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| Assets Planning and Delivery GroupEngineering  |

DESIGN STANDARD DS 26-16

Type Specifications – Electrical

Type Specification for Cable Connected Dry Type Transformer

in Kiosk

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| version 2revision 2 |
| June 2022 |

**FOREWORD**

The intent of Design Standards is to specify requirements that assure effective design and delivery of fit for purpose Water Corporation infrastructure assets for best whole-of-life value with least risk to Corporation service standards and safety. Design standards are also intended to promote uniformity of approach by asset designers, drafters and constructors to the design, construction, commissioning and delivery of water infrastructure and to the compatibility of new infrastructure with existing like infrastructure.

Design Standards draw on the asset design, management and field operational experience gained and documented by the Corporation and by the water industry generally over time. They are intended for application by Corporation staff, designers, constructors and land developers to the planning, design, construction and commissioning of Corporation infrastructure including water services provided by land developers for takeover by the Corporation.

Nothing in this Design Standard diminishes the responsibility of designers and constructors for applying the requirements of the Western Australia's Work Health and Safety (General) Regulations 2022 to the delivery of Corporation assets. Information on these statutory requirements may be viewed at the following web site location:

[Overview of Western Australia’s Work Health and Safety (General) Regulations 2022 (dmirs.wa.gov.au)](https://www.dmirs.wa.gov.au/sites/default/files/atoms/files/overview_general_regulations.pdf)

Enquiries relating to the technical content of a Design Standard should be directed to the Senior Principal Engineer - Electrical, Engineering. Future Design Standard changes, if any, will be issued to registered Design Standard users as and when published.

Head of Engineering

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REVISION STATUS

The revision status of this standard is shown section by section below.

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# GENERAL

* + - * 1. This Specification covers the requirements for the design, manufacture, assembly, inspection, factory testing, packaging, transport to site, mechanical installation at site, on site testing and commissioning of a cable connected dry type transformer in kiosk as detailed further herein.
				2. The transformer shall be required to be installed indoors or outdoors as specified in the Annexure.
				3. The transformer shall be supplied to site complete and shall include all necessary accessories and miscellaneous material, minor parts and other such items necessary to complete mechanical installation, testing and commissioning of the transformer.
				4. The electrical connection of the transformer will be carried out by others after the mechanical installation of the transformer has been completed by the Contractor.
				5. Once electrical connection of the transformer is complete, the Contractor shall return to the site to commission the transformer under the overall direction of the Principal.

#  SITE

The location of and access to the site for the installation of the transformer shall be as described in the Annexure.

#  OPERATING MODE

The mode under which the transformer will be operated shall be as described in the Annexure.

#  WORK BY THE PRINCIPAL

The work to be performed by the Principal shall be as detailed in the Annexure.

#  INFORMATION FROM THE CONTRACTOR

The Contractor shall provide the following documentation in respect of the substation within the listed number of calendar days after receipt of the Principal’s order.

1. General Arrangement Drawings 28 days
2. Electrical Wiring and Schematic Drawings 28 days
3. Manufacturing and Delivery Schedule 14 days
4. Specification Data Sheets 35 days
5. Inspection and Test Plan 35 days
6. Test Certificates On delivery
7. Operating and Maintenance Manual On delivery

# CONTRACTOR’S DRAWINGS

The Contractor shall submit two A3 copies of the Contractor’s Drawings for approval. The Contractor’s drawings shall show the general arrangement, circuit diagrams and equipment specifications.

All drawings submitted by the Contractor shall be in accordance with the latest issue of the relevant Australian Standards.

Adequate contrast shall be maintained between drawing detail and background, and the clarity and quality of the drawings shall enable the Principal to microfilm the prints and to reproduce by photographic processes clear and legible A3 copies for record purposes.

The drawings shall provide in the title block, the number and title of the Contract, as well as details to identify the drawing, its contents, revision status and date of issue.

All drawings shall be prepared using AutoCAD Release 2000 or later software. All drawings shall be prepared on A1 metric size drawing sheets, incorporating the Principal’s border and title block.

#  STANDARDS

In particular the transformer shall comply with the requirements of the relevant parts of AS 60076 as further detailed in this Specification. Specific reference is made in this Specification to the Australian and International Standards listed hereunder. In their absence, relevant International Standards together with the requirements of competent authorities having jurisdiction over all or part of the manufacture, installation and operation of the equipment shall be adhered to. Compliance with Standards and Regulations shall include all amendments after the date of tender.

AS 2374.1.2 Power transformers - Minimum Energy Performance Standard (MEPS) requirements for distribution transformers

AS 2700 Colour standards for general purposes

AS 60044.1 Instrument transformers - Current transformers
 (IEC 60044.1 modified)

AS 60076.1 Power transformers - General (IEC 60076.1 modified)

AS 60076.11 Power transformers - Dry Type Transformers

AS 62271.202 High voltage switchgear and controlgear - High voltage/low voltage prefabricated substation

AS/NZS 60076.3 Power transformers - Insulation levels, dielectric tests and external clearances in air (IEC 60076.3 modified)

AS/NZS 60076.10 Power transformers - Determination of sound levels

 (IEC 60076.10 modified)

AS/NZS ISO 9001 Quality Management Systems - Requirements

EN 50181 Plug in type bushings above 1 kV and up to 52 kV and from 250 A to 2.5 kA - for equipment other than liquid filled transformers

IEC 60815 Guide for the selection of insulators in respect of polluted conditions

AS 60529 Degree of Protection Provided by Enclosures for Electrical Equipment (IP Code)

IEEE std C57-110 Recommended Practice for establishing transformer capability when supplying non-sinusoidal loads

ISO 9223 Corrosion of metals and alloys - Corrosivity of atmospheres -Classification, determination and estimation

AS/NZS 2312 Guide to the Protection of Iron and Steel Against Exterior Atmosphere Corrosion

AS/NZS 3750 Paints for Steel Structures

#  QUALITY ASSURANCE

The prefabricated substation shall be manufactured under a Quality System certified by an Accredited Authority in accordance with AS/NZS ISO 9001 or an approved equivalent.

#  SAFETY REQUIREMENTS – ELECTRICAL WORK

All electrical work shall be performed by appropriately qualified and experienced personnel who shall hold a current electrical workers license to perform such work.

#  POWER SUPPLY

The incoming electrical supply voltage and other electrical supply conditions shall be as specified in the Annexure.

#  TRANSFORMER LOAD

The transformer load shall be as detailed in the Annexure.

#  AMBIENT CONDITIONS

The transformer shall be suitable for both continuous and cyclic full load operation under the following ambient site conditions:

1. Ambient temperature range of -5oC to 50oC,
2. Maximum relative humidity of 90% with periods of heavy condensation.
3. Pollution level in accordance with IEC 60815 as specified in the Annexure

# TYPE OF TRANSFORMER

# The type transformer shall be a cable connected dry type transformer in accordance with AS 60076.11 and as further specified hereunder.

# OPERATING ENVIRONMENT

The transformer shall be suitable for operation in one of the following environments, as specified in the Annexure:

1. Indoors in separate well ventilated transformer room,
2. Outdoors in a kiosk enclosure as per Type Specification DS26.42.

# KIOSK ENCLOSURE

1. The kiosk enclosure shall be provided by the Contractor as part of the Contract.
2. The kiosk enclosure shall comply with requirements of Type Specification DS26.42
3. The Contractor shall ensure that the transformer is designed and built so as to meet the requirements of this Specification when operating in that enclosure.

#  TRANSFORMER FUNCTIONAL REQUIREMENTS

The transformer shall satisfy the following functional requirements:

1. Number of Phases: 3
2. Frequency: 50 Hz
3. Number of Windings: 2
4. Phase to phase voltage:

 (i) Primary - as specified in the Annexure

 (ii) Secondary (No Load) - as specified in the Annexure

1. Connection:

 (i) Primary - delta

 (ii) Secondary - star with star point (i.e. neutral) brought out

1. Vector Group: Group 3
2. H.V. supply Earth Fault Factor: as specified in the Annexure
3. Secondary winding star point to be solidly grounded
4. kVA rating:

For linear loads the transformer nominal 50 Hz, 50oC kVA rating of the transformer shall not be less than the maximum load specified in the Annexure.

For non-linear loads the transformer 50oC kVA rating of the transformer after derating for harmonic currents as determined in accordance with IEEE Std. C57-110 shall not be less than the maximum load specified in the Annexure.

1. Type of load: as specified in the Annexure
2. Type of construction: core type
3. Type of cooling: AN or ANAF as specified in the Annexure
4. Cooling air temperature:

The service conditions shall be determined in accordance with AS 62271.202

1. Temperature limits: maximum winding temperature rise 90OC
2. High Voltage insulation level
	* 1. Lightning Impulse Withstand Voltage: as per AS 60076.11,
		Table 3, column 4, list 2
		2. Short Duration 50 Hz Withstand Voltage:

 as per AS 60076.11, Table 3, column 2

1. Maximum no load sound power level: standard limit as per AS 60076.10 Fig. ZA1
2. Kiosk degree of protection: IP22H as per AS 60529
3. Insulation class: F
4. Losses
	* 1. For transformers with linear loads the transformer efficiency at 50% full load shall be in accordance with the values shown at AS 2374.1.2, Table 2.
		2. Transformer with linear loads shall be of a low loss design with minimum eddy current losses.

(The transformer’s capability when supplying non sinusoidal loads shall be determined in accordance with IEEE Std. C57-110.)

1. Impedance: as detailed in the Annexure.
2. Voltage Tappings

(i) Range: +5%

(ii) Step Size: 2.5%

(iii) Tapped Winding: primary

# MISCELLANEOUS FITTINGS

The transformer shall be provided with the following miscellaneous fittings:

(a) EN 50181 Type C standard profile primary winding connection bushings in an enclosed cable box, suitable for use with fully screened dead break elbow High Voltage cable terminations and surge arresters. The High Voltage winding break-in bushings shall not be imbedded directly into the High Voltage coil resin, but will be installed in a cable box. That will prevent the surface of the High Voltage terminals being charged to high potential and the resulting electrical stress leading to corona discharges between the bushing and the cable elbow surfaces.

(b) Air insulated secondary winding connection bushings in an enclosed cable box suitable for terminating the transformer output cabling specified in the Annexure.

(c) The above secondary connections cable box shall include a protection class 5P10 current transformer measuring the current into the transformer secondary winding star point. This current transformer shall have a 1 amp rated secondary current and shall be as further detailed in the Annexure.

(d) If specified in the Annexure as being required, a 15 Amp HRC fuse, wiring and terminals providing a 240 VAC power supply for a capacitive circuit breaker tripping supply unit located with the associated incoming High Voltage supply circuit breaker (applies only to transformers with the secondary no load voltage of 433 Volts)

(e) Six PT 100 resistance temperature sensors, one per each primary and secondary winding phase for monitoring winding temperatures. The sensors shall be imbedded into the transformer windings to monitor winding hot spot temperatures and wired to a dedicated marshaling box.

(f) A temperature monitoring and control unit providing:

 (i) on-off control contacts for the transformer cooling fan if transformer cooling is ANAF,

 (ii) a 4/20 mA signal proportional for transformer temperature, if specified as required in the Annexure,

 (iii) over temperature warning contacts

 (iv) over temperature trip contacts

(g) An earthed screen between the primary and secondary windings, if the type of load is specified in the Annexure as non-linear,

(h) Earthing connection for transformer frame,

(i) Lifting lugs,

(j) Rating, connection diagram and terminal marking stainless steel plates

(k) Skid type base, suitable for direct bolting onto the base of the kiosk enclosure if the transformer is to be supplied in a kiosk enclosure, otherwise suitable for bolting down onto a concrete block foundation.

(l) The surge arresters specified in the Annexure are to be installed in the immediate vicinity of the transformer HV terminals. The surge arresters shall be connected directly to the transformer earth. In this way the transformer will undergo the overvoltage limited by the surge arrester.

 The number of discharges shall be tracked using a discharge counter, installed with the surge arrester’s earth connection.

#  CONSTRUCTION REQUIREMENTS

## General

The core, windings, framework, clamping arrangements and general structure of the transformers, when assembled, shall form a rigid construction which shall minimise vibration and noise, and shall be unaffected by normal use, short circuit conditions or handling during transport, installation or inspection.

The transformer windings shall be epoxy cast coil hermetically sealed in epoxy with reinforced multi-directional glass fiber. The reinforced glass fiber shall ensure mechanical strength in both radial and axial directions for short circuit withstand capability and to avoid the possibility of cracking caused by mechanical stresses due to temperature variations or sudden load peaks.

## Climatic Class

The transformer shall have a climatic class rating of Class C1 in accordance with AS 60076.11.

## Environmental Class

The transformer shall have an environmental class rating of Class E1 in accordance with AS 60076.11.

## Fire Behaviour Class

The transformer shall have fire behaviour class rating of Class F1 in accordance with AS 60076.11**.**

## Cores

1. The cores shall be constructed of high grade, cold rolled grain orientated silicon steel coated with temperature resistant inorganic insulation. The structure shall be formed into legs which are interconnected to the yokes with mitred joints. The active parts of the core shall be insulated from the structural support except for the earthing straps and any bolts passing through the core shall be fully insulated from it. The assembled core shall be protected against environmental contamination with two coats of high temperature insulating varnish.
2. The cores shall be so designed and constructed as to ensure that excessive temperatures do not occur at the centres of the cores.

## Protective Coatings on Exposed Steel Surfaces

1. All exposed steel surfaces shall be protected by the application of a painting system in accordance with AS/NZS 2312.
2. All paints comprising the paint system shall be from the same manufacturer. The paint coating shall be rated as providing medium term protection in tropical, industrial, marine and severe marine environments in accordance with ISO 9223.
3. The colour of the top coat paint applied to external surfaces shall be a standard colour in accordance with AS 2700, as specified in the Annexure.

# SHIELD ON PRIMARY WINDING HVCONNECTORS

(a) An appropriate bolt on shield shall be provided on the transformer to prevent removal of the primary winding High Voltage cable dead break elbow and surge arrester connectors unless the shield is removed first.

(b) The above shield shall be padlockable, or shall be interlockable with the associated High Voltage switchgear, so as to prevent removal of the shield unless the transformer is isolated from all possible sources of electrical supply.

(c) An aluminium label engraved as hereunder shall be fitted to the above shield.

**Caution**

**Dead break connectors**

**Do not connect or disconnect live**

#  TESTING

## Type Tests

Evidence shall be submitted on delivery indicating that all type tests required by relevant parts of AS 60076 have been carried out successfully on the transformer or on a transformer of an identical design.

## Type Tests on Transformer in Kiosk Enclosure

In addition to the above, if the transformer is to be provided in a kiosk enclosure, evidence shall be submitted on delivery indicating that the type tests listed hereunder have been carried out successfully in accordance with the requirements of AS 62271.202 on the transformer/enclosure combination, or on a transformer/enclosure of an identical design

(a) Temperature rise tests

(b) Sound level tests

## Routine Tests

1. The transformer shall undergo routine testing in accordance with the relevant parts of AS 60076.
2. In addition to the above, evidence shall be submitted on delivery indicating that the transformer provided in a kiosk enclosure passed successfully the routine tests and verifications stated in section 7 ‘Routine Tests’ of AS 62271.202 on the transformer/enclosure arrangement
3. The partial discharge measurement specified in AS60075.11 shall be carried out after completion of all dielectric tests.

The maximum level of partial discharges shall be 10 pC.

Partial discharge refers to a localised electrical discharge that is restricted to only a portion of a dielectric material and therefore, does not completely bridge the gap between electrodes. Dry-type transformers are especially sensitive to partial discharges often resulting in irreversible degradation and destruction of the insulation. This process leads to turn to turn insulation or HV to ground insulation breakdown.

The routine test certificate shall show all individual partial discharge measurements at 2sec intervals for the whole voltage application period.
4. The Contractor shall supply one copy of the routine test certificate on delivery of the transformer.

## Short Circuit Test

The AS/NZS 60076.5, Ability to Withstand Short Circuit, identifies the requirements for transformers to sustain without damage the effects of overcurrents originated by external short circuit.

The transformer manufacturer shall submit:

* a short circuit withstand capability test certificate of the proposed transformer design, or
* the theoretical evaluation of the ability of a power transformer to withstand the dynamic effects of short circuit and the thermal ability of a transformer. The documentation needed for the purpose includes all necessary technical data, such as electromagnetic design data sheets, calculations od short circuit currents, electromagnetic forces and mechanical stresses, supplemented by drawings, material specifications, manufacturing practices and process instructions, etc., either produced for the specific purpose of the electromagnetic and mechanical design of the transformer or as part of the manufacturer’s technology documentation.

## Test Certificates

All test certificates shall describe the tests carried out and the test results obtained.

#  LIQUIDATED DAMAGES FOR EXCESS LOSSES

In addition to any liquidated damages specified in the General Conditions of Contract, the Contractor shall be liable to the Principal for liquidated damages in respect to cost of the amount of transformer total losses in excess of the value quoted previously by the Contractor in the Tender Technical Response Schedule.

Such liquidated damages shall be calculated on the basis of the capitalised cost of losses quoted in the Annexure.

#  INSTALLATION ON SITE

1. The Contractor shall deliver the transformer to the site.
2. The Contractor shall uncrate and assemble the equipment if necessary.
3. The Contractor shall position the transformer mechanically in the appropriate position.

#  POST INSTALLATION REQUIREMENTS

## Final Inspection

Before final testing and commissioning of the transformer takes place, the Contractor shall undertake an inspection to verify that the transformer is undamaged, and that the mechanical and electrical installation is correct.

## Final Testing and Commissioning

The Contractor shall carry out the following tests after Final Inspection has been completed:

1. Insulation Resistance Check
2. Voltage Ratio Check

Once Final Inspection and Final testing has been completed, the Contractor shall commission the transformer in conjunction with the Principal’s electrical staff.

## As-Constructed Drawings

1. The Contractor shall provide As-Constructed information on all drawings.
2. As-Constructed drawings shall be provided in an electronic form together with A3 size hard copies.

## Manuals

The Contractor shall supply 3 copies of comprehensive instruction manuals, written in English and covering the complete operation and maintenance requirements of all equipment supplied under the Contract. The manuals shall be printed on high grade A4 size paper and shall be bound in a high grade A4 size loose leaf binder.

Information included in the manuals shall include:

1. operating instructions;
2. safety instructions and warnings;
3. maintenance instructions and schedules;
4. recommended spare parts and special tool list;
5. as constructed drawings;
6. detailed equipment performance specifications and;
7. test reports and test certificates.

 **Annexure to Specification**

**for**

**Cable Connected Dry Type Transformer**

**Project:**

**Site Location:**

**Work to be done by the Principal:**

**Capitalised Cost of Losses:** $/kW

**Special Service Conditions:**

 Pollution level in accordance with IEC 60815:

 Summer time average shade ambient temperature: oC

 Winter time average shade ambient temperature oC

**Operating Environment:**

(ie indoors or outdoors )…………………………………………

**H.V. Electrical Supply Conditions:**

 Highest Voltage for Equipment Um: kV

 System Fault Level: MVA

 Earth Fault Factor

**Transformer Load:**

 Type of Load (i.e. linear or non-linear):

 Maximum load:……………………………………………………… kVA

**Annexure to Specification**

**for**

**Cable Connected Dry Type Transformer**

**Transformer Rated Characteristics**

 Primary winding phase to phase voltage…………………………………………………………………kV

 Secondary winding phase to phase no load voltage ……………………………………………………..kV

 Tertiary winding phase to phase no load voltage ………………………………………………………..kV

 Impedance primary to secondary winding at …….. kVA ………………………………………………..%

Impedance primary to tertiary winding at …….. kVA …………………………………………………………….%

Impedance secondary to tertiary winding at …….. kVA ………………………………………………………….%

**Secondary Star Point Current Transformer**

Rated primary current ……………………………………………………………………………..….Amps

 Rated burden…………………………………………………………………………………………….VA

**Cooling**

 Type of cooling (i.e. AN or ANAF)……………………………………………………………………..…

**Winding Temperature Monitoring and Control Unit**

4/20 mA temperature signal (required or not)……………………………………………………………...

 Warning contracts ……………………………………………………………………………………….…

 Trip contracts ………………………………………………………………………………………………

 Number of PT100 temperature sensors and their location ………………………………………………...

 ………………………………………………………………………………………………………………

**Primary Cables**

Cable type …………………………………………………………………………………………………..

 Cable rated voltage……………………………………………………………………………………….kV

 Cable conductor size……………………………………………………………………………………mm2

 Number of cables per phase………………………………………………………………………………...

 Number of cables for neutral (if applicable) …………………………………………………………........

 Surge Diverters (Required or not required) ……………… ………………………………………………

 If required Type of Surge Diverter per phase ……………………… …………………..…………….

**Secondary Cables**

Cable type …………………………………………………………………………………………………..

 Cable rated voltage……………………………………………………………………………………….kV

 Cable conductor size……………………………………………………………………………………mm2

 Number of cables per phase…………………………………………………………………………………

 Number of cables for neutral (if applicable) ……………………………………………………………….

 Surge Diverters (Required or not required) ……………… ………………………………………………

 If required Type of Surge Diverter per phase ……………………… …………………..…………….

**Tertiary Cables**

Cable type …………………………………………………………………………………………………..

 Cable rated voltage……………………………………………………………………………………….kV

 Cable conductor size……………………………………………………………………………………mm2

 Number of cables per phase…………………………………………………………………………………

**L.V. Feed to H.V. Circuit Breaker Capacitive Trip Supply**(only required if transformer has 415 volt nominal secondary voltage and the H.V. switchboard does not have battery powered trip supply)

 L.V. trip supply feed (required or not) …………………………………………………………………

**Protective Coatings on Exposed Surfaces**

 Colour of top coat paint in accordance with AS 2700………………………………………………….

|  |
| --- |
| **Type Specification for Cable Connected Dry Type Transformer****Tender Technical Response Schedule** |
| **Clause No.** | **Subject** | **Noted** | **Compliance** | **Comments** |
|  |  |  | **Yes** | **No** |  |
| **1** | **General** |  |  |  |  |
| **2** | **Site** |  |  |  |  |
| **3** | **Operating Mode** |  |  |  |  |
| **4** | **Work by the Principal** |  |  |  |  |
| **5** | **Information from Contractor** |  |  |  |  |
| **6** | **Contractor’s Drawings** |  |  |  |  |
| **7** | **Standards** |  |  |  |  |
| **8** | **Quality Assurance** |  |  |  |  |
| **9** | **Safety Requirements – Electrical Work** |  |  |  |   |
| **10** | **Power Supply** |  |  |  |   |
| **11** | **Transformer Load** |  |  |  |   |
| **12** | **Ambient Conditions** |  |  |  |  |
| **13** | **Type of Transformer** |  |  |  |  |
| **14** | **Operating Environment** |  |  |  |  |
| **15** | **Kiosk Enclosure** |  |  |  |  |
| **16** | **Transformer Functional Requirements** |  |  |  |   |
| 16(a) | Number of phases |  |  |  |  |
| 16(b) | Frequency |  |  |  |  |
| 16(c) | Number of windings |  |  |  |  |
| 16(d) | Primary phase to phase voltage |  |  |  |  |
|  | Secondary no load phase to phase voltage |  |  |  |  |
| 16(e) | Primary connection |  |  |  |  |
|  | Secondary connection |  |  |  |  |
| 16(f) | Vector group |  |  |  | Vector group = |
| 16(g) | H.V. Earth Fault Factor |  |  |  |  |
| 16(h) | Secondary winding star point to be grounded |  |  |  |  |
| 16(i) | kVA rating |  |  |  | 50 deg. C rated kVA = |
|  |  |  |  |  | On site kVA rated kVA = |
| 16(j) | Type of load |  |  |  |  |
| 16(k) | Type of construction  |  |  |  |  |
| 16(l) | Type of cooling |  |  |  | Cooling type = |
| 16(m) | Cooling air temperature |  |  |  |  |
| 16(n) | Maximum winding temperature rise |  |  |  | FLV winding temperature rise deg. C = |
| 16(o) | Lightning impulse withstand voltage |  |  |  | LIWV kVp = |
|  | Short duration 50 Hz withstand voltage |  |  |  | ACSD WV kVrms = |

|  |
| --- |
| **Type Specification for Cable Connected Dry Type Transformer****Tender Technical Response Schedule** |
| **Clause No.** | **Subject** | **Noted** | **Compliance** | **Comments** |
|  |  |  | **Yes** | **No** |  |
| 16(p) | Maximum No Load Sound Power Level |  |  |  | No load sound power dBA = |
| 16(q) | Kiosk degree of Protection |  |  |  | IP rating = |
| 16(r) | Insulation class F |  |  |  |  |
| 16(s) | Losses |  |  |  | 50% load efficiency % = |
|  | MEPS losses limits |  |  |  |  |
| 16(t) | Impedance primary/secondary winding |  |  |  | Impedance % = …… at ……kVA |
|  | Impedance primary/tertiary winding |  |  |  | Impedance % = …… at ……kVA |
|  | Impedance secondarty/tertiary winding |  |  |  | Impedance % = …… at ……kVA |
| 16(u) | Voltage Tappings |  |  |  | Range % = |
|  |  |  |  |  | Step size % = |
|  |  |  |  |  | Tapped winding = |
| **17.** | **Miscellaneous Fittings** |  |  |  |  |
| 17(a) | Primary dead break elbow and surge arrester cable terminations |  |  |  |  |
| 17(b) | Secondary cable terminations |  |  |  |  |
| 17(c) | Secondary winding star point CT |  |  |  |  |
| 17(d) | 240 VAC supply to capacitive trip supply unit |  |  |  |  |
| 17(e) | Six PT 100 resistance temperature sensors |  |  |  |  |
| 17(f) | Temperature monitoring and control unit with: |  |  |  |  |
|  |  alarm contacts |  |  |  | Alarm temperature deg C = |
|  |  trip contacts |  |  |  | Trip temperature deg C = |
| 17(g) | Earthed screen |  |  |  |  |
| 17(h) | Earthing connection |  |  |  |  |
| 17(i) | Lifting Lugs |  |  |  |  |
| 17(j) | Stainless steel rating, connection and terminal marking plates |  |  |  |  |
| 17(k) | Skid base |  |  |  |  |
| 17(l) | Surge arresters and counters |  |  |  | Type = |
| **18.** | **Construction Requirements** |  |  |  |  |
| 18.1 | General |  |  |  |  |
| 18.2 | Climatic class |  |  |  | Offer C = |
| 18.3 | Environmental class |  |  |  | Offer E = |
| 18.4 | Fire behaviour class |  |  |  | Offer F = |
| 18.5 | Cores |  |  |  |  |
| 18.6 | Protective coatings on exposed steel surfaces |  |  |  |  |
| **19.** | Shield on Primary Winding H.V. Connectors |  |  |  |  |
| **20.** | Testing |  |  |  |  |
| 20.1 | Type Testing |  |  |  |  |
| 20.2 | Type Tests on Transformers in Kiosk Enclosure |  |  |  |  |
| 20.3 | Routine Tests |  |  |  |  |
| 20.4 | Short Circuit Test |  |  |  | Test certificate or theoretical evaluation attached =  |
| 20.5 | Test Certificates |  |  |  |  |
| 21. | Liquidated Damages for Excess Losses |  |  |  |  |
| 22. | Installation at Site |  |  |  |  |
| 23. | Post Installation Requirements |  |  |  |  |
| 23.1 | Final Inspection |  |  |  |  |
| 23.2 | Final Commissioning and Testing |  |  |  |  |
| 23.3 | As Constructed Drawings |  |  |  |  |
| 23.4 | Manuals |  |  |  |  |

END OF DOCUMENT