PART 1 GENERAL

1.1 RELATED SECTIONS

.1 Electrical Starting and Testing General Requirements Section 16070

.2 Electrical Performance Testing by [Owner’s] [Contractors] Testing Agent Section 16072

.3 Electrical Performance Testing by Owner Section 16073

1.2 TESTING

.1 Test included in this section will be paid by [(Choose one): Contractor] [Owner]

(Spec note: include this paragraph only when owner is selected in 1.2.1)

.2 These tests are provided for information purposes to permit the Contractor to make appropriate allowances for coordination of work with the Owner.

1.3 INTENT

.1 Read this Section in conjunction with Section 16070, Electrical Starting and Testing - General Requirements and other related electrical starting and test sections.

1.4 PRE-REQUISITES

.1 Provide records of all production tests required by EEMAC or CSA for all power distribution equipment to Consultant prior to field testing specified in this section with applicable copies of factory tests issued to the independent testing firm for comparative results.

.2 Any manufacturer, supplier or contractor who objects to test procedures, methods and test voltage levels specified herein to confirm objections in writing at least 10 working days prior to tender closing stating all reasons for such objections. Failing to do this constitutes acceptance of all test procedures stated herein and ensures that warranties are not voided by such tests and procedures.
PART 2 PRODUCTS

2.1 N/A

PART 3 EXECUTION

3.1 LOAD BREAK SWITCH TO 15 kV

.1 Procedures for high voltage switching operations must be strictly adhered to at all times.

.2 Load break switch to be worked on must be completely isolated from all power sources.

.3 Install temporary grounds.

.4 Record manufacturer, serial number, type and function or breaker, reading of operations counter, date of inspection, and signature of person responsible for inspection on verification form.

.5 Cleaning:

.1 Remove all accumulations of dirt from the insides of cubicles with vacuum cleaner and/or blower.

.2 All insulating surfaces should be brushed clean or wiped clean with lint free cloth.

.6 Mechanical inspection:

.1 Check the condition of primary contact clusters, control wiring plug-in contacts, moving and fixed main contacts and arcing contacts.

.2 Cracks or indications or tracking on insulators.

.3 Tracking or mechanical damage to interface barriers.

.4 Flaking or chipping or ceramics of arc chutes.

.5 Breaker, damages or missing springs on operating mechanism.

.6 Damage to operating linkage and that all clevis pins are securely retained in position.
.7 Correct alignment of operating mechanism and contacts.

.8 Evidence of corrosion and rusting of metals, and deterioration of painted surfaces.

.7 Torque all bolted connections and breaker components.

.8 Dress contact surfaces and check contact pressure.

.9 On completion of foregoing tasks, lightly lubricate all bearing points in the operating linkage with manufacturer's specified lubricant. Operate breaker several times to ensure smoothness of mechanical operation.

.10 Electrical tests:

.1 Contact resistance tests across closed line-load contacts. Record results. Clean contacts using appropriate tools to get lowest contact resistance reading possible.

.2 Insulation resistance test: All phases to others and ground.

3.2 DRY TYPE POWER TRANSFORMER

.1 Following tests and procedures apply to all dry type transformers:

.1 Visual inspection and cleaning
.2 Insulation power factor test
.3 Ratio test
.4 Insulation resistance test
.5 Dielectric strength test - DC hipot test
.6 Core ground test.

.2 Visual Inspection and Cleaning:

.1 Record nameplate data.

.2 Check all bushings and insulators for chips or cracks.

.3 Check tap changer for connection and proper mechanical and electrical operation.

.4 Check operation of temperature, and alarm devices through simulation test. Verify wiring is in accordance with manufacturer's schematic diagram.
.5 Check all connections (including ground and tap changer links) for tightness. Torque to proper value in accordance with manufacturer's recommended values and seal with red lacquer.

.6 Cleaning:

.1 If accumulation of dirt are evident on inspection, these should be removed with particular attention being given to the top and bottom of winding assemblies and ventilation ducts.

.2 Clean winding by using a vacuum cleaner and/or blower or compressed air.

.3 Lead or cable supports, tap changers, bushings and other insulating surfaces should be brushed clean or wiped clean with a lint free cloth.

.3 Insulation power factor test:

.1 Using capacitance bridge instrument, check insulation power factor of:

.1 Primary/secondary and ground
.2 Secondary/primary and ground.

.2 Record capacitance values, dissipation factor and insulation power factor. Compare field test results to manufacturer's factory test results.

.4 Ratio test:

.1 Carry out ratio test of windings in all tap positions to ensure accuracy to within 0.001 percent.

.2 Compare test data to factory test results.

.5 Insulation resistance:

.1 Using suitably sized Megger, measure resistance between:

.1 Primary and secondary
.2 Primary/secondary and ground
.3 Secondary/primary and ground.

.2 Compare test results to factory test data.

.6 Dielectric strength (DC hipot test for dry-type only 2.4 kV and above):

.1 DC hipot test utilizing the voltage step method as specified under "High voltage power cables (above 1000V)" in this Section. The maximum test
levels to be considered as the withstand and held for one minute. The
maximum test levels to be related to transformer BIL and voltage class as
follows but shall not exceed the AC test level as specified in CSA C9-
1981:

.1 25 kV class 125 kV BIL maximum test level 40 kV DC
.2 15 kV class 60 kV BIL maximum test level 30 kV DC
.3 15 kV class 95 kV BIL maximum test level 35 kV DC
.4 5k V class 30 kV BIL maximum test level 12 kV DC.

.7 Core ground test:
.1 Remove ground strap between laminated core and ground.
.2 Megger test using 250 volt megger (or size as recommended by
manufacturer) between core and ground to ensure no other grounds exist
between core and ground.
.3 Compare values to factory test values.
.4 Reconnect ground strap.

.8 Operational Test
.1 Energize transformers and apply incremental loads and document test
results.
.1 0% for 4 h.
.2 10% for next 1 h.
.3 25% for next 2 h.
.4 50% for next 3 h.
.5 At each load change, check temperature, ambient, enclosure,
ventilation air, windings.

3.3 MEDIUM VOLTAGE WIRING AND CABLES

.1 General:
.1 Test conductors at distribution centres and panel boards for insulation
resistance to ground (megger test).
.2 Test service grounding conductors for ground resistance.
.3 Provide Engineer with list of test results on approved verification form
showing location at which each test was made, circuit tested and results
of each test.
.4 Remove and replace entire length of cable if cable fails to meet any of the test criteria.

.2 Medium Voltage Power Cables (Above 1000 V)

.1 Cables shall be complete with all terminations and lugs and disconnected from component at both ends prior to Hipot test.

.2 Perform continuity and phasing tests prior to Hipot test.

.3 Dielectric strength, DC Hipot test

.1 Test electric strength of cables using the "step voltage" test method.

.2 Provide a safety man in addition to the testing technician.

.3 All tests to be applied between conductors and ground.

.4 Initial test level: 2 kV DC held for two minutes (Megger stabilization level).

.5 Second level: 5 kV DC held for five minutes (polarization level).

.6 All subsequent test levels: 5 kV DC increments for one minute at each level.

.7 Record current leakage values at each step.

.8 Final test level: to withstand level and held at constant voltage for 15 minutes. Record decay current at five minute intervals during this period. Plot decay curve-current versus time.

.4 Test data sheet to include the following:

.1 Table showing leakage current at each test level.

.2 Graph of applied test voltage versus leakage current.

.3 Cable data.

.4 Sketch of the part of the system in which cable is connected.

.5 Ambient conditions such as humidity and temperature.

.6 Date of test and signature of test technician.

.5 15 kV cable DC test levels
2 kV megger 2 minutes
5 kV polarization 5 minutes
10 kV 1 minute
15 kV 1 minute
20 kV 1 minute
25 kV 1 minute
30 kV 1 minute
35 kV 1 minute
40 kV 1 minute
45 kV 1 minute
50 kV 1 minute
55 kV 1 minute
55 kV withstand 15 minutes

3.4 MOLDED CASE SERVICE ENTRANCE AND DISTRIBUTION CENTRES – LOW VOLTAGE

.1 Enclosure:

.1 Visually inspect.

.2 Torque all bus connections to manufacturers requirements and seal with red lacquer.

.3 Megger test main bus at 1000 V.

.4 Check phasing and continuity of horizontal and vertical bus. This includes phasing and phase rotation of two incoming services or supplies.

.2 Wiring Checks:

.1 Check all control, relaying and instrumentation wiring against vendor wiring schematics, three line diagrams and project specifications.

.2 Test each circuit for continuity using a buzzer or similar device.

.3 All current circuits shall be injected, all voltage circuits shall be powered at 120 Volts, all devices functioned and checked against control schematic diagram.

.4 Check polarity and verify phase relationships on all three phase metering circuits.

.5 Where errors are discovered and changes are required, mark up and note required corrective action on vendor prints.
.3 Instrumentation:

.1 Test and calibrate all digital metering units in accordance with manufacturers bulletins.

.2 Check calibration on all ammeters using 5 Amp secondary injection test.

.3 Perform wiring checks as listed above.

.4 Breakers:

.1 Moulded Case Breakers 150 Amp Frame and larger and Molded Case Breakers 50 Amp and Larger Feeding Emergency Loads:

.1 Visually inspect.

.2 Ductor test.

.3 Megger test.

.4 Mechanical function test.

.5 Set all units with adjustable magnetic trip units.

.6 Where solid state protection is provided with large breakers, test units as follows:

.1 Inspect and test in accordance with manufacturer's most recent installation and maintenance brochure.

.2 Perform tests using manufacturer's relay test unit as applicable, with corresponding test instruction.

.3 If manufacturer's tester is not available, use an approved relay tester unit with proper test data and test accessories.

.4 Proof test each relay in its control circuit by simulated trip tests to ensure total and proper operation of breaker and relay trip circuit by injection of relay circuit to test trip operation.

.5 Check C/T and P/T ratios and compare to coordination data.

.5 Fused or Unfused Disconnect Switches:

.1 Visually inspect and clean.

.2 Ductor test across switch blade contact surfaces.
.3 Megger test.
.4 Mechanical function test.
.5 Verify fuse size and I.C. against drawings.

3.5 TRANSFORMERS – 300 kVA AND LARGER – LOW VOLTAGE

.1 Visual inspection of enclosure and all accessories.
.2 Torque test all bus connections and cable terminations and seal with red lacquer.
.3 Megger test.
.4 Dielectric power factor test.
.5 Core ground test.
.6 Ratio test in all tap positions.
.7 Test operation of temperature and operation of all associated alarm contacts.
.8

3.6 TRANSFORMERS – UNDER 300 kVA – LOW VOLTAGE

.1 Visual inspection of enclosure and all accessories.
.2 Torque test all bus connections and cable terminations.
.3 Megger test.
.4 Test operation of temperature gauge and operation of all associated alarm contacts.
.5

3.7 TRANSFER SWITCH – LOW VOLTAGE AUTOMATIC

.1 Torque test all bus joints and cable terminations and seal with red lacquer.
.2 Ductor test.
.3 Megger test.
.4 Apply device settings as specified.
.5 Perform phase match test to assure that load phase rotation remains the same when switch is in either position.

.6 Test transfer switch operation under load and record results.

3.8 PROTECTIVE RELAYING

.1 Set and test protective relays to settings provided in coordination study.

.2 The manufacturer's instructions for specific relay must always be used for information concerning connections, adjustments, repairs, timing and data.

.3 Microprocessor Type Relays:

(Spec Note: these devices are not often used. They are relays connected to PC's and usually are used for protection but also for data collection and analysis.)

.1 Mechanical Inspection:

.1 Remove cover from relay case carefully. Trip circuit is live circuit and on some relays it is possible to cause an instantaneous trip while removing relay cover. Inspect cover gasket. Check glass for tightness and cracks.

.2 Eliminate unwanted tripping, short-circuit current transformer secondary by careful removal of relay test plug or operation of appropriate current blocks.

.3 Check connections, circuit boards and modules for tightness.

.4 Check output relay coils for signs of overheating and brittle insulation.

.2 Cleaning:

.1 Clean glass inside and out.

.2 Clean relay compartment as required. Clean relay plug in contacts if applicable, using proper tools.

.3 Remove dust and foreign materials from interior of relay using small brush or low pressure 3.2 kg blower of nitrogen.

.4 Inspect for any signs of moisture and corrosion.

.5 Clean relay output contacts with burnishing tool or non-residue contact cleaner.
.3 Electrical Testing: Function Tests for typical overcurrent relays include:

.1 Energize relay from an appropriate DC power source and check "ON" indication.

.2 Time-current function test and trip flag operation.

.3 Instantaneous pickup functional trip and flag operation.

.4 Use tests listed above for most microprocessor overcurrent type relays.

.5 Check C/T and P/T ratios and compare to coordination data.

.4 Solid State Relays:

(Spec Note: these are more common, protection relays in use on the majority of the projects.)

.1 Mechanical Inspection:

.1 Remove cover from relay case carefully. Trip circuit is live circuit and on some relays it is possible to cause an instantaneous trip while removing relay cover. Inspect cover gasket. Check glass for tightness and cracks.

.2 Eliminate unwanted tripping, short-circuit current transformer secondary by careful removal of relay test plug or operation of appropriate current blocks.

.3 Check connections, circuit boards and modules for tightness.

.4 Check output relay coils for signs of overheating and brittle insulation.

.2 Inspect and test in accordance with manufacturer's most recent installation and maintenance brochure.

.3 Perform tests using manufacturer's relay test unit as applicable, with corresponding test instructions.

.4 If manufacturer's tester is not available, use an approved relay tester unit with proper test data and test accessories.

.5 Proof test each relay in its control circuit by simulated trip tests to ensure total and proper operation of breaker and relay trip circuit by injection of relay circuit to test the trip operation.
.6 Check C/T and P/T ratios and compare to coordination data.

3.9 BRANCH CIRCUIT WIRING IN PATIENT CARE AREAS

.1 Testing

[(Choose One) Owner] [Division 16] will retain the services of an independent testing agent to perform tests of the system as specified and as required by CAN 5/CSA-Z32.2.

.1 Scope

.1 It is the intent of this section of the testing specifications to provide clarification and further detail relative to the testing requirements.

.2 Patient care area receptacle testing as further detailed herein is intended to verify integrity of electrical services for patient care and treatment facilities. The testing to be performed by the Testing personnel will confirm acceptability of the final electrical installations in patient care areas and be used as a basis for routine repeated testing required by the Canadian Standard CAN/CSA-Z32.2-M89, Electrical Safety in Patient Care Areas.

.3 Patient care areas are classified as basic, intermediate or critical care areas generally corresponding to casual, external and internal contact procedures respectively.

.4 Risk classified patient rooms may contain at least one housekeeping or convenience outlet in addition to the patient care outlets. Housekeeping/convenience outlets do not require testing. Confirmation of specific outlets to be tested can be obtained from the Consulting Engineer.

.5 The testing procedures are NOT to be considered as part of the installation process but rather the basic purpose is to ensure performance of the system with all components in their proper place physically and electrically. The tests are performed only after the electrical trade has achieved a fully operational system (all devices installed, all wiring terminated, circuits energized, panel directories installed, and as-built drawings complete). To this end Division 16 will provide as-built drawings to the Testing personnel prior to start of the work.

.6 On the first day of testing for each of the referenced tests, the test equipment, configuration and procedure shall be reviewed on site by the Consulting Engineer. The testing personnel shall
satisfactorily demonstrate the actual testing procedure and sequence, including documentation of results for approval prior to beginning the testing. To this end, the Testing personnel shall notify the Consulting Engineer as to the scheduled start of testing.

.7 After initial demonstration, testing will be witnessed by the Consulting Engineer or his representatives on a non-continuous or spot-check basis.

.8 Work of testing personnel is to provide test data for every device in patient care areas. Where initial testing indicates a requirement for simple corrective action by contractor (non-operation of device, incorrect polarity, inadequate retentive force, etc.) testing personnel to immediately bring such deficiencies to the attention of the Consulting Engineer and to retest and document the corrected values when contractor completes the corrections.

.9 Prior to commencing testing, testing personnel shall verify circuits and circuit designations. Verify that lamicoids for emergency and housekeeping circuits in patient care areas are correct. Check panel directories and verify that circuit designations on “as-built” drawings are correct. Note that verification of circuit designation must precede testing since test results for each device are referenced by panel and circuit number.

.10 Prior to commencing test, submit samples test data forms to be used to the consulting engineer for review. Initials of testing technicians performing the test and the date of testing to be entered on each form.

.11 After completion of testing and provision of preliminary completed forms to the Consulting Engineer for evaluation, the Consulting Engineer will arrange for circuit and/or wiring corrections. After correction, the device must be retested.

.12 All test forms to contain a section for identifying circuit and device under test which must be completed by the testing personnel. The first component of this information is a room or area designation, while the second portion of identification reference is panel and circuit number which supplies the device under test.

.13 Another column on test form is to be provided for a location description such as north wall, south wall, above counter, etc. The intent is that the identification information provided on test form by testing personnel must relate to a specific device location to prevent confusion where several outlets are on same circuit in same area. Note that two columns are to be provided on form for
room number; one being for numbering system in use on construction and risk classification drawings and the other for later entry by Owner of a separate owner room numbering system.

.14 The final written report to be submitted by the testing personnel will provide a summary of the results of the testing and notification of general acceptability and violations. The final report to contain all test data sheets organized in logical grouping consistent with the flow of testing work through the building.

.2 Patient Care Area Testing

.1 General

.1 Receptacle and branch circuit wiring testing requirements for this contract consist of separate and distinct tests to be applied to electrical services for patient care areas.

.2 Each line of test data is to be followed by a line space to allow easy readability of the data and provide an entry location for subsequent testing after corrections have been completed where required.

.3 Acceptability criteria for each test is provided in the test documentation. Identify all violations against these criteria and highlight same for the owner’s attention by blacking in the revision date column on that data line. When corrections have been made and a subsequent retest proves satisfactory for the failed device or circuit, final test data is to be entered in the space afforded by the following empty line on the test form. The revision date is then entered in the revision date column.

.2 Measurement Instrumentation

.1 All measurements of voltages and currents to be made using high impedance, high accuracy digital meters.

.2 Voltmeters used in branch circuit impedance, rate of rise, and potential difference testing to be of high accuracy or be precisely calibrated such that measurement accuracy is greater than ±1/4% of the measured value, to have an input impedance greater than 150 kilo-ohms and to comply with CSA Standard C22.2, No. 125. Ammeters to have sufficiently high accuracy to maintain measured voltages within ±1/4% accuracy rating.
.3 Provide separate sensing leads for all voltage measurements so as to place the measurement at the exact point in the circuit where the voltage is to be measured. This will eliminate the measurement errors created by additional voltage drops in current carrying conductors.

.4 Voltage sensing leads are to be routed separately (physical placement) from current carrying conductors. Parallel conductor configurations (current carrying and voltage sensing) are disallowed because of the measurement errors generated by mutual inductance.

.5 Measurements not to be taken when meters are in proximity to a source of radio frequency interference such as portable radios. Where permanent equipment could generate such interference and affect measured values of digital meters, the testing personnel to make arrangements to minimize the potential for interference.

.3 Verification of Branch Circuit Designation

.1 To verify correctness of panelboard and branch circuit designations as shown on “as-built” drawings, panelboard directories, and where applicable lamicoid labelling.

.2 This verification is to be done for all patient care circuits in patient care areas.

.3 Within each room de-energize one circuit at a time and verify that the referenced devices have been de-energized. A standard polarity tester (herein) or a plug-in lamp fixture or radio should be used to prove loss of power. Subsequently, re-energize the circuit and verify that power is restored.

.4 Ensure that the panel and circuit designation is correct on the “as-built” set of drawings and all lamicoid labels provided. Check the panelboard directory to ensure description is correct for each circuit.

.5 Notify the Consulting Engineer immediately of any deviation from indicated designation and subsequently re-verify any circuits requiring wiring corrections.

.6 Provide, in report form, a listing of all deviations from indicated designation. The listing shall reference indicated
designations (from drawing and labelling) and actual “found” circuit designation. Provide a marked up set of prints to the Consulting Engineer showing any changes in designation (after correction) from the information indicated on the “as-built” drawings.

.4 Branch Circuit Wiring In Patient Care Areas (From CAN/CSA-Z32.-99 “Electrical Safety in Patient Care Areas”)

.1 Conductor Insulation Integrity Test:

.1 Measure each branch circuit supplied by a grounded system with all wiring devices (receptacles, switches, etc.) connected. Each circuit shall have an insulation resistance for all grounded conductors to ground of not less than 10 kOhm and all ungrounded conductors to ground of not less than 500 kOhm.

.2 The resistance shall be measured using a Megger with an open circuit voltage of 500 VDC.

.2 Branch Circuit Voltage Drop Test

.1 Refer to Detail 16072.01. Connect the test circuit as shown to outlet. Ensure all connected equipment is disconnected from the circuit.

.2 Apply a load of 80% of rated current of circuit between the receptacle poles for a period of 1 to 15 seconds.

.3 Record current I, and terminal voltage underload as VL.

.4 Open the switch SW and immediately record the terminal voltage without load as Vo.

.5 Voltage drop (Vo – VL) shall not exceed 5% of Vo.

.6 All results to be recorded on data forms provided by Owner.

.7 Circuit Breaker – Mechanical Operation: With the breaker loads off or disconnected, switch the breaker On and Off at least three times in succession.
.3 Receptacle Polarity and Retentive Force Tests:

.1 Polarity Test

.1 The polarity connection is correct, i.e., the neutral and “live” conductors are connected to the silver and brass screws respectively in grounded circuits, and the orange and brown conductors are connected to the silver and brass screws respectively in isolated circuits.

.2 The bonding conductor is connected to the outlet box bonding screw.

.3 A bonding jumper connects the ground pin of the receptacle to the outlet box bonding screw.

.2 Retentive Force Test

.1 All non-locking receptacles in Patient Care Areas shall resist removal of a test pin and test plug as required by CSA Standard C22.2 No. 42 by a pull of up to 1.1 N (125 g) using a round test pin in the ground slot and 13.3 N (1365 g) using a two pin test plug.

.2 Conformance to the above requirements shall be verified using a test probe or plug described in CSA Standard C22.2 No. 42.

.4 Voltage (Potential) Difference Between Ground Points

.1 Refer to detail 16072.02. Perform test procedure as follows:

.1 Confirm that all receptacles have been installed and that no utilization equipment, either permanently installed or cord-connected, is connect to the system.

.2 Energize the system.

.3 Select a local reference point known to be bonded to ground and record the measured voltage between this chosen reference and
each receptacle ground pole and each exposed conductive non-current carrying metal part in turn. If the test leads are long, the readings should be corrected for pickup (zero reading) when connected together.

.2 The maximum potential difference between grounding poles of all receptacles at a patient care location and between these poles and all other exposed conductive non-current carrying parts at the same patient care location, when tested as required by Clause 8.9.2 of CAN/CSA-Z32.2-M89, shall be less than 20 mV.

.5 Ground Return Path Voltage Rise for Grounded Systems

.1 Refer to detail 16072.03. Perform test procedure as follows:

.1 Connect the test circuit to the outlet.

.2 With switch SW open, record the voltage indicated by voltmeter V1 and VN, the neutral to ground voltage without load. If it exceed approximately 2 V, determine the cause and correct the defect.

.2 Using the low voltage supply, (nominally 5 V open circuit) apply a load of 80% of the rated current of the circuit, between the neutral and the bonding conductor for a period of from 1 to 5 s. To ensure accuracy, the low voltage supply should be energized from a circuit other than the one being tested.

.3 Record the current I and the voltage indicated by voltmeter V2 as V0. The return path voltage rise VO shall be not greater than 3 V.

3.10 FIRE ALARM VERIFICATION

.1 The owner will retain the services of a verification agent to direct verification of the fire alarm system in accordance with:

.1 CAN/ULC-5537-96 “Verification of Fire Alarm System Installations”.
.2 Alberta Labour General Safety devices Services Division “Fire Alarm Systems Manual, Revision 8”.

.3 Requirements of authority having jurisdiction.

END OF SECTION