USask Master Specification Directions: The master specifications are intended to be incorporated into the Consultant's final, project specific specification package. The project specific specifications are expected to include any and all sections or portions of sections (Part 1, Part 2, Part 3) that are required to create a fully executable project specification. USask Master Specs only provide information that USask **requires** be a part of the final specification package. Components or sections not included in the Master USask Specifications may still be required for a complete, well-designed project. **It is the consultant's responsibility to ensure all specifications match USask requirements. Any deviations or revisions to any section included in the master specifications requires written consent from the USask Engineering department. The consultant is liable for any omissions, errors, or incorrect equipment or components supplied to site.**
The Master Specifications shall be used in conjunction with USask's Design Guidelines. Any conflicts shall be brought to the attention of USask Engineering staff for clarification.

Part 1 General

.1 Source Quality Control

.1 Submit two (2) copies of standard factory test certificates of specific transformer testing and type test results for each transformer. High voltage accessories included to be as provided by the manufacturer.
.2 Submit two (2) copies of standard benchmark oil analysis testing completed prior to factory shipping of units. Testing to be to ASTM standards.
.3 Equipment and material to be CSA certified and manufactured to standards quoted.
.4 Manufacturer shall have local technical representative in Canada.

.2 Maintenance Materials

.1 Provide three (3) spare fuses for each type of fuse for each transformer.

Part 2 Products

.1 Equipment

.1 Three phase, dead front, pad mounted, two winding, oil filled, ONAN cooled, 60 Hertz transformers manufactured to CSA standard C227.4-06. Energy efficiency standard to be CAN/CSA C802.1.
.2 Suitable for bottom, HV, LV, ground, and alarm status cable entry.
.3 Oil shall be FR3.
.4 High voltage and low voltage copper windings.
.5 Externally clamped high voltage bushing wells complete with bushing inserts for connection to bushings for connection to distribution system primary cable terminals with solderless connectors.
.6 A total of 6 standoff brackets located adjacent to HV bushing wells.
.7 Continuous ground bus with connections to HV neutral and LV neutral bushings.
.8 Acceptable manufacturers: PTI

.2 Transformer Characteristics

.1 Temperature Rise

.1 When measured by resistance, the average temperature rise of each complete winding above ambient temperature shall not exceed 65^0C. The calculated hottest-spot winding temperature rise shall not exceed 80^0C. The temperature rise of the insulating oil shall not exceed 65^0C when measured near the top oil level.

.2 Temperature rise limits shall not be exceeded when the transformer is operating continuously at rated kVA and when connected to the rated voltage tap and is based on 30° (24 hour) ambient temperature.

.3 Leads, terminals, tap changer and bushings shall not limit the loading capability.

.4 Tank to be constructed such that cooling is achieved with the requirement for radiators

.5 Off-Circuit Voltage Taps

.1 Provide 5 standard HV off circuit taps @ 2½% of rated voltage (2 FCAN, 2 FCBN).

.2 Tap changer position to be indicated and operating mechanism complete with padlocking facilities.

.6 Insulation Class

.1 125 kV BIL at 25 kV primary, 30 kV BIL at 600 volts secondary.

.7 Operating Voltage Range

.1 Operating voltages to CAN3 C235-1983.

.2 Transformers shall be capable of operating continuously at rated kVA at 10% above or 5% below rated voltage of the connected tap.

.3 All control device and equipment to operate satisfactorily at 60Hz with normal operating limits.

.4 Transformers and all components to operate in extreme operating conditions without damage to equipment. Ambient temperature range is +45 degrees Celsius to -50 degrees Celsius. Maximum wind velocity of 160 km/hr.

.8 Audible Sound

.1 Transformers to be designed so that the audible sound level, when operated at rated voltage and measured according to ANSI/IEEE C57.12.90, shall not exceed 63 dB.

.9 Short-Circuit Capabilities

.1 Transformer impedance to be not less than 4.0%. Transformers shall be built to withstand the mechanical and thermal stresses caused by the short-circuit currents (25 per unit of symmetrical base current) and 120 cycles duration and ANSI/IEEE C57.12.90.

.3 Mechanical Characteristics

.1 General

.1 Dimensions to closely match drawing details. Maximum total dimensions shall be 1.483 m wide x 1.257 m deep. Refer also to CSA C227.4 standard dimensioning.

.2 The transformer shall have sufficient strength to withstand a minimum gauge pressure of 50kPa, without leakage or permanent distortion of the tank exceeding 0.25% of the diagonal dimension of the surface so affected. The transformer base shall be arranged so that the tank bottom does not touch the pad.

.3 Construction of the unit shall be such that it can be lifted, skidded, or slid into place on the mounting pad without disturbing high- or low-voltage cables/bus duct. Jacking and lifting provisions shall be so arranged on the tank as to prevent overturning when lifted.

.4 Jack steps or equivalent jacking facilities shall be provided on the tank. Vertical clearance for a jack shall be 150 mm minimum, 175 mm maximum.

.5 The transformer base shall be arranged for rolling in four directions, parallel to and at right angles to one side of the transformer.

.6 A pull-ring type automatic pressure relief device shall be provided in a separate lockable outside enclosure adjacent to the LV cable compartment. The opening pressure of the pressure relief device shall be less than the withstand pressure of the tank structure. It shall have a minimum flow rate of 16 I/s at a gauge pressure of 100 kPa.

.7 Switches, pressure relief devices and tap changer components shall be accessible for removal and replacement without the need to cut open the transformer tank. Accessibility may be achieved by means of a bolted tank cover or access covers. Where access covers are used, they shall have minimum dimensions of 375mm by 600mm.

.8 The transformer tank assembly shall be of sealed, reinforced welded steel construction, shall remain effectively sealed for a top oil temperature range of -45^{0}C to +105^{0}C and shall include a tamper-proof bolted cover. The cover shall direct any discharge away from high voltage and low voltage cabinets.

.9 Off-circuit tap shall be externally operable lever handle type and shall be lockable at all taps and made of corrosion resistant material. The means for operating these devices shall be installed in the L.V. cable entrance compartment and shall be clearly marked. The highest voltage tap shall be tap position ‘1’ (A).

.10 Devices such as switch handles, adapters and replaceable fuses that are designed for operation after the transformer is in place and energized shall be so located that they can be operated with hot line tools.

.11 The exterior and interior of enclosure shall be free of sharp corners or edges.

.12 Provide a separate exterior lockable box on the side of the transformer for safe access to the oil testing tap. Extend test tap to this box and clearly label.

.2 Cable Entrance Compartment

.1 The arrangement of the transformer and cable entrance compartment shall be such that the high- and low-voltage facilities are mounted side by side on the transformer tank, with the high-voltage on the left when viewed from the front. Cable entrances to be from the bottom. Access to the cable entrance compartments shall be by means of doors.

.2 Compartment Integrity and Locking Provisions

.1 The integrity of the cable entrance compartment shall be as per ANSI C57.12.28-1988.

.2 The cable entrance compartments shall be weatherproof and shall include tamperproof enclosure doors with grounding and hold open devices. A High Voltage door latch, Low Voltage door padlocking handle and a

minimum of 2 penta-head bolts are required. Integral, tamperproof enclosures shall be with access doors secured by a three-point latching system including at least one recessed, captive, penta-head bolt and suitable for padlocking. Captive penta-head stainless steel or silicon-bronze full-dog bolt(s) with fixed cup(s) shall be provided. The penta-head bolt(s) shall be held captive to prevent removal and thread damage during operation of the door including forceful closing. Stainless steel bolts fastened into stainless steel threaded receptacles are not permitted due to the potential to gall. There shall be no exposed screws, bolts, or other fastening devices that are externally removable, except for the penta-head bolt(s). Front metal door required for each of the HV and LV compartments. Door stays to hold compartment doors in 110 degrees open position. Provide an infrared viewing window on each door for access to both the high and low voltage connections to permit ease of future infrared testing. Window to be located such that the elbow connections on the primary side and the secondary side bolted lug cable connection points can be viewed. Similarly add 2 separate EEMAC 4 boxes on the side of the low voltage compartment to house the gauges and pressure relief device in one box and the oil drain in the other box. Boxes shall be enclosed utilizing penta head bolts and suitable for padlocking. See above for further enclosure details.

.3 Hinge assemblies and pins shall be as per ANSI C57.12.28-1988. They shall be made of corrosion-resistant material and shall be of sufficient strength to withstand adverse operating conditions.

.4 The interior of the roof of the cable compartments shall be covered with a condensation-inhibiting material.

.5 An internal flange shall be provided at the base of the cable entrance compartment to provide means of anchoring the unit on the pad.

.6 The doors and roof of the compartment shall be of sufficient size to provide adequate operating and working space when opened. The compartment side, sill, door, and roof shall be electrically bonded to the tank by flexible copper connections. If the compartment side is an integral part of the tank side, flexible copper connections between the tank and compartment side are not required.

.7 Factory assemble all components.

.3 Fusing

.1 Provide current limiting in tank fusing and Bay-o-net dual sensing fusing for each of the high voltage phases. Dual sensing fuses to be Bay-O-Net fuse link rated as per manufacturer’s specification.

.2 Provide 3 spare dual sensing fuses per transformer.

.3 The manufacturers catalogue number of the fuses shall be identified on the nameplate.

.4 Bushings, Terminals, and Grounding

.1 Bushings and Terminals (See also section 26 18 12)

.1 The high-voltage and low voltage bushings shall be externally clamped and bolted.

.2 High-Voltage Bushings (6) shall be ANSI/IEEE 386 bushing wells complete with removable studs, 25 kV bushing inserts and insulated caps.

.3 Low-Voltage Bushings shall be spade type with a thickness that will provide adequate ampacity. Terminals shall be of plated corrosion-resistant metal, suitable for use with copper or aluminum connectors. All four low voltage bushings to include spade type lugs - c/w 4 holes to C2 - M91 Standard.

.4 The low-voltage neutral shall be connected to an insulated terminal, designated X0, having a current-carrying capacity equal to the other low-voltage terminals.

.5 The low-voltage terminals shall be capable of withstanding a minimum vertical cantilever force of 750 N continuously applied at the outermost hole of the terminal without causing a lead, damage, or permanent distortion.

.6 The transformer shall be complete with 3 x 4 – 500 MCM 2-hole, long barrel, dual compression capability lugs for customer secondary cables and 3 – 4/0 ground/bond 2-hole, long barrel, dual compression capability lugs.

.7 Provide 25 kv load break rated elbow connectors for the high voltage terminations, complete with all connectors and terminations. Arrester shall be Hubbell PDE or approved equal.

.2 Grounding

.1 The grounding provision shall include a continuous rigid copper bus at the bottom of each of the H.V. and L.V. compartments. There shall be provision for attaching to the ground bus at least 5 solderless connectors in the H.V. compartment and at least 4 in the L.V. compartment. The provisions for the ground conductor connections shall be 2 holes meeting C2 M91 standard.

.2 A grounding bracket shall be bolted to the ground bus in the H.V. compartment to facilitate attachment of working ground clamps.

.3 The neutral terminals X0 and H0 shall be connected to the ground bus with removable ground straps of suitable ampacity rating.

.5 Factory Tests

.1 Factory tests to CSA standards.

.2 Submit two copies of standard factory test certificates for each type of test.

.3 Submit production test certificates for:

.1 Voltage ratio

.2 Polarity of angular displacement

.3 No-load losses

.4 Load losses

.5 Impedance

.6 Exciting current

.4 Submit type test certificates for:

.1 Temperature rise

.2 Sound level

.3 Breakdown insulation level

.6 Workmanship and Finish

.1 The exterior finish shall conform to ANSI C57.12.28-1988 except the salt spray test acceptance criteria shall be 1500 hours. The finish shall include a rust resistant primer and at least 2 coats of finish enamel.

.2 The exterior and interior finish shall be dark transformer (equipment) green to match existing site transformers and applied in accordance to EEMAC Y1-1-1985. Provide color sample to consultant for approval at time of approval drawings.

.3 All welding shall conform to the latest issue of CSA W59; the fabricator shall be fully qualified and approved by the Canadian Welding Bureau in accordance with the latest issue of CSA W47.1.

.7 Markings

.1 Nameplate and Connection Diagram

.1 Transformers shall be provided with a combined nameplate and connection diagram. The nameplate shall contain all information as specified in these specifications and remain legible for the life of the transformer under normal usage.

.2 The combined nameplate and diagram shall be located on the transformer interior at the low voltage termination compartment.

.3 The following information shall be shown on the combination nameplate:

.1 Padmount Type ONAN 60 Hz, 65^0C
.2 number of phases: 3
.3 *rating in kilovolt amperes
.4 *identification number (e.g. serial number)
.5 *per cent impedance at 85^0C (one decimal minimum)
.6 oil volume in litres
.7 BIL (Basic Impulse Level)
.8 total mass (including liquid)
.9 *rated high and low-voltage
.10 <2 ppm PCB
.11 *fuse rating and identification; terminal markings including physical identification, diagram of connections, and vector diagram
.12 year and month of manufacture
.13 specification number
.14 manufacturer reference number; and name of manufacturer and address.
.15 *tap voltages in per cent of rated voltage/corresponding position of switch

* Must be 4 mm high and legible from outside the cable entrance compartment.

.2 Any manufacturer's identification or rating plates shall be secured in such a way that its removal does not reduce the tamper-resistant quality of the unit.

.3 The identification of terminal connections shall be shown both on the tank and on the combined nameplate and connection diagram.

.4 Transformer Markings

.1 If decals are used, they shall meet the Type A label requirements of CSA Standard C22.2 No. 0.15 and maintain their integrity at -40^{0}C.

.2 The following information shall be stenciled on the exterior of the tank inside the cable compartments with 15 mm – 25 mm lettering.

.1 high-voltage terminal designations

.2 low-voltage terminal designations

.3 TC (tap changer switch, if present)

.4 Voltage markings of voltage selector switch positions

.5 Tap position of the tap changer switch in numerals (if indicator plate is provided, 8 mm minimum high numbering is acceptable)

.3 Warning labels as per EEMAC L16-1 shall be installed.

.1 Transformers having a welded cover shall be provided with a warning label meeting the requirements of EEMAC Label L1601 and indicating safety procedures to be followed before removing the cover.

.2 Transformers having an off-circuit switch with an external operating handle, shall be provided with a warning label adjacent to the handle and meeting the requirements of EEMAC Label L1602. The label shall indicate safety procedures to be followed before operating the switch.

.3 The EEMAC electrical hazard warning label as per EEMAC Label L1603.

.4 Information on Exterior of the Transformer

.1 A self-adhesive tag shall be externally attached to the side of the transformer The following information shall be provided on the tag:

.1 serial number

.2 purchaser’s stock code number; and

.3 manufacturer’s name or logo.

.2 The gross weight of the transformer shall be indicated beside a lifting lug, on the same side as the identification tag, with 15-25 mm lettering.

.3 A non-PCB sticker shall be installed by the manufacturer.

.4 Provide an Arc Flash label.

.8 Packaging

.1 Transformer to be shipped on a pallet with dimensions greater than the transformer. The transformer shall be secured to the pallet with screws or bolts, or with non-metallic straps. Metallic straps are not permitted.

.9 Accessories

.1 Liquid temperature thermometer complete with two sets of individually adjustable Form C alarm and trip contacts. Resettable maximum temperature indication is required. Mount in one of the exterior boxes on the low voltage side. See Section 2.3 of this specification

.2 Liquid level gauge complete with high and low oil level alarm contacts. Mount in one of the exterior boxes on the low voltage side. See Section 2.3 of this specification

.3 Tank top mounted pressure relief device complete with deflection hood to the rear of the tank. Pressure relief device to be complete with alarm/trip contacts. Mount in one of the exterior boxes on the low voltage side. See Section 2.3 of this specification.

.4 Alarm and trip contacts to be wired to a terminal block at the secondary connection cabinet for external connection to Owner's monitoring.

.5 Bottom of tank brass drain valve and top of tank filling brass plug. Provide exterior weatherproof lockable box and extend oil drain valve to this box for customer access when testing the oil. Mount in one of the exterior boxes on the low voltage side. See Section 2.3 of this specification.

Part 3 Transformer Testing

.1 Include for the services of a qualified and experienced field service technician to conduct testing and inspections as indicated below following installation but prior to energization.

.2 Winding insulation resistance corrected to a 20°C base for High voltage winding to low voltage winding and ground, Low voltage winding to high voltage winding and ground and high voltage winding and low voltage winding to ground.

.3 Inspect and clean bushings and insulators.

.4 Verify high/low oil level and temperature indicators trip and alarm circuitry and functions. Verify pressure relief device and alarm circuits. Verify back to Owner's PLC system.

.5 Conduct winding resistance and winding turns ration tests for all taps. Set transformer taps to rated voltage as specified upon completion.

.6 Inspect for oil leaks and evidence of damage or rust.

.7 Conduct standard oil and dissolved gas in oil sampling and analysis. Submit complete benchmark oil analysis report forms for inclusion in Maintenance and operating Manuals.

.8 Check fuses for correctness of type and size.

.9 Verify H0 and X0 bushings are firmly connected to ground. Verify transformer tank is grounded to ground grid in at least 2 locations.

.10 Verify HV elbow arrestors are properly installed and grounded.

.11 Provide the Engineer with full written test report documenting test results and confirming the above steps have been completed. Include manufacturer's recommendations if deviations from the specified characteristics are found.

END OF SECTION