Schedule D: Schedules of Technical Data 132 kV transformer (STD)

The Schedule of Technical Data (STD) shall be filled-in and dully signed and stamped by the Tenderer.

Any deviation from the required value shall be show clearly in the schedule L. and statement of compliance.

ITEM	DESCRIPTION	UNIT	DATA	
			Required	Offered
1.	MAIN TRANSFORMER (132/33 KV - 80 MVA)			
1.1	General Data			
	Manufacturer			
	Place and country of Manufacture			
	Place of Factory Inspection and Testing			
	Type		Three-phase, two-winding, oil immersed, with conservator	
	Type designation by the manufacturer			
	Standards		IEC 60076 IEC 60214	
	Installation		Outdoor, without wheels	
	Type of cooling (acc. to IEC 60076)		ONAN/ONAF	
	Method of earthing:			
	- HV winding		Solid	
	- LV winding		Via Neutral Earthing Resistor through Earthing Transformer	
	Transformer painting colour (RAL)		RAL 7001	
	Min. Peak Efficiency Index (PEI)	%	Min. 99.758	
1.2	Site/ Design Conditions			
	Altitude above sea level	m		
	Minimum ambient temperature	°C	-10	
	Maximum ambient temperature	°C	50	
	Design maximum ambient temperature	°C	50	
1.3	Rated Data and Characteristics			

ITEM	DESCRIPTION	UNIT	DATA	
			Required	Offered
	Rated power at site conditions:			
	- with ONAN cooling	MVA	54	
	- with ONAF cooling	MVA	80	
	Rated frequency	Hz	50	
	Efficiency at 100% of rated power:			
	- with ONAN cooling	%		
	- with ONAF cooling	%		
	Rated voltages:			
	- HV winding	kV	132	
	- LV winding	kV	33	
	Highest voltage for equipment:			
	- HV winding	kV	145	
	- LV winding	kV	36	
	Power frequency withstand voltage (r.m.s. value), AC (50 Hz, 1 min):			
	- HV winding	kV	275	
	- LV winding	kV	70	
	Lightning impulse withstand voltage (peak value), LI (1.2/50 µs):			
	- HV winding	kV	650	
	- LV winding	kV	≥170	
	Rated current at rated voltage:			
	- HV winding	A		
	- LV winding	A		
	Connection phase displacement symbol (Vector group)		YNd1	
	Short circuit impedance	%	12.5	
	No-load current (% of rated current):			
	- at 85% of rated voltage			
	- at rated voltage			
	- at 105% of rated voltage			
	Maximum temperature rises at rated power at:			
	- average windings	K	55	
	- hot spot of winding	K	68	
	- top oil	K	50	

ITEM	DESCRIPTION	UNIT	DATA	
			Required	Offered
	- oil at inlet of cooler	K		
	- oil at outlet of cooler	K		
	- core	K		
	Hot-spot factor (H)		1.3	
	Maximum No-load losses at rated tap and rated frequency	kW	The losses shall provide in financial part The detailed losses table in ANNEX C	
	Maximum Load losses at 75 °C, rated tap and rated frequency:			
	- at ONAN rated power	kW		
	- at ONAF rated power	kW		
	Cooling power for no-load operation	kW		
	Total cooling power at rated power	kW		
	Symmetrical short circuit withstand current (duration 3 s) at the terminals of the transformer:			
	- HV winding	kA	40	
	- LV winding	kA	31.5	
	Temperature rise of winding due to short circuit in duration of 3 s and:			
	- HV side short circuit current of 40 kA	K		
	- LV side short circuit current of 31.5 kA	K		
	Magnetizing current (HV winding)			
	- at 85% of rated voltage	A		
	- at rated voltage	A		
	- at 105% of rated voltage	A		
	Short circuit impedance at 75 °C, rated voltage and frequency:			
	- at principal tapping	%		
	- at extreme plus tapping	%		
	- at extreme minus tapping	%		
	Noise level measured in accordance with IEC 60076-10	dB	≤70	
1.4	**Structural Characteristics**			
	Type (graded/non-graded) of windings:			
	- HV winding			
	- LV winding			
	Winding arrangement (i.e. core/LV/HV/Taps)			

ITEM	DESCRIPTION	UNIT	DATA	
			Required	Offered
	Winding conductor material:			
	- HV winding		enamelled copper	
	- LV winding		enamelled copper	
	Winding conductor cross section:			
	- HV winding	mm^2		
	- LV winding	mm^2		
	Winding insulation:			
	- HV winding		thermally upgraded paper	
	- LV winding		thermally upgraded paper	
	Insulation system thermal class of the winding:			
	- HV winding		105	
	- LV winding		105	
	Maximum current density in the windings at rated power and at rated voltage:			
	- HV winding	A/mm^2		
	- LV winding	A/mm^2		
	Winding resistance at 75°C:			
	- HV winding	Ω/phase		
	- LV winding	Ω/phase		
	Magnetic core construction:			
	- taped/banded/bolted limbs			
	- taped/banded/bolted yokes			
	- taping/banding material			
	- number of limbs			
	- type of joints in magnetic core			
	- type of core laminations			
	-Thickness of core laminations			
	- maximum specific loss in core laminations at 1.7 T	W/kg	Max. 0.95	
	Maximum flux density in the core at rated voltage and at rated frequency:			
	- limbs	T	1.6	

ITEM	DESCRIPTION	UNIT	DATA	
			Required	Offered
	- yokes	T	1.6	
	Insulation of magnetic core:			
	- core laminations			
	- core screws			
	- washers for core screws			
	- end plates			
	Material of transformer tank			
	Thickness of transformer tank:			
	- sides	mm		
	- bottom	mm		
	- top	mm		
	Tank anticorrosion protection			
	Thickness of radiator plates	mm		
	Thickness of final paint	µm		
	Conservator vessel, radiators, fan grilles, control cabinets or boxes and pipework anticorrosion protection		Hot dip galvanized and painted	
1.5	**Tap Changer**			
	Manufacturer			
	Place and country of Manufacture			
	Place of Factory Inspection and Testing			
	Type		Maintenance free, Vacuum type	
	Type designation by the manufacturer			
	Standards		IEC 60214	
	Type of regulation		On-load	
	Position of tap changer		At HV winding	
	Range of regulation	%	+5%/-15%	
	Regulation step	%	1.67	
	Number of tap positions		13	
	Contact life (operations)		min. 300000	
	Tap changer local control cabinet		Yes	
	Location of transformer OLTC control cabinet		Mounted on transformer	

ITEM	DESCRIPTION	UNIT	DATA	
			Required	Offered
	OLTC control cabinet painting colour (RAL)			
1.6	**Transformer Protective Devices & Accessories**			
	Standards		IEC 60076-22-1 IEC 60076-22-7	
	Transformer cooling system control cabinet		Yes	
	Location of transformer cooling system control cabinet		Mounted on transformer	
	Control cabinet painting colour (RAL)			
	Heater inside transformer control cabinet		Yes	
	HV winding temperature indicator		Yes	
	LV winding temperature indicator		Yes	
	Oil temperature indicator		Yes	
	Buchholz relay		Yes	
	Pressure relief device		Yes	
	Transformer conservator		Yes	
	Total volume of conservator	litres		
	Dehydrating breather		Yes	
	Type of dehydrating breather		Air bag + Dehydrating agent, Maintenance free	
	Type of oil level gauge			
	Transformer wheels		No	
	Supply voltage for transformer auxiliaries	V	400/230 AC	
	Control & Protection voltage	V	110 DC	
	Impact recorder		Yes	
	Designed and manufactured constant acceleration in all directions	m/s^2	min. 20	
1.7	**Cooling System**			
	Total number of coolers (radiators) per transformer	pcs		
	Number of stand-by coolers (radiators)	pcs		
	Total number of fans	pcs		
	Number of stand-by fans	pcs		
	Rating of each fan	kW		
1.8	**Transformer Bushings**			
	Terminal type			

ITEM	DESCRIPTION	UNIT	DATA	
			Required	Offered
	HV line terminals		Cable box	
	HV neutral terminal		Bushing	
	LV line terminals		Bushing at cable box	
	Cable connection box on Transformer HV side **Note:** HV cable box shall be provided for TR at SS, where 132kV cable terminations, supplied by contractor, will be installed inside transformer HV connection box. Design of HV cable connection box shall be subject of Client's approval.			
	Cable box on Transformer LV side **Note:** LV cable box is applicable for TR at SS, where 33kV cable terminations, supplied by contractor, will be installed inside transformer LV box. In the LV side transformer cable box, provision for separation of cables going to 33kV SWG and to Earthing transformer shall be foreseen. Design of LV cable box shall be subject of Client's approval.			
	HV Bushings			
	Manufacturer			
	Place and country of Manufacture			
	Place of Factory Inspection and Testing			
	Type		Oil/oil	
	Type designation by the manufacturer			
	Standards		IEC 60137 IEC 60815	
	Material			
	Highest voltage for equipment	kV	145	
	Rated frequency	Hz	50	
	Power frequency withstand voltage (r.m.s. value), AC (50 Hz, 1 min)	kV	275	
	Lightning impulse withstand voltage (peak value), LI (1.2/50 µs)	kV	650	
	Minimum creepage distance	mm		
	Arcing horns and other accessories		As per IEC standard	
	HV Neutral Bushing			
	Manufacturer			

ITEM	DESCRIPTION	UNIT	DATA	
			Required	Offered
	Place and country of Manufacture			
	Place of Factory Inspection and Testing			
	Type		Oil/Air	
	Type designation by the manufacturer			
	Standards		IEC 60137 IEC 60815	
	Material			
	Highest voltage for equipment	kV	72.5	
	Rated frequency	Hz	50	
	Power frequency withstand voltage (r.m.s. value), AC (50 Hz, 1 min)	kV	According to manufacturer design	
	Lightning impulse withstand voltage (peak value), LI (1.2/50 µs)	kV	According to manufacturer design	
	Minimum creepage distance	mm	According to manufacturer design	
	Arcing horns and other accessories		Yes As per IEC standard	
	LV Bushings			
	Manufacturer			
	Place and country of Manufacture			
	Place of Factory Inspection and Testing			
	Type		Oil/air	
	Type designation by the manufacturer			
	Standards		IEC 60137 IEC 60815	
	Material			
	Highest voltage for equipment	kV	36	
	Rated frequency	Hz	50	
	Power frequency withstand voltage (r.m.s. value), AC (50 Hz, 1 min)	kV	70	
	Lightning impulse withstand voltage (peak value), LI (1.2/50 µs)	kV	≥170	
	Minimum creepage distance	mm	1368	

ITEM	DESCRIPTION	UNIT	DATA	
			Required	Offered
	Arcing horns and other accessories		As per IEC standard	
1.9	**Current Transformers**			
	Current Transformer in HV Bushing			
	Number of current transformers per transformer	pcs	2	
	Number of secondary cores	pcs		
	Rated transformation ratio	A/A		
	Accuracy class			
	Rated output	VA		
	Current Transformer in LV Bushing			
	Number of current transformers per transformer	pcs	2	
	Number of secondary cores	pcs		
	Rated transformer ratio	A/A		
	Accuracy class			
	Rated output	VA		
1.10	**Dimensions and Masses**			
	Overall dimensions of the assembled transformer in operation:			
	- length	mm		
	- width	mm		
	- height	mm		
	Total mass of the assembled transformer in operation	kg		
	Individual masses of transformer:			
	- core / core lamination	kg		
	- windings	kg		
	- total mass excluding oil	kg		
	- oil mass in tank	kg		
	- oil mass in radiators	kg		
	- total oil required	kg		
		litres		
	Dimensions of transformer arranged for transport:			
	- length	mm		
	- width	mm		
	- height	mm		

ITEM	DESCRIPTION	UNIT	DATA	
			Required	Offered
	Mass of transformer arranged for transport	kg		
	Filling medium of reactor tank for transport		Oil	
2.	**MAIN TRANSFORMER (132/33 KV - 63 MVA)**			
2.1	**General Data**			
	Manufacturer			
	Place and country of Manufacture			
	Place of Factory Inspection and Testing			
	Type		Three-phase, two-winding, oil immersed, with conservator	
	Type designation by the manufacturer			
	Standards		IEC 60076 IEC 60214	
	Installation		Outdoor, without wheels	
	Type of cooling (acc. to IEC 60076)		ONAN/ONAF	
	Method of earthing:			
	- HV winding		Solid	
	- LV winding		Via Neutral Earthing Resistor through Earthing Transformer	
	Transformer painting colour (RAL)		RAL 7001	
	Min. Peak Efficiency Index (PEI)	%	Min. 99.745	
2.2	**Site/ Design Conditions**			
	Altitude above sea level	m		
	Minimum ambient temperature	°C	-10	
	Maximum ambient temperature	°C	50	
	Design maximum ambient temperature	°C	50	
2.3	**Rated Data and Characteristics**			
	Rated power at site conditions:			
	- with ONAN cooling	MVA	43	
	- with ONAF cooling	MVA	63	
	Rated frequency	Hz	50	

ITEM	DESCRIPTION	UNIT	DATA	
			Required	Offered
	Efficiency at 100% of rated power:			
	- with ONAN cooling	%		
	- with ONAF cooling	%		
	Rated voltages:			
	- HV winding	kV	132	
	- LV winding	kV	33	
	Highest voltage for equipment:			
	- HV winding	kV	145	
	- LV winding	kV	36	
	Power frequency withstand voltage (r.m.s. value), AC (50 Hz, 1 min):			
	- HV winding	kV	275	
	- LV winding	kV	70	
	Lightning impulse withstand voltage (peak value), LI (1.2/50 µs):			
	- HV winding	kV	650	
	- LV winding	kV	≥170	
	Rated current at rated voltage:			
	- HV winding	A		
	- LV winding	A		
	Connection phase displacement symbol (Vector group)		YNd1	
	Short circuit impedance	%	12.5	
	No-load current (% of rated current):			
	- at 85% of rated voltage			
	- at rated voltage			
	- at 105% of rated voltage			
	Maximum temperature rises at rated power at:			
	- average windings	K	55	
	- hot spot of winding	K	68	
	- top oil	K	50	
	- oil at inlet of cooler	K		
	- oil at outlet of cooler	K		
	- core	K		
	Hot-spot factor (H)		1.3	

ITEM	DESCRIPTION	UNIT	DATA	
			Required	Offered
	Maximum No-load losses at rated tap and rated frequency	kW	The losses shall provide in financial part The detailed losses table in ANNEX C	
	Maximum Load losses at 75 °C, rated tap and rated frequency:			
	- at ONAN rated power	kW		
	- at ONAF rated power	kW		
	Cooling power for no-load operation	kW		
	Total cooling power at rated power	kW		
	Symmetrical short circuit withstand current (duration 3 s) at the terminals of the transformer:			
	- HV winding	kA	40	
	- LV winding	kA	31.5	
	Temperature rise of winding due to short circuit in duration of 3 s and:			
	- HV side short circuit current of 40 kA	K		
	- LV side short circuit current of 31.5 kA	K		
	Magnetizing current (HV winding)			
	- at 85% of rated voltage	A		
	- at rated voltage	A		
	- at 105% of rated voltage	A		
	Short circuit impedance at 75 °C, rated voltage and frequency:			
	- at principal tapping	%		
	- at extreme plus tapping	%		
	- at extreme minus tapping	%		
	Noise level measured in accordance with IEC 60076-10	dB	≤70	
2.4	**Structural Characteristics**			
	Type (graded/non-graded) of windings:			
	- HV winding			
	- LV winding			
	Winding arrangement (i.e. core/LV/HV/Taps)			
	Winding conductor material:			

ITEM	DESCRIPTION	UNIT	DATA	
			Required	Offered
	- HV winding		enamelled copper	
	- LV winding		enamelled copper	
	Winding conductor cross section:			
	- HV winding	mm^2		
	- LV winding	mm^2		
	Winding insulation:			
	- HV winding		thermally upgraded paper	
	- LV winding		thermally upgraded paper	
	Insulation system thermal class of the winding:			
	- HV winding		105	
	- LV winding		105	
	Maximum current density in the windings at rated power and at rated voltage:			
	- HV winding	A/mm^2		
	- LV winding	A/mm^2		
	Winding resistance at 75°C:			
	- HV winding	Ω/phase		
	- LV winding	Ω/phase		
	Magnetic core construction:			
	- taped/banded/bolted limbs			
	- taped/banded/bolted yokes			
	- taping/banding material			
	- number of limbs			
	- type of joints in magnetic core			
	- type of core laminations			
	-Thickness of core laminations			
	- maximum specific loss in core laminations at 1.7 T	W/kg	Max. 0.95	
	Maximum flux density in the core at rated voltage and at rated frequency:			
	- limbs	T	1.6	
	- yokes	T	1.6	

ITEM	DESCRIPTION	UNIT	DATA	
			Required	Offered
	Insulation of magnetic core:			
	- core laminations			
	- core screws			
	- washers for core screws			
	- end plates			
	Material of transformer tank			
	Thickness of transformer tank:			
	- sides	mm		
	- bottom	mm		
	- top	mm		
	Tank anticorrosion protection			
	Thickness of radiator plates	mm		
	Thickness of final paint	µm		
	Conservator vessel, radiators, fan grilles, control cabinets or boxes and pipework anticorrosion protection		Hot dip galvanized and painted	
2.5	**Tap Changer**			
	Manufacturer			
	Place and country of Manufacture			
	Place of Factory Inspection and Testing			
	Type		Maintenance free, Vacuum type	
	Type designation by the manufacturer			
	Standards		IEC 60214	
	Type of regulation		On-load	
	Position of tap changer		At HV winding	
	Range of regulation	%	+5%/-15%	
	Regulation step	%	1.67	
	Number of tap positions		13	
	Contact life (operations)		min. 300000	
	Tap changer local control cabinet		Yes	
	Location of transformer OLTC control cabinet		Mounted on transformer	
	OLTC control cabinet painting colour (RAL)			

ITEM	DESCRIPTION	UNIT	DATA	
			Required	Offered
2.6	**Transformer Protective Devices & Accessories**			
	Standards		IEC 60076-22-1 IEC 60076-22-7	
	Transformer cooling system control cabinet		Yes	
	Location of transformer cooling system control cabinet		Mounted on transformer	
	Control cabinet painting colour (RAL)			
	Heater inside transformer control cabinet		Yes	
	HV winding temperature indicator		Yes	
	LV winding temperature indicator		Yes	
	Oil temperature indicator		Yes	
	Buchholz relay		Yes	
	Pressure relief device		Yes	
	Transformer conservator		Yes	
	Total volume of conservator	litres		
	Dehydrating breather		Yes	
	Type of dehydrating breather		Air bag + Dehydrating agent, Maintenance free	
	Type of oil level gauge			
	Transformer wheels		No	
	Supply voltage for transformer auxiliaries	V	400/230 AC	
	Control & Protection voltage	V	110 DC	
	Impact recorder		Yes	
	Designed and manufactured constant acceleration in all directions	m/s^2	min. 20	
2.7	**Cooling System**			
	Total number of coolers (radiators) per transformer	pcs		
	Number of stand-by coolers (radiators)	pcs		
	Total number of fans	pcs		
	Number of stand-by fans	pcs		
	Rating of each fan	kW		
2.8	**Transformer Bushings**			
	Terminal type			

ITEM	DESCRIPTION	UNIT	DATA	
			Required	Offered
	HV line terminals		Cable box	
	HV neutral terminal		Bushing	
	LV line terminals		Bushing at cable box	
	Cable connection box on Transformer HV side **Note:** HV cable box shall be provided for TR at SS, where 132kV cable terminations, supplied by contractor, will be installed inside transformer HV connection box. Design of HV cable connection box shall be subject of Client's approval.			
	Cable box on Transformer LV side **Note:** LV cable box is applicable for TR at SS, where 33kV cable terminations, supplied by contractor, will be installed inside transformer LV box. In the LV side transformer cable box, provision for separation of cables going to 33kV SWG and to Earthing transformer shall be foreseen. Design of LV cable box shall be subject of Client's approval.			
	HV Bushings			
	Manufacturer			
	Place and country of Manufacture			
	Place of Factory Inspection and Testing			
	Type		Oil/oil	
	Type designation by the manufacturer			
	Standards		IEC 60137 IEC 60815	
	Material			
	Highest voltage for equipment	kV	145	
	Rated frequency	Hz	50	
	Power frequency withstand voltage (r.m.s. value), AC (50 Hz, 1 min)	kV	275	
	Lightning impulse withstand voltage (peak value), LI (1.2/50 µs)	kV	650	
	Minimum creepage distance	mm		
	Arcing horns and other accessories		As per IEC standard	
	HV Neutral Bushing			
	Manufacturer			

ITEM	DESCRIPTION	UNIT	DATA	
			Required	Offered
	Place and country of Manufacture			
	Place of Factory Inspection and Testing			
	Type		Oil/Air	
	Type designation by the manufacturer			
	Standards		IEC 60137 IEC 60815	
	Material			
	Highest voltage for equipment	kV	72.5	
	Rated frequency	Hz	50	
	Power frequency withstand voltage (r.m.s. value), AC (50 Hz, 1 min)	kV	According to manufacturer design	
	Lightning impulse withstand voltage (peak value), LI (1.2/50 µs)	kV	According to manufacturer design	
	Minimum creepage distance	mm	According to manufacturer design	
	Arcing horns and other accessories		Yes As per IEC standard	
	LV Bushings			
	Manufacturer			
	Place and country of Manufacture			
	Place of Factory Inspection and Testing			
	Type		Oil/air	
	Type designation by the manufacturer			
	Standards		IEC 60137 IEC 60815	
	Material			
	Highest voltage for equipment	kV	36	
	Rated frequency	Hz	50	
	Power frequency withstand voltage (r.m.s. value), AC (50 Hz, 1 min)	kV	70	
	Lightning impulse withstand voltage (peak value), LI (1.2/50 µs)	kV	≥170	
	Minimum creepage distance	mm	1368	

ITEM	DESCRIPTION	UNIT	DATA	
			Required	Offered
	Arcing horns and other accessories		As per IEC standard	
2.9	**Current Transformers**			
	Current Transformer in HV Bushing			
	Number of current transformers per transformer	pcs	2	
	Number of secondary cores	pcs		
	Rated transformation ratio	A/A		
	Accuracy class			
	Rated output	VA		
	Current Transformer in LV Bushing			
	Number of current transformers per transformer	pcs	2	
	Number of secondary cores	pcs		
	Rated transformer ratio	A/A		
	Accuracy class			
	Rated output	VA		
2.10	**Dimensions and Masses**			
	Overall dimensions of the assembled transformer in operation:			
	- length	mm		
	- width	mm		
	- height	mm		
	Total mass of the assembled transformer in operation	kg		
	Individual masses of transformer:			
	- core / core lamination	kg		
	- windings	kg		
	- total mass excluding oil	kg		
	- oil mass in tank	kg		
	- oil mass in radiators	kg		
	- total oil required	kg		
		litres		
	Dimensions of transformer arranged for transport:			
	- length	mm		
	- width	mm		
	- height	mm		

ITEM	DESCRIPTION	UNIT	DATA	
			Required	Offered
	Mass of transformer arranged for transport	kg		
	Filling medium of reactor tank for transport		Oil	
3.	**EARTHING & AUXILIARY TRANSFORMER (33/0.4 KV)**			
3.1	**General Data**			
	Manufacturer			
	Place and country of Manufacture			
	Place of Factory Inspection and Testing			
	Type		Three-phase, Two-winding, oil immersed, with conservator	
	Type designation by the manufacturer			
	Standards		IEC 60076	
	Installation		Outdoor, without wheels	
	Type of cooling (acc to IEC 60076)		ONAN	
	Method of earthing:			
	- HV winding		Via Neutral Earthing Resistor	
	- LV winding		Solid	
	Transformer painting colour (RAL)		RAL 7001	
3.2	**Site / Design Conditions**			
	Altitude above sea level	m	<1000	
	Minimum ambient temperature	°C	-10	
	Maximum ambient temperature	°C	50	
	Design maximum ambient temperature	°C	50	
3.3	**Rated Data and Characteristics**			
	Rated power of LV star winding at site conditions	kVA	At least 200	
	Rated frequency	Hz	50	
	Current ratings of HV interconnected star winding:			
	- 30 s earth fault current in neutral	A	1400	
	- Rated continuous current	A	70	
	Efficiency at 100% of rated power			
	Rated voltages U_r:			

ITEM	DESCRIPTION	UNIT	DATA	
			Required	Offered
	- HV winding	kV	33	
	- LV winding	kV	0.4	
	Highest voltage for equipment U_m:			
	- HV winding	kV	36	
	- LV winding	kV	1.1	
	Power frequency withstand voltage (r.m.s. value), AC (50 Hz, 1 min):			
	- HV winding	kV	70	
	- LV winding	kV	3	
	Lightning impulse withstand voltage (peak value), LI (1.2/50 µs):			
	- HV winding	kV	≥170	
	- LV winding	kV		
	Rated current at rated voltage:			
	- HV winding	A		
	- LV winding	A		
	Connection phase displacement symbol (Vector group)		ZNyn11	
	Short circuit impedance	%		
	No-load current (% of rated current):			
	- at 95% of rated voltage			
	- at rated voltage			
	- at 105% of rated voltage			
	Maximum temperature rises at rated power at:			
	- average windings	K	55	
	- hot spot of winding	K	68	
	- top oil	K	50	
	- oil at inlet of cooler	K		
	- oil at outlet of cooler	K		
	- core	K		
	Hot-spot factor (H)		1.1	
	Maximum No-load losses at rated voltage and rated frequency	kW	The losses shall provide in financial part	
	Maximum Load losses at 75 °C and rated frequency	kW	The detailed losses table in ANNEX C	

ITEM	DESCRIPTION	UNIT	DATA	
			Required	Offered
	Symmetrical short circuit withstand current for HV winding in duration of 3 s	kA	31.5	
	Temperature rise of HV winding due to short circuit current of 31.5 kA in duration of 3 s	K		
	Temperature rise of HV winding due to earth fault current of 1400 A in duration of 30 s	K		
	Magnetizing current (HV winding)			
	- at 95% of rated voltage	A		
	- at rated voltage	A		
	- at 105% of rated voltage	A		
	Short circuit impedance at 75 °C, rated voltage and frequency:			
	- at principal tapping	%		
	- at extreme plus tapping	%		
	- at extreme minus tapping	%		
	Noise level measured in accordance with IEC 60076-10	dB	≤70	
3.4	**Structural Characteristics**			
	Type (graded/non-graded) of windings:			
	- HV winding			
	- LV winding			
	Winding arrangement (i.e. core/LV/HV/Taps)			
	Winding conductor material:			
	- HV winding		enamelled copper	
	- LV winding		enamelled copper	
	Winding conductor cross section:			
	- HV winding	mm^2		
	- LV winding	mm^2		
	Winding insulation:			
	- HV winding		thermally upgraded paper	
	- LV winding		thermally upgraded paper	
	Insulation system temperature class of the winding:			
	- HV winding		105	

ITEM	DESCRIPTION	UNIT	DATA	
			Required	Offered
	- LV winding		105	
	Maximum current density in the windings at rated power and at rated voltage:			
	- HV winding	A/mm²		
	- LV winding	A/mm²		
	Maximum current density in the interconnected star winding, with the earth fault current specified, for:			
	- 30 s fault current rating	A/mm²	23	
	- 15 s fault current rating	A/mm²		
	Maximum current density in the interconnected star winding at 3 second rating	A/mm²		
	Winding resistance at 75°C:			
	- HV winding	Ω/phase		
	- LV winding	Ω/phase		
	Zero sequence impedance at 75°C:			
	- HV interconnected star winding (LV winding open-circuited)	Ω/phase	≤45	
	- LV winding (HV winding open-circuited)	Ω/phase		
	Magnetic core construction:			
	- taped/banded/bolted limbs			
	- taped/banded/bolted yokes			
	- taping/banding material			
	- number of limbs			
	- type of joints in magnetic core			
	- type of core laminations			
	-Thickness of core laminations			
	- maximum specific loss in core laminations at 1.7 T	W/kg	Max. 0.95	
	Maximum flux density in the core at rated voltage and at rated frequency:			
	- limbs	T	1.6	
	- yokes	T	1.6	
	Insulation of magnetic core:			
	- core laminations			
	- core screws			
	- washers for core screws			

ITEM	DESCRIPTION	UNIT	DATA	
			Required	Offered
	- end plates			
	Material of transformer tank			
	Thickness of transformer tank:			
	- sides	mm		
	- bottom	mm		
	- top	mm		
	Tank anticorrosion protection			
	Thickness of radiator plates	mm		
	Thickness of final paint	µm		
	Conservator vessel, radiators, boxes and pipework anticorrosion protection		Hot dip galvanized and painted	
3.5	**Tap Changer**			
	Type of regulation		Off-load	
	Position of tap changer		At HV winding	
	Range of regulation	%	±5%	
	Regulation step	%	2.5	
	Number of tap positions		5	
3.6	**Transformer Protective Devices & Accessories**			
	Standards		IEC 60076-22-1 IEC 60076-22-7	
	Fuse switch disconnector on LV side		Yes	
	Location of fuse switch box		Mounted on transformer	
	Fuse switch box painting colour (RAL)			
	Thermometer		Yes	
	Thermometer setting:			
	- alarm	°C		
	- trip	°C		
	Buchholz relay		Yes	
	Pressure relief device		Yes	
	Transformer conservator		Yes	
	Total volume of conservator	litres		
	Dehydrating breather		Yes	

ITEM	DESCRIPTION	UNIT	DATA	
			Required	Offered
	Type of dehydrating breather		Air bag + Dehydrating agent, Maintenance free	
	Type of oil level gauge			
	Transformer wheels		No	
	Supply voltage for transformer auxiliaries	V	400/230 AC	
	Control & Protection voltage	V	110 DC	
3.7	**Cooling System**			
	Total number of coolers (radiators) per transformer	pcs		
	Number of stand-by coolers (radiators)	pcs		
3.8	**Transformer Bushings**			
	Terminal type			
	HV line terminals		Bushing at cable box	
	HV neutral terminal		Bushing	
	LV line terminals		cable box	
	Cable connection box on Earthing transformer HV side **Note:** HV cable box shall be provided for ET at SS, where 33kV cable terminations, supplied by contractor, will be installed inside transformer 33 connection box. Design of 33 cable connection box shall be subject of Client's approval.			
	HV Bushings		Inside cable box	
	Manufacturer			
	Place and country of Manufacture			
	Place of Factory Inspection and Testing			
	Type			
	Type designation by the manufacturer			
	Standards		IEC 60137 IEC 60815	
	Material			
	Highest voltage for equipment	kV	36	
	Rated frequency	Hz	50	

ITEM	DESCRIPTION	UNIT	DATA	
			Required	Offered
	Power frequency withstand voltage (r.m.s. value), AC (50 Hz, 1 min)	kV	70	
	Lightning impulse withstand voltage (peak value), LI (1.2/50 µs)	kV	≥170	
	Minimum creepage distance	mm	1368	
	Arcing horns and other accessories		As per IEC standard	
	HV Neutral Bushing		Bushing in air	
	Manufacturer			
	Place and country of Manufacture			
	Place of Factory Inspection and Testing			
	Type			
	Type designation by the manufacturer			
	Standards		IEC 60137 IEC 60815	
	Material			
	Highest voltage for equipment	kV	36	
	Rated frequency	Hz	50	
	Power frequency withstand voltage (r.m.s. value), AC (50 Hz, 1 min)	kV	70	
	Lightning impulse withstand voltage (peak value), LI (1.2/50 µs)	kV	≥170	
	Minimum creepage distance	mm	1368	
	Arcing horns and other accessories		Yes As per IEC standard	
	LV Bushings		Cable box	
	Manufacturer			
	Place and country of Manufacture			
	Place of Factory Inspection and Testing			
	Type			
	Type designation by the manufacturer			
	Standards		IEC 60137 IEC 60815	
	Material			
	Highest voltage for equipment	kV	1.1	

ITEM	DESCRIPTION	UNIT	DATA	
			Required	Offered
	Rated frequency	Hz	50	
	Power frequency withstand voltage (r.m.s. value), AC (50 Hz, 1 min)	kV	3	
	Lightning impulse withstand voltage (peak value), LI (1.2/50 µs)	kV		
	Minimum creepage distance	mm	42	
	Arcing horns and other accessories		As per IEC standard	
3.9	**Dimensions and Mass**			
	Overall dimensions of the assembled transformer in operation:			
	- length	mm		
	- width	mm		
	- height	mm		
	Total mass of the assembled transformer in operation	kg		
	Individual masses of transformer:			
	- core / core lamination	kg		
	- windings	kg		
	- total mass excluding oil	kg		
	- oil mass in tank	kg		
	- oil mass in radiators	kg		
	- total oil required	kg		
		Litres		
	Dimensions of transformer arranged for transport:			
	- length	mm		
	- width	mm		
	- height	mm		
	Mass of transformer arranged for transport	kg		
	Filling medium of reactor tank for transport		oil	
4.	Main Transformer Remote Tap Changer Control (RTCC) Panel		**For each transformer with OLTC**	
4.1	General Data			
	Manufacturer			
	Place and country of Manufacture			
	Place of Factory Inspection and Testing			

ITEM	DESCRIPTION	UNIT	DATA	
			Required	Offered
	Type		Free-standing type	
	Type designation by the manufacturer			
	Standards			
	Installation		indoor	
	Panels painting colour (RAL)		RAL 6019	
	Degree of mechanical protection		IP41	
4.2	Voltage Regulator			
	Manufacturer			
	Place and country of Manufacture			
	Place of Factory Inspection and Testing			
	Type			
	Type designation by the manufacturer			
	Standards			
4.4	Panel Design Characteristics			
	Anti-condensation heater		Yes	
	Internal lighting		Yes	
	Type of indication lamps		Neon/LED	
	Panel steel sheet thickness	mm		
	Dimensions and masses of the RTCC panel:			
	- width	mm		
	- depth	mm		
	- height	mm		
	- mass	kg		
5	**Transformer Mineral Insulating Oil**	**As IEC 60296:2020 - table 4 see ANNEX D**		
	Manufacturer			
	Place and country of Manufacture			
	Place of Factory Inspection and Testing			
	Type		Uninhibited mineral naphthenic oil	
	Type designation by the manufacturer			
	Standards		IEC 60296 IEC 62535	

ITEM	DESCRIPTION	UNIT	DATA	
			Required	Offered
	Insulation oil meeting special applications		Yes	
	Insulation oil meeting special applications		Yes	
	Free of corrosive sulphur (as per IEC 62535), PCB, DBDS (dibenzyl disulphide), Antioxidant, passivator, metal deactivator and other additives		Yes	
	Additional test method for corrosive sulphur according to ASTM D1275 B		Yes	
	Function:			
	Appearance		Clear, free from sediment	
	Viscosity: ISO 3104[a] or ASTM D7042			
	- at 40 °C	mm^2/s	Max. 12	
	- at -30 °C	mm^2/s	Max. 1800	
	Pour point ISO 3016	°C	Max -40	
	Water content IEC 60814	mg/kg	Max. 30[d]/40[e]	
	Breakdown voltage: IEC 60156			
	- before treatment	kV	Min. 30	
	- after treatment	kV	Min. 70	
	Density at 20 °C ISO 12185 [a] or ISO 3675 or ASTM D7042	kg/m^3	Max. 895	
	DDF at 90 °C IEC 60247 [a] or IEC 61620		Max. 0.005	
	Refining and Stability			
	Colour ISO 2049		Max. 1.5	
	Appearance		Clear, free from sediment and suspended matter	
	Acidity IEC 62021-2a or 62021-1	mgKOH/g	Max. 0.01	
	Interfacial Tension IEC 62961 a or ASTM D971	mN/m	Min. 40	
	Corrosive sulphur DIN 51353		non-corrosive	
	Potentially corrosive sulphur IEC 62535		non-corrosive	
	DBDS IEC 62697-1	mg/kg	non-detectable	
	Inhibitor content IEC 60666	%	non-detectable	
	Metal Passivator additives IEC 60666	mg/kg	non-detectable	

ITEM	DESCRIPTION	UNIT	DATA	
			Required	Offered
	Other additives		See [g]	
	2-Furfural and related compounds content IEC 61198	mg/kg	non-detectable[h]	
	Performance			
	Oxidation stability at 120 °C, 164 h[i] according to IEC 61125 C			
	- total acidity [j] 4.8.4 of IEC 61125:2018	mg KOH/g	Max. 1.2	
	- sludge [j] 4.8.4 of IEC 61125:2018	wt%	Max. 0.8	
	- DDF at 90 °C [j] 4.8.4 of IEC 61125:2018		Max. 0.5	
	Health, Safety and environment (HSE) [K]			
	Flash point ISO 2719	° C	Min 135	
	Polycyclo Aromatic Content (PCA) [l] IP 346	%	< 3	
	Polychlorinated Biphenyl Content (PBC) IEC 61619	mg/kg	not detectable	
	Other tests as per IEC and ISO standards		Yes	

Stray gassing under thermo-oxidative stress (see 6.19) is not included as a normative test for mineral oils Type B, Because there has been insufficient data to determine appropriate limits. The requirement for a stray gassing test, as well as the limit values, if stipulated, can be negotiated between the user and supplier.

a Reference method.

b This is the standard LCSET for a transformer oil (see 6.1) and can be modified depending on the climatic condition of each country. Pour point should be minimum 10 °C below LCSET.

c Standard LCSET for low temperature switchgear oil.

d For bulk supply.

e For delivery in drums and IBC.

f After laboratory treatment (see 6.4).

g The supplier shall declare the function and chemical family of all additives (3.3), and the concentrations in the cases of inhibitors antioxidants and passivators (3.4).

h In agreement with the customer, oils with a higher furfural content can be delivered, when these values do not jeopardize the application.

i In some countries there can be lower requirements for oxidation stability.

j At the end of oxidation stability tests.

k In some countries there can be additional requirements, e.g. REACH in the EU.

l Some individual PAH compounds can be determined by EN 16143.

6.	POWER TRANSFORMER (33/11 KV)			
6.1	General Data			
	Manufacturer			
	Place and country of Manufacture			
	Place of Factory Inspection and Testing			

	Type		Three-phase, Two-winding, oil immersed, with conservator	
	Type designation by the manufacturer			
	Standards		IEC 60076 IEC 60214	
	Installation		Outdoor, without wheels	
	Type of cooling (acc to IEC 60076)		ONAN	
	Method of earthing:			
	- HV winding			
	- LV winding			
	Transformer painting colour (RAL)		RAL 7001	
6.2	**Site / Design Conditions**			
	Altitude above sea level	m	1000	
	Minimum ambient temperature	°C	-10	
	Maximum ambient temperature	°C	50	
	Design maximum ambient temperature	°C	50	
6.3	**Rated Data and Characteristics**			
	Rated power of LV star winding at site conditions	MVA	30	
	Rated frequency	Hz	50	
	Current ratings of HV winding:			
	Efficiency at 100% of rated power			
	Rated voltages U_r:			
	- HV winding	kV	33	
	- LV winding	kV	11	
	Highest voltage for equipment U_m:			
	- HV winding	kV	36	
	- LV winding	kV	12	
	Power frequency withstand voltage (r.m.s. value), AC (50 Hz, 1 min):			
	- HV winding	kV	70	
	- LV winding	kV	28	
	Lightning impulse withstand voltage (peak value), LI (1.2/50 µs):			
	- HV winding	kV	≥170	

	- LV winding	kV	75	
	Rated current at rated voltage:			
	- HV winding	A		
	- LV winding	A		
	Connection phase displacement symbol (Vector group)		Dyn1	
	Short circuit impedance	%	10	
	No-load current (% of rated current):			
	- at 95% of rated voltage			
	- at rated voltage			
	- at 105% of rated voltage			
	Maximum temperature rises at rated power at:			
	- average windings	K	55	
	- hot spot of winding	K	68	
	- top oil	K	50	
	- oil at inlet of cooler	K		
	- oil at outlet of cooler	K		
	- core	K		
	Hot-spot factor (H)		1.1	
	Maximum No-load losses at rated voltage and rated frequency	kW	The losses shall provide in financial part The detailed losses table below	
	Maximum Load losses at 75 ºC and rated frequency	kW		
	Symmetrical short circuit withstand current for HV winding in duration of 3 s	kA	31.5	
	Temperature rise of HV winding due to short circuit current of 31.5 kA in duration of 3 s	K		
	Magnetizing current (HV winding)			
	- at 95% of rated voltage	A		
	- at rated voltage	A		
	- at 105% of rated voltage	A		
	Short circuit impedance at 75 ºC, rated voltage and frequency:			
	- at principal tapping	%	10	
	- at extreme plus tapping	%	As per IEC	
	- at extreme minus tapping	%	As per IEC	
	Noise level measured in accordance with IEC 60076-10	dB	≤70	
6.4	**Structural Characteristics**			

	Type (graded/non-graded) of windings:			
	- HV winding			
	- LV winding			
	Winding arrangement (i.e. core/LV/HV/Taps)			
	Winding conductor material:			
	- HV winding		enamelled copper	
	- LV winding		enamelled copper	
	Winding conductor cross section:			
	- HV winding	mm^2		
	- LV winding	mm^2		
	Winding insulation:			
	- HV winding		thermally upgraded paper	
	- LV winding		thermally upgraded paper	
	Insulation system temperature class of the winding:			
	- HV winding		105	
	- LV winding		105	
	Maximum current density in the windings at rated power and at rated voltage:			
	- HV winding	A/mm^2		
	- LV winding	A/mm^2		
	Winding resistance at 75°C:			
	- HV winding	Ω/phase		
	- LV winding	Ω/phase		
	Zero sequence impedance at 75°C:			
	- HV winding (LV winding open-circuited)	Ω/phase		
	- LV winding (HV winding open-circuited)	Ω/phase		
	Magnetic core construction:			
	- taped/banded/bolted limbs			
	- taped/banded/bolted yokes			
	- taping/banding material			
	- number of limbs			
	- type of joints in magnetic core			
	- type of core laminations			

	-Thickness of core laminations			
	- maximum specific loss in core laminations at 1.7 T	W/kg	Max. 0.95	
	Maximum flux density in the core at rated voltage and at rated frequency:			
	- limbs	T	1.6	
	- yokes	T	1.6	
	Insulation of magnetic core:			
	- core laminations			
	- core screws			
	- washers for core screws			
	- end plates			
	Material of transformer tank			
	Thickness of transformer tank:			
	- sides	mm		
	- bottom	mm		
	- top	mm		
	Tank anticorrosion protection			
	Thickness of radiator plates	mm		
	Thickness of final paint	µm		
	Conservator vessel, radiators, boxes and pipework anticorrosion protection		Hot dip galvanized and painted	
6.5	**Tap Changer**			
	Manufacturer			
	Place and country of Manufacture			
	Place of Factory Inspection and Testing			
	Type		Maintenance free, Vacuum type	
	Type designation by the manufacturer			
	Standards		IEC 60214	
	Type of regulation		On-load	
	Position of tap changer		At HV winding	
	Range of regulation	%	+5%/-15%	
	Regulation step	%	1.25	
	Number of tap positions		17	
	Contact life (operations)		min. 300000	

	Tap changer local control cabinet		Yes	
	Location of transformer OLTC control cabinet		Mounted on transformer	
	OLTC control cabinet painting colour (RAL)			
6.6	**Transformer Protective Devices & Accessories**			
	Standards		IEC 60076-22-1 IEC 60076-22-7	
	Transformer oil type		Uninhibited mineral naphthenic oil	
	Control cabinet painting colour (RAL)			
	Heater inside control cabinet		Yes	
	HV winding temperature indicator		Yes	
	LV winding temperature indicator		Yes	
	HV winding temperature indicator		Yes	
	Thermometer setting:			
	- alarm	°C		
	- trip	°C		
	Buchholz relay		Yes	
	Pressure relief device		Yes	
	Transformer conservator		Yes	
	Total volume of conservator	litres		
	Dehydrating breather		Yes	
	Type of dehydrating breather		Air bag + Dehydrating agent, Maintenance free	
	Type of oil level gauge			
	Transformer wheels		No	
	Supply voltage for transformer auxiliaries	V	400/230 AC	
	Control & Protection voltage	V	110 DC	
	Location of transformer control cabinet		Mounted on transformer	
	Current transformer		Yes	
6.7	**Cooling System**			
	Total number of coolers (radiators) per transformer	pcs		
	Number of stand-by coolers (radiators)	pcs		

6.8	**Transformer Bushings**			
	Terminal type			
	HV line terminals		Bushing at cable box	
	HV neutral terminal		Bushing	
	LV line terminals		Bushing at cable box	
	Cable connection box on transformer **Note:** HV and LV cable box shall be provided, where cable terminations, supplied by contractor, will be installed inside transformer connection box. Design of cables connection boxes shall be subject of Client's approval.			
	HV Bushings		Inside cable box	
	Manufacturer			
	Place and country of Manufacture			
	Place of Factory Inspection and Testing			
	Type			
	Type designation by the manufacturer			
	Standards		IEC 60137 IEC 60815	
	Material			
	Highest voltage for equipment	kV	36	
	Rated frequency	Hz	50	
	Power frequency withstand voltage (r.m.s. value), AC (50 Hz, 1 min)	kV	70	
	Lightning impulse withstand voltage (peak value), LI (1.2/50 µs)	kV	≥170	
	Minimum creepage distance	mm	As per IEC standard	
	Arcing horns and other accessories		As per IEC standard	
	LV Bushings		Inside Cable box	
	Manufacturer			
	Place and country of Manufacture			
	Place of Factory Inspection and Testing			
	Type			
	Type designation by the manufacturer			
	Standards		IEC 60137	

			IEC 60815	
	Material			
	Highest voltage for equipment	kV	12	
	Rated frequency	Hz	50	
	Power frequency withstand voltage (r.m.s. value), AC (50 Hz, 1 min)	kV	28	
	Lightning impulse withstand voltage (peak value), LI (1.2/50 µs)	kV	75	
	Minimum creepage distance	mm	As per IEC standard	
	Arcing horns and other accessories		As per IEC standard	
	LV Neutral Bushing		Bushing or according to design	
	Manufacturer			
	Place and country of Manufacture			
	Place of Factory Inspection and Testing			
	Type			
	Type designation by the manufacturer			
	Standards		IEC 60137 IEC 60815	
	Material			
	Highest voltage for equipment	kV	12	
	Rated frequency	Hz	50	
	Power frequency withstand voltage (r.m.s. value), AC (50 Hz, 1 min)	kV	28	
	Lightning impulse withstand voltage (peak value), LI (1.2/50 µs)	kV	75	
	Minimum creepage distance	mm	As per IEC standard	
	Arcing horns and other accessories		As per IEC standard	
6.9	**Dimensions and Mass**			
	Overall dimensions of the assembled transformer in operation:			
	- length	mm		
	- width	mm		
	- height	mm		
	Total mass of the assembled transformer in operation	kg		

	Individual masses of transformer:			
	- core / core lamination	kg		
	- windings	kg		
	- total mass excluding oil	kg		
	- oil mass in tank	kg		
	- oil mass in radiators	kg		
	- total oil required	kg		
		Litres		
	Dimensions of transformer arranged for transport:			
	- length	mm		
	- width	mm		
	- height	mm		
	Mass of transformer arranged for transport	kg		
	Filling medium of reactor tank for transport		oil	
7.	POWER TRANSFORMER (33/0.4 KV)			
7.1.	General Data			
	Manufacturer			
	Place and country of Manufacture			
	Place of Factory Inspection and Testing			
	Type		Three-phase, Two-winding, oil immersed, with conservator	
	Type designation by the manufacturer			
	Standards		IEC 60076 IEC 60214	
	Installation		Outdoor, without wheels	
	Type of cooling (acc to IEC 60076)		ONAN	
	Method of earthing:			
	- HV winding		-	
	- LV winding		Solid	
	Transformer painting colour (RAL)		RAL 7001	
7.2	Site / Design Conditions			
	Altitude above sea level	m	1000	
	Minimum ambient temperature	°C	-10	
	Maximum ambient temperature	°C	50	

	Design maximum ambient temperature	°C	50	
7.3	Rated Data and Characteristics			
	Rated power of LV star winding at site conditions	KVA	at least 200	
	Rated frequency	Hz	50	
	Current ratings of HV winding:			
	Efficiency at 100% of rated power			
	Rated voltages Ur:			
	- HV winding	kV	33	
	- LV winding	kV	0.4	
	Highest voltage for equipment Um:			
	- HV winding	kV	36	
	- LV winding	kV	1.1	
	Power frequency withstand voltage (r.m.s. value), AC (50 Hz, 1 min):			
	- HV winding	kV	70	
	- LV winding	kV	3	
	Lightning impulse withstand voltage (peak value), LI (1.2/50 µs):			
	- HV winding	kV	≥170	
	- LV winding	kV		
	Rated current at rated voltage:			
	- HV winding	A		
	- LV winding	A		
	Connection phase displacement symbol (Vector group)		Dyn11	
	Short circuit impedance	%		
	No-load current (% of rated current):			
	- at 95% of rated voltage			
	- at rated voltage			
	- at 105% of rated voltage			
	Maximum temperature rises at rated power at:			
	- average windings	K	55	
	- hot spot of winding	K	68	
	- top oil	K	50	
	- oil at inlet of cooler	K		
	- oil at outlet of cooler	K		
	- core	K		

	Hot-spot factor (H)		1.1	
	Maximum No-load losses at rated voltage and rated frequency	kW	The losses shall provide in financial part The detailed losses table below	
	Maximum Load losses at 75 °C and rated frequency	kW		
	Symmetrical short circuit withstand current for HV winding in duration of 3 s	kA	31.5	
	Temperature rise of HV winding due to short circuit current of 31.5 kA in duration of 3 s	K		
	Magnetizing current (HV winding)			
	- at 95% of rated voltage	A		
	- at rated voltage	A		
	- at 105% of rated voltage	A		
	Short circuit impedance at 75 °C, rated voltage and frequency:			
	- at principal tapping	%	As per IEC	
	- at extreme plus tapping	%	As per IEC	
	- at extreme minus tapping	%	As per IEC	
	Noise level measured in accordance with IEC 60076-10	dB	≤70	
7.4	**Structural Characteristics**			
	Type (graded/non-graded) of windings:			
	- HV winding			
	- LV winding			
	Winding arrangement (i.e. core/LV/HV/Taps)			
	Winding conductor material:			
	- HV winding		enamelled copper	
	- LV winding		enamelled copper	
	Winding conductor cross section:			
	- HV winding	mm^2		
	- LV winding	mm^2		
	Winding insulation:			
	- HV winding		thermally upgraded paper	
	- LV winding		thermally upgraded paper	
	Insulation system temperature class of the winding:			

	- HV winding		105	
	- LV winding		105	
	Maximum current density in the windings at rated power and at rated voltage:			
	- HV winding	A/mm^2		
	- LV winding	A/mm^2		
	Winding resistance at 75°C:			
	- HV winding	Ω/phase		
	- LV winding	Ω/phase		
	Zero sequence impedance at 75°C:			
	- HV winding (LV winding open-circuited)	Ω/phase		
	- LV winding (HV winding open-circuited)	Ω/phase		
	Magnetic core construction:			
	- taped/banded/bolted limbs			
	- taped/banded/bolted yokes			
	- taping/banding material			
	- number of limbs			
	- type of joints in magnetic core			
	- type of core laminations			
	-Thickness of core laminations			
	- maximum specific loss in core laminations at 1.7 T	W/kg	Max. 0.95	
	Maximum flux density in the core at rated voltage and at rated frequency:			
	- limbs	T	1.6	
	- yokes	T	1.6	
	Insulation of magnetic core:			
	- core laminations			
	- core screws			
	- washers for core screws			
	- end plates			
	Material of transformer tank			
	Thickness of transformer tank:			
	- sides	mm		
	- bottom	mm		
	- top	mm		
	Tank anticorrosion protection			

	Thickness of radiator plates	mm		
	Thickness of final paint	µm		
	Conservator vessel, radiators, boxes and pipework anticorrosion protection		Hot dip galvanized and painted	
7.5	**Tap Changer**			
	Manufacturer			
	Place and country of Manufacture			
	Place of Factory Inspection and Testing			
	Type designation by the manufacturer			
	Standards		IEC 60214	
	Type of regulation		Off-load	
	Position of tap changer		At HV winding	
	Range of regulation	%	±5%	
	Regulation step	%	2.5	
	Number of tap positions		5	
7.6	**Transformer Protective Devices & Accessories**			
	Standards		IEC 60076-22-1 IEC 60076-22-7	
	Transformer oil type		Uninhibited mineral naphthenic oil	
	Control cabinet painting colour (RAL)			
	Heater inside control cabinet		Yes	
	HV winding temperature indicator		Yes	
	LV winding temperature indicator		Yes	
	HV winding temperature indicator		Yes	
	Thermometer setting:			
	- alarm	°C		
	- trip	°C		
	Buchholz relay		Yes	
	Pressure relief device		Yes	
	Transformer conservator		Yes	
	Total volume of conservator	litres		

	Dehydrating breather		Yes	
	Type of dehydrating breather		Air bag + Dehydrating agent, Maintenance free	
	Type of oil level gauge			
	Transformer wheels		No	
	Supply voltage for transformer auxiliaries	V	400/230 AC	
	Control & Protection voltage	V	110 DC	
	Location of transformer control cabinet		Mounted on transformer	
	Current transformer			
7.7	**Cooling System**			
	Total number of coolers (radiators) per transformer	pcs		
	Number of stand-by coolers (radiators)	pcs		
7.8	**Transformer Bushings**			
	Terminal type			
	HV line terminals		Bushing at cable box	
	HV neutral terminal		Bushing	
	LV line terminals		Bushing at cable box	
	Cable connection box on transformer **Note:** HV and LV cable box shall be provided, where cable terminations, supplied by contractor, will be installed inside transformer connection box. Design of cables connection boxes shall be subject of Client's approval.			
	HV Bushings		Inside cable box	
	Manufacturer			
	Place and country of Manufacture			
	Place of Factory Inspection and Testing			
	Type			
	Type designation by the manufacturer			
	Standards		IEC 60137 IEC 60815	
	Material			
	Highest voltage for equipment	kV	36	

	Rated frequency	Hz	50	
	Power frequency withstand voltage (r.m.s. value), AC (50 Hz, 1 min)	kV	70	
	Lightning impulse withstand voltage (peak value), LI (1.2/50 µs)	kV	≥170	
	Minimum creepage distance	mm	As per IEC standard	
	Arcing horns and other accessories		As per IEC standard	
	LV Bushings		Inside Cable box	
	Manufacturer			
	Place and country of Manufacture			
	Place of Factory Inspection and Testing			
	Type			
	Type designation by the manufacturer			
	Standards		IEC 60137 IEC 60815	
	Material			
	Highest voltage for equipment	kV	1.1	
	Rated frequency	Hz	50	
	Power frequency withstand voltage (r.m.s. value), AC (50 Hz, 1 min)	kV	3	
	Lightning impulse withstand voltage (peak value), LI (1.2/50 µs)	kV	-	
	Minimum creepage distance	mm	As per IEC standard	
	Arcing horns and other accessories		As per IEC standard	
	LV Neutral Bushing		Bushing or according to design	
	Manufacturer			
	Place and country of Manufacture			
	Place of Factory Inspection and Testing			
	Type			
	Type designation by the manufacturer			
	Standards		IEC 60137 IEC 60815	
	Material			

	Highest voltage for equipment	kV	1.1	
	Rated frequency	Hz	50	
	Power frequency withstand voltage (r.m.s. value), AC (50 Hz, 1 min)	kV	3	
	Lightning impulse withstand voltage (peak value), LI (1.2/50 µs)	kV	-	
	Minimum creepage distance	mm	As per IEC standard	
	Arcing horns and other accessories		As per IEC standard	
7.9	**Dimensions and Mass**			
	Overall dimensions of the assembled transformer in operation:			
	- length	mm		
	- width	mm		
	- height	mm		
	Total mass of the assembled transformer in operation	kg		
	Individual masses of transformer:			
	- core / core lamination	kg		
	- windings	kg		
	- total mass excluding oil	kg		
	- oil mass in tank	kg		
	- oil mass in radiators	kg		
	- total oil required	kg		
		Litres		
	Dimensions of transformer arranged for transport:			
	- length	mm		
	- width	mm		
	- height	mm		
	Mass of transformer arranged for transport	kg		
	Filling medium of reactor tank for transport		oil	

Annex A: Equipment's suppliers (shall specify one supplier for each equipment's only according to qualification requirements)

Item	Manufacturer	Place of Manufacture	Place of testing and Inspection
Main transformers, complete			
Earthing/auxiliary transformers complete			
Core plates			
Tanks			
Radiators			
Marshalling kiosk and/or cabinets			
132 outdoor Bushings 33 kV outdoor Bushings Main transformer neutral Bushings Earthing transformer neutral bushings			
Cable Box			
Voltage control apparatus (Tap Changer)			
Oil			
Oil Valves			
Air Blowers			
Motor Control Gear of tap changer			
Fan Motors			
Alarms			
Gas And Oil Actuated Relays			
Oil Temperature Indicators			
Winding Temperature Indicators			
Digital Meters			
MCBs			
Silicagel Breather			

Item	Manufacturer	Place of Manufacture	Place of testing and Inspection
Valves			
Pressure Relief Device			
Buchholz Relays			
OFF Load Tap changer			
CTs			
Contactors			
Terminal blocks			
Fuses			
AVR Relay			
Oil level indicator			

ANNEX B: NEPCO PROPERTY PLATE DETAILS (WILL BE PROVIDED AT ENGINEERING STAGE)

POWER TRANSFORMER

SERIAL NO.	NEPCO SERIAL NO.	S/S NAME	RATING M.V.A	RATIO K.V

Earthing Transformers

SERIAL NO.	NEPCO SERIAL NO.	S/S NAME	RATING V.A	RATIO K.V

All NEPCO serial number shall mounted on separate plate.

ANNEX C
(Information to be supplied with Financial Bid)

Main Transformer

"Shall be filled for each type of transformers "

80 MVA 132/33 kV Power transformer

A. Capitalization For the purposes of Bid evaluation, these losses are capitalized in accordance with the following formula:

Total Cost = IC + 7438.54 (P0 + Pc0) + 1473.01 (Pk + Pcs – Pc0),

where:

- IC: Transformer initial cost, in JOD;
- P0: No load losses at rated tap;
- Pc0: The cooling power for no load operation;
- Pk: Load losses at rated tap;
- Pcs: Total cooling power at rated Power.

(Transformers) shall be evaluated based on the main and earthing transformer Total Cost.

B. Energy performance - Peak efficiency index evaluation

- Tender evaluation is relatively simple because it is only to check that guaranteed energy performance proposed by Bidder fulfil NEPCO energy performance requirements. NEPCO will use the following equation to calculate the minimum Peak efficiency index, according to BS EN 50708-1-1:2020:

$$min.PEI = 1 - \frac{2}{s}\sqrt[2]{(P_O + P_{C0})P_{K1}}$$

- S = Maximum Rated Power
- P_O= No load Losses
- P_{C0}= Cooling Losses
- P_{K1}= Load Losses

The reference Table 1 from EN 50708-3-1:2020.

TIER2 shall be applied from 1 July 2021 for the values of losses following Commission Regulation (EU) No548/2014 of 21 May 2014 and its amendment No 2019/1783 of 1 October 2019.

- The guaranteed PEI value is 99.758 % for 80 MVA

	Maximum No-load losses at rated tap and rated frequency KW	
	Cooling power for no-load operation KW	

	Maximum Load losses at 75 ºC, rated tap and rated frequency:	
	- at ONAN rated power KW	
	- at ONAF rated power KW	
	Total cooling power at rated power (Pcs) KW	
Item No	**Description**	
1	No load losses at rated No load losses at rated voltage ratio :	
1.1 1.2	At IEC rating kW Input to cooling plant kW	
2	Load losses at 75°C and rated voltage ratio : When operating under site conditions:	
2.1	HV/LV kW	
2.2	At ONAN rating (HV/LV) kW	
3	Total losses at 75°C and rated voltage ratio and with all winding loaded at HV/LV excluding Cooling losses:	
3.1	At CMR when operating under site condition kW	
3.2 3.3	At ONAN rating kW Total losses at site condition kW	
3.4	Tap position on which maximum losses occur at CMR. CMR= Continuous Maximum Rated	
3.5	Load losses at C.M.R on tap position with maximum losses kW	
3.6	Proportion of sum of fixed and load losses at rated	
3.7	Power which will be supplied during the temperature rise test per cent	
3.8	Regulation at 75°C and C.M.R: -at unity P.F per cent of normal Voltage -at 0.8 P.F Lagging	
4	Number of coolers or cooler banks per transformers	
4.1	Number of fans	
4.2	Rating of each cooler or cooler bank KW	
4.3	rating of each fan kW	
4.5	Starting current of each fan A	

63 MVA 132/33 kV Power transformer

A. Capitalization For the purposes of Bid evaluation, these losses are capitalized in accordance with the following formula:

Total Cost = IC + 7438.54 (P0 + Pc0) + 2040.88 (Pk + Pcs – Pc0),

where:

- IC: Transformer initial cost, in JOD;
- P0: No load losses at rated tap;
- Pc0: The cooling power for no load operation;
- Pk: Load losses at rated tap;
- Pcs: Total cooling power at rated Power.

(Transformers) shall be evaluated based on the main and earthing transformer Total Cost.

B. Energy performance - Peak efficiency index evaluation

- Tender evaluation is relatively simple because it is only to check that guaranteed energy performance proposed by Bidder fulfil NEPCO energy performance requirements. NEPCO will use the following equation to calculate the minimum Peak efficiency index, according to BS EN 50708-1-1:2020:

$$min.PEI = 1 - \frac{2}{S}\sqrt[2]{(P_O + P_{C0})P_{K1}}$$

- S = Maximum Rated Power
- P_O= No load Losses
- P_{C0}= Cooling Losses
- P_{K1}= Load Losses

The reference Table 1 from EN 50708-3-1:2020.

TIER2 shall be applied from 1 July 2021 for the values of losses following Commission Regulation (EU) No548/2014 of 21 May 2014 and its amendment No 2019/1783 of 1 October 2019.

- The guaranteed PEI value is 99.745 % for 63 MVA

	Maximum No-load losses at rated tap and rated frequency KW	
	Cooling power for no-load operation KW	
	Maximum Load losses at 75 ºC, rated tap and rated frequency:	
	- at ONAN rated power KW	
	- at ONAF rated power KW	
	Total cooling power at rated power (Pcs) KW	

Item No	Description	
1	No load losses at rated No load losses at rated voltage ratio :	
1.1	At IEC rating kW	
1.2	Input to cooling plant kW	
2	Load losses at 75°C and rated voltage ratio : When operating under site conditions:	
2.1	HV/LV kW	
2.2	At ONAN rating (HV/LV) kW	
3	Total losses at 75°C and rated voltage ratio and with all winding loaded at HV/LV excluding Cooling losses:	
3.1	At CMR when operating under site condition kW	
3.2	At ONAN rating kW	
3.3	Total losses at site condition kW	
3.4	Tap position on which maximum losses occur at CMR. CMR= Continuous Maximum Rated	
3.5	Load losses at C.M.R on tap position with maximum losses kW	
3.6	Proportion of sum of fixed and load losses at rated	
3.7	Power which will be supplied during the temperature rise test per cent	
3.8	Regulation at 75°C and C.M.R: -at unity P.F per cent of normal Voltage -at 0.8 P.F Lagging	
4	Number of coolers or cooler banks per transformers	
4.1	Number of fans	
4.2	Rating of each cooler or cooler bank KW	
4.3	rating of each fan kW	
4.5	Starting current of each fan A	

Earthing Transformer 33/0.4 kV

1	No load losses “Maximum No-load losses at rated voltage and rated frequency” kW	
2	Load losses (at CMR of lower voltage winding) at 75°C “Maximum Load losses at 75 ºC and rated frequency “ kW	

- **Rate of losses and price Schedules should be included with the financial envelope which should be closed and separated from the technical envelope.**

(Information to be supplied with Financial Bid)
Losses table

Capitalization For the purposes of Bid evaluation, these losses are capitalized in accordance with the following formula:

Total Cost = IC + 7438.54 (P0 + Pc0) + 1473.01 (Pk + Pcs – Pc0),

where:

- IC: Transformer initial cost, in JOD;
- P0: No load losses at rated tap;
- Pc0: The cooling power for no load operation;
- Pk: Load losses at rated tap;
- Pcs: Total cooling power at rated Power.

(Transformers) shall be evaluated based on the transformers Total Cost.

POWER TRANSFOMER 33/11 KV		
1	No load losses “Maximum No-load losses at rated voltage and rated frequency” kW	
2	Load losses (at CMR of lower voltage winding) at 75°C “Maximum Load losses at 75 ºC and rated frequency “ kW	
AUXILIARY SUPPLY TRANSFOMER 33/0.4 KV		
1	No load losses “Maximum No-load losses at rated voltage and rated frequency” kW	
2	Load losses (at CMR of lower voltage winding) at 75°C “Maximum Load losses at 75 ºC and rated frequency “ kW	

Annex D: Transformer oil specification

Table 4 – General specifications, Type B (uninhibited and inhibited standard grade oils)

Property	Test method	Limits	
		Transformer oil	Low temperature switchgear oils
1 – Function			
Viscosity at 40 °C	ISO 3104[a] or ASTM D7042	Max. 12 mm^2/s	Max. 3,5 mm^2/s
Viscosity at –30 °C [b]	ISO 3104[a] or ASTM D7042	Max. 1 800 mm^2/s	–
Viscosity at –40 °C [c]	IEC 61868	–	Max. 400 mm^2/s
Pour point	ISO 3016	Max. –40 °C	Max. –60 °C
Water content	IEC 60814	Max. 30 mg/kg [d]/ 40 mg/kg [e]	
Breakdown voltage	IEC 60156	Min. 30 kV / 70 kV [f]	
Density at 20 °C	ISO 12185 [a] or ISO 3675 or ASTM D7042	Max. 895 kg/m^3	
DDF at 90 °C	IEC 60247 [a] or IEC 61620	Max. 0,005	
2 – Refining/stability			
Colour	ISO 2049	Max. 1,5	
Appearance	–	Clear, free from sediment and suspended matter	
Acidity	IEC 62021-2[a] or 62021-1	Max. 0,01 mg KOH/g	
Interfacial tension	IEC 62961 [a] or ASTM D971	Min. 40 mN/m	
Corrosive sulphur	DIN 51353	Not corrosive	
Potentially corrosive sulphur	IEC 62535	Not corrosive	
DBDS	IEC 62697-1	Not detectable (< 5 mg/kg)	
Inhibitors of IEC 60666	IEC 60666	Uninhibited (U): not detectable (< 0,01 %) Trace inhibited (T): ≥ 0,01 < 0,08% Inhibited oil (I): 0,08 % to 0,40 % (see 3.5 to 3.7)	
Metal passivator additives of IEC 60666	IEC 60666	Not detectable (< 5 mg/kg), or as agreed upon with the purchaser	
Other additives		See [g]	
2-furfural and related compounds content	IEC 61198	Not detectable (< 0,05 mg/kg) for each individual compound[h]	
3 – Performance			
Oxidation stability	IEC 61125 Test duration [i] (U) Uninhibited oil: 164 h (T) Trace inhibited oil: 332 h (I) Inhibited oil: 500 h	For oils with other antioxidant additives and metal passivator additives, see 6.12.2	
– Total acidity [j]	4.8.4 of IEC 61125:2018	max. 1,2 mg KOH/g	
– Sludge [j]	4.8.1 of IEC 61125:2018	max. 0,8 %	
– DDF at 90 °C [j]	4.8.5 of IEC 61125:2018	max. 0,500	
4 – Health, safety and environment (HSE)[k]			
Flash point	ISO 2719	Min. 135 °C	Min. 100 °C
PCA content[l]	IP 346	< 3 %	
PCB content	IEC 61619	Not detectable (< 2 mg/kg)	

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Stray gassing under thermo-oxidative stress (see 6.19) is not included as a normative test for mineral oils Type B, because there has been insufficient data to determine appropriate limits. The requirement for a stray gassing test, as well as the limit values, if stipulated, can be negotiated between the user and supplier.

[a] Reference method.

[b] This is the standard LCSET for a transformer oil (see 6.1) and can be modified depending on the climatic condition of each country. Pour point should be minimum 10 °C below LCSET.

[c] Standard LCSET for low temperature switchgear oil.

[d] For bulk supply.

[e] For delivery in drums and IBC.

[f] After laboratory treatment (see 6.4).

[g] The supplier shall declare the function and chemical family of all additives (3.3), and the concentrations in the cases of inhibitors antioxidants and passivators (3.4).

[h] In agreement with the customer, oils with a higher furfural content can be delivered, when these values do not jeopardize the application.

[i] In some countries there can be lower requirements for oxidation stability.

[j] At the end of oxidation stability tests.

[k] In some countries there can be additional requirements, e.g. REACH in the EU.

[l] Some individual PAH compounds can be determined by EN 16143.

7 Additional properties

Table 3 – General specifications, Type A (fully inhibited high grade oils)

Property	Test method	Limits	
		Transformer oil	Low temperature switchgear oils
1 – Function			
Viscosity at 40 °C	ISO 3104[a] or ASTM D7042	Max. 12 mm^2/s	Max. 3,5 mm^2/s
Viscosity at –30 °C [b]	ISO 3104[a] or ASTM D7042	Max. 1 800 mm^2/s	–
Viscosity at –40 °C [c]	IEC 61868	–	Max. 400 mm^2/s
Pour point	ISO 3016	Max. –40 °C	Max. –60 °C
Water content	IEC 60814	Max. 30 mg/kg [d] / 40 mg/kg [e]	
Breakdown voltage	IEC 60156	Min. 30 kV / 70 kV [f]	
Density at 20 °C	ISO 12185 [a] or ISO 3675 or ASTM D7042	Max. 895 kg/m^3	
DDF at 90 °C	IEC 60247 [a] or IEC 61620	Max. 0,005	
2 – Refining/stability			
Colour	ISO 2049	L0,5 (less than 0,5)	
Appearance	–	Clear, free from sediment and suspended matter	
Acidity	IEC 62021-2[a] or 62021-1	Max. 0,01 mg KOH/g	
Interfacial tension	IEC 62961 [a] or ASTM D971	Min. 43 mN/m	
Total sulphur content	ISO 14596 [a] or ISO 8754	Max. 0,05 %	
Corrosive sulphur	DIN 51353	Not corrosive	
Potentially corrosive sulphur	IEC 62535	Not corrosive	
DBDS	IEC 62697-1	Not detectable (< 5 mg/kg)	
Inhibitors of IEC 60666	IEC 60666	(I) Inhibited oil: 0,08 % to 0,40 % (see 3.7)	
Metal passivator additives of IEC 60666	IEC 60666	Not detectable (< 5 mg/kg), or as agreed upon with the purchaser	
Other additives		See [g]	
2-furfural and related compounds content	IEC 61198	Not detectable (< 0,05 mg/kg) for each individual compound	
Stray gassing under thermo-oxidative stress	Procedure in Clause A.4 (oil saturated with air) in the presence of copper	Non stray gassing: < 50 µl/l of hydrogen (H_2) and < 50 µl/l methane (CH_4) and < 50 µl/l ethane (C_2H_6)	
3 – Performance			
Oxidation stability	IEC 61125: Test duration (I) Inhibited oil: 500 h	For oils with other antioxidant additives and metal passivator additives, see 6.12.2	
– Total acidity [h]	4.8.4 of IEC 61125:2018	Max. 0,3 mg KOH/g	
– Sludge [h]	4.8.1 of IEC 61125:2018	Max. 0,05 %	
– DDF at 90 °C [h]	4.8.5 of IEC 61125:2018	Max. 0,050	
4 – Health, safety and environment (HSE)[i]			
Flash point	ISO 2719	Min. 135 °C	Min. 100 °C
PCA content[j]	IP 346	< 3 %	
PCB content	IEC 61619	Not detectable (< 2 mg/kg)	

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a	Reference method.
b	This is the standard LCSET for a transformer oil (see 6.1) and can be modified depending on the climatic condition of each country. Pour point should be minimum 10 °C below LCSET.
c	Standard LCSET for low temperature switchgear oil.
d	For bulk supply.
e	For delivery in drums and IBC.
f	After laboratory treatment (see 6.4).
g	The supplier shall declare the chemical family and function of all additives (3.3), and the concentrations in the cases of inhibitors, antioxidants and passivators (3.4).
h	At the end of oxidation stability tests.
i	In some countries there can be additional requirements, e.g. REACH in the EU.
j	Some individual PAH compounds can be determined by EN 16143.

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