by 0.001 w.r.t. factory results (measured at approx. similar temperature conditions) during warrantee period.