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## **Executive Summary**

This specification covers the design, manufacture and testing of dry type power transformer for use in electrical systems of up to 15kV for

## **Definitions/Abbreviations**

**Within this specification, the following definitions shall apply:**

**COMPANY**

**CONTRACTOR**

The CONTRACTOR is the party which carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project or operation/maintenance of a facility.

**SUPPLIER**

Company/organization supplying equipment, materials or services.

## **1. SCOPE**

- 1.1 This Specification covers the general requirements for the design, manufacture and testing of dry type power transformers for \_\_\_\_\_ in West Kazakhstan Oblast in the Republic of Kazakhstan.
- 1.2 The specific requirements for individual transformers are given in the Transformer Data Sheet.

## **2. CODES AND STANDARDS**

- 2.1. The Dry Type Power Transformer shall be designed, manufactured and tested in accordance with the latest applicable sections of the IEC codes and standards listed in section 17 and shall be approved for use in the Republic of Kazakhstan. Other standards may only be used with the consent of the COMPANY.
- 2.2. The word 'should' shall be replaced by 'shall' wherever it appears in the reference standards.
- 2.3. This specification shall also be read in conjunction with all Attachments to the material requisition. Any conflicts between referenced documents shall be identified to the COMPANY in writing for resolution. In general the order of precedence is:-

- Transformer Data Sheets
- Material Requisition
- This Specification.
- Single line diagram and schedules (when reference to the single line diagram is made in the following sections of this specification, it shall be deemed to include reference to the associated schedules.)
- Reference Standards/Codes.

- 2.4. Although not supplied for installation in a member country of the European Union, the equipment shall be supplied in accordance with all applicable European Community Directives. Particular attention should be paid to:

- Electromagnetic Compatibility.
- Low Voltage Equipment.
- Machinery.
- Safety.
- CE Marking. Directive 2014/34/EU "Equipment and Protective Systems Intended for use in Potentially Explosive Atmospheres" shall apply.
- Custom Union compliance

- 2.5. Where the transformer datasheet indicates that transformer is for use in hazardous area. The transformer and all its associated parts shall comply with the requirements of an approved certifying authority and shall the labels and markings in accordance with the relevant sections of IEC 60079.

### **3. SERVICE CONDITIONS**

- 3.1. The site climatic conditions are stated in the Project Specification for Climatic, Environmental and Utility Data 23858-00L-3PS-0000-00003. Electrical equipment shall be designed for use in external temperatures ranging minus 45 to plus 40 degrees Celsius. Internal electrical equipment installed in heated indoor locations shall be designed for use in temperatures ranging from minus 5 to plus 40 degrees Celsius.
- 3.2. The dry type power transformer shall have a design life of at least 20 years and periodic maintenance interval of greater than four years.
- 3.3. Electrical Equipment intended for indoor installation shall have minimum protection to IP31 in accordance with IEC 60529 Electrical equipment intended for outdoor installation shall have minimum protection to IP55 in accordance with IEC 60529.
- 3.4 Compliance with specifications codes and standards does not relieve the supplier of the responsibility for supplying equipment of proper design and construction fully suitable for all specified operating conditions.

### **4. ELECTRICAL SYSTEM**

- 4.1. All components of the transformer shall be rated for the electrical system characteristics shown on the Data Sheet.
- 4.2. The winding connections of the transformer shall be to the phase group specified on the Data Sheet

### **5. GENERAL CONSTRUCTION REQUIREMENTS**

- 5.1. The transformer construction shall be as specified on the Data Sheet (see IEC 60076-11) and be either:
  - I. Sealed (non-breathing)
  - II. Totally enclosed (breathes but the air does not circulate to cool)
  - III. Enclosed (the air circulates to cool)
  - IV. Non-enclosed (cooled by ambient air).
- 5.2. The transformers shall be provided with a sheet steel, adequately ventilated enclosure, with the minimum degree of protection stated in the Data Sheets. The enclosure shall act as a safeguard against contact with any electrical part of the transformer. The enclosure shall have lockable doors and be demountable to facilitate easier installation and removal of the transformers. The rating of each transformer shall be based on its location within the enclosure.

All leads, bars and connections within the enclosure shall be insulated and shall be supported for the full fault rating.
- 5.3. Transformers shall be free standing and suitable for floor mounting. The transformers shall be suitable for mounting adjacent to a wall. The Supplier shall state the minimum allowable distance between the transformer and wall.

- 5.4. The core assembly shall be constructed from high-quality, non-ageing, grain oriented, electrical grade silicon steel sheets, with both sides coated. The assembly shall be accurately cut and stacked. Joints shall have the least possible air gaps and shall be rigidly clamped to produce an assembly with minimum core loss and noise generation. The core laminations shall be specially treated to avoid moisture ingress and consequent core corrosion.
- 5.5. The core shall be braced to withstand thermal and dynamic stress caused by a bolted fault on the secondary for a duration of 2 seconds without permanent mechanical damage. Core bracing and support shall also prevent any transformer damage that might take place during transportation and positioning.
- 5.6. Transformers shall have separate primary and secondary windings
- 5.7. Transformers shall have cast resin encapsulated windings, unless they are of sealed design. The minimum class of insulation shall be F, with temperature rise limited to class B in accordance with IEC60085. When sealed dry-type transformers are considered the gas shall be non-toxic, pose no possible threat to the environment and be non-flammable.
- 5.8. Transformers having aluminium windings shall have copper leads brought out to the connections. The aluminium to copper transitions shall be made within the resin encapsulation.
- 5.9. Internal winding connections shall be welded, brazed or crimped-on. Soldered or bolted connections are not acceptable
- 5.10. Transformers shall be provided with facilities for lifting the core and coil assembly as well as for removing it from the enclosure (where applicable).
- 5.11. There shall be no exposed bare copper. With the cables/bus ducts connected, all connections and live parts shall be insulated and within a metal enclosure.
- 5.12. All material used shall be of "self-extinguishing" type.
- 5.13. Materials of construction shall be selected having concern for the minimum temperature expected at the site.

## **6. ACCESSORIES AND FITTINGS**

- 6.1. In addition to standard fittings and accessories as listed in the referenced codes and standards and/or mentioned above, each transformer shall be furnished with the accessories listed on the Transformer Data Sheet.
- 6.2. Two earthing pads (or threaded studs complete with nuts and washers) shall be provided on the transformer at diagonally opposite corners of the base. Provision shall also be made adjacent to each gland plate for cable gland or conduit earthing connection.
- 6.3. When enclosures are specified, the transformers enclosure shall be earthed to the main frame by two copper connections. Each connection shall have a minimum cross-sectional area of 70 sq. mm.
- 6.4. Where local temperature indication is specified on the data sheet a local indicator shall be provided to monitor the winding temperature on all three phases.
- 6.5. Instruments provided with the transformers shall be arranged so that they can be easily read by a person standing at ground level.

- 6.6. When specified on the Data Sheets, heaters suitably rated to prevent condensation shall be provided within the enclosure and marshalling cubicle.
- 6.7. The heaters shall be protected by a miniature circuit breaker and controlled by a thermostat.
- 6.8. When cooling fans are specified on the Data Sheet the protective and control equipment shall be installed in a separate, transformer mounted enclosure. Each motor shall be protected individually against short circuit and overload. The control equipment shall be fully automatic, based upon winding temperature and shall include an alarm annunciator with provision for connection of a remote common alarm.
- 6.9. When provision for future cooling fans is specified on the Data Sheet, the provision shall include the temperature control device with two contacts (one for alarm and one for fan control), mounting space and brackets for the fans, and mounting space for the control enclosure.
- 6.10. When CTs are specified, all secondary leads shall be run in armoured cable to the terminal box. The leads for each CT shall be crimped using self-insulated compression ring-type lugs and terminated to adjacent terminals of a shorting screw-type terminal block. The terminal blocks shall be clearly marked designating the CT phase, and tap number in accordance with referenced standards.
- 6.11. If neutral point CTs are specified they shall be situated between the neutral tap off point and the earth connection point unless stated otherwise. All CTs and their connections shall be accessible.
- 6.12. Off circuit tap changing facilities shall be provided so that the tapping connections, which shall be located in the primary winding, may be changed when the transformer is disconnected from the supply.
- 6.13. The tapping range required shall be as stated in the Data Sheets. If not stated on the Data Sheets, the range of the voltage tap-changer shall be  $\pm 2 \times 2.5\%$   $U_n$  and shall be suitable to carry the fully load current of the transformers continuously. The current shall be based on the value at the minimum tap position. The tap changer shall be installed in an easily accessible position.
- 6.14. Clearly marked, accessible, bolted type solid copper links are acceptable.
- 6.15. The tap changing facilities shall be protected by an insulating cover.

## **7. TERMINATIONS**

- 7.1. When terminations for bus duct are specified on the Data Sheet, provision shall be made for the support and fastening of the ducting at the transformer. The transformer terminals shall provide a sufficient pre-drilled contact area for accepting flexible connectors, and provision shall be made for access for convenient making off, or disconnection of, the connections while the duct remains in place.
- 7.2. When air filled cable terminal chambers are specified on the Data Sheet access covers shall be full height, bolted and gasketed. Cable supports, an earthing bus and removable top/bottom undrilled gland-plate shall be provided. Clearance between the termination and the gland-plate shall allow for the bending of cables as necessary.

Primary and secondary winding terminal boxes shall preferably be located at the same side of the transformer.

- 7.3. Provision shall be made for connecting the number of conductors per phase as specified on the Data Sheet. Supplier shall provide 2 hole, long barrel compression lugs for the size of cable specified. Uncluttered, straight conductor connections shall be possible, i.e. provide copper bars or flags.
- 7.4. In case of a three phase and neutral arrangement, all four terminals shall be provided in a single terminal compartment. The star point earth terminal shall be accommodated in a separate terminal box.
- 7.5. Cable termination accessories (other than the cable lugs) including stress relieving devices, where necessary, and cable glands, will be provided by the COMPANY unless specified otherwise on the Data Sheet.
- 7.6. Where single core cables are specified on the Data Sheet, the gland plate shall be of non-ferrous material.
- 7.7. A separate terminal box shall be provided for termination of auxiliary items such as alarms, CTs, fans etc.
- 7.8. Terminal compartments, auxiliaries' enclosures, and boxes shall be mounted at a height of at least 1.0 metre above the foundation level. They shall be to the degree of protection sated on the Data Sheet as a minimum.
- 7.9. Cable entry shall be from below or above as specified on the Data Sheet. Supplier shall make provision for mounting clamps below the terminal boxes to support cables rising from ground level, where applicable.
- 7.10. Alarm/trip wiring, current transformer wiring, cooling fan power and control wiring, thermistor wiring, anti-condensation heater power and control wiring, and all alarm wiring shall have copper conductors of the manufacturers standard sizing, (subject to Company's approval) and shall be run in armoured cable, to the terminal box. Wiring shall be crimped using self-insulated compression spade-type terminal blocks which shall be suitably identified. Conductors shall be fitted with sleeve ferrules bearing the same identification as the terminal to which they are connected.
- 7.11. The following bus bar/wiring phase colours shall be adopted:

3 Phase/neutral Systems:

Line 1:-	Yellow
Line 2:-	Green
Line 3:-	Red
Neutral:-	Blue
Earth:-	Green/Yellow

Single Phase/neutral (2 wire) Systems:

Line:-	Red
Neutral:-	Blue
Earth:-	Green/Yellow

Single Phase/neutral (3 wire) Systems:

Line 1:-	Yellow
Line 2:-	Red
Neutral:-	Blue
Earth:-	Green/Yellow

Direct Current Systems:



Positive:-	Red
Negative:-	Black
Earth:-	Green/Yellow

## **8. NAMEPLATES**

- 8.1. The manufacturers rating plate shall be of AISI 316L stainless steel and show all information in accordance with the standard specified in addition to the Company's purchase order and item number. The star, triangle and zig-zag connections of the phase windings shall also be clearly marked on the rating plate.
- 8.2. The word 'SEALED' shall be added to the cooling classification where applicable.
- 8.3. The impedance value stamped on the nameplate shall be the actual measured value obtained during testing.
- 8.4. In addition to the standard nameplate referred to above, each transformer shall be identified with a transformer identification plate. Plates shall be machine engraved phenolic, with black figures on a white background and shall be securely attached with stainless steel self-tapping screws. Identification plate information shall be defined by the COMPANY.
- 8.5. All text on nameplates and labels shall be in both Russian and English.

## **9. PAINTING AND FINISH**

- 9.1 Transformers shall be prepared, painted and finished as specified on the attachments to the material requisition.
- 9.2. Manufacturers standard paint finish is acceptable provided that it is no less effective than that specified above. The Supplier shall provide copies of the standard paint specification with his quotation.
- 9.3. The Supplier shall supply a quantity of paint for field touch up.

## **10. NOISE/TRANSFORMER LOSSES**

- 10.1 Noise levels shall conform to the requirements specified in the attachments to the material requisition
- 10.2 Transformer losses stated in the vendor quotation shall be guaranteed by the vendor.

## **11. SPECIAL TOOLS**

- 11.1 All special tools which are required for installation and maintenance of the transformers shall be supplied with the transformers.

## **12. SPARES**

- 12.1. Supplier shall identify and provide recommended commissioning spare parts along with supply of Transformer.
- 12.2. Supplier shall identify and provide complete list of 2 Year Operational spare parts with their manufacturing part numbers.

## **13. INSPECTION AND TESTING**

13.1. Type tests, including a short circuit test, shall have been carried out on identical transformers by an independent testing authority and type test certificates shall be supplied with the quotation. Final certificates shall have conclusion confirming compliance to datasheet and fit for installation

13.2. The following tests shall be carried out on all transformers:

- a) Measurement of winding resistance.
- b) Voltage ratio, voltage vector relationship and polarity.
- c) Impedance voltage.
- d) Load losses.
- e) No-load losses and no-load current.
- f) Measurement of insulation resistance
- g) Separate source voltage-withstand.
- h) Induced over-voltage-withstand.
- i) Tap changer operation and measurement of tap voltage.

13.3. In addition to the above and other standard routine tests, the following shall be performed:

13.4. All tap-changers, alarm/trip contacts, temperature sensors, current transformers, fans and all other accessories shall be electrically and functionally tested.

13.5. Full load temperature rise test.

13.6. Partial discharge test.

13.7. Other tests, if required, will be stated on the transformer Data Sheet or other attachment to the material requisition.

## **14. SHIPPING, HANDLING AND STORAGE**

14.1. Preparation for shipment shall be as stated in the Project Specification .GT-SPC-00001 and I .GT-SPC-00002 for Supplier Preservation, Storage, Handling and Shipment. The SUPPLIER shall be solely responsible for the adequacy of the preparation for shipment provisions stated.

## **15. DRAWINGS AND DATA requirements**

- 15.1. SUPPLIER shall provide the documentation detailed in the SUPPLIER Documentation Requirement Schedule (SDRS) and the "Supplier Documentation Descriptions" as listed in the Requisition.

## **16. DEVIATIONS**

- 16.1. Deviations from this specification are only acceptable where the SUPPLIER has listed in his quotation the requirements he cannot or does not wish to comply with, and the COMPANY has accepted, in writing, the deviations before the order is placed. If the SUPPLIER is also to offer alternatives resulting in technical or price advantages he should submit a supplement to the main tender.
- 16.2. In the absence of a list of deviations, it will be assumed by the COMPANY that the SUPPLIER complies with this specification.

## **17. INTERNATIONAL STANDARDS**

IEC 60071-1	Insulation co-ordination - Part 1: Definitions, principles and rules
IEC 60417:2002 DB	Graphical symbols for use on equipment
IEC 60529	Degrees of protection provided by enclosures (IP Code).
IEC 60617:2012 DB	Graphical symbols for diagrams
IEC 60684-1	Flexible insulating sleeving - Part 1: Definitions and general requirements
IEC 60076	Power Transformers.
IEC 60076-8	Power Transformer Part 8 Application Guide.
IEC 60076-10	Power Transformer Part 10 Determination of sound levels.
IEC 60076-11	Power Transformer Part 11 Dry Type Power transformers.
IEC 60905	Loading Guide for Dry Type Power transformers.
IEC 60044	Instrument Transformers.
IEC 60099	Surge Arrestors.
IEC 60616	Terminal and tapping markings for power transformers.
IEC 60445	Identification of equipment terminals and of terminations of certain designated conductors including general rules for an alphanumeric system.
IEC 60137	Bushings for alternating voltages above 1000V.
IEC 60214	On Load Tap Changers.
IEC 60542	Application guide for on load tap changers.
PUE 2015	Kazakhstan Electrical code