



**DELHI METRO RAIL CORPORATION LIMITED**

***DMRC ELECTRICAL STANDARDS &  
DESIGN WING (DESDW)***

**SPECIFICATION NO.  
DMES- 0005/ DMRC-E-TR-TRANSF-05**

**SPECIFICATIONS FOR THREE PHASE 33 kV/415 V  
AUXILIARY TRANSFORMER**

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## 1. 33 KV / 415 V, 3 PHASE AUXILIARY TRANSFORMERS

The Auxiliary Transformers, also referred to as Auxiliary Station Transformers are required to supply the power requirement at 415 / 230 V of various electrical equipments, systems and appliances. Mainly these comprise of power required for lighting, fans, air-conditioning, control and monitoring circuits, battery chargers, space heaters in the switchgear / panels etc.

### 1.1 GENERAL

This specification defines the main technical characteristics required for the 33000 / 415-240 V dry type transformers to be used in Auxiliary Substations (ASS), Auxiliary Main Substations (AMS) or as required. This specification is applicable for the transformers of power rating of following capacity:

Transformer Capacity	
AN (Air Natural)	AF (Air Forced)
200 kVA	N/A
500 kVA	N/A
630 kVA	N/A
1000 kVA	N/A
1600 kVA	N/A
2500 kVA	3000 kVA
3000 kVA	3500 kVA

The transformer offered shall be complete in all respects with all parts and accessories necessary for their efficient operation in sub stations. All such parts & accessories shall be deemed to be within the scope of this specification whether specifically mentioned or not.

The transformer shall satisfy the following requirements and shall also comply with standards in force when the transformers are manufactured, particularly which are in the following table –

Standard #	Description
IEC 60076	Power transformers - Insulation levels, dielectric tests and external clearances in air
IEC 60726	Dry-type power transformers
IS 2026	Power transformers: Terminal marking, tappings and connections, Ability to Withstand Short Circuit
IS 11171/1985	Dry-Type Power Transformers
BS 171	Power transformers Specification for insulation levels and dielectric tests

IEC publication No. 1963 or latest and IE Rules and BEE Guidelines applied in the manner altered, amended or supplemented by this specification, wherever applicable. In all cases, latest revision to these specifications referred to above shall apply.

The transformer shall be dry type.

## 1.2 CHARACTERISTICS

- Climatic conditions: indoor operation
- Operation: continuous
- Windings: Aluminium
- Primary line voltage (across phases): 33 kV
- Secondary voltage, off-load : 415 V
- Secondary voltage at full load and p.f. 0,8: 400 V
- Insulation rated voltage: 36 kV
- Frequency: 50 Hz
- Withstand at industrial frequency: 70 kV
- Voltage surge withstands: 170 kV
- Coupling: Dyn11
- Cooling: Air natural/ Air forced
- Off load tap changer: 0,  $\pm 2.5\%$  and  $\pm 5\%$
- Class of insulation: F Class

The voltage shall be adjusted by a 5 positions switch which can be used “dead” and provides -5%, - 2.5%, 0, + 2.5%, and + 5% settings.

The magnetic circuit shall be in low-loss oriented-grain silicon steel sheet.

The primary and the secondary windings shall be capable of withstanding a symmetrical three-phase short-circuit regardless of the tapping selected., that is to say a short circuit current, at secondary side, of 7000 A. The short Circuit level at secondary side for various ratings of transformers shall be as follows:

630 KVA	21.9 KA
800 KVA	22.6 KA
1000 KVA	24 KA
1600 KVA	37.1 KA
2000 KVA	43- 46.4 KA
2500 KVA	58 KA
3150 KVA	73 KA

The terminals shall be of the 36 kV type.

Conductors insulated at 36 KV realize delta connection on primary side.

The secondary neutral shall be solidly earthed

The medium and low voltage connections shall be made using braids whose cross-section is suited for the current level to be transmitted and which are very easy to disconnect so as to enable very quick replacement of the transformer in the event of breakdown.

This equipment shall satisfy all the requirements for interchangeability, interlock ability and functional servo-control applicable to this type of equipment. It shall use a technology and components identical to those of the equipment to be installed in the Auxiliary stations.

### 1.3 ACCESSORIES

- Installed on rollers/ base channels
- Lifting rings
- Nameplate
- Grounding terminal

The connection with different terminals of transformer shall be through C type or suitable connector for sufficient clearances from transformer windings. HV connections of transformer shall be connected through insulated cables. HV terminals shall have suitable arrangement to provide sufficient clearance to 33 KV cables from transformer windings.

### 1.4 TEMPERATURE PROTECTION

Transformers shall be fitted with a temperature protection system that allows winding temperatures to be monitored.

This shall consist of two sensors placed on each low-voltage winding, i.e. three alarm sensors and three trip out sensors.

An indicator shall be installed on the front door of the bay to indicate continuously the winding temperature. This shall be installed on the middle low voltage winding.

### 1.5 TRANSFORMER VALUES

The contractor shall confirm the following characteristics for each power distribution transformer:

- Short-circuit voltage,
- No-load losses,
- Full-load copper losses
- Efficiency at different load conditions:
  - 1/4 - load: power factor = 1 (Minimum: 98.95%)  
power factor = 0.8 (Minimum: 98.7%)
  - 1/2 - load: power factor = 1 (Minimum: 98.87%)  
power factor = 0.8 (Minimum: 98.59%)
  - 3/4 - load: power factor = 1 (Minimum: 98.67%)  
power factor = 0.8 (Minimum: 98.34%)
  - Full load: power factor = 1 (Minimum: 98.4%)  
power factor = 0.8 (Minimum: 98%)

### 1.6 TRANSFORMER CUBICLE

Transformers shall be installed in dismantable cubicle, wire-mesh type. Alternatively, the transformers may be supplied in a cubicle with enclosure having a degree of protection of not less than IP-31 and without any HV portions exposed. The door shall be provided with a mechanical interlocking system, to ensure that it is possible to open the door only when the protection circuit breakers on the HV side as well as LV side of the transformer are in 'open'

position. Also transformer should trip if somebody tries to open the door with its key without opening the HV & LV side breakers.

Enclosure shall have inspection windows to view primary & secondary sides.

Temperature monitoring devices with two thresholds (alarm and tripping) must be provided and located on the upper part of the secondary windings.

The cubicle shall provide protection against direct contact with the power transformer. It shall include connections for the MV lines from the protection bay and connections for the low voltage circuit.

Cable arrangement shall facilitate the exchange of the either of the transformers without any difficulty, i.e. the cables shall be laid along each side and connected to the transformer in such a way that it will not block the passage for removal of any of the transformer during service. The contractor will provide suitable size stiffeners in enclosure for connection of bus duct and to ensure that the enclosure does not deform due to Bust duct connection.

The cubicles shall be protected against fire by means of an 'automatic fire detector and extinguisher system', 'Fire trace' type or equivalent, complete with CO<sub>2</sub> Gas cylinder, approved by Chief Controller of Explosives, valve, flexible detection and delivery system in the form of a flexible tube made of special polymer, capable of withstanding a normal pressure of 12 bar and a maximum pressure of 20 bar, suitably routed inside the panel for detection of fire. The CO<sub>2</sub> gas cylinder shall be suitably mounted on the panel and shall be capable of flooding the cubicle with CO<sub>2</sub> gas, within the shortest response time, not more than 10 seconds after the fire is sensed by the flexible detector tube.

The contractor shall submit the complete technical data of the system and shall obtain the approval of DMRC before ordering for manufacture of transformer enclosure.

The bimetallic strip required for connection in any case shall be provided by the contractor.

## 1.7 DESCRIPTION

Two doors containing two windows to allow observation of the transformer accessories shall be provided in the front face.

These doors shall be closed and locked to prevent access to the transformer while either the MV or the LV side is live.

Consequently, ventilation louvers shall be installed at the bottom of the front doors and in the bay rear panel and roof. A metal sheet shall be installed at 10 to 15 cm from the top grating to provide protection against any falling water.

## **1.8 TERMINAL ARRANGEMENTS**

The terminal arrangement for high voltage side shall be suitable for required size of cables with FRLS/FRLSOH outer sheath. Suitable arrangements shall be available for cable terminations so that the cable weight doesn't come on the terminals. The terminal on HV & LV shall be suitable for receiving XLPE cable and termination with cable gland and anodized hard wire for the cable termination. The terminals on the primary side shall be of the 36 KV type.

## **1.9 PAINTING**

All steel surfaces shall be painted which shall be suitable for polluted atmosphere and has to comply with ICE-60072-2-5 standard. After baring of all metal surfaces, an Intel two coat of rust proofing and anti corrosive paint shall be applied then they will be covered with three coatings of glossy oil & weather resistance non fading paint.

## **1.10 NUTS & BOLTS**

The threads and hexagons of all nuts, bolts and stud shall confirm to relevant IS or BS. No Bolt or stud shall project through its nut(s) more than 6 mm (or) four threads, except when otherwise approved for terminating stud/bolts. All the bolts and nuts shall be so placed that they are inaccessible by means of ordinary spanners. All terminals should be provided with suitable cadmium plated and passivated high tensile steel hard wires to facilitate cables termination.

**2. DATA SHEET**

**2.1 AUXILIARY TRANSFORMERS**

**2.1.1 AUXILIARY TRANSFORMER 200 KVA**

INDICATIONS	U	VALUES Required
Manufacturer		
Place of manufacture		
Port of embarkation		
Manufacturer drawing reference		
Standards		IEC 60076
Insulation type		Cast resin
Rated power	kVA	200
Cooling mode		AN
Primary rated insulation voltage	kV	36
Primary operating voltage	kV	33
Secondary rated operating voltage	V	415/240
Rated short duration power frequency withstand voltage for primary winding	kV	70
Rated lightning impulse withstand voltage for primary winding	kV	170
Short-circuit voltage	%	4
Voltage setting	%	+5.0, +2.5, 0, -0.25, -5.0
Vector Group		Dyn11
Maximum noise level	dBA	70
Maximum iron losses	W	450 ±10%
Maximum load losses	W	2300 ±10%
Dimensions (maximum)*		
- Length	mm	2000
- Width	mm	1500
- Height	mm	2250
Weight (maximum)*	kg	1700

\*Dimensions shown are indicative only



**2.1.2 AUXILIARY TRANSFORMER 630 KVA**

INDICATIONS	U	VALUES Required
Manufacturer		
Place of manufacture		
Port of embarkation		
Manufacturer drawing reference		
Standards		IEC 76
Insulation type		Cast resin
Rated power	kVA	630
Cooling mode		AN
Primary rated insulation voltage	kV	36
Primary operating voltage	kV	33
Secondary rated operating voltage	V	415/240
Rated short duration power frequency withstand voltage for primary winding	kV	70
Rated lightning impulse withstand voltage for primary winding	kV	170
Short-circuit voltage	%	4
Voltage setting (Off load Tap changer)	%	+5.0, +2.5, 0, -2.5, -5.0
Vector Group		Dyn11
Maximum noise level	dB(A)	65 dB at 1.5 metres
Maximum iron losses	W	As per Manufacture (Efficiency required is defined in Specifications)
Maximum load losses	W	As per Manufacture (Efficiency required is defined in Specifications)
Dimensions (maximum)*		
- Length	mm	2000
- Width	mm	2000
- Height	mm	2250
Weight (maximum)*	kg	3000

\*Dimensions shown are indicative only

**2.1.3 AUXILIARY TRANSFORMER 1600 KVA**

INDICATIONS	U	VALUES
		<b>Required</b>
Type		Dry Type Cast Resin
Standards		IEC 76, IS 2026 and IS 11171/985
Insulation type		Cast resin
No. of Phases		3
Rated frequency	Hz	50
Rated power (Air Natural)	MVA	1.6
Cooling mode		AN
<b>System Highest Voltage</b>		
Primary Voltage side	KV	36 Kv
Secondary voltage	V	460 V
<b>Impulse Withstand Voltage</b>		
Primary Voltage winding	KV	170 Kv rms
Secondary Voltage winding	KV	3.5 kV rms
<b>Power frequency Voltage</b>		
Primary Voltage winding	KV	70 Kv
Secondary Voltage winding	KV	3 kV
Impedence at normal Voltage and frequency	%	6.0%
Voltage setting (Off load Tap changer)	%	+5.0, +2.5, 0, -2.5, -5.0
Vector Group		Dyn11
Winding material		
HV Side		Aluminium
LV Side		Aluminium
Winding Connection		
Primary Voltage Winding		Delta
Secondary Voltage Winding		Star
Whether Neutral Terminal are to be brought out		
Primary Voltage winding		No
Secondary Voltage Winding		Yes
Type of Live Terminals		
Primary Voltage winding		Cable sealing ends
Secondary Voltage Winding		Bus Duct entry
Maximum noise level	dBA	65 dB at 1.5 metres
Class of Insulation		F
Enclosure & Housing		IP-31
Maximum iron loses	W	As per Manufacture (Efficiency required is defined in Specifications)
Maximum load loses	W	As per Manufacture (Efficiency required is defined in Specifications)
Dimensions (maximum)*		V

- Length	mm	2000
- Width	mm	2000
- Height	mm	2250
Weight (maximum)*	kg	8000

\*Dimensions shown are indicative only

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**2.1.3 AUXILIARY TRANSFORMER 2000 KVA**

INDICATIONS	U	VALUES Required
Type		Dry Type Cast Resin
Standards		IEC 76, IS 2026 and IS 11171/985
Insulation type		Cast resin
No. of Phases		3
Rated frequency	Hz	50
Rated power (Air Natural)	MVA	2.0
Cooling mode		AN
<b>System Highest Voltage</b>		
Primary Voltage side	KV	36 Kv
Secondary voltage	V	460 V
<b>Impulse Withstand Voltage</b>		
Primary Voltage winding	KV	170 Kv rms
Secondary Voltage winding	KV	3.5 kV rms
<b>Power frequency Voltage</b>		
Primary Voltage winding	KV	70 Kv
Secondary Voltage winding	KV	3 kV
Impedence at normal Voltage and frequency	%	6.0%
Voltage setting (Off load Tap changer)	%	+5.0, +2.5, 0, -2.5, -5.0
Vector Group		Dyn11
Winding material		
HV Side		Aluminium
LV Side		Aluminium
Winding Connection		
Primary Voltage Winding		Delta
Secondary Voltage Winding		Star
Whether Neutral Terminal are to be brought out		
Primary Voltage winding		No
Secondary Voltage Winding		Yes
Type of Live Terminals		
Primary Voltage winding		Cable sealing ends
Secondary Voltage Winding		Bus Duct entry
Maximum noise level	dBa	65 dB at 1.5 metres
Class of Insulation		F
Enclosure & Housing		IP-31
Maximum iron losses & maximum Load losses		
Maximum iron loses	W	As per Manufacture
Maximum load loses	W	(Efficiency required is defined in Specifications)
Dimensions (maximum)*		V
- Length	mm	2000
- Width	mm	2700
- Height	mm	2250
Weight (maximum)*	kg	8000

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\*Dimensions shown are indicative only

### 2.1.4 AUXILIARY TRANSFORMER 2500 KVA/3000 KVA

INDICATIONS		U	VALUES Required
Manufacturer			
Place of manufacture			
Port of embarkation			
Manufacturer drawing reference			
Standards			IEC 76
Insulation type			Cast resin
Rated power	AN	kVA	2500
	AF	KVA	3000
Cooling mode			AN
			AF
Primary rated insulation voltage		kV	36
Primary operating voltage		kV	33
Secondary rated operating voltage		V	415/240
Rated short duration power frequency withstand voltage for primary winding		kV	70
Rated lightning impulse withstand voltage for primary winding		kV	170
Short-circuit voltage		%	6
Voltage setting (Off load Tap changer)		%	+5.0, +2.5, 0, -2.5, -5.0
Vector Group			Dyn11
Maximum noise level		dBA	65 dB at 1.5 metres
Maximum iron losses		kW	As per Manufacture (Efficiency required is defined in Specifications)
Maximum load losses		kW	As per Manufacture (Efficiency required is defined in Specifications)
Dimensions (maximum)*			
- Length		mm	2100
- Width		mm	2900
Height		mm	2250
Weight (maximum)*		kg	8000

\*Dimensions shown are indicative only

**2.1.5 AUXILIARY TRANSFORMER 3000 KVA / 3500 KVA**

INDICATIONS		U	VALUES Required
Manufacturer			
Place of manufacture			
Port of embarkation			
Manufacturer drawing reference			
Standards			IEC 76
Insulation type			Cast resin
Rated power	AN	kVA	3000
	AF	KVA	3500
Cooling mode			AN
			AF
Primary rated insulation voltage		kV	36
Primary operating voltage		kV	33
Secondary rated operating voltage		V	415/240
Rated short duration power frequency withstand voltage for primary winding		kV	70
Rated lightning impulse withstand voltage for primary winding		kV	170
Short-circuit voltage		%	7
Voltage setting (Off load Tap changer)		%	+5.0, +2.5, 0, -2.5, -5.0
Vector Group			Dyn11
Maximum noise level		dBA	65 dB at 1.5 metres
Maximum iron losses		kW	As per Manufacture (Efficiency required is defined in Specifications)
Maximum load losses		kW	As per Manufacture (Efficiency required is defined in Specifications)
Dimensions (maximum)*			
- Length		mm	2200
- Width		mm	3000
Height		mm	2350
Weight (maximum)*		kg	8500

\*Dimensions shown are indicative only

**3. TEST SHEET**

**3.1 AUXILIARY TRANSFORMERS**

INDICATIONS	TYPE of TEST			
	Type	Routine	On site	Specials
Temperature rise*	X			
Lightning impulse withstand voltage test*	X			
Separate-source voltage withstand test		X		
Measurement of winding resistance		X		
Measurement of voltage ration and check of phase displacement		X		
Measurement of no load loss and current		X		
Visual inspection		X	X	

\* For these type tests, the Contractor could provide a report on similar equipment