283770/2020/O/o PED/TI/RDSO

Reasoned Document for Final Draft of Auto Transformer Specification to be used in the 2X25kV Traction

SN	Spec. Clause No.	Specification description	Comment of Firm	RDSO Remark on the comment
1.	1.6.2.1	Protection System of Traction Transformer	**M/s Toshiba** Protection shall be taken care by RDSO /EPC Contractor	In the specification it is mentioned only for the introduction of the system, not in the scope of transformer manufacturer.
2.	1.6.2.2 & 1.6.2.1	Circuit breaker & Interrupter	**M/s Toshiba** Our scope limits to supply of transformer only. All other components of Circuit breaker, Interrupters etc., are not under Transformer manufacturer scope of supply.	In the specification it is mentioned only for the introduction of the system, not in the scope of transformer manufacturer.
3.	1.6.2.2	The protection system for the OHE	**M/s Toshiba** Shall be taken care by RDSO/EPC Contractor.	In the specification it is mentioned only for the introduction of the system, not in the scope of transformer manufacturer.
4.	1.7.1	Conservator tank	**M/s Prime Meiden** We recommend the tank for transformer shall be conventional with flanges on the outside. And top space between top cover and oil level, it fills nitrogen gas instead of oil. Therefore, non-requirement of Conservator. Due to the above recommendation, Transformer dimensions could be reduced.	Firm comment for the nitrogen sealed tank may be accepted as an optional with the conservator type tank in the specification considering the advantage that the transformer dimensions can be reduced. Also, DFCCIL has already used this type of autotransformers.
5.	1.7.1	Suitable air cell/separator arrangement of high quality material shall be provided in the conservator to ensure that the transformer insulating oil does not come in contact with air.	**M/s High Volt** Aircell is required only for conservator diameter more than 500 mm and quantity of oil more than 500 litre. The 8MVA to 24MVA AT does not have such big volume & Aircell is not required**.** **M/s ABB** We would recommend the addition of a cell/separator leak detector to the conservator to detect cell rupture /damage or significant air leakage to the fluid side. This will ensure that a damaged cell is recognised and can be rectified. It will reduce risk of accelerated fluid oxidation and moisture ingress is avoided. Appropriate type of detector will also avoid false alarms.	Since the presence of Aircell in the conservator avoids the contact of the transformer oil with air, aircell can be provided, comment of the firm may not be accepted. The comment of M/s ABB may be accepted considering the monitoring of the aircell.

6.	1.7.2	**Oil level gauge:** It shall be of magnetic type having a dial diameter of 250mm. The gauge shall have markings corresponding to minimum oil level, maximum oil level and oil level corresponding to oil temperature of 30^0C, 45^0C and 85^0C. The oil level indicator shall be so designed and mounting that the oil level is clearly visible to an operator standing on the ground.	**M/s ABB** We would recommend the addition of low and high fluid level alarms to the oil gauge requirement. This will give warning if there is a significant loss of fluid due to major leakage and also warning if during long periods of overload at high ambient there is risk to the transformer for overpressure or rupture of the conservator cell /separator.	Firm suggestion may be accepted as it is a monitoring of the system.
7.	1.7.3	**Silica gel breather** It shall be complete with oil seal and connecting pipes. The connecting pipes shall be secured properly. The container of the silica gel breather shall be of transparent flexi glass or similar material suitable for outdoor application. Orange Silica Gel (round balls 2 to 5mm) with quantity of two DTO-8 silica gel connecting with flanged mounting two pipes control through two different valves as per DIN:42567 & IS:3401 to be provided.	**M/s ABB** We would recommend the use of: Self-Dehydrating silica gel breather. The breather shall be able to automatically regenerates the own silica gel and report the status of the regeneration through LEDs and suitable communication. The selection of suitable breather should be based on the total quantity of oil in Transformer and its application. All the external parts of the breather shall be suitable for outdoor use and & resistive to transformer oil. It should also be able to withstand the site conditions like ultraviolet rays, pollution & saline atmosphere. The breather shall be suitable to work on ambient temperature of -20°C to +80°C. The equipment must be capable to withstand all possible environmental conditions. Control box degree of protection shall be at least IP65. The type pest certificate for the same must be submitted. Breather should also be equipped with a manual regeneration button to test the regeneration functionality. Control box shall be equipped with Analogue output signal (4-20ma) for the silica gel saturation & USB / RS 485 port for downloading the operational data logged by the unit. Required software supporting the analog and digital functions shall also be provided. Supply of Laptop/PC for above software is not envisaged. The equipment shall operate at input supply of 230V AC, 50 Hz. Any converter if required shall be supplied with the equipment. The breather shall also be equipped with suitable protection against overvoltage Type Tests reports must be submitted for offered breather.	Firm suggestion of self-dehydrating breather may be accepted as an optional requirement in the specification, so that for any remote or very humid location, it can be utilized by Indian railways, if required.

			The supply shall have a minimum 5-year manufacturing experience and minimum 2 performance certificate of more than 1 year of successful operation shall be available from state / central Indian utility 1. No need of replacing silica gel for minimum 10 Years 2. No silica gel visual inspection, replacement & disposal. 3. Full control of drying agent saturation status. 4. SCADA connectivity for signals displaying the silica gel saturation level. 5. No environmental impact for silica-gel disposal 6. Total cost of ownership reduction. **M/S Prime Meiden** We recommend for Nitrogen gas sealed type Transformer tank, therefore, Silica gel breather is not required.	Noted, para may be modified accordingly.
8.	1.7.4	**Pressure relief device:** It shall be designed to operate to release internal pressure at preset value without endangering the equipment or operator and shall be of instantaneous reset type. Shroud Pressure relief Device will be used and have provision of discharge of oil from PRD to safe place by closed pipeline. This avoids hazards of fire and it is safe to persons working near Transformer & it is environmental friendly.	**M/s ABB** Given the very frequent occurrence of short circuits and overloads, we recommend the use of a smart pressure relief valve. The PRD shall be capable of continuously indicating the pressure in main tank through 4-20mA analog communication. The PRD shall have provision of digital communication through Modbus or similar protocol. This shall be suitable for integration with SCADA if required. Also, if required PRD should be capable of giving soft alarm in system. This device detects and reports pressure increase as well as pressure relief valve operation. Evolving problems due to frequent short circuits may possibly be detectable well prior to tripping of transformer and the need for unexpected outage avoided. Also, the possible discharge of oil may be avoided.	Firm suggestion may be accepted as an optional requirement with the conventional PRV, since the manufacturers of smart PRV are limited in India at present, it is mainly imported item.
9.	1.7.8	**Buchholz relay:** It shall be of double float type, with two shut - off valves of 80 mm size, one between the conservator tank and Buchholz relay and the other between the transformer tank and Buchholz relay. The relay shall have one alarm contact and one trip contact, none of the contacts being	**M/s ABB** Given the very frequent occurrence of short circuits and overloads, we recommend the use of a smart gas pressure relay (Buchholz relay). Along with the conventional features, Buchholz relay shall be suitable for remote indication of the parameters being measures as defined below. a) The Buchholz relay shall be capable of continuously communicating the oil level	Firm suggestion may be accepted as an optional requirement with the conventional Buchholz, since the manufacturers of smart Buchholz relay are limited in India at present, it is mainly imported item

		earthed. The contacts shall be magnetic switch or micro switch type, electrically independent and wired up to the marshaling box. A testing petcock shall be brought down through a pipe for the purpose of sampling the gas, if any, collected in the Buchholz relay.	through 4-20mA analog output. b) The Buchholz relay shall have provision of digital communication through Modbus or similar protocol. This shall be suitable for integration with SCADA if required. The protection class of Buchholz relay shall be at least IP65. This device detects and reports accumulating volume of gas as well as normal Buchholz functions. Evolving problems due to frequent short circuits may possibly be detectable well prior to traditional alarm and tripping of transformer and the need for unexpected outage avoided. **M/s Prime Meiden** As we have recommended Nitrogen gas sealed type Transformer tank, Buchholz relay is not required. Instead we shall supply Sudden Gas Pressure relay to suffice the requirement. **M/s Toshiba** Since we have offered N2 gas sealed transformers, Buchholz relay is not required.	Noted, para may be modified accordingly. Noted, Para may be modified accordingly.
10.	1.7.10	It shall have one alarm contact, one trip contact, two contacts for FAN operations and two normally open spare contacts, none of the contacts being earthed.	**M/s HighVolt** It will not have contacts for FAN operations as this transformer are naturally/air cooled & no cooling fan.	Firm comment may be accepted, para of the specification shall be corrected.
11.	1.7.12	Thermo Siphon Filter System is to be provided for absorbing the moisture present in the insulating oil with the natural convection. The full details for installation and subsequent maintenance have to be furnished to RDSO and the consignee	**M/s Prime Meiden** We recommend to delete the requirement, as our proposed Transformer is nitrogen gas sealed type transformer. There is no possibility of entry of moisture into Main tank and no chance of mixing with oil, Therefor there is no need for providing Thermo siphon filter. Thermosiphon filter system is a obsolete system that was used by many Indian utilities earlier, where well established air cell type type oil preservation system were not in place. **M/s ABB** We recommend exclusion of this clause. In case specifically required we recommend use of online transformer oil drying system which is universally accepted and are more reliable. Thermosiphon Filters are primitive solution which does not find much relevance with	Comments of the firms may be accepted for non-addition of thermo syphon filter. Already aircell has been included so the air (already dried with breather) will not come in contact with transformer oil.

			improved design and use of air cell. **M/s High Volt** It is recommended only when volume of oil is more than 6000liters. All these ATs the oil volume is less than 6000liters.	
12.	1.7.13	NIFPES	**M/s High Volt** Requirement of NIFPES is not recommended due to less volume of oil.	Considering the fact that the oil capacity is less, there is no tap changer in the auto transformer, the comment of the firm is accepted for not adding the NIFPES with transformer.
13.	1.7.17 (v)	In case of Transformer manufacturer change in the make of OCTC for approved design of transformer, the routine testing of the transformer also shall be witnessed by RDSO.	**M/s High Volt** There are no taps for Autotransformer hence OCTC is not required.	Comment may be accepted. Para of the specification shall be corrected.
14.	1.7.14	**Fiber Optic Winding Hot Spot Temperature Monitor:** Fiber optical winding hot spot temperature monitor to be provided with the transformer windings, connected in addition to the winding temperature indicator in parallel to measure transformer winding hot spots in real time and activate control of the cooling system. The Fiber to be given high strength casing through jacketing and Fiber Optic shall be governed by IEC-60076-2 (Ed.3.0)	**M/s High Volt** As per IEEMA & CBIP for single phase transformer above 50MVA this system is require, hence in these Autotransformer should not be insisted for. **M/s ABB** We recommend that the fibre optics are also used to monitor the hotspot temperature in service to validate the effects of harmonics. Additionally, the temperature rise information (with and without harmonics) from a design review meeting together with the FAT fibre optic results (without harmonics) should be used: • To set the winding temperature indicator to simulate hotspot gradient with harmonics • Determine if the transformer FAT results	The autotransformer used in the 2X25kV system is a single phase autotransformer and in this there is a single winding. In the IEC 60076-2, the number of sensors has been defined for the single phase transformers above 50MVA. In the comment it is also mentioned that as per IEEMA & CBIP for single phase above 50MVA it is required. Thus the comment of the firm for not adding the FOS may be accepted. Since one comment is accepted for non-addition of FOS, no comment is required on M/s ABB comment.

			meet the allowable temperature rise limits for the service situation with harmonics.	
15.	2	**Environmental & Operating Conditions**	**M/s Toshiba** We recommend transformer design suitable to withstand up to an altitude level of 1000mtrs above mean sea level and service conditions as per IS 2026.	Already specification mention for altitude max 1000m.
16.	3.1	The overall dimensions of the transformer shall be max, Length- -	**M/s Prime Meiden** Since, PML proposed Transformers are with N_2 sealed type tank, the overall dimensions could be reduced for the Auto Transformers. For example, 8 MVA Auto Transformers overall dimensions could be reduced up to as: Length 2400 mm, Breadth 3500 Height 3000 mm.	Specification defines the maximum dimension, however it shall be reviewed as per the comments
17.	3.2.1	The tank for the transformer shall be of bell type construction with flanges on the outside and shall have a flat top .The flanges of the upper and lower tanks shall be jointed by bolts, nuts and suitable plain/spring/beveled washers. A suitable gasket and metallic stoppers shall be provided between the flanges of upper and lower tank so as to prevent leakage of Insulating Oil. The tank shall be so designed that the winding and core get fully exposed when the bell tank cover is lifted.	**M/s Prime Meiden** We recommend to keep the tank construction details as per the specification no. TI/SPC/PSI/TRNPWR/6200, with details as: The tank for the transformer shall be of the top cover jointed with bolted connection. The bottom plate of main tank shall be firmly welded to the main body and the top cover is a plate reinforced with ribs. We recommended to delete' The tank shall be so designed that the winding and core get fully exposed when the bell tank cover is lifted', based on our manufactured and supplied autotransformer to DFCC. **M/s ABB** The tank for the transformer shall be of **Conventional** type construction with flanges on the outside and shall have a flat top .The flanges of the upper and lower tanks shall be joined by bolts, nuts and suitable plain/spring/bevelled washers. A suitable gasket and metallic stoppers shall be provided between the flanges of upper and lower tank so as to prevent leakage of Insulating Oil. The tank shall be so designed that the winding and core get fully exposed when the bell tank cover is lifted. As per Clause 6.1 of recent CBIP manual, ***"All transformer reactor tanks should generally be of conventional type"***. The Bell tank is not generally recommended. It is asked only if there is a facility limitation to lift the active part for full inspection purpose. ABB recommends not to expose	As per CBIP manual on transformer issued in April 2013, publication no. 317 - "All transformer reactor tanks should be generally be of conventional type i.e. tank body with top cover, Bell shaped construction can be specified for 100MVA and higher rating transformer unless otherwise mutually agreed between Purchaser and Manufacturer. This manual does not make a mandatory requirement for the bell tank below 100MVA, Considering the possibilities of the overhauling of the transformer at the site, the bell type transformer tank has been used in the Indian Railways, and thus the bell type tank is recommended for this rating also.

			the active part to the atmosphere and thus bell type tank is not recommended. Also, there could be hot spots on bolts at the curb of bell and the damage to the gaskets can cause leakage in long term operation. The oil head is also more at the curb joint in case of Bell type tank which also increases the chances of oil leakages.	
18.	3.2.4	The tank shall be fitted with an under carriage and mounted on eight bi-directional swiveling type flanged rollers for being rolled on 1676 mm (5' 6") gauge track on which it shall also rest in the final position	**M/s ABB** We would recommend that 4 bi-directional rollers is sufficient for a transformer of this size **M/s TBEA** Four/eight rollers shall be used based on the size and weight of the transformer.	Firm comment may be acceptable for four rollers since size of autotransformer is small.
19.	3.2.6	The rubberised cork/gaskets used in the transformer shall conform to IS: 4253 (Part - II).	**M/s TBEA** We propose to use Nitrile Butadiene rubber as it has better performance over SRBC gasket.	Firm comment may be accepted for incorporation in specification.
20.	3.2.7	All valves used in the transformer shall conform to IS: 3639	**M/s Toshiba** IS- 3639 will not represent for any valve requirement. We will follow IS 778 for valve requirement.	Valves are covered in the IS: 3639 do firm comment may not be accepted.
21.	3.3	RTCC Panel	As these transformers does not have tap changer and cooling fan so RTCC panel is not required.	Firm comment is justified, the requirement of RTCC panel word shall be removed from the specification.
22.	3.4.1	The core shall be built from high permeability Cold Rolled Grain Oriented (CRGO) silicon steel laminations conforming to IS: 3024. The flux density in any part of the core and yokes at the principal tapping with primary winding excited at the rated primary voltage and frequency shall not exceed 1.55T.	**M/s Toshiba** The core shall be built-up of high permeability cold rolled grain oriented silicon steel laminations conforming to JIS C2553 or equivalent IS as indicated in Table No. 2.1-1.The flux density in any part of the core and yokes at the principal tapping with primary winding excited at the rated primary voltage and frequency shall not exceed 1.55 T. **M/s ABB** We would recommend that the normal flux density is limited to 1.7 T rather than 1.55 T. The core steel grade used should have tested single strip loss results at 1.7 T (50 Hz) less than 1.25 W/kg. Additionally, in order to avoid local heating and flux concentration, the core should use step lapped core joints and laminations should not have holes such as for manufacturing alignment nor have bolts (insulated or otherwise) through the laminations. The Bidder shall submit the Flux Density Calculation along with the design review and	JIS is Japanese standard, since the IS is available for the item, the standard of any other country cannot be mentioned in view of the 'Make in India' concept. As per CBIP manual on transformer issued in April 2013, publication no. 317, Para no. 2.9.1 (page 11), Maximum Flux Density shall not exceed 1.9 Tesla. In addition to these, the use higher flux density will have advantages that it shall reduce the size of the transformer which shall be beneficial to Indian Railways for space saving

			the same specified parameters shall be verified during physical stage inspections by methods as specified in the stage inspection procedure. Indian transformer manufacturers shall use core material as per above specification with BIS certification. Modern core steels have a saturation flux density > 2.0 T. Hence normal flux densities of 1.7 T are still very safe. Even with system highest voltage applied continuously to the transformer, the flux density of 1.89 T is comfortably below saturation and excessive heating. This is provided a modern core design is used with step lapped joints and no lamination holes or through-bolts giving local flux concentrations. The use of the modern steels can be assessed with submission of typical B-H curves and assessment of the core exciting current at tender and factory assessment testing stages. We can offer some suggestions /information on this via our application engineering team if it is of interest.	for the TSS. Considering the above and reason mentioned by the firm, the comment of M/s ABB may be accepted in view of the reasons mentioned. In the specification it may be mentioned as flux density shall not exceed 1.7T. Comment of M/s ABB that "Indian transformer manufacturers shall use core material as per above specification with BIS certification" may be added in the specification to ensure quality.
23.	3.4.3	The core shall be electrically connected to the tank.	**M/s ABB** We recommend that the core, core clamps and tank should be insulated from each other with a single location conscious earth connection. The insulation shall be high temperature, non-deteriorating (non-cellulose) material. The earth connection shall be accessible without draining any oil, behind a cover-plate to allow the connection to be opened for testing of the insulation resistance at 2.5 kV. This will ensure that the core is earthed in service at one point only to avoid any possible circulating currents. It also allows the insulation integrity to be verified periodically during POH or in response to adverse DGA signatures. For a transformer that is subjected to frequent short circuits, this arrangement is recommended.	Firm comment may be accepted for adding in this para. Already in the specification 2kV insulation test is mentioned between core laminations and core clamping bolts.
24.	3.4.6	Manufacturer shall, preferably have the core cutting facility in their works and proper monitoring and quality control to avoid any mixing with defective /second grade materials.	**M/s ABB** We recommend that it is not necessary to have the core cutting facility at the manufacturer's works if the appropriate monitoring and quality control systems are in place. We recommend adding a requirement to perform and analyse a core resistance test across the lamination steps of the completed core to assess for this. This will ensure that the core is earthed in service	As per the specification it is not a mandatory requirement, so any change is not required in the specification. The no load losses are already defined in the specification, which are measured during the

			at one point only to avoid any possible circulating currents. It also allows the insulation integrity to be verified periodically during POH or in response to adverse DGA signatures. For a transformer that is subjected to frequent short circuits, this arrangement is recommended.	routine testing of the each job. For addition of CORE resistance test any reference standard has not been linked with the comment, so cannot be accepted.
25.	3.5.1	The winding shall be of concentric disc type. The windings shall be uniformly insulated. The two outer terminals of the winding shall be brought out through 52kV OIP condenser bushings, whereas the neutral terminal (center tapping) through a 12kV oil-filled porcelain bushing.	**M/s High Volt** As per specification Neutral terminal shall have 12kV oil filled bushing but being Autotransformer the neutral point is midpoint of 54kV and see voltage of 27kV. By mistake it is not earthed properly than for safety reason the bushing should by of 36kV. The same should be modified as all AT received up to date are of 36kV. **M/s Toshiba** The winding shall be of disc/concentric /interleaved/multilayer type. **M/s ABB** We recommend that the winding type be changed to: The windings shall be of an axially clamped concentric winding design. Windings shall not be multi-layer type which rely on epoxy dot bonding to interlayer paper/pressboard cylinders to maintain short circuit axial force withstand. Winding types shall be axially clamped disc, helical or single/double layer types of substantial radial depth. We recommend that the requirement for uniformly insulated windings removed. This is because the 28 kV separate source test level in Clause 6.4.9.2 defines a non-uniformly insulated winding. Additionally, clauses 3.5.2, 17, 18 etc require a 12 kV neutral bushing, versus the 52 kV for the line bushings. Due to the very frequent short circuits, it is necessary to have windings with substantial radial dimension and are firmly axially clamped. Distribution transformer type multilayer windings using diamond dot interlayer papers to bond to the turns for axial force withstand are not secure enough for this transformer duty.	As per the specification transformers design is accepted which passed all the type test including the dynamic stability short circuit test in a laboratory, the design is not accepted on the basis of the theoretical calculations. Therefore, the type of the transformer winding may be decided by the transformer manufacturer after ensuring that the all the parameters mentioned in the specification are fulfilled with that design. The clause shall be modified accordingly.
26.	3.5.2	The windings shall be made of continuous electrolytic copper conductor, paper insulated to class - A insulation. The conductor shall not have sharp edges which may damage the insulation.	**M/s ABB** Thermally upgraded insulation, while still class A material has a better thermal lifetime performance. For a transformer that is subject to high levels of harmonics, the winding hotspot is at risk of higher values and more sensitive to increased harmonics. Thermally upgraded paper is more resistant	As pre the IS: 2026 (Part:14): 2018, Para 3.6, Thermally upgraded paper is cellulose-based paper which has been chemically modified to reduce the rate at which

			to the impact of the higher winding hotspots. Epoxy bonded continuously transposed cable which includes enamelled strands is particularly suitable for transformers with harmonics and high short circuit demands. Its small strands are helpful to reduce the increased eddy losses from the harmonics while the epoxy bonding of the strands dramatically increases the short circuit withstand strength.	the paper decomposes. Also as per the para 5.6 of IS:2026 Part – 7, The purpose of thermally upgrading insulation paper is to neutralize the production of acids caused by the hydrolysis (thermal degradation) of the material over the lifetime of the transformer. This hydrolysis is even more active at elevated temperatures, and published research results indicate that thermally upgraded insulation papers retain a much higher percentage of their tensile and bursting strength than untreated papers when exposed to elevated temperatures. In view of the above, The comment to use thermally upgraded paper may be accepted. Option for epoxy bonded continuously transposed conductor shall also be added in the specification, since for normal single phase transformers CTC conductor are already being used by RDSO approved vendors from many years.
27.	3.5.3	Normally, no joint shall be used in the winding conductor. If a joint becomes inescapable, it shall be brazed with high silver alloy grade BA Cu Ag6 conforming to IS: 2927 or electrically butt - welded.	**M/s High Volt** As now days exact length & size of copper conductor (PICC) are available, there should not be any joint in the windings.	Already in the specification it is mentioned that normally no joint shall be used, if it is made compulsory in the specification, it has to be verified by the inspector during the stage

				inspection, which is not possible after complete winding, so no change in specification is required.
28.	3.5.9	The axial pre - compression on the windings shall preferably be double the calculated axial thrust that may be set up under dead short - circuit condition so as to ensure that the windings do not become loose due to frequent short circuits in service.	**M/s ABB** We recommend that: The short circuit withstand can be determined by either: 1. Winding dynamic force response to the electromagnetic field calculations for this specific design. 2. Electromagnetic field calculations alone with standardised dynamic response factors. It is strongly preferred that the short circuit withstand is based on the design specific dynamic response behaviour method. For dynamic for calculations: The transformer short circuit withstand should be preferably analysed and demonstrated using and including: Dynamic force response calculations derived from electromagnetic leakage field plots. The dynamic response calculations shall be specific to the windings of this transformer. The dynamic response is to account for the compressible nature of the insulation materials within and outside the windings. Winding offsets to account for manufacturing tolerances and errors Winding offsets to account for the pitch of any helical or layer windings Determination of winding resonant frequencies which should not coincide with 50 Hz or its multiples. The axial pre-compression force for the windings shall be based on the maximum axial dynamic response and the minimisation of mechanical stress in the system. To account for the high frequency of short circuit events, the allowable withstand stresses shall be reduced to 80% of the normal material withstand levels. For electromagnetic field only calculations: If the transformer short circuit withstand is not analysed with the individual design specific dynamic force response then the forces shall be determined by use of electromagnetic field plots which also include: Winding offsets to account for manufacturing tolerances and errors Winding offsets to account for the pitch of	As per the specification, the dynamic stability of every design is tested by the short circuit test in a laboratory, the design is not accepted on the basis of the theoretical calculations. Also, the suggestion of the firm has not been supported by any national or international document, thus in the specification it is not feasible to incorporate. Also, the suggestion of the firm has not been supported by any national or international document, thus in the specification it is not feasible to incorporate.

			any helical or layer windings. The electromagnetic forces from the field plot shall be increased by a factor of 1.5 to account for the dynamic winding response. The axial end force shall be the greater of the 1.3 times the electromagnetic end forces or the peak axial compression force within the winding. Additionally, the stresses so determined shall not exceed one third of the material maximum permissible stresses or 50% of the allowable withstand levels given in IEC 60076.5, whichever is lower. The axial pre-compression of the windings will be significantly higher than double the end thrust due to the electromagnetic force calculation. This is due to the dynamic nature of the short circuit forces and hence the "bounce back" reaction forces from the windings. For geometrically balanced windings, the electromagnetic forces at the ends appear relatively small but the actual resultant dynamic forces are much larger. While these are sometimes estimated by experience, for transformers subject to frequent short circuits, it is necessary to perform an actual dynamic force calculation for the specific windings of this transformer and design accordingly. Please see the comments in the general recommendations about short circuit withstand integrity. We would be pleased to offer our application engineering team to deliver some technical training on short circuit withstand of power transformers including "self supporting" windings behaviour, dynamic force calculations and learnings for short circuit testing	
29.	3.5.10 3.5.20	During short circuits, the stresses actually set up in conductors, spacers, end blocks, clamping rings and such other parts of the transformer shall not exceed one third of the maximum permissible values.	**M/s ABB** Given the Annexure 4 force calculation expected accuracy, we can understand the very low 33% withstand limit. Typically, modern practice would determine forces via electromagnetic field plots and dynamic oscillation factors. For transformers with this high frequency of short circuit events we would recommend that the winding dynamic response is directly calculated for this individual design and the resonant frequencies are determined and controlled. Given this much more accurate,	As per the specification, the dynamic stability of every design is tested by the short circuit test in a laboratory, the design is not accepted on the basis of the theoretical calculations. Also, the suggestion of the firm has not been supported by any national or international

			well proven approach the stress limitations can be increased substantially. Inner windings experience radial buckling forces that include free buckling modes of failure. These are often the lowest withstand mode of radial failure. Such free buckling failures are independent of the number or spacing of mechanical supports inside the winding. Additionally, any supports that are tight inside the winding when new will shrink over time with the normal thermal aging of the transformer insulation. Hence, they will no longer remain tight throughout the transformer life. For these reasons, we believe it is essential to design the windings to be "self-supporting" against radial failure and not rely on the inner supports for short circuit withstand. Supports are in place for transport and geometry and cooling performance control but not for short circuit withstand. This is especially import for transformer with heavy and high frequency short circuit duty.	document, thus in the specification it is not feasible to incorporate.
30.	3.5.14	In order to cater for shrinkages that may occur in service, substantial clamping rings shall be provided at the tops of the windings, being pressed down upon them by means of adjustable pressure screws or oil dash pots or any other suitable device, so as to maintain a constant pressure and obviate the need for any retightening in between successive periodical overhauls.	**M/s ABB** Our understanding of this clause is that uniform clamping force and uniform axial dimension is required upon the whole circumference of the coil or set of coils during pressing before and immediately after the dry out process.	No remarks required.
31.	3.5.15	The core and winding of the transformer have to be dried preferably using Vapour Phase Drying (VPD). The coil and core assembly shall be retightened after oil impregnation. The manufacturer shall ensure that there is no further shrinkage of the coil assembly in any additional cycle after the final curing.	**M/s High Volt** The CORE/winding must be dried by Vapour Phase drying (VPD) only. This is to improve the PI Values. **M/s ABB** We recommend that an additional alternative process could be considered: If the core and coils are vapour phase dried to less than 0.4% moisture and it can be demonstrated with data records that the manufacturing systems and controls are sufficiently strong then the final tightening post impregnation may be deleted.	The comment of the firm may be accepted as in RDSO STR, the VPD is an essential facility. Specification mention that, there shall be no further shrinkage, comment is a manufacturing procedure practice which manufacturer to ensure, no need to add in the specification.
32.	3.5.17	The core and winding of the	**M/s ABB**	

		transformer have to be dried preferably using Vapour Phase Drying (VPD). To ensure the removal of moisture from the transformer the PI value after drying has to be achieved equal to or more than 2 (two) in the manufacturing at the works	We recommend that vapour phase drying is used and either the moisture level of a sample block from the vapour phase or later DFR (dielectric frequency response) measurement is used to demonstrate that cellulose moisture content is <0.5%. We would not recommend that PI >2 for moisture assessment criteria for a new transformer in the supplier's factory. It is not a sensitive measure for this new transformer stage. Additionally, modern, good quality, new transformer oils often have very high resistivity and this results in PI < 2 even for very dry, clean, high resistivity transformers. PI should be measured as a benchmark only for future PI measurements.	The measurement of PI can be done the inspector during the testing of job, the cellulose moisture content measurement can be done at the manufacturing stages by the manufacturer itself, it is not needed to make it a part of the specification.
33.	3.5.19	Pre-compressed pressboard conforming to grade PSP: 3052	**M/s Toshiba** We propose pressboard as per IEC 60641 (grade 3.1.A) which will meet all electrical and mechanical properties for class A insulation	Firm comment may be accepted for as per IEC also.
34.	3.6	The transformer shall be supplied with new Inhibited Mineral Insulating Oil conforming to IS: 335:2018 (Type-II) and the additional requirements stipulated under clause 6.3.8.9. In addition 10% extra oil by volume shall be supplied in non-returnable steel drums. The characteristics of the insulating oil before energisation of the new transformer and during its maintenance and supervision in service shall conform to IS: 1866.	**M/s Toshiba** The transformer shall be supplied with new insulating oil conforming to IEC60296. In addition, 10% extra oil by volume, shall be supplied in nonreturnable steel drums. The characteristics of the insulating oil before energisation of service shall conform to IEC 60296.	Indian Railway is using the Insulating Oil as per the Indian Standard in the conventional single phase traction transformers, auxiliary Transformer, CT, PT, same can be used for this also, no need to change.
35.	3.7 3.7, 3.7.1 3.7.3 3.7.4	OIP Condenser Bushing	**M/s ABB** We would recommend that dry type condenser bushings are used employing resin impregnated paper or synthetic material rather than OIP condenser bushings. This will significantly reduce the safety risk of a possible fire. We would also recommend the use of polymer shed on the outdoor side of the bushings rather than porcelain. For the 12 kV bushings we recommend that solid moulded resin/polymer bushings are preferable for the same reasons as given for the Dry type condenser bushings.	The use of Dry type bushings is a separate policy decision can be decided separately when the sources of Indigenous make are easily available.

			RIP/RIS bushings if damaged or if subject to internal failure tend to act as a plug maintaining a seal for the transformer oil away from the atmosphere. This reduces the risk of fire. OIP bushings tend to shatter, fall into the transformer internals and leave an opening to the atmospheric oxygen into the transformer and hence fire risk. The polymer sheds are much less fragile than porcelain and hence less likely to be damaged or shatter. Additionally, in the event of a bushing failure the explosive velocity of porcelain shrapnel is a high risk for personnel injury/death. The polymer sheds do not shatter and remove this risk entirely.	
36.	3.7.1	On the neutral side, 12kV class oil-filled porcelain bushing shall be used.	**M/s High Volt** Neutral side Bushing shall be of 36kV only	Firm comment may be accepted in view of the reason mention in a comment by the firm. In the specification 33kV shall be mentioned which is a standard voltage.
37.	3.7.4	The bushings shall have a non- breathing oil expansion chamber.	**M/s High Volt** The OIP bushings shall have a non- breathing oil expansion chamber.	It is a typographical only, para will be changed as per the comment.
38.	3.7.6	Insulation level of 12kV Neutral bushings	**M/s High Volt** The Neutral Bushing shall be of 36kV & insulation level should be mentioned accordingly.	May be accepted and clause shall be modified.
39.	3.7.7	Adjustable arcing horn shall be provided on both the primary and secondary bushings	**M/s ABB** We recommend replacing arcing horns with surge arresters as per modern practice **M/s High Volt** 36kV Neutral bushing with suitable gap of Arcing horn.	Arcing Horn and surge arrester both are provide in Indian Railways
40.	3.11.3	In case of use of headers, isolating valves of size 80mm shall be used between tank and headers.	**M/a TBEA** In case of use of headers, isolating valves of size 80mm (minimum) shall be used between tank and headers.	Firm comment may not be accepted as any specific size with reason has not been commented. Also, a standard size is required to be specified for uniformity in all the transformers of same rating.
41.	3.12	Fasteners The material of the stainless steel fasteners shall conform to IS: 1570 (Part- V). Grade 04Cr17Ni12Mo2.	**M/s Toshiba** We propose SS hardware 304 grade.	In specification equivalent or better shall be mentioned.
42.	5.1(2)	Short circuit current (symmetrical) 25 (Twenty five) times of the rated	**M/s Prime Meiden** For 8 MVA and 12.3 MVA AT: Short circuit current rating of 25 times of	Firm has mentioned only to reduce the values, in

<table>
<tr><td></td><td></td><td>current</td><td>rated current is Ok. However, for ratings 16 MVA, 18 MVA and 24 MVA: the short circuit current rating of 25 times needs to be reviwed as this will increase the dimensions and cost of Transformers substantially. Further we would also like to inform that, our manufactured and supplied 14.3 MVA Auto Transformers in DFCC project has 12 kA rating and not 25 times. Therefore, requesting RDSO to review and inform the values of short circuit current rating for ATs above 12.3 MVA.

M/s Toshiba (for 8MVA)
Thirty Five times or Twenty Five times</td><td>view of the cost, any technical reason has not been given, also, the supplied transformer short circuit current 12kA is nearly 22.5 times.

Twenty Five times is mentioned, 35 times already cover 25 times, no change is required</td></tr>
<tr><td>43.</td><td>5.1(5)</td><td><table><tr><td>MVA</td><td>No Load loss</td><td>Load loss</td><td>Leakage impedance</td></tr><tr><td>8</td><td>6.5</td><td>24</td><td>0.45</td></tr><tr><td>12.3</td><td>8</td><td>45</td><td rowspan="3">0.92</td></tr><tr><td>16</td><td>8</td><td>45</td></tr><tr><td>18</td><td>8</td><td>45</td></tr><tr><td>24</td><td>-----</td><td>-----</td><td>-----</td></tr></table></td><td>M/s Prime Meiden
We as per our manufactured and supplied 12.3 MVA Auto Transformer in DFCC project recommend the following for 12.3 MVA AT as: No load: 6.5 KW. Load: 24 KW Maximum leakage impedance as seen from secondary side (ohm): 0.45 For other ratings beyond 12.3 MVA, we request you to kindly suggest and advice.
M/s TBEA
Tolerance is not mentioned for the impedance values, please specify the same.
M/s Toshiba
Max. No-load losses, kW =7.5 kW
Max. load losses =26.5kW

(These loss and design has already been considered in other Railway projects and validated design is available. In case if Bidder is having Short circuit test of similar or higher rating then short circuit test is not required to be conducted).
M/s High Volt<table><tr><td>MVA</td><td>No Load loss</td><td>Load loss</td></tr><tr><td>8</td><td>6.5</td><td>21</td></tr><tr><td>12.3</td><td>7.6</td><td>29</td></tr><tr><td>16</td><td>8.5</td><td>31</td></tr><tr><td>18</td><td>9</td><td>38</td></tr><tr><td>24</td><td>9.5</td><td>42</td></tr></table></td><td>In the final draft of the specification the maximum values among the suggested values may be mentioned considering the increase in vendor base.

Maximum value has been mentioned, no tolerance is required on max value.</td></tr>
<tr><td>44.</td><td>5.1(11)</td><td>The temperature rise over an ambient temperature of 50^{0}C both at rated and overload conditions shall not exceed the value indicated below:
1. Winding: 50 ^{0}C at rated load, and 60 ^{0}C for overloads as specified in Clause 5.1.1(11) (temperature measured</td><td>M/s ABB
We recommend that the specification of winding hotspot temperature rise limits should be added to this clause.
If the more modern aspects of winding gradient hotspot factors recommended for Clause 6.3.1.2 are included and consideration included for the effects of harmonics plus the use of fibre optic probes measured hotspot results are included, then</td><td>The winding hotspot temperature rise limits are already mentioned in the other clause may be mentioned in this clause also.

The temperature rise limits are verified during</td></tr>
</table>

		by resistance method). 2. Top oil: 45 ^{0}C (temperature rise measured by thermometer). 3. Current carrying parts in air: 40 ^{0}C (temperature rise measured by thermometer).	we would recommend the following revised temperature rise limits: At Rated load (with harmonics included): Top Oil Temperature rise = 50 C Average winding Rise (by Resistance) = 55 C Winding Hotspot Rise = 68 C via the highest of techniques in comments for Clause 6.3.1.2 At Overload (with harmonics included): Winding Hotspot Rise = 80 C via the highest of techniques in comments for Clause 6.3.1.2 We would be pleased to explain the background and basis of these recommendations via a video conference discussion with our application engineering team.	the type testing of the transformer which is conducted at the works of the manufacturer, not at TSS location. The requirements mentioned in the specification are sufficient.
45.	5.1(14)	Current density in the windings at rated current Shall preferably not exceed 2.5 A/mm^2	M/s ABB The suggested current density limit is very low. We recommend that this limit is removed. The Current Density Limit of 2.5 A/mm2 is very low. This low limit is not necessary with modern power transformer design. Such a low limit would only be considered for older type distribution type transformer multi-layer windings without cooling ducts. For power transformer clamped windings with disc and helical windings much higher current densities are readily suitable. More importantly, the cross-sectional area and current density should be determined by correct short circuit withstand strength and suitably limited winding hotspot gradients in the presence of the stated harmonics. Suggestions for these characteristics are given in other comments	The requirement mentioned in the specification is a preferably requirement not a mandatory requirement. So no change is required in the specification.
46.	5.1 (12)	Ability to withstand short circuit Thermal ability: 5 s Dynamic ability : 0.5 s	**M/s Prime Meiden** We recommend the Ability to withstand short circuit of Thermal ability of 2[sec], based on our designed and supplied experience. In case of requirement of 5[sec], it will lead to costly Transformers. **M/s ABB** We recommend changing duration for dynamic short circuit test from 0.5 seconds to 0.25 seconds as per standards. **M/s HighVolt** Dynamic short circuit test duration: 0.25 seconds **M/s Toshiba** In case if Bidder is having Short circuit test of similar or higher rating then short circuit test	For dynamic stability, in the IS: 2026-2011, part-5 (para 4.2.5.5), the duration of 0.25second is mentioned for dynamic stability and for thermal stability in Para 4.1.3 it is mentioned that the duration of the current I to be used for the calculation of the thermal ability to withstand short circuit shall be 2 s unless a different duration is specified.

			is not required to be conducted	The para in the Final Draft may be modified.
47.	5.1(16)	12kV Neutral bushing	**M/s high Volt** Neutral bushing shall be of 36kV.	Standard Voltage 33kV Bushing shall be mentioned in the specification, explained in a comment.
48.	5.1(15)	Acoustic sound level when energized at rated voltage and at no-load. Not more than 75 dB at a distance of one meter.	**M/s Toshiba** NEMA Standard TR-1-1993 (R2000) Table -2	Any reference value has not been suggested by the comment; no change in specification is required.
49.	5.1(17)	The bushing type current transformers shall be in accordance with IS: 2705	**M/s Toshiba** The bushing type current transformers shall be tested in accordance with IEC60044-1.Class of accuracy as per IEC60044-1=PX	Since the Indian Standard in available, the mentioning of IEC is not required considering the 'Make in India' concept
50.		K=309(I+0.25C).I=Max. NLL in Watt and C= Max. Load loss in Watt	**M/s Toshiba** Capitalisation of Transformer Losses : Not Applicable	The comment of the firm is not accepted, the capitalization is calculated to evaluate the cost of the transformer in Indian Railways.
51.	6.2.1.3	Pressure test: Every transformer tank, radiator and conservator tank shall be subjected to an air pressure corresponding to twice the normal static head of oil or to the normal static head of oil or to the normal static oil head pressure plus 35 kN/m^2 (0.35 kgf/cm^2), whichever is lower, as measured at the base of the tank. The pressure shall remain constant for 1 h to indicate that there is no leakage.	**M/s ABB** We recommend that the "air pressure test" should be replaced with "pressure test". Ie do not perform the test with a vessel full of compressible gas. Alternatively, this test could be deleted and only rely on the test in Clause 6.2.1.1 which is of the same pressure levels. Performing a pressure test with the vessel filled with gas can be dangerous as the energy stored in the large volume of compressible gas is very large. In the event of an unexpected rupture there can be a dangerous "explosive" style release of energy. The pressure test is best performed with the vessel filled or almost filled with liquid (incompressible) and the overpressure is applied to a small gas space above the liquid. The stored energy is then dramatically reduced making the situation non-dangerous. This will also allow the test to also simulate the normal static pressure head profile of pressure making it more representative of the real service environment.	The air pressure test should be conducted on the transformer tank during the manufacturing stage, so that any leakage, if there, can be rectified. If only oil leakage test is mentioned, which is done final stage, It will not easy to rectify that.

52.	6.2.1 (5)	Test for pressure relief device**:**	**M/s Toshiba** Test Certificate for supplier shall be provided	Specification mention only to verify the operation test for the PRV, which con be conducted at the transformer manufacturer, it does not mention the routine/type test of PRV of which test certificate are submitted.
53.	6.2.2.2 a	Transformer Tank: following tests shall be conducted: (i) The pressure test and vacuum test shall be done as per the clause no. 6.2.1.2 & 6.2.1.3 of this specification. (ii) The Dye Penetration (DP) Test at the jacking and lifting pads.	**M/s ABB** A cumulative core resistance test across the stacked height of the laminations of the completed core could be added to this clause. This would allow assessment of core steel insulation quality throughout the core as well as edge burr suitability.	The suggested test is for manufacturing stage test which is not done on each job moreover, if any test is added in the specification, its acceptance limits has to be specified, already no load losses are mentioned, it is not required.
54.	6.3	Type Test	**M/s High Volt** Type test of components used from approved source of RDSO. The components purchased from RDSO approved sources shall not require to repeat any type test or routine test as been an approved source and we shall produce the test certificate at the time of BOM approval.	Already in the para 6.3.8 of the specification it is mentioned that type test on accessories are normally not conducted.
55.	6.3.1.2 item2	The ambient temperature shall be measured using alcohol in glass thermometers only.	**M/s ABB** We recommend that measurement of ambient temperature by use of thermocouples or electronic thermometers is also allowed. The more modern, accurate and safer practice of measuring ambient temperature is via the use of thermocouple or electronic thermometers. This allows remote and even continuous readings to be taken without endangering personnel to the transformer under test	The firm comment is accepted as per the latest practices being followed during the testing.
56.	6.3.1.2 item6	The temperature of the hot - spot in the winding shall be the sum of the temperature of the top oil and 1.1 times the temperature rise of the winding above the average oil temperature.	**M/s ABB** We recommend that the winding hotspot should be based on K*H *(the temperature rise of the winding above the average oil temperature), where K is the maximum of • 1.3 • The design review meeting demonstrated value of hotspot factor (50 Hz) • The temperature rise test measured value derived from the fibre optic probes H is the increase in hotspot gradient due to	The suggestion of the firm has not been supported by any national or international document, thus it is not feasible to incorporate in the specification.

			the service harmonics as established at the design review meeting and the winding information The winding temperature indicator should be set in accordance with the values above. Modern International standards recognise and give guidance that hotspot gradient factors are significantly higher than 1.1, typically at least 1.3 is considered appropriate but up to 1.6 is not unusual depending upon the design details. Here, the measured hotspot factor at 50 Hz can be determined via the use of the included fibre optic probes. Additionally, for transformers that are subjected harmonics, the hotspot factor will be significantly increased. This harmonic increase can be determined from the FAT 50 Hz fibre optic results plus knowledge from a design review meeting of the winding details and harmonic levels	
57.	6.3.1.3.1 item1	A quantum of power equal to the sum of the measured losses viz. No- load loss and load losses measured at lowest tap position, corrected to 75^0C plus 10% of such sum shall be fed to the primary winding of the transformer with the secondary windings short-circuited.	**M/s ABB** We would recommend that the load losses supplied should be the measured 50 Hz load losses (corrected to 75 C) plus the additional losses equal to the additional eddy losses from the service harmonics. The additional harmonic eddy losses should be based on the measured 50 Hz eddy losses and the agreed calculations from the design review meeting. Normally, the total losses equal to the sum of the no load losses and the load losses is supplied rather without an additional 10% losses. However, in the case of transformers experiencing service harmonics the additional harmonic eddy losses should be added for the test.	Already in the specification, it is mentioned that 10% addition on sum of the load and no load losses, the basis of the agreed calculations from the design review meetings cannot be standardized.
58.	6.3.1.3.1 Item 4,7,8 6.3.1.3.2 6.3.1.3.3	• The measurement of hot resistance shall commence as soon as possible after switching off. The first reading of the resistance shall be taken before the expiry of 90 s from the instant of switching off and the first ten readings shall be taken at intervals of 15 s apart. Thereafter, another ten readings shall be taken at intervals of 30 s apart. • The temperature of	**M/s ABB** We would recommend that the fibre optic probes are measured at: • 30 sec intervals for the first 15 minutes of the temperature rise • 30 min intervals (whenever the oil temperatures are measured) for the duration of temperature test. • 1-minute intervals when the current is returned to rated current. 30 second intervals from the time of shutdown The fibre optic probes will give the most accurate measured value (direct	Since the Comment has been accepted not to add the FOS in the Autotransformer, no need to add this Para.

		the ambient, top oil, the top and bottom radiator header oils shall also be recorded at half - hourly intervals through out the test starting from the instant power supply is switched on to commence the test till it is switched off. • The WTI and OTI readings shall also be recorded at half-hourly intervals right from the instant the power supply is switched on to commence the test till it is switched off. • After power supply is switched off, the readings of OTI and WTI shall be recorded at intervals of 1 min apart for 30 min.	measurement) of hotspot temperature at 50 Hz. These should be used as much as possible. They are also the best source of data to determine the winding time constant.	
59.	6.3.1.7	The temperature rise of the oil, windings and current carrying parts in air under both the overloads conditions stipulated in Clauses 6.3.1.3.2 and 6.3.1.3.3 above shall not exceed the values stipulated in Clause 5.1 (14) of this specification. The winding hot - spot temperature under the overload conditions shall not exceed 115^0 C.	**M/s ABB** We believe that the reference to Clause 5.1 (14) should be Clause 5.1 (12). We recommend that a winding hotspot temperature rise limit is added to clause 5.1 for both rated load and overload. It should be clear whether these limits include harmonic current temperature increases or are for 50 Hz load only. For the limit given for winding hotspot, it is recommended to express it as a temperature rise rather than temperature otherwise the ambient temperature needs to be included. We have also suggested some changes to the allowable temperature rise limits given in clause 5.1 based on modern knowledge and more accurate data for winding hotspot calculation, inclusion of the effects of harmonics and the use of fibre optic probes	Since the Comment has been accepted not to add the FOS in the Autotransformer, no remarks is required on the comment.
60.	6.3.1.9	Determination of the thermal time constant of the WTI: The thermal time constant of the WTI shall be determined for comparison with the thermal time constant of the winding of the transformer with respect to the transformer oil. For this purpose, the indications of	**M/s ABB** We recommend that some reference to the use of fibre optic probe results to determine winding time constants should be included.	Since the Comment has been accepted not to add the FOS in the Autotransformer, no remarks is required on the comment..

		the WTI and the OTI shall be recorded every 1 or 2 min during the first 1 h from the instant the transformer is loaded. From the slope of the curve plotted with the time on the X - axis and the difference between the readings of the WTI and OTI at the particular time on the Y - axis, the thermal time constant of the WTI shall be determined. This value shall not vary appreciably from the thermal time constant of the winding as calculated theoretically and as ascertained from the slope of the cooling curves		
61.	6.3.4.2	Tests prior to short circuit: (9) Recording of recurrent surge oscillogram (RSO) at the highest, lowest and principal tapping	**M/s Prime Meiden** RSO can be conducted at works before and after the SC test but not at the place (namely Indian Govt Test labs in India who does not have this facility at their end) where SC test will be conducted. Therefore, we recommend to include the RSO under Routine Test.	The tests prior and after the short circuit test can be conducted at the manufacturer works, the para in the specification shall be modified accordingly.
62.	6.3.4.3	The test shall preferably be done by closing the breaker on the secondary side after energizing the primary winding at its rated voltage.	**M/s Prime Meiden** As informed by CPRI, SC will be conducted TEST will be conducted by closing the Circuit breaker using PRESET method.	The para mentioned in the specification is preferably not mandatory. Also, the preset method not explained in the comment. Thus, no change required in the specification.
63.	6.3.8.5	Vibration test for temperature Indicator	**M/s Toshiba** We request you to kindly provide the respective standard in order to check with our supplier.	The test shall be mentioned in the specification.
64.	6.4 Item 10	Dielectric tests comprising: 1) Separate- source voltage withstand test. 2) Induced over voltage withstand test.	**M/s ABB** We recommend that the RSO test should be made a type test. Additionally, if the supplier has suitable lightning impulse design software to demonstrate the developed voltages including waveforms then we suggest that the results of the software outputs could be accepted instead of RSO tests. We note that for the 2x25kV single phase autotransformer, that RSO assessment may not be necessary as there are very few voltages that can be measured. We suggest that the scope of the RSO	The comment for the acceptance of the software outputs instead of RSO test is not accepted. The reason for mentioning the RSO test only in type test is not justified, thus the comment of the firm is not accepted.

			measurements should be added to this clause.	
65.	8.0	The offer shall include the training of two personnel of the Indian Railways free of cost at the manufacturer's works in India or abroad and at the maintenance depots/workshops on a Railway system or other public utility where transformers of similar/identical design are in operation. The total duration of training for each personnel shall be 2 weeks of which approximately one week will be at manufacturer's works and one week on a Railway system or other public utility. If the country of manufacturer is not India, the cost of travel to that country and back will be borne by the Indian Railways. Other details shall be settled at the time of finalizing the contract/Purchase Order.	**M/s ABB** We recommend that the scope and type of training required is given in this clause. eg Installation procedures, maintenance procedures, familiarisation with accessories and features etc	Firm comment is justified and clause has been modified in the final draft.
66.	9.2	The transformer shall be dispatched with its core and windings along with the tap-changer assembly in the transformer tank filled with oil and the space above the oil filled with pure dry air or inert gas like nitrogen at a pressure slightly above atmospheric pressure. However, if there are limitations on account of weight, the tank shall be filled with nitrogen under pressure and the oil for the first filling shall be supplied separately in steel drums. In case the tank is filled with inert gas the temperature and pressure at the time of filling shall be	**M/s Prime Meiden** We recommend to change the mentioned clause of RDSO as: 'However, if there are limitations on account of weight, the tank shall be filled with nitrogen/dry air under pressure and the oil…… steel drums'.	Firm comment is accepted in view of the present practices being followed by different manufacturers that Transformer is transported with dry air filled.

		marked conspicuously on the transformer.		
67.	9.8	The transformer shall be erected and commissioned by the Purchaser. The successful tenderer /manufacturer shall invariably make available at site the services of an engineer of his to ensure, by his continued presence, that the process of erection, testing and commissioning of the transformer is in accordance with established practices. For this purpose prior intimation regarding the dates/period and locations at which the transformers are to be erected and testing / commissioning done shall be given by the Purchaser to the successful tenderer /manufacturer. No charges shall be payable by the purchaser to the successful tenderer /manufacturer for the services of his engineer in this regard	**M/s Prime Meiden** We recommend to add the intimation of requirement of Supervisor (SV) at site at least 2 weeks prior to the site requirements. Further, to avoid idleness of manpower (of Indian Railways and Transformer manufacturer), we shall submit a 'Site Readiness Checklist' alongwith the O&M Manual at the time of Transformer dispatch from Factory for validation by Indian Railways personnel at site/respective office, which shall be returned back to Transformer manufacturer to initiate and process the SV requirement.	The duration of two weeks cannot be mentioned in the specification as it may be as per the site requirements and conditions.
68.	9.9	If any transformer has been received at site in a damaged condition and in the opinion of the Railway's Engineer at site it is required to be repaired at the successful tenderer/manufacturer's works, the transformer shall be taken back to the works promptly and after repair, all necessary tests including the routine tests shall be done on the complete transformer in the presence of and to the satisfaction of the Railway's Engineer prior to returning the transformer to site. Such tests are necessary to ensure that the quality of the workmanship during repairs is satisfactory and shall be done free of cost. Any tests, as decided by the Railway's	**M/s ABB** We would recommend that transport acceleration measurement using transport impact recorders is added. Additionally, that factory and site SFRA testing is performed to confirm the integrity of the transformer from damage. The allowable accelerations during transport should be required in the offered returnable schedules.	"Transport acceleration measurement" is not described in the comment, also the existing para of the specification is clearer, thus no change is required.

		Engineer at site shall also be conducted on the transformer at site free of cost.		
69.	Annexure2	FOS	**M/s High Volt** As per IEEMA & CBIP for single phase transformer above 50MVA this system is require, hence in these Autotransformer should not be insisted for. **M/s ABB** We recommend that the quantity of fibre optic probes is increased to ensure redundancy and correct location for winding hotspot of both windings. We would also recommend that during the design review meeting that the supplier must demonstrate the temperature rise and fluid velocity of every disc to ensure that the winding hotspot location is correctly located and understood.	Comment of non-addition of FOS is accepted. No remarks required as FOS is not to be added.
70.	Annexure4	Force calculations	**M/s ABB** We recommend that these force calculations are replaced with the requirement to perform electromagnetic field plots and design specific dynamic response calculations. Please see more detailed comment against the other clauses. **M/s High Volt** As we are carrying out actual test on transformer short circuit test, it gives the result against mechanical force, hence calculations should not be insisted for.	Firm suggestion has not been supported by any national or international document, thus in the specification so it is not feasible to incorporate. Firm can submit the calculation to the RDSO for their reference, it is not an extra activity forced on the firm.
71.	10.1	The manufacturer shall warrant that all equipments shall be free from defects and faults in design, material, workmanship, manufacture and are of the highest grade consistent with the established and generally accepted standards. The equipments are in full conformity with this specification and shall operate properly.	**M/s Prime Meiden** We recommend to delete and shall operate properly. The highlighted content, as we shall submit the Operation and Maintenance manual in hard copy during the Transformer dispatch from factory, which is to be followed by the Indian Railways personnel.	Firm comment is not acceptable, the manufacturer of the Transformer should take responsibility for proper operation of the transformer.
72.	6.8	The manufacturer may quote separately his charges for short-circuit and temperature rise tests. No	**M/s Prime Meiden** We recommend changing the mentioned clause of RDSO as: 'The manufacturer may quote separately his	The clause shall be removed from the specification as these may be the tender conditions.

		charges shall be payable for any other type and routine tests.	charges and time for short-circuit and temperature-rise tests, keeping in view the timelines of Short-circuit test at testing lab.	Vendor approval is done as per ISO procedures.
73.	8.0	The offer shall include the training of two personnel of the Indian Railways free of cost at the manufacturer's works in India or abroad and at the maintenance depots/workshops on a Railway system or other public utility where transformers of similar/identical design are in operation. The total duration of training for each personnel shall be 2 weeks of which approximately one week will be at manufacturer's works and one week on a Railway system or other public utility. If the country of manufacturer is not India, the cost of travel to that country and back will be borne by the Indian Railways. Other details shall be settled at the time of finalizing the contract/Purchase Order.	**M/s Prime Meiden** We would like to recommend in place of highlighted content as: As the 2x25 kV system is first being adopted now in India, therefore, few limitations shall arise at depots/worskhops or at public utilities alongwoith the limitation of training materials/facilities. Therefore, we would like to request for removal of the and at the maintenance depots/workshops on a Railway system or other public utility where transformers of similar/identical design are in operation. We Recommended to change the mentioned clause as "The expense related to travel, lodging, boarding and allowance in personnel of Indian railways shall be borne by the Indian Railways".	Already 2X25kV system is in operation in Indian Railways since 20years back , it is not being first adopted at present. These may be governed by the separate policies of RB, not required to detail in the specification.
74.	9.9	If any transformer has been received at site in a damaged condition and in the opinion of the Railway's Engineer at site it is required to be repaired at the successful tenderer/ manufacturer's works, the transformer shall be taken back to the works promptly and after repair, all necessary tests including the routine tests shall be done on the complete transformer in the presence of and to the satisfaction of the Railway's Engineer prior to returning the transformer to site. Such tests are necessary to ensure that the quality of the workmanship during repairs is satisfactory and shall be done free of cost. Any tests, as decided by the Railway's	**M/s Prime Meiden** We recommend to delete the last highlighted content i.e. 'Any tests, as decided by the Railway's Engineer at site shall also be conducted on the transformer at site free of cost.', as the requirement of test at Factory is already stated in the preceding contents	This clause is to ensure that every efforts are made by the manufacturer to reach the job on site in a good condition, any specific test requirement cannot be mentioned in the specification as it may vary as per the situation.

		Engineer at site shall also be conducted on the transformer at site free of cost.		
75.	10.3	**Warranty** The manufacturer's liability in respect of any complaint, defects and/or claims shall not be limited to the furnishing and installation of replacement of parts free of any charge or the repair of defective parts only to the extent that such replacement or repairs are attributable to or arise from faulty workmanship or material or design in the manufacture of the goods, provided that the defects are brought to the notice of the manufacturer within 3(Three) months of their being first discovered during the warranty period of 3(Three) months from the date of expiry of warranty period, or at the option of the Purchaser, to the payment of the value, expenditure and damage as hereafter mentioned	**M/s Prime Meiden** We recommend to change the content of notice to manufacturer 'within 3 months from date of expiry of warranty period' to 'within the warranty period'.	Firm comment is not accepted, it is not expected that the equipment are failed within three months after the warranty period.
76.	10.4	The manufacturer shall, if required, replace or repair the equipment of such portion thereof as is rejected by the Purchaser free of cost at the ultimate destination or at the option of the Purchaser. Manufacturer shall pay to the Purchaser value thereof at the contract price or in the absence of such price at a price decided by the Purchaser and such other expenditure and damages as may arise by reason of the breach of the conditions herein specified.	**M/s Prime Meiden** We recommend to delete "manufacturer shall, if required, replace or repair the equipment of such portion thereof as is rejected by the Purchaser free of cost at the ultimate destination or at the option of the Purchaser. Manufacturer shall pay to the Purchaser value thereof at the contract price or in the absence of such price at a price decided by the Purchaser and such other expenditure and damages as may arise by reason of the breach of the conditions herein specified" as the requirement in RDSO draft specification is not clear.	The clause shall be modified.
77.	-----	Erection, Testing & Commissioning	**M/s Toshiba** Shall be taken care by RDSO/EPC Contractor.	Transformer manufacturer needs to coordinate as detailed in different Para of the specification

78.	10.5	All replacement and repairs that the Purchaser shall call upon the manufacturer to deliver or perform under this warranty shall be delivered and performed by the manufacturer, promptly and satisfactorily and in any case within 2(Two) months of the date of advice to this effect.	**M/s Prime Meiden** We recommend to change the clause to: All replacement and repairs that the Purchaser shall call upon manufacturer to deliver or perform under this warranty shall be delivered and performed by the manufacturer, promptly and satisfactorily and in any case within 5(Five) months of the date of advice to this effect.	Firm comment is not accepted, Railway Traction Transformer is used with the public traffic movement, and outage time of a transformer of five months is a very big time.
79.	10.8	The decision of the Purchaser in regard to successful tenderer/manufacturer's liability and the amount, if any, payable under this warranty shall be final and conclusive	**M/s Prime Meiden** We recommend to delete the highlighted content, as the requirement in RDSO draft specification is not clear.	The specification requirements are clear, no change is required
80.	11.2	The manufacturer shall make necessary arrangements for closely monitoring the performance of the transformer through periodical (preferably once in two months during the warranty period) visit to the locations where they have been erected for observations and interactions with the operating and maintenance personnel of Indian Railways. Arrangements shall also be made by the manufacturer for emergency /standby spare parts being kept readily available to meet exigencies warranting replacement so as to keep the transformer in service with least down time.	**M/s Prime Meiden** We shall provide the O&M manual as stated in above recommendations, for necessary steps of operation at site. Operating and maintaining the equipment/s lies completely with the Indian Railways as per maufcaturer's O&M with no liability of Transformer manufacturer for periodic visit. Further, for spare parts, Indian Railways shall provide the additional list of required spare parts incase required and we shall quote for the same with the delivery timeline. However, it shall not be possible to store the spare parts at our works as emergency/standby spare parts.	The AMC is a tender condition, Para may be removed from the specification.
81.	11.3	The manufacturer shall respond promptly on any call given by Indian Railways for any assistance by way of attending to failures, investigations into the causes of failures including the tests, if any, to be done and such other items with a view to seeing that the transformer serves the purpose for which it is procured. Besides, technical	**M/s Prime Meiden** We recommend to delete the "Besides, technical guidance to ensure proper operation and maintenance of the transformer shall be constantly rendered" as the requirement in RDSO draft specification is not clear	Technical guidance can be provided by the manufacturer, if required to user. No need to change the clause.

		guidance to ensure proper operation and maintenance of the transformer shall be constantly rendered.		
82.	General	----------	**M/s ABB** We have made a number of significant recommendations in areas including: • Short circuit force calculation withstand and consideration of frequent short circuit faults. Calculation and control of dynamic winding response during short circuits. • Understanding and limiting of temperature rise particularly for the use of winding hotspot including the effects of harmonics • Scope, Benefits and importance to include a detailed design review meeting • Use of modern "dry type" condenser bushings and solid resin/polymer bushings to further reduce fire risk and improve safety. • Determining transformer quality from and analysing FAT results. We realise that these may be significant considerations whose reasons/benefits cannot easily be described in a few sentences. Therefore, we offer as part of our specification feedback to deliver to Customer Knowledge Training on the above topics The Indian Ministry of Railways.	The design of the Traction transformer is done by the transformer manufacturer, technical specification is a requirement which is verified by the certain tests which are mentioned in the specification The remarks on the comments on the specific clause has already been mentioned at respective clauses. Any input if required by the manufacturer can be provided by the user for better design.
83.	General		**M/s ABB** Given the frequent and severe short circuit duty of the transformers, we recommend the use of the latest technology and analysis techniques for short circuit withstand. The recommended aspects include: • Calculation of electromagnetic forces using field plots. • Design specific dynamic response of the windings to be determined. • Inclusion of winding offsets to account for manufacturing tolerances and pitch of helical windings. • Use of modern mechanical withstand limits associated with high density, high grade materials • Consideration of free buckling modes of radial failure • Design of inner windings that do not rely	----do-----

			on inner supports for radial buckling withstand ("self-supporting" windings). This ensure ongoing short circuit withstand and withstand of free buckling failure. • Reduction of withstand limits to account for the frequency of short circuit. • Use of epoxy bonded continuously transposed cable Detailed assessment of short circuit testing requirements	
84.	General		**M/s ABB** These transformers are subjected to high levels of harmonics in service. The harmonics significantly increase the winding hotspot temperature being concentrated at the winding ends. However, the harmonics cannot be supplied during factory acceptance testing (FAT). We therefore recommend that a detailed analysis is conducted including how they are managed by appropriate winding design. This aspect and others should be prescribed for the design review meeting. Further, it is important to understand, simulate by calculation and correct the 50 Hz measured losses and temperature rise from the FAT to the service situation. This is facilitated and made more accurate with the use of fibre optic probes during FAT to have accurate winding hotspot measurements. In at least some transformers we would recommend that service measurements of the fibre optic probes including the harmonics losses should be conducted to validate the simulations and impacts on the WTI readings.	----do-----
85.	General		**M/s ABB** For transformers of this type which include harmonics, frequent short circuits, a short circuit type test, nitrogen injection systems & thermo-syphon equipment, fibre optic probes etc, we would recommend a detailed design review meeting. In addition to the criteria described in CIGRE Brochure 529 and IEC 60076 the design review meeting should define broad scope and expectations including: • Short circuit calculations for design specific dynamic forces and control for frequent short circuits. • Effect of harmonics in service (which	

			cannot be supplied at the supplier factory). • Temperature rise details including temperatures and fluid velocity of every disc of the main windings • Assessment of the true winding hotspot gradient both without and with harmonics • Correction of FAT temperature rise results to the values expected with harmonics in service The use and placement and measurement of fibre optic probes.	
86.	General		Our understanding from the specification that management of fire risk (inclusion of nitrogen injection and fire extinguishing system) is of importance. We would therefore recommend the use of modern technology bushings: • Dry type condenser bushings (resin impregnated paper/synthetic - RIP/RIS) instead of OIP. These dry type bushings tend to act as a plug when they or the transformer suffer an internal failure whereas OIP bushings shatter and expose the transformer internal to oxygen (fire risk) or contamination (porcelain and burnt paper). • Solid resin/polymer bushings rather oil filled porcelain bushings - same benefits as the RIP bushings. In general, we would also recommend polymer sheds for the outdoor side of al bushings instead of porcelain as this removes the safety risk for personnel of shrapnel like pieces of porcelain in the event of failure.	----do-----