International Association of Oil & Gas Producers

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Supplementary Specification to IEC 60076-1 Power Transformers – Part 1: General

JIP33
JOINT INDUSTRY PROGRAMME

Revision history

VERSION	DATE	PURPOSE
0.1	November 2019	Issued for Public Review

Acknowledgements

This IOGP Specification was prepared by a Joint Industry Project 33 Standardization of Equipment Specifications for Procurement organized by IOGP with support by the World Economic Forum (WEF).

Foreword

This specification was prepared under Joint Industry Programme 33 (JIP33) "Standardization of Equipment Specifications for Procurement" organized by the International Oil & Gas Producers Association (IOGP) with the support from the World Economic Forum (WEF). Companies from the IOGP membership participated in developing this specification to leverage and improve industry level standardization for projects globally in the oil and gas sector. The work has developed a minimized set of supplementary requirements for procurement, with life cycle cost in mind, resulting in a common and jointly approved specification, building on recognized industry and/or international standards.

Recent trends in oil and gas projects have demonstrated substantial budget and schedule overruns. The Oil and Gas Community within the World Economic Forum (WEF) has implemented a Capital Project Complexity (CPC) initiative which seeks to drive a structural reduction in upstream project costs with a focus on industry-wide, non-competitive collaboration and standardization. The CPC vision is to standardize specifications for global procurement for equipment and packages, facilitating improved standardization of major projects across the globe. JIP33 provides the oil and gas sector with the opportunity to move from internally to externally focused standardization initiatives and provide step change benefits in the sector's capital projects performance.

This specification has been developed in consultation with a broad user and supplier base to realize benefits from standardization and achieve significant project and schedule cost reductions.

The JIP33 work groups performed their activities in accordance with IOGP's Competition Law Guidelines (November 2014).

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Introduction

The purpose of this specification is to define a minimum common set of specification requirements for the procurement of transformers in accordance with IEC 60076-1, Edition 3, 2011-04 for application in the petroleum and natural gas industries.

This JIP33 standardized procurement specification follows a common document structure comprising the four documents as shown below, which together with the purchase order define the overall technical specification for procurement.

JIP33 Specification for Procurement Documents
Supplementary Technical Specification

It is required to use all of these documents in conjunction with each other when applying this specification, as follows.

S-720: Specification for Transformers

This specification is written as an overlay to IEC 60076-1, following the clause structure of the parent standard, to assist in cross-referencing the requirements. Where clauses from the parent standard IEC 60076-1 are not covered in this specification, there are no supplementary requirements or modifications to the respective clause. The terminology used within this specification follows that of the parent standard and otherwise is in accordance with ISO/IEC Directives, Part 2.

Modifications to the parent standard defined in this specification are identified as *Add* (add to clause or add new clause), *Replace* (part of or entire clause) or *Delete*.

S-720D: Data Sheet for Transformers

This document provides project specific requirements where this specification requires the purchaser to define an application specific requirement. It also includes information required by the purchaser for technical evaluation. Additional purchaser supplied documents are also listed in the data sheet, to define scope and technical requirements for enquiry and purchase of the equipment.

S-720L: Information Requirements for Transformers

This document defines the information requirements, including format, timing and purpose, for information to be provided by the vendor. It also defines the specific conditions which must be met for conditional information requirements to become mandatory. The information requirements listed in the IRS have references to the source of the requirement.

S-720Q: Quality Requirements for Transformers

This document includes a conformity assessment system (CAS) which specifies standardized user interventions against quality management activities at four different levels. The applicable CAS level is specified by the purchaser in the data sheet.

The data sheet and IRS are published as editable documents for the purchaser to specify application specific requirements. The supplementary specification and QRS are fixed documents.

Unless defined otherwise in the purchase order, the order of precedence (highest authority listed first) of the documents shall be:

a) regulatory requirements;

b) contract documentation (e.g. purchase order);

c) purchaser defined requirements (data sheet, IRS, QRS);

d) this specification;

e) the parent standard.

2 Normative references

Add to clause

IEC 60034-1	Rotating Electrical Machines (Part 1: Rating and Performance)
IEC 60076-20	Power transformers - Part 20: Energy efficiency
IEC 60076-6	Power transformers - Part 6: Reactors
IEC 60079 (all parts)	Explosive atmospheres
IEC 60099-1	Surge arresters – Part 1: Non-linear resistor type gapped surge arresters for a.c. systems
IEC 61099	Insulating liquids – Specifications for unused synthetic organic esters for electrical purposes
IEC 61378-1	Converter transformers-Part 1: Transformers for industrial applications
IEC 61869-2	Instrument transformers – Part1: Current transformers
IEC 62535	Insulating Liquids - Test method for detection of potentially corrosive sulfur in used and unused insulating oil
IEC TS 60076-20	Power transformer - Part 20: Energy efficiency

4 Service conditions

4.1 General

Add to first paragraph

The installation environment shall comply with IEC 60076-1, IEC 60076-11 and as specified in the data sheet.

Add to subclause

Transformers shall have a design lifetime of at least 25 years, when delivering rated output under the service conditions specified.

Transformers shall be suitable for continuous operation at full load for at least 40 000 hours without maintenance requiring the transformer to be de-energized.

In case of dry type transformers, insulating materials in the range Class B to H, inclusively, may be used in accordance with the temperature rises stated in IEC 60076-11.

4.2 Normal service conditions

Replace fourth paragraph of list item f) with

f) Environmental conditions within the following definitions according to IEC 60721-3-4:2019:

- climatic conditions (K);
- special climatic conditions (Z);
- biological conditions (B);
- chemically active substances (C);

– mechanically active substances (S);
– mechanical conditions (M).

Add new list item g)

g) Transformers and reactors located in hazardous area shall comply with the requirements of the relevant parts of IEC 60079. ATEX certificate shall be applicable in EU and IECEx certificate shall be applicable outside the EU.

Add new list item h)

h) Climatic, environmental and fire behavior classes for dry type transformers shall be specified in Clause 12 of IEC 60076-11.

Add new list item i)

i) Seismic class of transformers and reactors shall comply with IEC 60721-2-6.

Add new list item j)

j) Corrosion class shall be C5 for onshore locations and Cx for offshore locations as per ISO 12944-2.

Add new list item k)

k) Normal service conditions for converter transformers shall comply with 4.2 of IEC 61378-1.

Add new list item i)

i) Unusual service conditions for converter transformers shall comply with 4.3 of IEC 61378-1.

5 Rating and general requirements

5.1 Rated power

5.1.1 General

Add to subclause

Transformer feeding a group of motors shall be capable of withstanding infrequent restarting loads of up to 1.8 times the rated current of the transformer and shall allow five such restarts in succession at five second intervals.

Motor unit transformers supplying individual motors shall be able to withstand three successive motor starts and a further two successive starts after a cooling-off period of half an hour.

All transformers shall comply with level 2 of the energy efficiency requirements of IEC 60076-20.

Ratings for converter transformers shall comply with Clause 5 of IEC 61378-1.

5.1.3 Minimum power under alternative cooling modes

Add to subclause

5.2.2 of IEC 60076-11 shall apply in case of dry type transformers for rated power with cooling fans or heat exchangers.

5.2 Cooling mode

Add to subclause

Cooling methods for oil immersed reactors shall be as per Clause 4 of IEC 60076-2.

Cooling methods for dry type transformers and reactors shall be as per 5.8 of IEC 60076-11.

If specified on the data sheet, the provision for mounting of cooling fans in future without hot work shall be provided to allow a minimum increase in rating by 25 % (ONAF).

5.4 Rated voltage and rated frequency

5.4.3 Operation at higher than rated voltage and/or at other than rated frequency

Add to subclause

The transformer shall be capable of continuous operation at full load with the following system supply voltage and frequency variations:

1) Voltage: ± 5 %;
2) Frequency: ±2 %.

5.5 Provision for unusual service conditions

Add to subclause

Unusual service conditions shall be specified in the data sheet.

5.7 Additional information required for enquiry

5.7.2 Winding connection and number of phases

Add to subclause

Dry type transformers shall have either cast resin encapsulated windings, cast resin non-encapsulated windings or vacuum pressure encapsulated windings as specified in the data sheet.

Preferred connections for dry type transformers shall be as per Clause 7 of IEC 60076-11.

5.7.3 Sound level

Add to subclause

Measurement of acoustic sound level (type test, special test) for reactors shall be done as per 7.8.12 of IEC 60076-6.

Compliance with the noise limits shall be achieved by methods other than the provision of sound attenuation enclosures.

The manufacturer/supplier shall submit with their quotation the maximum sound pressure level of the transformer with forced cooling in operation.

5.7.4 Transport

5.7.4.1 Transport limitation

Add new subclause

5.7.4.1.1 Mechanical handling

Unless specified otherwise on data sheets, transformers and reactors shall be designed for skid movement in any direction without use of rollers, plates, or rails.

Centre of gravity shall be marked on the general arrangement drawings.

Lifting and jacking points shall be:

1) mounted on tanks, enclosures, or frames;
2) arranged to prevent damaging stresses during lifting and jacking operations.

If spreader bars are required for lifting all or part of the tank, an informational plate shall be mounted on tank.

Location of lifting and jacking points shall be identified on the general arrangement drawing and marked on the tank, enclosure, or frame.

Add new subclause

5.7.4.1.2 Transport

Transformers, and associated cooling equipment when transported separately, shall each be provided with lifting lugs to facilitate transport to, and assembly at, site. If lifting lugs are fitted on the tank walls, additional lugs on the tank covers shall be provided for lifting the cover, if removable.

Transformers with an assembled mass of more than 2 000 kg shall be provided with jacking pads.

Transport blocks, binding, etc. shall be clearly marked such that their removal is ensured. Special precautions that need to be observed in removal of shipping restraints shall be clearly marked on shipping container or crate.

Components with moving parts that could be damaged in shipment shall be securely blocked and braced to prevent damage.

The transformer shall be designed such that the transformer, complete with oil if applicable, can be moved on rollers in any direction without damage.

The transformers and their radiators, if transported separately, shall be inerted in nitrogen or with dry air. They shall be equipped with devices enabling their internal pressure to be measured.

Appropriate protection against mechanical damage and the effects of corrosion shall be applied for transportation and throughout storage on site.

Any openings shall be protected by metal covers in order to prevent damage during transportation.

5.7.4.2 Transport acceleration

Add before NOTE

The requirement of impact recorders shall be specified in the data sheet.

5.8 Components and materials

Add to subclause

Insulating liquids shall comply with IEC 61099 for synthetic organic esters, IEC 60836 for silicon oil or as agreed for other liquids.

The transformer oil shall be non-corrosive on the basis of tests in accordance with IEC 62535.

Insulating liquid shall comply with the following:

a) The manufacturer/supplier shall stipulate in the quotation the characteristics of the liquid proposed.
b) the liquid shall not contain, nor be contaminated with, polychlorinated biphenyls (PCBs).

The requirement of additional inhibitors in the oil shall be specified in the data sheet.

6 Requirements for transformers having a tapped winding

6.1 General - Notation of tapping range

Add to subclause

Tappings for dry type transformers shall be provided as per Clause 6 of IEC 60076-11.

6.3 Tapping power. Full-power tappings - reduced-power tappings

Replace second paragraph with

All tappings shall be full-power tappings, that is, the rated tapping current at each tapping shall be the rated power divided by the rated tapping voltage at each tap.

Delete third to sixth paragraphs

6.4 Specification of tappings in enquiry and order

6.4.1 General

Delete third paragraph

6.4.2 Constructional specification

Delete list item c)

Delete list item d)

Add to subclause

On-load tap-changers for converter transformers shall comply with 5.8 of IEC 61378-1.

6.4.3 Functional specification

Delete list item f)

6.6 Load loss and temperature rise

Add to list item b)

Temperature rise tests for converter transformers shall comply with 7.6 of IEC 61378-1.

7 Connection phase displacement symbols

7.1 Connection and phase displacement symbols for three-phase transformers and for single phase transformers connected in a three phase bank

7.1.1 Connection symbol

Add to subclause

Phase displacement and terminal identification for converter transformers shall comply with 5.5 of IEC 61378-1.

Converter transformers with loaded tertiary windings shall comply with 5.7 of IEC 61378-1.

8 Rating plates

8.1 General

Add to first paragraph

The rating plate shall be permanently fixed to a readily accessible and non-removable part of the transformer.

Add to subclause

The nameplate shall be of stainless steel with engraved text and markings.

The rating plate for converter transformer shall comply with 5.6 of IEC 61378-1.

8.2 Information to be given in all cases

Add new list item q)

q) The supplier's purchase order number shall be stated on the rating plate.

8.3 Additional information to be given when applicable

Add new list item l)

l) Tank design pressure shall be indicated in case of sealed type transformers with gas cushion.

9 Safety, environmental and other requirements

9.1 Safety and environmental requirements

9.1.1 Liquid leaks

Add to second paragraph

Gasket material shall be durable type such as neoprene/nitrile rubber with bonded cork or equivalent.

Add to subclause

All material, including gaskets and sealant, shall be free from asbestos, mercury, ceramic fibre and chlorofluorocarbons.

9.1.2 Safety considerations

Add to NOTE

The requirement of ladder for access shall be specified in the data sheet.

9.2 Dimensioning of neutral connection

Add to subclause

The low voltage neutral terminal of polyphase liquid immersed distribution transformers shall be rated to carry not less than 50 % of the phase current unless stated otherwise in the data sheet.

The low voltage neutral terminal of dry type transformers shall be capable of carrying full rated phase current.

9.3 Liquid preservation system

Add to second paragraph

Desiccant used in the breather shall be non-carcinogenic and regenerative type.

Add to fifth paragraph

Hermetically sealed type transformers shall be limited to 3150 kVA, unless approved by principal.

Add to subclause

Pressure gauge suitable for measuring design variations in pressure shall be provided for sealed type transformers with gas cushion.

Add new subclause heading

9.6 Construction requirements

Add new subclause heading

9.6.1 General

Add new subclause

9.6.1.1

The tank and radiator material shall be made of steel with surface treatment provided as per the category of corrosivity specified in the data sheet.

The durability of the protective paint system shall comply with class VH specified in ISO 12944-1.

Add new subclause

9.6.1.2

IOGP specification S-560 for Low voltage switchgear and control gear shall apply for auxiliary wiring and terminals and all local and remote control panels which are part of the transformer package.

Add new subclause

9.6.1.3

Pressure relief devices shall be fitted to liquid immersed transformers if specified in the data sheet. Pressure relief devices shall be:

– provided with a trip contact.
– resetting, rapid acting, relief valve type that has a mechanical operation indicator.
– provided with facility for directing emissions of liquid from the relief device in the direction specified.

Add new subclause

9.6.1.4

Breathers shall be accessible from ground level and protected from mechanical damage.

Add new subclause

9.6.1.5

For outdoor environments, nuts, bolts, studs, and washers shall be stainless steel. Painted surfaces shall be protected by nylon washers placed between the steel washer and the painted surface.

Add new subclause

9.6.1.6

All indicating instruments shall have unrestricted access and shall be easily readable from ground level.

Add new subclause heading

9.6.1.7 Tanks and radiators

Add new subclause

9.6.1.7.1

Liquid immersed transformers and reactors shall be provided with a sampling orifice fitted with a valve to enable condition monitoring of liquid for each independent fluid compartment. Valves shall be provided with a screwed plug. This function may be combined with the draining orifice.

Add new subclause

9.6.1.7.2

All devices fixed to the tank or tank lid of liquid immersed transformers shall be flanged.

Add new subclause

9.6.1.7.3

Devices fixed to the tank of liquid immersed transformers and reactors shall be provided with an isolation valve.

Add new subclause

9.6.1.7.4

Removable radiators shall have isolating valves on tank and radiator sides and vent and drain orifices fitted with screw plugs.

Add new subclause heading

9.6.1.8 Conservators

Add new subclause

9.6.1.8.1

Conservators shall be removable for transport purposes and be provided with:

1) Level indicator.
2) Filling hole with screwed plug.
3) Combined filter and drain valve.
4) Detachable end plate.
5) Lockable isolating valve.
6) Dehydrating breather.
7) Short standpipe to prevent sludge from entering the tank.

Add new subclause

9.6.1.8.2

Liquid level indicator provided on conservator shall be provided with minimum and maximum level markings and shall be readable from ground level.

Add new subclause

9.6.1.8.3

For use in high-humidity areas, a conservator that prevents contact between the oil in the transformer tank and the ambient air should be used, e.g. either the membrane type or multi-compartment type of split conservator.

Add new subclause

9.6.1.8.4

Transformers with conservators shall be provided with a Buchholz relay complete with alarm and trip contacts, an air relief valve, flanges and valves to enable its removal without the need to drain the oil.

Add new subclause

9.6.1.9 Valves

Valves shall be provided with permanently marked position indication for open or closed position.

Add new subclause

9.6.1.10 Cabling connection

Cabling connection shall be installed between all instruments and terminal boxes.

Add new subclause heading

9.6.2 Windings and tappings

Add new subclause

9.6.2.1

Winding connections inside transformer shall be brazed or crimped.

Add new subclause

9.6.2.2

Winding material shall be as specified in the data sheet.

Add new subclause

9.6.3 Core construction

For three-phase transformers, in-line, three-limb cores shall be used.

Add new subclause heading

9.6.4 Earthing

Add new subclause

9.6.4.1

All metal parts of the core, frame, tank and cable boxes and their internal earthing bars or studs shall be interconnected for earthing via the earthing boss provided on the tank.

Add new subclause

9.6.4.2

Two sets of earthing terminals or earthing pads shall be provided on the transformer tank. Terminals or pads shall be suitable for termination of earth strip or earth cable of the size as specified in the data sheet.

Add new subclause heading

9.6.5 Cooling

Add new subclause

9.6.5.1

If forced air cooling is specified, the manufacturer/supplier shall provide the associated control cubicle mounted on the transformer unless stated otherwise in the data sheet.

Add new subclause

9.6.5.2

In case of sealed transformers, corrugated tank walls may be used.

Add new subclause

9.6.5.3

Forced air cooled transformers shall be provided with duty and standby cooling fans.

Add new subclause

9.6.5.4

If forced liquid cooling is specified, the specification and design of the cooling circuit shall be decided by discussion between purchaser and supplier.

Add new subclause

9.6.5.5

Air duct and fan protective covers shall be provided with IP2X protection

Add new subclause heading

9.6.6 Temperature measurement

Add new subclause

9.6.6.1

Facilities should be provided for measuring the top oil temperature by the installation of a tubular pocket at the top of the tank.

Add new subclause

9.6.6.2

The indicator shall be a dial-type calibrated in degrees Celsius.

Add new subclause

9.6.6.3

The indicator shall be fitted with two adjustable setting contacts, for remote alarm and trip purposes

Add new subclause

9.6.6.4

The indicator shall be fitted with a hand-reset pointer to register the highest temperature attained.

Add new subclause

9.6.6.5

Fibre optic temperature measurement for windings shall be provided if specified in the data sheet.

Add new subclause heading

9.6.6.6 Temperature of each winding measurement

Add new subclause

9.6.6.6.1

The temperature of each winding shall be determined by one set of measurements per phase by means of thermistors or PT 100 resistance type temperature detectors.

Add new subclause

9.6.6.6.2

The measuring elements shall be interchangeable.

Add new subclause

9.6.6.6.3

The leads shall be brought out to a terminal box located on the outside of the transformer enclosure.

Add new subclause

9.6.6.6.4

The thermistors shall be of the positive temperature coefficient (PTC) type.

Add new subclause

9.6.6.6.5

The thermistors or resistance elements shall be supplied with the auxiliary equipment necessary to initiate remote alarms/trips via voltage-free changeover contacts.

Add new subclause

9.6.6.6.6

The thermistors or resistance elements shall be designed and located in such a manner as to avoid the transfer of over-voltages to auxiliary or external connections.

Add new subclause

9.6.6.6.7

A minimum two thermistors or resistance elements shall be provided per phase.

Add new subclause heading

9.6.7 Cable connecting boxes

Add new subclause

9.6.7.1

Cable connecting boxes shall be made of steel.

Add new subclause

9.6.7.2

Cable connecting boxes shall be dimensioned to allow termination of the cables specified in the data sheet. Dimensions, creepage distances and clearances shall be suitable for air-insulated connections.

Add new subclause

9.6.7.3

The enclosures shall offer a minimum degree of protection in accordance with IEC 60529 as below:

1) indoor - IP 41;
2) outdoor, onshore - IP 55;
3) offshore - IP 56.

Add new subclause

9.6.7.4

Separate cable connecting boxes shall be provided for the connection of the specified cables to:

a) the HV side of the transformer;
b) the LV side of the transformer;
c) the transformer auxiliary circuits (direct measuring alarm/trip devices, CT secondaries, etc.);
d) the forced cooling installation, if applied;
e) the on-load tap changer, if applied;
f) the neutral connection for transformers with HV secondary voltages;

NOTE List items c) and d) may be combined.

Add new subclause

9.6.7.5

Boxes shall be designed to prevent deterioration or failure due to the accumulation of condensation. If specified in the data sheet, anti-condensation heaters shall be provided with suitable MCB and thermostat.

Add new subclause

9.6.7.6

The cover of all cable boxes shall be secured by means of captive bolts or screws. Bolts and screws shall not be removable without the use of tools.

Add new subclause

9.6.7.7

When specified on the requisition / data sheet, transformers installed outdoors shall include metal canopies installed over all cable connecting boxes. The canopies shall have an overhang of at least 50 mm on all sides. The canopies shall be designed to shed water and protect the boxes from rain and sun. An air space of at least 50 mm above the top cover shall be provided for ventilation.

Add new subclause

9.6.7.8

The following are requirements for main cable connecting boxes:

a) connection boxes for multicore cables shall be of a type which minimizes the cable bending requirements.

b) connection boxes shall allow single-core conductors to be connected straight onto the terminating point without the conductors needing to be bent.

c) gland plates shall be constructed from a non-magnetic material in case of single-core conductors.

d) In case of cable boxes mounted above transformer tank or if two or more parallel conductors are to be connected, straight conductors (e.g. copper bars or flags of adequate dimensions) shall be provided so that each cable conductor can be separately terminated.

e) all connections shall be sized to carry the maximum continuous current and the prospective through-fault currents.

f) test certificates or calculations shall be available for all main cable connecting boxes to confirm their short circuit withstand capability.

g) removable cover access plates shall be provided with handles, or if weighing 25 kg or more, with lifting lugs.

h) easily accessible removable links within the main cable connecting boxes shall be provided for dielectric testing of cables.

Add new subclause heading

9.6.8 Cable terminations

Add new subclause

9.6.8.1

Main cable terminations shall be provided as per the cable types and sizes indicated in the data sheet.

Add new subclause

9.6.8.2

Auxiliary cable terminations shall be provided as below:

1) Undrilled gland plates shall be provided at the bottom of the cable box for all external cables.

2) These gland plates shall be separate from those used for the cabling interconnecting the on-skid auxiliary equipment.

Add new subclause

9.6.8.3

Bushings inside cable boxes shall comply with SPS class c and exposed bushings shall comply with SPS class e as per IEC TS 60815-1 for outdoor transformers.

Add new subclause heading

9.6.9 Cable screen and armour earthing

Add new subclause

9.6.9.1

Copper earthing bars shall be provided for the earthing of protective screen and/or armour inside each cable connecting box for each cable specified.

Add new subclause heading

9.6.10 Terminals

Add new subclause

9.6.10.1

Main terminals shall be provided as below:

1) Terminals and lugs shall be suitable for the cable conductors specified in the data sheet.
2) For LV single core cable terminations, clamping methods shall be used in order to avoid cable alignment problems associated with lugs.
3) All terminals shall be clearly and indelibly marked to identify the phase connections in accordance with the connection diagram on the rating plate.

Add new subclause

9.6.10.2

Auxiliary terminals shall be provided as below:

1) Individual terminals shall be provided for each external cable core.
2) Terminals shall be of the non-loosening wedge type, avoiding the need for cable lugs.
3) The terminals shall be logically arranged, circuit-by-circuit, with adequate barrier shields and spacers in between them.
4) Terminals shall be clearly and indelibly marked in accordance with the transformer auxiliary wiring diagrams.

Add new subclause

9.6.11 Cable supports and clamps

Cable supports and clamps for the main cables shall be provided to within 500 mm of the bottom of the cable boxes. The spacing between supports/clamps for the main cables shall not exceed 500 mm.

Add new subclause

9.6.12 Surge arrestors

If specified in the requisition / data sheet, transformers shall be equipped with suitable surge arrestors, complying with IEC 60099-4. If required, surge arrestors shall be mounted on the transformer terminal box.

Add new subclause heading

9.6.13 Auxiliary wiring

Add new subclause

9.6.13.1

Conductors shall be stranded copper with a cross-section of at least 1.5 mm^2.

Add new subclause

9.6.13.2

All auxiliary wiring and cabling shall be ferruled in accordance with the manufacturer / supplier's wiring diagram.

Add new subclause heading

9.6.14 Electric motors

Add new subclause

9.6.14.1

Motors shall have a minimum degree of protection of IP 55, as defined in IEC 60529.

Add new subclause

9.6.14.2

Motors shall comply with IOGP S-703 for low voltage motors.

Add new subclause heading

9.6.15 Current transformers

Add new subclause

9.6.15.1

If current transformers are included with the transformer, they shall be in accordance with IEC 61869-2.

Add new subclause

9.6.15.2

All secondary terminals of current transformers shall be wired to a terminal block in the transformer auxiliary cable connecting box. The terminals shall be provided with short-circuiting links.

Add new subclause

9.6.15.3

The current transformer for the neutral-earth connection shall be located in a separate terminal box for HV and in the main terminal box for LV. The current transformer shall be located after neutral bifurcation.

Add new subclause

9.6.15.4

Current transformers shall have a minimum rating of 10 VA and an accuracy class 5P10.

Add new subclause heading

9.6.16 Tap changers

Add new subclause

9.6.16.1

Tap changers shall comply with IEC 60214-1 and IEC 60214-2.

Add new subclause heading

9.6.16.2 Off circuit tap-changer

Add new subclause

9.6.16.2.1

Except where an on-load tap changer is specified on the requisition, a manually operated off-circuit tap changer shall be provided and meet the following requirement: the tapping range of ± 5 %.

Add new subclause

9.6.16.2.2

Except where an on-load tap changer is specified on the requisition, a manually operated off-circuit tap changer shall be provided and meet the following requirement: the tapping range in 2.5 % steps.

Add new subclause

9.6.16.2.3

Except where an on-load tap changer is specified on the requisition, a manually operated off-circuit tap changer shall be provided and meet the following requirement: the operating handle shall be metal and sized to allow operation without tools.

Add new subclause

9.6.16.2.4

Except where an on-load tap changer is specified on the requisition, a manually operated off-circuit tap changer shall be provided and meet the following requirement: The handle shall be located in a directly accessible position and not require the removal of any covers.

Add new subclause

9.6.16.2.5

Except where an on-load tap changer is specified on the requisition, a manually operated off-circuit tap changer shall be provided and meet the following requirement: One handle shall operate all phases simultaneously.

Add new subclause

9.6.16.2.6

Except where an on-load tap changer is specified on the requisition, a manually operated off-circuit tap changer shall be provided and meet the following requirement: Off-circuit tap changer for dry type transformers shall be provided with bolted links.

Add new subclause heading

9.6.16.3 On-load tap changer

Add new subclause

9.6.16.3.1

The switching medium for tap changing shall be specified in the data sheet.

Add new subclause

9.6.16.3.2

The tap changer shall be a polyphase unit with a single drive mechanism.

Add new subclause

9.6.16.3.3

The insulation level and short circuit rating shall not be less than that of the winding to which the tap changer is connected.

Add new subclause

9.6.16.3.4

The diverter switch oil compartment shall be connected to a separate conservator or segregated section of the main conservator of the transformer.

Add new subclause

9.6.16.3.5

The diverter switch oil compartment shall be provided with the following facilities:

a) Oil sampling connection at bottom of compartment.
b) One filling/filter connection valve and one drain/filter connection valve.
c) A dehydrating breather.
d) Liquid-flow controlled relay.

Add new subclause

9.6.16.3.6

The motor drive mechanism shall be supplied with the following features:

a) lockable incoming supply switch.
b) local control facilities.
c) manual operation facilities.
d) Individual fault indications with two sets of common voltage-free changeover contacts.
e) Anti-condensation heater.

Add new subclause heading

9.6.16.3.7 Remote control panel for on-load tap changer.

Add new subclause

9.6.16.3.7.1

The degree of protection shall be IP 41, and IP 2X with its door(s) open.

Add new subclause

9.6.16.3.7.2

The master/follower method of controlling two or more transformers operating in parallel shall be applied.

Add new subclause

9.6.16.3.7.3

a) automatic, solid-state voltage regulator relay with adjustable set point, selectable time characteristics, and under voltage and overcurrent blocking.

b) manual control facilities.

c) tap position indicator.

d) "Tap change in progress" indicating lamp (white).

e) "Tap changer fault" indicating lamp (red).

f) anti-condensation heater.

Add new subclause heading

9.6.17 Surface preparation, galvanizing and finishing

Add new subclause

9.6.17.1

The paint system applied shall provide adequate protection against the adverse effects of the climate specified in 4.2 f). Proposed coating shall be suitable for the corrosion class specified in the data sheet.

Add new subclause

9.6.17.2

The finish of internal walls of tank, covers, connecting boxes and cooling systems shall effectively protect against the effects of corrosion and the influence of the oil or synthetic liquid used in the transformer.

Add new subclause

9.6.18 Markings

Transformers and their accessories shall be clearly marked to facilitate assembly and erection at site.

Add new subclause

9.7 Additional requirements for sealed transformers

The tank cover shall be welded to the tank with a continuous weld.

10 Tolerances

Add to second paragraph

For reactors, the allowable tolerances shall be as per relevant clauses of IEC 60076-6

Add to subclause

Total cost of ownership calculation as per IEC 60076-20 incorporating the guaranteed no-load and load losses shall be submitted by vendor if specified in the requisition.

11 Tests

11.1 General requirements for routine, type and special tests

11.1.1 General

Add to subclause

Converter transformer testing shall comply with Clause 7 of IEC 61378-1.

11.1.2 Routine tests

11.1.2.1 Routine tests for all transformers

Add new list item k)

k) 14.2 of IEC 60076-11 shall apply for routine tests in case of dry type transformers.

Add new list item l)

l) 7.8.2 of IEC 60076-6 shall apply in case of reactors for routine tests.

Add new list item m)

m) Measurement of dissipation factor (tan δ) of the insulation system capacitances.

Add new list item n)

n) Measurement of d.c. insulation resistance each winding to earth and between windings.

Add new list item o)

o) Measurement of dissolved gasses in dielectric liquid.

Add new list item p)

p) Functional tests on auxiliary circuits, if any.

Add new list item q)

q) Routine tests shall include visual and functional check of various transformer components and accessories as applicable such as:

1) Conservators.
2) Tanks.
3) Radiators.
4) Valves.
5) Cooling provisions.
6) Earthing provisions.
7) Cable boxes and cable terminations.
8) Tap changers.
9) Current transformers.
10) Remote tap changer cabinet.

11.1.3 Type tests

Add new list item f)

f) 14.3 of IEC 60076-11 shall apply in case of type tests for dry type transformers and 7.8.3 of IEC 60076-6 shall apply in case of type tests for reactors.

11.1.4 Special tests

Add to first paragraph

14.4 of IEC 60076-11 shall apply in case of special tests for dry type transformers and 7.8.4 of IEC 60076-6 shall apply in case of special tests for reactors.

Add to subclause

Following test shall be conducted for unit transformer if no short-circuit type test certificate for an identical transformer is available.

A simulated transformer/motor on-load start test, with the transformer at its normal operating temperature, shall be performed. The test procedure shall be:

1) Measurement of reactance at normal operating temperature.
2) Three tests with a current corresponding to the motor starting current. The duration of the test shall be equal to the running-up time of the motor.
3) Measurement of reactance after the simulated starts. The measured value shall not deviate by more than 2 % from the value prior to tests.

11.4 Measurement of short-circuit impedance and load loss

Add after seventh paragraph (before NOTE 1)

In case of dry type transformers, 14.2.3 of IEC 60076-11 shall be followed for measurement of short-circuit impedance and load loss.

Load loss test for converter transformers shall comply with 7.5 of IEC 61378-1.

11.6 Measurement of zero-sequence impedance(s) on three-phase transformers

Add after eighth paragraph (before NOTE 1)

10.9.5 of IEC 60076-6 shall apply in case of reactors for measurement of zero-sequence impedance.

12 Electromagnetic compatibility (EMC)

Add before NOTE 1

For European installations, equipment shall be certified in compliance with European EMC Directive 2004/108/EC.

Add to NOTE 1

Accessories shall conform to IEC 61000-6-2 and IEC 61000-6-4, for industrial type installations, for both immunity and emissions.

Annex A
(informative)
Check list of information to be provided with enquiry and order

A.1.2

Add list item u)

u) The percentage regulation of the transformer shall be informed by the manufacturer.

Annex E
(normative)
Temperature correction of load loss

Add to annex

In case of dry type transformer (refer to Annex D of IEC 60076-11) and in case of reactor (refer to Annex D of IEC 60076-6) shall be followed for calculation of temperature correction of load loss.

Annex F
(informative)
Facilities for future fitting of condition monitoring systems to transformers

Add before Table F.1

Online condition monitoring tools such as dissolved gas analysis (DGA) and fibre optic temperature sensing shall be provided where specified in the requisition / data sheet.

Annex G
(informative)
Environmental and safety considerations

Add to second paragraph

The vendor shall submit a lifetime calculation for the transformer, if specified in the requisition.

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