1. SCOPE OF WORK

.1 Work under this contract covers the high voltage transformer replacement in the Council's Building M55 of the National Research Council.

2. DRAWINGS

.1 The following drawings illustrate the work and form part of the contract documents:

5104-E01 SINGLE LINE DIAGRAM AND FLOOR PLAN

3. COMPLETION

.1 Complete all work within 16 week(s) after receipt of notification of acceptance of tender.

4. GENERAL

.1 The word "provide" in this Specification means to supply and install.

.2 Provide items mentioned in either the drawings or the specification.

5. SPECIFIED ACCEPTABLE & ALTERNATIVE EQUIPMENT & MATERIALS

.1 Materials and equipment scheduled and/or specified on the drawings or in the specifications have been selected to establish a performance and quality standard. In most cases, acceptable manufacturers are stated for any material or equipment specified by manufacturer's name and model number. Contractors may base their tender price on materials and equipment supplied by any of the manufacturers' names as acceptable for the particular material or equipment.

.2 In addition to the manufacturers specified or named as acceptable, you may propose alternative manufacturers of materials or equipment to the Departmental Representative for acceptance. For a product to be considered as an alternative product substitute, make a written application to the Departmental Representative during the tender period, not later than ten (10) working days before tender closing.

.3 Certify in writing that the alternative meets all requirements of the specified material or equipment. In addition, it shall be understood that all costs required by or as a result of acceptance or proposed alternatives, will be borne by the contractor.

.4 Approval of alternatives will be signified by issue of an Addendum to the Tender Documents.

.5 Any alternative manufacturers or materials submitted which are incomplete and cannot be evaluated, or are later than ten (10) working days before tender closing date or after the tender period, will not be considered.

6. MINIMUM STANDARDS

.1 Conform to or exceed minimum acceptable standards of the various applicable federal, provincial and municipal codes such as The National Building Code, The National Fire Code, Canadian Plumbing Code, Canadian Electrical Code, Canadian Code for Construction Safety and the Provincial Construction Safety Act.

.2 Work to conform to referenced standards and codes as reaffirmed or revised to date of specification.

7. WORKPLACE HAZARDOUS MATERIAL INFORMATION SYSTEM (WHMIS)

.1 The general contractor shall comply with Federal and Provincial legislation regarding the WHMIS. The contractor's responsibilities include, but are not limited to the following:

.1 To ensure that any controlled product brought on site by the contractor or sub-contractor is labeled;

.2 To make available to the workers and the Departmental Representative, Material Safety Data Sheets (MSDS) for these controlled products;

.3 To train own workers about WHMIS, and about the controlled products that they use on site;

.4 To inform other contractors, sub-contractors, the Departmental Representative, authorized visitors and outside inspection agency personnel about the presence and use of such products on the site.

.5 The site foreman or superintendent must be able to demonstrate, to the satisfaction of the Departmental Representative, that he/she has had WHMIS training and is knowledgeable in its requirements. The Departmental Representative can require

replacement of this person if this condition or implementation of WHMIS is not satisfactory.

8. REQUIREMENTS OF BILL 208, SECTION 18(a)

Under the requirements of Bill 208 of the Ontario Ministry of Labour Occupational Health & Safety Act, the following designated substances may be encountered while performing the work described in these contract documents:

.1 Acrylonitrile, Isocyanates, Arsenic, Lead, Asbestos, Mercury, Benzene, Silica, Coke Oven Emissions, Vinyl Chloride, and Ethylene Oxide

.1 It is the responsibility of the general contractor to ensure that each prospective subcontractor for this project has received a copy of the above list.

.2 The general contractor is advised to take the following precautions when dealing with the above substances:

9. COST BREAKDOWN

.1 Submit, for approval by the Departmental Representative, a cost breakdown of tender 72 hours after the contract is awarded.

.2 Use the approved cost breakdown as the basis for submitting all claims.

.3 Request Departmental Representative's verbal approval to amount of claim prior to preparing and submitting the claim in its final form.

10. SUB-TRADES

.1 Submit no later than 72 hours after tender closing, a complete list of sub trades for the Departmental Representative's review.

11. PERSONNEL SECURITY AND IDENTIFICATION

.1 All persons employed by the contractor, or by any subcontractor and present on the site must be security cleared in accordance with the requirements of the Section entitled Special Instructions to Tenderers.

.2 All such persons must wear and keep visible identification badges as issued by the Security Office of NRC.

12. WORKING HOURS AND SECURITY

.1 Normal working hours on the NRC property are from 8:00 a.m. until 4:30 p.m., Monday to Friday inclusive, except statutory holidays.

.2 At all other times, special written passes are required for access to the building site.

~~.3~~ Before scheduling any work outside normal working hours, obtain permission from the Departmental Representative to perform the specific tasks.

.4 An escort may be required whenever working outside normal hours. Contractor to bear the associated costs.

13. SCHEDULE

.1 The contractor shall prepare a detailed schedule, fixing the date for commencement and completion of the various parts of the work and update the said schedule. Such schedule shall be made available to the Departmental Representative not later than two weeks after the award of the contract and prior to commencement of any work on site.

.2 Notify Departmental Representative in writing of any changes in the schedule.

.10 day(s) before the scheduled completion date, arrange to do an interim inspection with the Departmental Representative.

14. PROJECT MEETINGS

.1 Hold regular project meetings at times and locations approved by the Departmental Representative.

.2 Notify all parties concerned of meetings to ensure proper coordination of work.

.3 Departmental Representative will set times for project meetings and assume responsibility for recording and distributing minutes.

15. SHOP DRAWINGS

.1 Submit to Departmental Representative for review, shop drawings, product data and samples specified within 2 week(s) after contract award.

.2 Submit to Departmental Representative for review a complete list of all shop drawings, product data and samples specified and written confirmation of corresponding delivery dates within one (1) week after shop drawings, product data and samples approval date. This list shall be updated on a TWO week basis and any changes to the list shall be immediately notified in writing to the Departmental Representative.

.3 Review shop drawings, data sheets and samples prior to submission.

.4 Submit electronic copy of all shop drawings and product data and samples for review, unless otherwise specified.

.5 Review of shop drawings and product data by the Departmental Representative does not relieve the contractor of the responsibility for errors and omissions and for the conformity with contract documents.

16. SAMPLES AND MOCK-UPS

.1 Submit samples in sizes and quantities as specified.

.2 Where colour, pattern or texture is criterion, submit full range of samples.

.3 Construct field samples and mock-ups at locations acceptable to Departmental Representative.

.4 Reviewed samples or mock-ups will become standards of workmanship and material against which installed work will be checked on the project.

17. MATERIALS AND WORKMANSHIP

.1 Install only new materials on this project unless specifically noted otherwise.

.2 Only first class workmanship will be accepted, not only with regard to safety, efficiency, durability, but also with regard to neatness of detail and performance.

18. WORK & MATERIALS SUPPLIED BY OWNER

.1 Work and materials not included in this contract are described on drawings and in this specification.

.2 Deliver to a storage place, as directed by the Departmental Representative, all materials returned to the Owner.

.3 Unless otherwise specified, accept owner-supplied materials at their storage location and provide all transportation as required.

.4 General Contractor's duties:

.1 Unload at site.

.2 Promptly inspect products and report damaged or defective items.

.3 Give written notification to the Departmental Representative for items accepted in good order.

.4 Handle at site, including uncrating and storage.

.5 Repair or replace items damaged on site.

.6 Install, connect finished products as specified.

19. SITE ACCESS

.1 Make prior arrangements with the Departmental Representative before starting work or moving materials and equipment on site.

.2 Obtain approval of Departmental Representative for regular means of access during the construction period.

.3 Obtain approval of Departmental Representative before temporarily suspending operations on site; before returning to the site and before leaving the site at the end of the job.

.4 Provide and maintain access to site.

.5 Build and maintain temporary roads and provide snow removal during period of work.

.6 Make good any damage and clean up dirt, debris, etc., resulting from contractor's use of existing roads.

20. USE OF SITE

.1 Restrict operations on the site to the areas approved by the Departmental Representative

.2 Locate all temporary structures, equipment, storage, etc., to the designated areas.

.3 Restrict parking to the designated areas.

21. ACCEPTANCE OF SITE

.1 Inspect the site before commencing work, review any unexpected conditions with the Departmental Representative.

.2 Commencement of work will imply acceptance of existing conditions.

22. SITE OFFICE & TELEPHONE

.1 Contractor to erect a temporary site office at his own expense.

.2 Install and maintain a telephone, if necessary.

.3 Use of NRC phones is not permitted unless in the case of an emergency.

23. SANITARY FACILITIES

.1 Obtain permission from the Departmental Representative to use the existing washroom facilities in the building.

24. TEMPORARY SERVICES

.1 A source of temporary power will be made available in the area. Bear all costs to make connections to the power source and perform distribution on site.

.2 Provide all load centres, breakers, conduit, wiring, disconnects, extension cords, transformers, as required from the source of power.

.3 Power is to be used only for power tools, lighting, controls, motors, and not for space heating.

.4 A source of temporary water will be made available if required.

.5 Bear all costs associated with distributing the water to the required locations.

.6 Comply with NRC requirements when connecting to existing systems in accordance with the articles entitled "Co-operation" and "Service Interruptions" of this section.

25. DOCUMENTS REQUIRED AT WORK SITE

.1 The contractor shall keep on the site, one (1) up-to-date copy of all contract documents, including specifications, drawings, addenda, shop drawings, change notices, schedule and any reports or bulletins pertaining to the work, in good order, available to the Departmental Representative and to his / her representatives at all times.

.2 At least one (1) copy of specifications and drawings shall be marked by the contractor to show all work "As Built" and shall be provided to the Departmental Representative with the Application for Payment and for the Final Certificate of Completion.

26. CO-OPERATION

.1 Co-operate with NRC staff in order to keep disruption of normal research work to an absolute minimum.

.2 Work out in advance, a schedule for all work which might disrupt normal work in the building.

.3 Have schedule approved by the Departmental Representative.

.4 Notify the Departmental Representative in writing, 72 hours prior to any intended interruption of facilities, areas, corridors, mechanical or electrical services and obtain requisite permission.

27. PROTECTION AND WARNING NOTICES

.1 Provide all materials required to protect existing equipment.

.2 Erect dust barriers to prevent dust and debris from spreading through the building.

.3 Place dust protection in the form of cover sheets over equipment and furniture and tape these sheets to floors, to ensure no dust infiltration.

.4 Repair or replace any and all damage to Owner's property caused during construction, at no cost to the Owner and to the satisfaction of the Departmental Representative.

.5 Protect the buildings, roads, lawns, services, etc. from damage which might occur as a result of this work.

.6 Plan and co-ordinate the work to protect the buildings from the leakage of water, dust, etc.

.7 Ensure that all doors, windows, etc., that could allow transfer of dust, noise, fumes, etc., to other areas of the building are kept closed.

.8 Be responsible for security of all areas affected by the work under the Contract until acceptance by NRC. Take all necessary precautions to prevent entry to the work area by unauthorized persons and guard against theft, fire and damage by any cause. Secure working area at the end of each day’s work and be responsible for same.

.9 Provide and maintain adequate safety barricades around the work sites to protect NRC personnel and the public from injury during the construction.

.10 Post warnings, in all instances where possible injury could occur such as Work Overhead, Hard Hat Areas, etc. or as required by the Departmental Representative.

.11 Provide temporary protective enclosures over building entrances and exits to protect pedestrians. All enclosures to be structurally sound against weather and falling debris.

28. BILINGUALISM

.1 Ensure that all signs, notices, etc. are posted in both official languages.

.2 Ensure that all identification of services called for by under this contract are bilingual.

29. LAYOUT OF WORK

.1 Location of equipment, fixtures, outlets and openings indicated on drawings or specified are to be considered as approximate.

.2 Locate equipment, fixtures and distribution systems to provide minimum interference and maximum usable space and in accordance with the manufacturer’s recommendations for safety, access and maintenance.

.3 Employ competent person to lay out work in accordance with the contract documents.

30. DISCREPANCIES & INTERFERENCES

.1 Prior to the start of the work, examine drawings and specifications. Report at once to the Departmental Representative, any defects, discrepancies, omissions or interferences affecting the work.

.2 Contractor to immediately inform the Departmental Representative in writing, of any discrepancies between the plans and the physical conditions so the Departmental Representative may promptly verify same.

.3 Any work done after such a discovery, until authorized, is at the contractor's risk.

.4 Where minor interferences as determined by the Departmental Representative are encountered on the job and they have not been pointed out on the original tender or on the plans and specifications, provide offsets, bends or reroute the services to suit job conditions at no extra cost.

.5 Arrange all work so as not to interfere in any way with other work being carried out.

31. MANUFACTURER'S INSTRUCTIONS

.1 Unless otherwise specified, comply with manufacturer's latest printed instructions for materials and installation methods.

.2 Notify the Departmental Representative in writing of any conflict between these specifications and manufacturer's instruction. Departmental Representative will designate which document is to be followed.

32. TEMPORARY HEATING AND VENTILATING

.1 Bear the costs of temporary heat and ventilation during construction including costs of installation, fuel, operation, maintenance, and removal of equipment.

.2 Use of direct-fired heaters discharging waste products into the work areas will not be permitted unless prior approval is given by the Departmental Representative.

.3 Furnish and install temporary heat and ventilation in enclosed areas as required to:

.1 Facilitate progress of work.

.2 Protect work and products against dampness and cold.

.3 Reduce moisture condensation on surfaces to an acceptable level.

.4 Provide ambient temperature and humidity levels for storage, installation and curing of materials.

.5 Provide adequate ventilation to meet health regulations for a safe working environment.

.4 Maintain minimum temperature of 10 ^{o}C (50 ^{o}F) or higher where specified as soon as finishing work is commenced and maintain until acceptance by the Departmental Representative. Maintain ambient temperature and humidity levels as required for comfort of NRC personnel.

.5 Prevent hazardous or unhealthy accumulations of dust, fumes, mists, vapours or gases in areas occupied during construction including also, storage areas and sanitary facilities.

.1 Dispose of exhaust materials in a manner that will not result in a harmful or unhealthy exposure to persons.

.6 Maintain strict supervision of operation of temporary heating and ventilating equipment.

.1 Enforce conformance with applicable codes and standards.

.2 Comply with instructions of the Departmental Representative including provision of full-time watchman services when directed.

.3 Enforce safe practices.

.4 Vent direct-fired combustion units to outside.

.7 Submit tenders assuming existing or new equipment and systems will not be used for temporary heating and ventilating.

.8 After award of contract, Departmental Representative may permit use of the permanent system providing agreement can be reached on:

.1 Conditions of use, special equipment, protection, maintenance, and replacement of filters.

.2 Methods of ensuring that heating medium will not be wasted and in the case of steam, agreement on what is to be done with the condensate.

.3 Saving on contract price.

.4 Provisions relating to guarantees on equipment.

33. CONNECTIONS TO AND INTERRUPTIONS TO EXISTING SERVICES

.1 Where work involves breaking into or connecting to existing services, carry out work at times and in the manner agreed to by the Departmental Representative and by authorities having jurisdiction, with minimum disruption to NRC Personnel and vehicular traffic and minimum service interruption. Do not operate any NRC equipment or plant.

.2 Before commencing work, establish location and extent of service lines in area of work and notify Departmental Representative of findings.

.3 Submit a schedule to and obtain approval from the Departmental Representative for any shut-down or closure of active service or facility; allow minimum 72 hours notice. Adhere to approved schedule and provide notice to the Departmental Representative.

.4 Where unknown services are encountered, immediately advise Departmental Representative and confirm findings in writing.

.5 Provide detours, bridges, alternate feeds, etc., as required to minimize disruptions.

.6 Protect existing services as required and immediately make repairs if damage occurs.

.7 Remove any abandoned service lines as indicated on the contract documents and as approved by the Departmental Representative; cap or otherwise seal lines at cut-off points. Record and provide a copy to the Departmental Representative of locations of maintained, re-routed and abandoned service lines.

34. CUTTING AND PATCHING

.1 Cut existing surfaces as required to accommodate new work.

.2 Remove all items as shown or specified.

.3 Patch and make good with identical materials, the surfaces that have been disturbed, cut or damaged, to the satisfaction of the Departmental Representative.

.4 Where new pipes pass through existing construction, core drill an opening. Size openings to leave 12mm (1/2") clearance around the pipes or pipe insulation. Do not drill or cut any surface without the approval of the Departmental Representative.

.5 Obtain written approval of the Departmental Representative before cutting openings through existing or new structural members.

.6 Seal all openings where cables, conduits or pipes pass through walls with an acoustic sealant conforming to CAN/CGSB-19.21-M87.

.7 Where cables, conduits and pipes pass through fire rated walls and floors, pack space between with compressed glass fibres and seal with fire stop caulking in accordance with CAN/CGSB-19.13-M87 AND NBC 3.1.7.

35. FASTENING DEVICES

.1 Do not use explosive actuated tools, without first obtaining permission from the Departmental Representative.

.2 Comply with the requirements of CSA A-166 (Safety Code for Explosive Actuated Tools).

.3 Do not use any kind of impact or percussion tool without first obtaining permission from the Departmental Representative.

36. OVERLOADING

.1 Ensure that no part of the building or work is subjected to a load which will endanger safety or cause permanent deformation or structural damage.

37. DRAINAGE

.1 Provide temporary drainage and pumping as required to keep excavations and site free of water.

38. ENCLOSURE OF STRUCTURES

.1 Construct and maintain all temporary enclosures as required to protect foundations, sub-soil, concrete, masonry, etc., from frost penetration or damage.

.2 Maintain in place until all chances of damage are over and proper curing has taken place.

.3 Provide temporary weather tight enclosures for exterior openings until permanent sash and glazing and exterior doors are installed.

.4 Provide lockable enclosures as required to maintain the security of NRC facilities and be responsible for the same.

.5 Provide keys to NRC security personnel when required.

.6 Lay out the work carefully and accurately and verify all dimensions and be responsible for them. Locate and preserve general reference points.

.7 Throughout the course of construction, keep continuously acquainted with field conditions, and the work being developed by all trades involved in the project. Maintain an awareness of responsibility to avoid space conflict with other trades.

.8 Conceal all services, piping, wiring, ductwork, etc., in floors, walls or ceilings except where indicated otherwise.

39. STORAGE

.1 Provide storage as required to protect all tools, materials, etc., from damage or theft and be responsible for the same.

.2 Do not store flammable or explosive materials on site without the authorization of the Departmental Representative.

40. GENERAL REVIEW

.1 Periodic review of the contractor's work by the Departmental Representative does not relieve the contractor of the responsibility of making the work in accordance with contract documents. Contractor shall carry out his own quality control to ensure that the construction work is in accordance with contract documents.

.2 Inform the Departmental Representative of any impediments to the installation and obtain his / her approval for actual location.

41. INSPECTION OF BURIED OR CONCEALED SERVICES

.1 Prior to concealing any services that are installed, ensure that all inspection bodies concerned, including NRC, have inspected the work and have witnessed all tests. Failure to do so may result in exposing the services again at the contractor's expense.

42. TESTING

.1 On completion, or as required by local authority inspectors and/or Departmental Representative during progress of work and before any services are covered up and flushing is complete, test all installations in the presence of the Departmental Representative.

.2 Obtain and hand to the Departmental Representative all acceptance certificates or test reports from authority having jurisdiction. The project will be considered incomplete without the same.

43. PARTIAL OCCUPANCY

.1 NRC may request partial occupancy of the facility if the contract extends beyond the expected completion date.

.2 Do not restrict access to the building, routes, and services.

.3 Do not encumber the site with materials or equipment.

44. DISPOSAL OF WASTES

.1 Dispose of waste materials including volatiles, safely off NRC property. Refer to the section entitled "General and Fire Safety Requirements" included as part of this specification.

45. CLEAN-UP DURING CONSTRUCTION

.1 On a daily basis, maintain project site and adjacent area of campus including roofs, free from debris and waste materials.

.2 Provide on-site dump containers for collection of waste materials and rubbish.

46. FINAL CLEAN-UP

.1 Upon completion do a final clean-up to the satisfaction of the Departmental Representative.

.2 Clean all new surfaces, lights, existing surfaces affected by this work, replace filters, etc.

.3 Clean all resilient flooring and prepare to receive protective finish. Protective finish applied by NRC

47. WARRANTY AND RECTIFICATION OF DEFECTS IN WORK

.1 Refer to General Conditions "C", section GC32.

.2 Ensure that all manufacturers' guarantees and warranties are issued in the name of the **General** Contractor and the National Research Council.

48. MAINTENANCE MANUALS

.1 Provide three (3) bilingual copies of maintenance manuals or two English and two French maintenance manuals immediately upon completion of the work and prior to release of holdbacks.

.2 Manuals to be neatly bound in hard cover loose leaf binders.

.3 Manuals to include operating and maintenance instructions, all guarantees and warranties, shop drawings, technical data, etc., for the material and apparatus supplied under this contract.

END OF SECTION

1. GENERAL CONSTRUCTION SAFETY REQUIREMENTS

.1 The Contractor shall take all necessary steps to protect personnel (workers, visitors, general public, etc.) and property from any harm during the course of the contract.

.2 The Contractor shall be solely responsible for the construction safety of both its employees and those of its sub-contractors at the work site, and for initiating, maintaining and supervising safety precautions, programs and procedures in connection with the performance of the work.

.3 The Contractor shall comply with all Federal, Provincial and Municipal safety codes and regulations and the Occupational Health and Safety Act and the Workplace Safety and Insurance Board. In the event of any conflict between any provisions in legislation or codes, the most stringent provisions shall apply.

.4 Periodic review of the contractor's work by the Departmental Representative, using the criteria of the contract documents, does not relieve the contractor of his safety responsibilities in carrying out the work in accordance with the contract documents. The contractor shall consult with the Departmental Representative to ensure that this responsibility is carried out.

.5 The Contractor shall ensure that only competent personnel are permitted to work on site. Throughout the term of the contract, any person will be removed from the site who is not observing or complying with the safety requirements.

.6 All equipment shall be in safe operating condition and appropriate to the task.

.7 Following a project and site hazard assessment, the Contractor shall develop a Site Specific Safety Plan based on the following minimum requirements:

.1 Provide a safety board mounted in a visible location on the project site, with the following information included thereon:

- .1 Notice of Project
- .2 Site specific Safety Policy
- .3 Copy of Ontario Health and Safety Act
- .4 Building Schematic showing emergency exits
- .5 Building emergency procedures
- .6 Contact list for NRC, Contractor and all involved sub-contractors
- .7 Any related MSDS sheets
- .8 NRC Emergency phone number

.8 The Contractor shall provide competent personnel to implement its safety program and those of any Health and Safety Act legislation applicable at this project location, and to ensure they are being complied with.

.9 The Contractor shall provide safety orientation to all its employees as well as those of any subcontractors under its jurisdiction.

.10 The Departmental Representative will monitor to ensure that safety requirements are met and that safety records are properly kept and maintained. Continued disregard for safety standards can cause the contract to be cancelled and the Contractor or sub-contractors removed from the site.

.11 The Contractor will report to the Departmental Representative and jurisdictional authorities, any accident or incident involving Contractor or NRC personnel or the public and/or property arising from the Contractor's execution of the work.

.12 If entry to a laboratory is required as part of the work of the Contractor, a safety orientation shall be provided to all his employees as well as those of any subcontractors regarding lab safety requirements and procedures, as provided by the Researcher or the Departmental Representative.

2. FIRE SAFETY REQUIREMENTS

.1 Authorities

1. The Fire Commissioner of Canada (FC) is the authority for fire safety at NRC.
2. For the purpose of this document, "Departmental Representative" will be deemed as the NRC person in charge of the project and who will enforce these Fire Safety Requirements.
3. Comply with the following standards as published by the Office of the Fire Commissioner of Canada:
    a. Standard No. 301 - June 1982 "Standard for Construction Operations";
    b. Standard No. 302 - June 1982 "Standard for Welding and Cutting".

.2 Smoking

.1 Smoking is prohibited inside all NRC buildings, as well as roof areas.

.2 Obey all "NO SMOKING" signs on NRC premises.

.3 Hot Work

.1 Prior to commencement of any "Hot Work" involving welding, soldering, burning, heating, use of torches or salamanders or any open flame, obtain a Hot Work Permit from the Departmental Representative.

.2 Prior to commencement of "Hot Work", review the area of hot work with the Departmental Representative to determine the level of fire safety precautions to be taken.

.4 Reporting Fires

.1 Know the exact location of the nearest Fire Alarm Pull Station and telephone, including the emergency phone number.

.2 REPORT immediately, all fire incidents as follows:

.1 Activate nearest fire alarm pull station and;

.2 Telephone the following emergency phone number as appropriate:

FROM AN NRC PHONE	**333**
FROM ANY OTHER PHONE	**(613) 993-2411**

4. When reporting a fire by phone, give the location of fire, building number and be prepared to verify location.
5. The person activating fire alarm pull station must remain at a safe distance from the scene of the fire but readily available to provide information and direction to the Fire Department personnel.

.5 Interior and Exterior Fire protection & Alarm Systems

.1 DO NOT OBSTRUCT OR SHUT OFF FIRE PROTECTION EQUIPMENT OR SYSTEMS, INCLUDING BUT NOT LIMITED TO FIRE ALARM SYSTEMS, SMOKE/HEAT DETECTORS, SPRINKLER SYSTEM, PULL STATIONS, EMERGENCY CALL BUTTONS AND PA SYSTEMS, WITHOUT AUTHORIZATION FROM THE DEPARTMENTAL REPRESENTATIVE.

.2 WHEN ANY FIRE PROTECTION EQUIPMENT IS TEMPORARILY SHUT DOWN, ALTERNATIVE MEASURES AS PRESCRIBED BY THE DEPARTMENTAL REPRESENTATIVE SHALL BE TAKEN TO ENSURE THAT FIRE PROTECTION IS MAINTAINED.

.3 DO NOT LEAVE FIRE PROTECTION OR ALARM SYSTEMS INACTIVE AT THE END OF A WORKING DAY WITHOUT NOTIFICATION AND AUTHORISATION FROM THE DEPARTMENTAL REPRESENTATIVE. THE DEPARTMENTAL REPRESENTATIVE WILL ADVISE THE (FPO) OF THE DETAILS OF ANY SUCH EVENT.

.4 DO NOT USE FIRE HYDRANTS, STANDPIPES AND HOSE SYSTEMS FOR OTHER THAN FIRE FIGHTING PURPOSES UNLESS AUTHORISED BY DEPARTMENTAL REPRESENTATIVE.

.6 Fire Extinguishers

.1 Provide a minimum of 1-20 lb. ABC Dry Chemical Fire Extinguisher at each hot work or open flame location.

.2 Provide fire extinguishers for hot asphalt and roofing operations as follows:

a. Kettle area - 1-20 lb. ABC Dry Chemical;
b. Roof - 1-20 lb. ABC Dry Chemical at each open flame location.

.3 Provide fire extinguishers equipped as below:

c. Pinned and sealed;
d. With a pressure gauge;
e. With an extinguisher tag signed by a fire extinguisher servicing company.

.4 Carbon Dioxide (C02) extinguishers will not be considered as substitutes for the above.

.7 Roofing Operations

.1 Kettles:

.1 Arrange for the location of asphalt kettles and material storage with the Departmental Representative before moving on site. Do not locate kettles on any roof or structure and keep them at least 10m (30 feet) away from a building.

.2 Equip kettles with 2 thermometers or gauges in good working order; a hand held and a kettle-mounted model.

.3 Do not operate kettles at temperatures in excess of 232^{o}C (450 ^{o}F).

.4 Maintain continuous supervision while kettles are in operation and provide metal covers for the kettles to smother any flames in case of fire. Provide fire extinguishers as required in article 2.6.

.5 Demonstrate container capacities to Departmental Representative prior to start of work.

.6 Store materials a minimum of 6m (20 feet) from the kettle.

.2 Mops:

.1 Use only glass fibre roofing mops.

.2 Remove used mops from the roof site at the end of each working day.

.3 Torch Applied Systems:

.1 DO NOT USE TORCHES NEXT TO WALLS.

.2 DO NOT TORCH MEMBRANES TO EXPOSED WOOD OR CAVITY

.3 Provide a Fire Watch as required by article 2.9 of this section.

.4 Store all combustible roofing materials at least 3m (10 feet) away from any structure.

.5 Keep compressed gas cylinders a minimum of 6m (20 feet) away from the kettle, protected from mechanical damage and secured in an upright position.

.8 Welding / Grinding Operations

.1 Contractor to provide fire blankets, portable fume extraction devices, screens or similar equipment to prevent exposure to welding flash, or sparks from grinding.

.9 **Fire Watch**

.1 Provide a fire watch for a minimum of one hour after the termination of any hot work operation.

.2 For temporary heating, refer to General Instructions Section 00 010 00.

.3 Equip fire watch personnel with fire extinguishers as required by article 2.6.

.10 Obstruction of access/egress routes-roadways, halls, doors, or elevators

.1 Advise the Departmental Representative in advance of any work that would impede the response of Fire Department personnel and their apparatus. This includes violation of minimum overhead clearance, erection of barricades and the digging of trenches.

.2 Building exit routes must not be obstructed in any way without special permission from the Departmental Representative, who will ensure that adequate alternative routes are maintained.

.3 The Departmental Representative will advise the FPO of any obstruction that may warrant advanced planning and communication to ensure the safety of building occupants and the effectiveness of the Fire Department.

.11 Rubbish and Waste Materials

.1 Keep rubbish and waste materials to a minimum and a minimum distance of 6m (20 feet) from any kettle or torches.

.2 Do not burn rubbish on site.

.3 Rubbish Containers

.1 Consult with the Departmental Representative to determine an acceptable safe location for any containers and the arrangement of chutes etc. prior to bringing the containers on site.

.2 Do not overfill the containers and keep area around the perimeter free and clear of any debris.

.4 Storage

.1 Exercise extreme care when storing combustible waste materials in work areas. Ensure maximum possible cleanliness, ventilation and that all safety standards are adhered to when storing any combustible materials.

.2 Deposit greasy or oily rags or materials subject to spontaneous combustion in CSA or ULC approved receptacles and remove at the end of the work day or shift, or as directed.

.12 Flammable Liquids

.1 The handling, storage and use of flammable liquids is governed by the current National Fire Code of Canada.

.2 Flammable Liquids such as gasoline, kerosene and naphtha may be kept for ready use in quantities not exceeding 45 litres (10 imp gal), provided they are stored in approved safety cans bearing the ULC seal of approval and kept away from buildings, stockpiled combustible materials etc. Storage of quantities of flammable liquids exceeding 45 litres (10 imp gal) for work purposes, require the permission of the Departmental Representative.

.3 Flammable liquids are not to be left on any roof areas after normal working hours.

.4 Transfer of flammable liquids is prohibited within buildings.

.5 Do not transfer flammable liquids in the vicinity of open flames or any type of heat producing device.

.6 Do not use flammable liquids having a flash point below 38 ^{o}C (100 ^{o}F) such as naphtha or gasoline as solvents or cleaning agents.

.7 Store flammable waste liquids for disposal in approved container located in a safe, ventilated area. Waste flammable liquids are to be removed from the site on a regular basis.

.8 Where flammable liquids, such as lacquers or urethane are used, ensure proper ventilation and eliminate all sources of ignition. Inform the Departmental Representative prior to, and at the cessation of such work.

3. Questions and/or clarifications

.1 Direct any questions or clarification on Fire or General Safety, in addition to the above requirements, to the Departmental Representative.

END OF SECTION

1 REFERENCES

.1 Perform all work to meet or exceed the requirements of the Canadian Electrical Code, CSA Standard C22.1 - (latest edition).

.2 Consider CSA Electrical Bulletins in force at time of tender submission, while not identified and specified by number in this Division, to be forming part of related CSA Part II standard.

.3 Do overhead and underground systems in accordance with CSA C22.3 except where specified otherwise.

.4 Where requirements of this specification exceed those of above mentioned standards, this specification shall govern.

.5 Notify the NRC Departmental Representative as soon as possible when requested to connect equipment supplied by NRC which is not CSA approved.

.6 Refer to Sections 00 10 00 & 0015 45.

2 PERMITS AND FEES

.1 Submit to Electrical Inspection Department and Supply Authority necessary number of drawings and specifications for examination and approval prior to commencement of work.

.2 Pay all fees required for the performance of the work.

3 START-UP

.1 Instruct the NRC Departmental Representative and operating personnel in the operation, care and maintenance of equipment supplied under this contract.

4 INSPECTION AND FEES

.1 Furnish a Certificate of Acceptance from the Authorized Electrical Inspection Department on completion of work.

.2 Request and obtain Special Inspection approval from the Authorized Electrical Inspection Department for any non-CSA approved control panels or other equipment fabricated by the contractor as part of this contract.

.3 Pay all fees required for inspections.

5 FINISHES

.1 Shop finish metal enclosure surfaces by removal of rust and scale, cleaning, application of rust resistant primer inside and outside, and at least two coats of finish enamel.

.1 Outdoor electrical equipment "equipment green" finish to EEMAC Y1-1-1955.

.2 Indoor switchgear and distribution enclosures light grey to EEMAC 2Y-1-1958.

.2 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.

6 ACOUSTICAL PERFORMANCE

.1 In general provide equipment producing minimal sound levels in accordance with the best and latest practices established by the electrical industry.

.2 Do not install any device or equipment containing a magnetic flux path metallic core, such as gas discharge lamp ballasts, dimmers, solenoids, etc., which are found to produce a noise level exceeding that of comparable available equipment.

7 EQUIPMENT IDENTIFICATION

.1 Identify with 3mm (1/8") Brother, P-Touch non-smearing tape, or an alternate approved by the NRC Departmental Representative, all electrical outlets shown on drawings and/or mentioned in the specifications. These are the lighting switches, recessed and surface mounted receptacles such as those in offices and service rooms and used to plug in office equipment, telecommunication equipment or small portable tools. Indicate only the source of power (Ex. for a receptacle fed from panel L32 circuit #1: "L32-1").

.2 Light fixtures are the only exceptions for electrical equipment identification (except as noted in 7.13 below). They are not to be identified.

.3 Identify with lamicoid nameplates all electrical equipment shown on the drawings and/or mentioned in the specification such as motor control centers, switchgear, splitters, fused switches, isolation switches, motor starting switches, starters, panelboards, transformers, high voltage cables, industrial type receptacles, junction boxes, control panels, etc., regardless of whether or not the electrical equipment was furnished under this section of the specification.

.4 Coordinate names of equipment and systems with other Divisions to ensure that names and numbers match.

.5 Wording on lamicoid nameplates to be approved by the NRC Departmental Representative prior to fabrication.

.6 Provide two sets of lamicoid nameplates for each piece of equipment; one in English and one in French.

.7 Lamicoid nameplates shall identify the equipment, the voltage characteristics and the power source for the equipment. Example: A new 120/240 volt single phase circuit breaker panelboard, L16, is fed from panelboard LD1 circuit 10.

"PANEL L16
120/240 V
FED FROM LD1-10"

PANNEAU L16
120/240 V
ALIMENTE PAR LD1-10

.8 Provide warning labels for equipment fed from two or more sources - "DANGER MULTIPLE POWER FEED" black letters on a yellow background. These labels are available from NRC's Facilities Maintenance group in building M-19.

.9 Lamicoid nameplates shall be rigid lamicoid, minimum 1.5 mm (1/16") thick with:

.1 Black letters engraved on a white background for normal power circuits.

.2 Black letters engraved on a yellow background for emergency power circuits.

.3 White letters engraved on a red background for fire alarm equipment.

.10 For all interior lamicoid nameplates, mount nameplates using two-sided tape.

.11 For all exterior lamicoid nameplates, mount nameplates using self-tapping 2.3 mm (3/32") dia. slot head screws - two per nameplate for nameplates under 75 mm (3") in height and a minimum of 4 for larger nameplates. Holes in lamicoid nameplates to be 3.7 mm (3/16") diameter to allow for expansion of lamicoid due to exterior conditions.

.1 No drilling is to be done on live equipment.

.2 Metal filings from drilling are to be vacuumed from the enclosure interiors.

.12 All lamicoid nameplates shall have a minimum border of 3 mm (1/8"). Characters shall be 9 mm (3/8") in size unless otherwise specified.

.13 Identify lighting fixtures which are connected to emergency power with a label "EMERGENCY LIGHTING/ÉCLAIRAGE D'URGENCE", black letters on a yellow background. These labels are available from NRC's Facilities Maintenance group in building M-19.

.14 Provide neatly typed updated circuit directories in a plastic holder on the inside door of new panelboards.

.15 Carefully update panelboard circuit directories whenever adding, deleting, or modifying existing circuitry.

8 WIRING IDENTIFICATION

.1 Unless otherwise specified, identify wiring with permanent indelible identifying markings, using either numbered or coloured plastic tapes on both ends of phase conductors of feeders and branch circuit wiring.

.2 Maintain phase sequence and colour coding throughout.

9 CONDUIT AND CABLE IDENTIFICATION

.1 All new conduits to be colour-coded EMT, type as follows:

.1 Fire alarm – red conduit

.2 Emergency power circuits – yellow conduit

.3 Voice/data – blue conduit

.4 Gas detection system – purple conduit

.5 Building Automation system – orange conduit

.6 Security system – green conduit

.7 Control system – white conduit

.2 Apply paint to the covers of junction boxes and condulets of existing conduits as follows:

.1 Fire alarm – red
.2 Emergency power circuits – yellow
.3 Voice/data – blue
.4 Gas detection system – purple
.5 Building Automation system – orange
.6 Security system – green
.7 Control system - white

.3 For system running with cable, half-lap wrap with dedicated coloured PVC tape to 100 mm width, tape every 5 m and both sides where cable penetrates a wall.

.4 All other systems need not be coloured.

10 MANUFACTURER'S & APPROVALS LABELS

.1 Ensure that manufacturer's registration plates are properly affixed to all apparatus showing the size, name of equipment, serial number, and all information usually provided, including voltage, cycle, phase and the name and address of the manufacturer.

.2 Do not paint over registration plates or approval labels. Leave openings through insulation for viewing the plates. Contractor's or sub-contractor's nameplate not acceptable.

11 WARNING SIGNS AND PROTECTION

.1 Provide warning signs, as specified or to meet requirements of Authorized Electrical Inspection Department and NRC Departmental Representative.

.2 Accept the responsibility to protect those working on the project from any physical danger due to exposed live equipment such as panel mains, outlet wiring, etc. Shield and mark all live parts with the appropriate voltage. Caution notices shall be worded in both English and French.

12 LOAD BALANCE

.1 Measure phase current to new panelboards with normal loads operating at time of acceptance. Adjust branch circuit connections as required to obtain best balance of current between phases and record changes, and revise panelboard schedules.

.2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.

13 MOTOR ROTATION

.1 For new motors, ensure that motor rotation matches the requirements of the driven equipment.

.2 For existing motors, check rotation before making wiring changes in order to ensure correct rotation upon completion of the job.

14 GROUNDING

.1 Thoroughly ground all electrical equipment, cabinets, metal supporting frames, ventilating ducts and other apparatus where grounding is required in accordance with the requirements of the latest edition of the Canadian Electrical Code Part 1, C.S.A. C22.1 and corresponding Provincial and Municipal regulations. Do not depend upon conduits to provide the ground circuits.

.2 Run separate green insulated stranded copper grounding conductors in all electrical conduits including those feeding toggle switches and receptacles.

15 TESTS

.1 Provide any materials, equipment and labour required and make such tests deemed necessary to show proper execution of this work, in the presence of the NRC Departmental Representative.

.2 Correct any defects or deficiencies discovered in the work in an approved manner at no additional expense to the Owner.

.3 Megger all branch circuits and feeders using a 600V tester for 240V circuits and a 1000V tester for 600V circuits. If the resistance to ground is less than permitted by Table 24 of the Code, consider such circuits defective and do not energize.

.4 The final approval of insulation between conductors and ground, and the efficiency of the grounding system is left to the discretion of the local Electrical Inspection Department.

16 COORDINATION OF PROTECTIVE DEVICES

.1 Ensure circuit protective devices such as overcurrent trips, fuses, are installed to values and settings as indicated on the Drawings.

17 WORK ON LIVE EQUIPMENT & PANELS

.1 NRC requires that work be performed on non-energized equipment, installation, conductors and power panels. For purposes of quotation assume that all work is to be done after normal working hours and that equipment, installation, conductors and power panels are to be de-energized when worked upon.

END OF SECTION

PART 1 - GENERAL

1.1 SCOPE

.1 The work listed in these specifications involves hazardous voltages, materials, operations, and equipment. These specifications do not claim to address all of the safety problems associated with their use. It is the responsibility of the user to review all applicable regulatory limitations prior to the use of these specifications.

.2 The contractor shall provide qualified services, or shall engage the services of a specialized, qualified testing firm, for the purpose of performing inspections and tests as herein specified.

.3 The contractor, or specialized testing firm, shall provide all material, equipment, labor, and technical supervision to perform such tests and inspections.

.4 The contractor will arrange and pay for all required ESA maintenance and inspection certificates for their scope of work.

1.2 REFERENCES

.1 NETA, MTS-2007, Maintenance Testing Specification for Electrical Power Distribution Equipment and Systems.

.2 IEEE – Standard Collection C57 – 1998.

.3 IEEE – Standards Collection C37 – 1998.

.4 CSA Z462 ‘Workplace Electrical Safety’

1.3 QUALIFICATIONS OF TESTING FIRM

.1 The testing firm shall be regularly engaged in the testing of electrical equipment devices, installations, and systems.

.2 All employees of the testing firm shall be qualified as per CSA Z462 requirements.

.3 The testing firm shall have at least one person on site with the following qualifications to provide technical supervision and/or guidance as required for the remainder of the testing personnel:

.1 An employee certified by the InterNational Electrical Testing Association (NETA)

.2 A Professional Engineer (P. Eng) licensed in the Province of Ontario with specialized training and experience in the testing and inspection of electrical power distribution equipment

.3 A member of the Ontario Association of Certified Engineering Technicians and Technologists (OACETT) with specialized training and experience in the testing and inspection of electrical power distribution equipment

.4 The contractor is to supply the Client, within 10 business days of awarding of contract, the name and qualifications of the proposed on-site supervisor. Approval, in writing from the Client, is required if the contractor needs to change the on-site supervisor for any reason. The Client will have the right to reject candidates not meeting the above qualifications.

.4 All work designated 'Specialist Testing' shall be performed by employees of the specialist testing firm and all personnel must be qualified to operate, test, and commission high and low voltage electrical equipment.

.5 All work designated 'Generalist Testing' may be completed by qualified electricians, technicians, technologists, or engineers employed or subcontracted by the specialist testing firm or electrical contractor.

.6 The contractor to supply the Client with a list of people proposed for site work with their qualifications at least 5 business days before the shutdown, or as early as required to receive appropriate clearances. The Client will have the right to reject candidates not meeting the above qualifications.

.7 The agency must have the necessary wiring, materials, equipment, tools, instruments, measuring devices and all other tools necessary to carry out the work.

.8 The testing firm shall submit interim proof of all the above qualifications when responding to the Request for Proposals.

.9 Acceptable test firm: Schneider Electric, Eaton Electric or approved equivalent.

1.4 DIVISION OF RESPONSIBILITY

.1 The testing firm shall supply a suitable and stable source of electrical power to each test site unless notified by the client in writing that sufficient local power will be available for operating test equipment. All portable alternating current (AC) power sources shall operate at 60 Hz +/- 0.1 Hz.

.2 The testing firm shall supply adequate portable lighting for each test site unless notified by the client in writing that sufficient local lighting will be available for operating test equipment. Ensure adequate lighting is available both with and without normal and/or emergency power.

.3 The owner, or owner's representative, will supply an up to date short circuit analysis and coordination study, a protective device setting sheet, a complete set of electrical plans, specifications, and any pertinent change orders to the testing firm prior to commencement of testing.

.4 The owner, or owner's representative, shall notify the testing firm when equipment becomes available for maintenance tests. Work shall be coordinated to expedite project scheduling. Note: various pieces of equipment are required to maintain each buildings environmental condition. It is imperative that the communication between each building's operations personnel and the testing firm be established prior to the isolation of any equipment. Sufficient time shall be given for the shutdown and startup of equipment such as chillers, pumps, and other essential equipment.

.5 The testing firm shall notify the owner, or owner's representative, prior to commencement of any testing.

.6 Deviation from the planed schedule of work for each stage of the work must be approved by the owner or owner's representative prior to the isolation of any additional equipment.

.7 The testing firm shall be fully responsible for their own safety, including all switching procedures, equipment isolation, and grounding procedures. At the end of each stage of the work, the testing firm shall ensure that all temporary grounds are removed from the equipment and all equipment is placed into its normal operation position prior to releasing the 'Station Guarantee'. It is the testing firm's responsibility to record the position of all circuit breakers and switches under the scope of the contract and to ensure that the 'As found' position is maintained after the work is completed.

1.5 SAFETY AND PRECAUTIONS

.1 Safety practices shall include, but are not limited to, the following requirements:

- .1 The current Occupational Health and Safety Act
- .2 CSA Z462 'Workplace Electrical Safety'
- .3 Workplace Hazardous Materials Information System (WHMIS). Submit to owner, or owner's representative, pertinent MSDS information.
- .4 Applicable Provincial, local, and client safety operating procedures
- .5 National Fire Protection Association – NFPA, and the National Fire Code of Canada 1995
- .6 OSHA 29 CFR 1910.147. Control of Hazardous Energy Sources (Lockout/Tagout)

.2 All tests shall be performed with apparatus de-energized except where otherwise specifically required. Lock out and tag procedures shall be in effect. All testing firm representatives shall lock and tag all equipment tested under the scope of work. The testing agency shall provide a 'lock box' for any equipment requiring more that 3 locks. All equipment to be tested under the scope of work shall be isolated from all sources of power, locked and tagged, tested for voltage potential with an approved potential tester rated for the voltage application, and grounded from all sources of power using approved temporary grounds.

.3 As per CSA Z462, all testing firm representatives shall wear the appropriate Personal Protective Equipment (PPE) including approved safety boots, side impact hard hats, safety glasses and/or safety shields, arc flash coveralls, and rubber gloves with protectors during switching operations. All PPE shall be rated for the appropriate voltage class application.

.4 The contractor shall review and supervise all operations with respect to safety, and notify any sub-contractors and/or the client of any known or found hazards or information about the client's installation that needs to be transmitted to sub-contractors.

1.6 TEST EQUIPMENT

.1 All test equipment shall be in good mechanical and electrical condition.

.2 Metering or monitoring equipment shall be true RMS sensing only. (Peak sensing equipment shall not be permitted).

.3 Field test metering used to check power system meter calibration must have an accuracy higher than that of the instrument being checked. Field Test Equipment shall meet the following criteria;

.1 1000 volt DC Insulation Resistance test equipment shall have a meter scale of at least 500 Gig Ohms.

.2 5000 volt DC Insulation Resistance test equipment shall have a meter scale of at least 500 Meg Ohms

.3 Low Resistance test equipment shall have a minimum of 5 ampere DC output and the ability to measure down to a 5 micro Ohms.

.4 Transformer turns ratio test equipment shall have a minimum of 130 to 1 ratio and scaled operate to three (3) significant digits. Test equipment shall have excitation current measurement capability to at least 5 amperes.

.5 Winding Resistance test equipment shall have a minimum of 5 ampere DC output and the ability to measure to a 100 milli-Ohms scale.

.6 Relay test equipment shall have a minimum of 100 amperes AC output in order to test standard mechanical overcurrent relays.

.7 Accuracy of metering in test equipment shall be appropriate for the test being performed but not in excess of 2% of the scale used.

.8 Waveshape and frequency of test equipment output waveforms shall be appropriate for the test and tested equipment. Test equipment shall not exceed 2.0 percent Total Harmonic Distortion THD output on voltage waveforms and 2.0 percent THD output on current waveforms.

.4 Test Instrument Calibration

.1 The testing firm shall have a calibration program, which assures that all applicable test instruments are maintained within rated accuracy.

.2 Calibration shall be done by a calibration agency compliant with International Standards Organization ISO 17025 and Standard Council of Canada CAN-P-4D.

.3 Dated calibration labels shall be visible on all test equipment.

.4 Records must be available and up to date for the owner, or owner's representative, to inspect calibration of each piece of equipment.

1.7 TEST REPORT

.1 The testing firm shall maintain a written or typed record of all field tests, and then shall assemble and certify a final completely typed test report.

.2 The test report shall include the following:

.1 Summary of project, complete with a detailed deficiency list, comments, results, analysis, and recommendations.

.2 Description of all equipment tested which shall include complete equipment nameplate values and/or installation information (e.g. Manufacturer, Date, Model Number, Serial Number, Voltage, Ampacity, Phases, kW, Power Factor, Horsepower, RPM, Torque, Type, Size, Insulation Type, Insulation Rating (100%, 133%, etc.), Shield if present, Number of conductors, Free air or Raceway rating, Configuration, etc.). Please note, the above list is not a complete and comprehensive list. Each device test sheet should have enough data to clearly identify the device, its location within the distribution system, a unique identifier, and all parameters which define its ratings and application. As a minimum, each device test sheet should usually include all parameters defined by the device's ruling Industry Standard.

.3 Include results from all tests above with starting conditions noted.

.4 Include any items found out of specified tolerances.

.5 Include any relevant comments about the condition of the switchgear.

.3 A blank copy of all applicable test sheets on the project shall be submitted to the Client for approval within five (5) business days of the contract issuance. The Client has the right to reject test sheets that do not include all required information or test results.

.4 Submit test results as per section 01 33 00.

PART 2 - INSPECTION AND TEST PROCEDURES

2.1 WORK COMMON TO MOST ELECTRICAL ASSEMBLIES

.1 Inspection

.1 Compare equipment nameplate information with latest single line diagram to ensure agreement.

.2 Inspect for evidence of corrosion, the presence of corona or insulation breakdown, and/or for environmental contamination, especially on insulators or insulating surfaces.

.3 Verify acceptable anchorage, required area clearances, and proper alignment.

.4 Verify presence of required warning signs.

.5 Verify that protective devices and settings, instrument transformers and ratios, and all other electrical elements correspond to single line drawings, coordination study, and/or relevant documentation.

.6 Verify that ventilation filters are present and in good condition, and/or that ventilation openings or vents are clear.

.7 Verify that there are no inadvertent connections of the ground bus to the neutral bus on any electrical systems containing a neutral. Ensure that a ground to neutral bond(s) is in the correct location.

.2 Mechanical/Functional Verification

.1 For commissioning, verify tightness of accessible bolted electrical connections by calibrated torque-wrench in accordance with manufacture's published data or, if not available, use NETA Table 10.12. For maintenance, verify general tightness of accessible bolted electrical connections.

.2 Test operation, alignment, and penetration of instrument and control power transformer withdrawal disconnects, current-carrying and grounding.

.3 Exercise all active components, and verify the operation of all mechanical indicating devices.

.4 Test all electrical and mechanical interlock systems for proper operation and sequencing:

.5 Attempt to close locked-open devices. Attempt to open locked-closed devices.

.6 Make Kirk Key exchanges with devices operated in off-normal positions.

.7 Verify that Kirk Key numbers match with the single line diagram and record them on the approved test sheet.

.3 Cleaning

.1 Thoroughly clean switchgear cells or electrical equipment prior to testing. Clean equipment using cleaning agents that have high dielectric properties, repel moisture, prevent corona tracking, and are not harmful to the electrical equipment insulation, such as Banwet manufactured by Brodi.

.2 Vacuum all loose elements from electrical switchgear, junction boxes, and other areas within or without electrical equipment. Blowers shall not be used unless no other methods to remove contaminants are possible.

.4 Lubrication

.1 Verify appropriate contact lubricant on moving current carrying parts. Refer to manufacturer's recommendations on lubrication of components.

.2 Verify appropriate lubrication on moving and sliding surfaces. Refer to manufacturer's recommendations on lubrication of components.

2.2 SWITCHGEAR ASSEMBLIES, GREATER THAN 750V

.1 Visual and Mechanical Inspection, provide all typical inspections and cleaning.

.2 Electrical Tests

.1 Disconnect all equipment and conductors that are not part of the equipment assembly prior to testing and ensure that all phases are properly identified (Phase A – Red, Phase B –Black, Phase C – Blue). After testing re-connect equipment and conductors in the original phasing order. Perform field taping if required in accordance to Section 3.

.2 Perform tests on all instrument and control power transformers in accordance with relevant Section.

.3 Perform insulation resistance tests on each bus section. Energize each phase with the correct test voltage ensuring the opposing two phases and neutral (4 wire only) are grounded. Each test shall occur for a duration of one (1) minute. Electrical equipment rated from 600 volts AC to 2,600 volts AC shall be tested at 1,000 volts DC. Electrical equipment rated from 2,601 volts AC to 69,000 volts DC shall be tested at 5,000 volts DC.

.4 Perform an overpotential (hi-pot) test on each bus section. Energize each phase with the correct DC test voltage ensuring the opposing two phases and neutral (4 wire only) are grounded. Each test shall occur for a duration of one (1) minute. The step voltage method shall be used to achieve the full test voltage, whereby the test voltage is raised to final value in 10 equal steps (increments of 1/10 the final test voltage). There will be a 30 second delay between incremental steps where the micro-Amp leakage current will be recorded for each step. After 6 step intervals a linear rate of change leakage current versus test voltage shall be established. During the final 4 step changes if the predicted rate of change is greater than 5 to 1 leakage current versus test voltage the test shall be terminated and all test results up to that point will be documented. All tests shall be performed as per manufacturers published data. If manufacturer's data is not available this test shall be performed in accordance to the NETA standard Table 10.2.

.5 Perform a system function test. Use the elementary diagrams of the switchgear to identify each remote control and protective device. Energize control circuits with the correct designed tripping and closing circuit voltages.

.6 Operate all circuit breakers and switches manually and electrically in local and remote modes of operation to ensure correct closing and tripping.

.7 Verify that all indication and alarm lights and audible devices operate correctly.

.1 General Industrial/Commercial Application: red signifies device closed and green signifies device open.

.2 General Utility Application: green signifies device closed and red signifies device open.

.8 Verify the operation of switchgear cell heaters.

.3 Test Values

.1 Compare bus connection resistances to values of similar connections.

.2 Microhm or millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's data is not available, investigate any values, which deviate from similar bus by more than 25 percent of the lowest value. Microhm value should not exceed the following:

.1 $$\frac{0.050 volts}{Equipment\ Continuous\ Current\ Rating} \times 1{,}000{,}000$$

.3 Insulation resistance values for bus, control wiring, and instrument & control power transformers shall be in accordance with manufacturers published data. In the absence of manufacturers published data, use NETA Standard Table 10.1. (Note: Do not use test voltage levels in NETA Table 10.1) Values of insulation resistance less than this table or manufacturers minimum should be investigated. Overpotential tests should not proceed until insulation resistance levels are raised above minimum values.

.4 The insulation shall withstand the overpotential test voltage applied. Flag any values greater than 10 Micro Amperes.

2.3 LOAD BREAK SWITCHES, GREATER THAN 750V

.1 Visual and Mechanical Inspection, provide all typical inspections and cleaning, plus:

.1 Switch

.1 Blade and Jaw - verify correct blade alignment, blade penetration, travel stops, and mechanical operation.

.2 Arc Blade – verify correct alignment, erosion, ensure arc blade operates properly on opening with arc chute

.3 Arc Chute – verify correct alignment, absence of cracks

.4 Operating Arm – free movement, break over

.5 Operating Mechanism – sprockets, chain, pushrod arms, lubrication.

.6 Door interlock – verify door unable to open when switch closed.

.7 Latch Spring and Latch – verify switch unable to close when door open.

.8 Interrupter Head – Verify correct alignment of contacts.

.2 Electrical Tests

.1 Disconnect all conductors that are not part of the equipment assembly prior to testing and ensure that all phases are properly identified (Phase A – Red, Phase B – Black, Phase C – Blue, Neutral – White). After testing re-connect equipment and conductors in the original phasing order

.2 Perform insulation resistance tests on each pole, phase to phase and phase to ground with switch closed and across each open pole for one minute. Electrical equipment rated from 600 volts AC to 2600 volts AC shall be tested at 1000 volts DC. Electrical equipment rated from 2601 volts AC to 15,000 volts AC shall be tested at 5000 volts DC.

.3 Perform resistance measurements through all switch contacts with a low resistance ohmmeter.

.3 Test Values

.1 Compare bolted connection resistances to values of similar connections.

.2 Bolt torque levels shall be in accordance with NETA Standard Table 10.12 unless otherwise specified by manufacturer.

.3 Microhm or millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's data is not available, investigate any values which deviate from adjacent poles or similar switches by more than 25 percent of the lowest value. Microhm value should not exceed the following:

.1 $$\frac{0.050 volts}{Equipment\ Continuous\ Current\ Rating} \times 1{,}000{,}000$$

.4 If switch contact resistance exceeds above formula, burnish main contacts and apply lubrication as per manufacturer’s specification until correct contact resistance is achieved.

.5 Insulation resistance shall be in accordance with NETA Standard Table 10. 1. (Note: Do not use DC test voltage levels in NETA Standard Table 10.1.)

2.4 FUSES, GREATER THAN 750V

.1 Visual and Mechanical Inspection, provide all typical inspections and cleaning, plus:

.1 Disassemble fuse units to inspect link conditions and record link nameplate data.

.1 Measure fuse resistance before and after this operation to ensure proper re-assembly

.2 Fuse Holder – Inspect for cracks, corona and erosion, especially where fuse link seats into holder

.3 Fuse Mounting – Record fixed or drawout, verify that each fuse holder has adequate mechanical support.

.4 Fuse Alignment – verify latch on drawout mounts

.5 Muffler – Verify that expulsion limiting devices are in place on all holders having expulsion type elements, verify arc stop material in good condition

.2 Electrical Tests

.1 Measure fuse resistance with a Low Resistance Test Set. (Ensure that Low Resistance test set current output does not exceed rated fuse current.)

.3 Test Values

.1 Investigate fuse resistance values that deviate from each other by more than 15 percent. Fuse links may have crystallized.

2.5 CIRCUIT BREAKERS, VACUUM, GREATER THAN 750V

.1 Visual and Mechanical Inspection, provide all typical inspections and cleaning, plus:

.1 Ground Contact – verify breaker moving contact fingers with ground bus

.2 Floor Trip/Close Tripper – Verify circuit breaker trips and removes potential kinetic energy for closing (spring charge type mechanism) or inhibits close coil operation (electrical coil type mechanism) while racking in and out of cell.

.3 Position Indicator – verify fully connected, test, and fully disconnected indicators.

.4 Secondary Contact Blocks - verify alignment, engagement, and correct contact

.5 Padlock/Key Lock Operator – ensure breaker can be locked in the fully disconnected position

.6 Racking Mechanism - verify unobstructed operation with breaker.

.7 Verify that all maintenance devices are available for servicing and operating the breaker. (umbilical cord, racking handle, drawout rails, lifting mechanism)

.8 Circuit Breaker

.1 Operation Counter – record number of as found and as left operations

.2 Auxiliary Switches – ensure that breaker properly engages and toggles ‘a’, ‘b’, and position contacts

.3 Cut Off Switch – ensure electrical motor cutoff operates consistently.

.4 Electrical Interlocks – Ensure anti-pumping (Y) relay operates correctly. Ensure (52 X) relay operates correctly (electrical coil close only).

.9 Vacuum Bottles

.1 Verify that all vacuum bottles are sealed and without dents or other mechanical indications of problems.

.2 Verify that vacuum bottle contact wear indicator is not indicating

.2 Electrical Tests

.1 Perform a contact resistance test with a low resistance ohmmeter. Test should be performed through the entire breaker from line side primary drawout contact to load side primary drawout contact.

.2 Perform insulation-resistance tests on each pole, phase-to-phase and phase-to-ground with switch closed and across each open pole for one minute. Test voltage shall be in accordance with manufacturer's published data or Table 10.1.

.3 Perform vacuum bottle integrity (overpotential) test across each vacuum bottle with the switch in the open position in strict accordance with manufacturer's published data. Do not exceed maximum voltage stipulated for this test. Provide adequate barriers and protection against x radiation during this test. Do not perform this test unless the contact displacement of each interrupter is within manufacturer's tolerance. (Be aware that some dc high-potential test sets are half wave rectified and may produce peak voltages in excess of the switch manufacturer's recommended maximum.)

.4 Perform resistance measurements through all bolted connections with a low resistance ohmmeter.

.5 Perform insulation resistance test at 250 volts DC on all control wiring. Do not perform insulation resistance tests on solid state or electronic control devices.

.6 Measure the following coil resistances with a DC ohmmeter;

.1 Closing Coil

.2 Tripping Coil

.3 52 X Coil

.7 With breaker in the test position, make the following tests:

.1 Trip and close breaker with the control switch.

.2 Trip breaker by operating each of its protective relays.

.3 Verify trip free and antipump (Y relay) function.

.4 Perform minimum pickup voltage tests on trip coil and record value.

.3 Test Values

.1 Compare bolted connection resistances to values of similar connections.

.2 Bolt torque levels shall be in accordance with NETA Standard Table 10.12 unless otherwise specified by manufacturer.

.3 Microhm or millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's data is not available, investigate any values which deviate from adjacent poles or similar breakers by more than 25 percent of the lowest value. Microhm value should not exceed the following:

.1 $$\frac{0.050 volts}{Equipment\ Continuous\ Current\ Rating} \times 1{,}000{,}000$$

.4 If breaker contact resistance exceeds above formula, burnish main contacts and apply lubrication as per manufacturer specification until correct contact resistance is achieved.

.5 Circuit breaker insulation resistance shall be in accordance with NETA Standard Table 10.1. (Note: Do not use DC test voltage levels in NETA Standard Table 10.1)

.6 Control wiring insulation resistance shall be a minimum of two megohms.

.7 Insulation resistance values should be in accordance with manufacturer's published data or Table 10.1.

.8 Critical distances of operating mechanism should be in accordance with manufacturer's published data.

.9 The vacuum bottles shall withstand the overpotential voltage applied.

.10 Coil resistances should be consistent with previous year's results.

.11 Minimum pickup for trip coil shall conform to manufacturers published data. If data is not available trip coil should operate at 25 percent below rated voltage.

2.6 DISCRETE PROTECTIVE RELAYS

.1 Visual and Mechanical Inspection, provide all typical inspections and cleaning, plus:

.1 Prior to cleaning the relay, record as-found settings.

.2 Tighten case connections. Inspect cover for correct gasket seal. Clean cover glass. Inspect shorting hardware, connection paddles, and/or knife switches. Remove any foreign material from the case. Verify target reset.

.3 Inspect relay for foreign material, particularly in disc slots of the damping and electromagnets. Verify disk clearance. Verify contact clearance and spring bias. Inspect spiral spring convolutions. Inspect disk and contacts for freedom of movement and correct travel. Verify tightness of mounting hardware and connections. Burnish contacts. Inspect bearings and/or pivots.

.4 Verify that all settings are in accordance with coordination study or setting sheet supplied by owner.

.2 Electrical Tests

.1 Perform insulation resistance test at 250 volts DC on each circuit to frame. Do not perform insulation resistance test on solid state and microprocessor based relays.

.2 Inspect targets and indicators.

.3 Ensure correct magnitude and polarity of power supply to relay including the verification of any external power supply voltage drop resistors inherent to the relay (solid state and microprocessor based relays only)

.4 Determine pickup and dropout of electromechanical targets.

.5 Verify operation of all light emitting diode indicators.

.6 Set contrast for liquid crystal display readouts.

.3 Functional Operation

.1 50/50G Instantaneous Overcurrent Relay

.1 Record the relays setting and operating range.

.2 Determine pickup current.

.3 Determine dropout current.

.4 Determine time delay at rated current.

.2 51/51N/51G Time Overcurrent Relay

.1 Record the relays tap setting, time dial setting, tap range, time dial range, seal in coil setting, seal in coil range, and time current curve type.

.2 Verify and/or calibrate timed contact zero adjustment.

.3 Perform secondary current injection test

.4 Determine minimum pickup current value.

.5 Determine time delays at two points on the manufacturers published time current curve or published formula. Time values shall be selected at 2 and 5 times the relay tap setting from the published time current curve with respect to the time dial setting.

.6 Verify the operation of the seal in target.

.3 Control Verification

.1 Perform primary injection test:

.2 Utilizing a high output relay test set, wrap window type current transformers individually with the appropriate number of turns to functionally operate the corresponding phase and ground overcurrent relay. If the current transformers are bar type remove the CT secondary conductors and perform a secondary injection test at the secondary conductors to functionally operate the corresponding phase and ground overcurrent relays

.3 Verify that each of the relay contacts performs its intended function in the control scheme including breaker trip tests, close inhibit tests, 86 lockout tests, and alarm functions.

.4 Verify control wiring from the instrument transformers to each protective relay.

.4 Test Values

.1 When not otherwise specified, use manufacturer's recommended tolerances.

.2 When critical test points are specified, the relay should be calibrated to those points even though other test points may be out of tolerance.

.3 If the 51-timed overcurrent relay is found to be out of manufacturer’s tolerances for the two point test, a combination of dampening magnet and core flux set screw shall be adjusted to properly calibrate the relay at 2 and 5 times the tap setting.

2.7 INSTRUMENT TRANSFORMERS, BOTH CTS AND PTS, APPLIED TO CIRCUITS GREATER THAN 750V

.1 Visual and Mechanical Inspection, provide all typical inspections and cleaning, plus:

.1 Verify that all required grounding and shorting connections are correct. Ensure that after tests are completed all functioning Current Transformer (CT) shorting connections are not made and that all non-functioning CTs shorting connections are made. Ensure that after tests are completed all CTs have a completed permanent secondary circuit through the correct corresponding device.

.2 Ensure that donut type CTs rated for 0.6 kV systems have sufficient insulation and clearance from the primary switchgear bus when being applied to medium voltage systems. Ensure that bar type CTs do not exhibit any signs of corona discharge at the CT mounting base.

.3 Verify correct operation of transformer withdrawal mechanism and grounding operation. Ensure that shutters operate properly on Potential Transformer (PT) cabinets. Verify that hinged type, drawout PT cabinets are mechanically interlocked so that entry cannot be gained while the PTs are energized.

.4 Ensure that all PTs are correctly installed so that the PT primary circuit is connected through current limiting fuses and not directly connected to the switchgear phase bus.

.5 Ensure that all PT primary circuit cable conductors are properly installed and mechanically braced. Verify that all jumper type cable conductor sizes are at least 2 AWG or greater. Verify that all shielded conductors have proper stress cones.

.2 Electrical Tests, Current Transformers

.1 Perform insulation resistance test of the current transformer and wiring to ground at 1000 volts DC. Do not perform insulation resistance test on solid state and microprocessor based relays.

.2 Perform a polarity test of each current transformer using the DC injection bumping method, or any automated method within an approved test set.

.3 Perform a ratio verification test by injecting a large enough amount of current through the primary circuit of the CT to be able get a measurable amount of current from the secondary circuit of the CT, note the amount and calculate the measured ratio.

.4 Perform an excitation test on transformers used for relaying applications in accordance with ANSI/IEEE C57.13.1.

.1 Before the excitation test is made, the current transformer should be demagnetized. To perform the test, an ac test voltage is applied to the secondary winding with the primary open circuited. The voltage applied to the secondary of the current transformer is varied, and the current drawn by the winding at each selected value of voltage is recorded. Readings near the knee of the excitation curve are especially important in plotting a comparison curve. For current transformers with taps, the secondary tap should be selected to assure that the current transformer can be saturated with the test equipment available. The highest tap which can accommodate that requirement should be used. The selection of instruments is especially important for this test. The ammeter should be an RMS instrument.

.2 CAUTION: If voltage is applied to a portion of the secondary winding, the voltage across the full winding will be proportionately higher because of autotransformer action. Current transformers should not remain energized at voltages above the knee of the excitation curve any longer than is necessary to take readings. Any substantial deviation of the excitation curve for the current transformer under test from curves of similar transformers or manufacturer's data should be investigated.

.3 Electrical Tests, Voltage Transformers

.1 Perform insulation resistance tests primary winding to ground with the secondary winding grounded. Test voltages shall be applied for one minute at 1000 volts DC. Do not perform this test with solid state devices connected.

.2 Perform a polarity test on each transformer to verify the polarity marks or H1 X1 relationship.

.3 Perform a turns ratio test on all tap positions.

.4 Test Values

.1 Microhm or millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's data is not available, investigate any values which deviate from similar connections by more than 25 percent of the lowest value.

.2 Insulation resistance measurement on any instrument transformer shall be not less than that shown in NETA Standard Table 10.1.

.3 Polarity results shall agree with transformer markings.

.4 Ratio accuracy shall be within 0.5 percent of nameplate or manufacturer's published data.

.5 Deviation from the excitation test manufacturers expected results may indicate a turn to turn short circuit, distortion of test supply voltage waveform, or the presence of a completed conducting path around the current transformer core.

2.8 LIGHTNING ARRESTORS, GREATER THAN 750V

.1 Visual and Mechanical Inspection, provide all typical inspections and cleaning, plus:

.1 Verify that the ground lead on each device is individually attached to a ground bus or ground electrode.

.2 Verify that stroke counter, if present, is correctly mounted and electrically connected.

.2 Electrical Tests

.1 Disconnect all conductors prior to testing and ensure that all phases are properly identified (Phase A – Red, Phase B – Black, Phase C – Blue, Neutral – White). After testing, re-connect equipment and conductors in the original phasing order. For equipment rated over 750 volts AC ensure that the connections are covered with “air seal” and high voltage rubber tape correctly applied as per the system rated voltage levels. “Duct seal” shall not be permitted.

.2 Perform resistance measurements of ground connection with a low resistance ohmmeter.

.3 Perform an insulation resistance test at voltage levels in NETA Standard Table 10.1.

.3 Test Values

.1 Compare bolted connection resistances to values of similar connections.

.2 Resistance between the arrester ground terminal and the ground system shall be less than 0.5 ohm.

.3 Insulation resistance values should be in accordance with NETA Standard Table 10. 1.

2.9 CABLES, GREATER THAN 750V

.1 Visual and Mechanical Inspection, provide all typical inspections and cleaning, plus:

.1 Inspect exposed sections of cables for physical damage and evidence of overheating and corona.

.2 Inspect terminations and splices for evidence of overheating and corona.

.3 Inspect for proper shield grounding or isolation as required, cable support, and termination.

.4 Verify that visible cable bends meet or exceed ICEA and/or manufacturers minimum allowable bending radius.

.5 If cables are terminated through window type current transformers, make an inspection to verify that neutral and ground conductors are correctly placed and that shields are correctly terminated for operation of protective devices.

.2 Electrical Tests

.1 Disconnect all conductors prior to testing and ensure that all phases are properly identified (Phase A – Red, Phase B – Black, Phase C – Blue, Neutral – White). After testing, re-connect equipment and conductors in the original phasing order. Retape as per section 3.

.2 Perform a shield continuity test on each power cable by ohmmeter method.

.3 Perform an insulation resistance test utilizing a megohmmeter with a voltage output of at least 5000 volts DC for cables rated greater than 750 volts AC. Individually test each conductor with all other conductors and shields grounded. Test duration shall be one minute.

.4 Provide DC Hi-Pot testing for all PILC cables to NETA standards.

.5 Provide VLF testing for all shielded power cables containing extruded dielectric insulation to IEEE 400.2 "Guide for Field Testing of Shielded Power Cable Systems Using Very Low Frequency (VLF)".

- Acceptance test for new cable, maintenance test for in-service cable.

.3 Test Values

.1 Shielding must exhibit continuity. Investigate resistance values in excess of ten ohms per 1000 feet of cable.

2.10 TRANSFORMERS, MEDIUM VOLTAGE, LIQUID FILLED

.1 Visual and Mechanical Inspection, provide all typical inspections and cleaning

.1 Inspect primary and secondary bushings, tank wall, gaskets, and radiators for insulating fluid leaks and cracks.

.2 Inspect pressure relief diaphragm for damage.

.3 Verify that alarm, control, and trip settings on temperature indicators are as specified.

.4 Verify that cooling fans and/or pumps operate correctly.

.5 Verify operation of all alarm, control, and trip circuits from temperature and level indicators, pressure relief device, and fault pressure relay.

.6 Verify correct liquid level in all tanks and bushings. Ensure temperature correction is applied when reading gauges.

.7 Verify "silica gel" or equivalent breathing apparatus is present on all conservator type transformers and that the "silica gel" colour indication is at least 70% blue or orange. (Conservator type only)

.8 Verify that the valve between the main tank and conservator tank is in the fully open position and that there are no obstructions in the breathing pipe. (Conservator type only)

.2 Electrical Tests

.1 Disconnect all equipment and conductors that are not part of the equipment assembly prior to testing and ensure that all phases are properly identified (Phase A – Red, Phase B – Black, Phase C – Blue, Neutral – White). After testing, re-connect equipment and conductors in the original phasing order. Make field connects as per Section 3.

.2 Perform insulation resistance tests (two winding transformers). With all primary side (High) electrical connections shorted together and all secondary side (Low) electrical connections shorted together test the following;

.1 High to Low with Low Grounded

.2 Low to High with High Grounded

.3 High and Low connected together to Ground

.4 Test voltage shall be 1000 volts DC with resistances tabulated and graphed at 10 seconds, 20 seconds, 30 seconds, one minute, five minutes, and 10 minutes. Test duration shall be for ten minutes. Calculate polarization index and dielectric absorption values. Correct the ten minute value to 20°C in accordance with test equipment manufacturer's published data.

.1 $$D.A. = \frac{1\,Min.\,\mathrm{Re}\,sult}{30\,Sec.\,\mathrm{Re}\,sult}$$

.2 $$P.I. = \frac{10\,Min.\,\mathrm{Re}\,sult}{1\,Min.\,\mathrm{Re}\,sult}$$

.3 Perform turns ratio tests on all tap positions for all phases to ensure proper exercising of the off load tap changer. Return the tap changer to the designated "as found" tap position, lock tap changer in place, and perform turns-ratio test on all phases after all other electrical tests have been completed.

.4 On all liquid transformers larger than 1500kVA, perform insulation power factor/dissipation factor test (two winding transformers). With all primary side (High) electrical connections shorted together and all secondary side (Low) electrical connections shorted together perform the following test:

.1 Energize High

.1 Ground Low (GST), (CH + CHL)

.2 Guard Low (GST), (CH)

.3 Unground Low (UST), (CHL) (UST)

.2 Energize Low

.1 Ground High (GST), (CL + CHL)

.2 Guard High (GST), (CL)

.3 Unground High (UST), (CHL) (UST)

.3 AC test voltages shall be equivalent to but not exceed equipment nameplate nominal ratings and never exceed 10 kVAC. Capacitance values for each test shall be recorded. Accepted insulation power factor/dissipation test sets are Doble MH2 or equivalent.

.5 On all top mounted exposed bushings, perform the following power factor/dissipation factor tests for all bushings rated above 2601 volt AC:

.1 Hot collar watts loss tests.

.2 C1 capacitance test. (applicable for bushings with C1 tap only)

.3 C2 capacitance test. (applicable for bushings with C1 tap only)

.4 Hot Collar test shall be performed at 10 kVdc. Capacitance test voltage shall be performed as per bushing manufacturer's published data. Correct for 20°C in accordance with test equipment manufacturer's published data.

.6 Perform excitation current tests in accordance with test equipment manufacturer's published data.

.7 Measure the resistance of each winding with an approved winding resistance tester, on all primary windings in each tap changer positions and on each secondary winding.

.8 If core ground strap is accessible, measure core insulation resistance at 500 volts DC.

.9 Remove a sample of insulating liquid in accordance with ASTM D923.Sample shall be tested in accordance with the referenced standard.

.1 Dielectric breakdown voltage: ASTM D877 and/or ASTM D1816

.2 Acid neutralization number: ANSI/ASTM D974

.3 Interfacial tension: ANSI/ASTM D971 or ANSI/ASTM D2285

.4 Color: ANSI/ASTM D1500

.5 Visual Condition: ASTM D1 524

.6 Parts per million water: ASTM D1 533. Required on 25 kV or higher voltages and on all silicone filled units.

.7 Measure dissipation factor or power factor in accordance with ASTM D924.

.8 Part per million of PCB (Perform only if values are not known)

.10 Remove a sample of insulating liquid in accordance with ASTM D3613 and perform dissolved gas analysis (DGA) in accordance with ANSI/IEEE C57.104 or ASTM D3612. (Atmospheric air shall not enter the test sample) Test should include dissolved water and total dissolved gas concentration complete with the following gas concentrations:

.1 Hydrogen (H2)

.2 Methane (CH4)

.3 Carbon Monoxide (CO)

.4 Acetylene (C2H2)

.5 Ethylene (C2H4)

.6 Ethane (C2H6)

.7 Carbon Dioxide (CO2)

.8 Oxygen (O2)

.9 (N2)

.10 Evaluation of gas concentrations with recommendations shall be submitted within chemical analysis report.

.3 Test Values

.1 Insulation resistance test values at one minute should not be less than values recommended by the manufacturer. Resistance values to be temperature corrected in accordance with the manufacturer.

.2 The polarization index should be compared to previously obtained results. Polarization Index calculations range from 2 to 5. Investigate any values which deviate from range.

.3 Turns ratio test results shall not deviate more than one half percent from either the adjacent coils or the calculated ratio.

.4 Maximum power factor of liquid filled transformers corrected to 20□C shall be in accordance with transformer manufacturer's published data. Representative values are indicated in NETA Standard Table 10.3. Compare with test equipment manufacturer's published data. To ensure test results are valid the Grounded Specimen Tests must equal the summation of the Guarded Specimen Test and the Ungrounded Specimen Test. Measured capacitance values have the same relationship.

.5 Investigate bushing power factors and capacitances that vary from nameplate values by more than ten percent. Investigate any bushing hot collar watts loss results that exceed the test equipment manufacturers published data. Investigate hot collar results, which deviate from similar results by more than 15 percent. In the case of hermetically sealed liquid filled bushings perform the hot collar test on every bushing skirt in order to detect bushing oil levels.

.6 Typical excitation current test data pattern for three legged core transformer is two similar current readings and one lower current reading.

.7 Winding resistance measurements should compare within one percent of previously obtained results after factoring in temperature correction. Investigate any values which deviate from similar connections by more than 15 percent of the lowest value.

.8 Core insulation values should be comparable to previously obtained results but not less than one megohm at 500 volts dc. If the core insulation is breached a circulating current in the transformer core will be established that will tend to cause adverse heating of the unit. Monitor transformer running temperature.

.9 Insulating liquid shall be in accordance with NETA Standard Table 10.4. Make observations on acceptability.

.10 Evaluate results of dissolved gas analysis in accordance with ANSI/IEEE Standard C57.104 and make observations on acceptability.

2.11 TRANSFORMERS, MEDIUM VOLTAGE, AIR COOLED

.1 Visual and Mechanical Inspection, provide all typical inspections and cleaning

.1 Verify that control and alarm settings on temperature indicators are as specified.

.2 Verify that cooling fans operate if present.

.3 Perform specific inspections and mechanical tests as recommended by manufacturer.

.4 Verify that as-found tap connections are recorded before changing tap position, and as-left tap connections are as specified.

.5 Verify if surge arresters, neutral ground resistors, current transformers, or other non-transformer devices are present within the transformer enclosure.

.2 Electrical Tests

.1 Disconnect all equipment and conductors that are not part of the equipment assembly prior to testing and ensure that all phases are properly identified (Phase A – Red, Phase B – Black, Phase C – Blue, Neutral – White). After testing, re-connect equipment and conductors in the original phasing order. Make field connections as per Section 3.

.2 Perform resistance measurements through bolted connections with a low-resistance ohmmeter.

.3 Perform insulation resistance tests (two winding transformers). With all primary side (High) electrical connections shorted together and all secondary side (Low) electrical connections shorted together test the following;

.1 High to Low with Low Grounded

.2 Low to High with High Grounded

.3 High and Low connected together to Ground

.4 Test voltage shall be 1000 volts DC with resistances tabulated and graphed at 10 seconds, 20 seconds, 30 seconds, one minute, five minutes, and 10 minutes. Test duration shall be for ten minutes. Calculate polarization index and dielectric absorption values. Correct the ten minute value to 20°C in accordance with test equipment manufacturer's published data.

.1 $$D.A. = \frac{1\,Min.\,\mathrm{Re}\,sult}{30\,Sec.\,\mathrm{Re}\,sult}$$

.2 $$P.I. = \frac{10\,Min.\,\mathrm{Re}\,sult}{1\,Min.\,\mathrm{Re}\,sult}$$

.4 Perform insulation power factor/dissipation factor test (two winding transformers). With all primary side (High) electrical connections shorted together and all secondary side (Low) electrical connections shorted together perform the following test:

.1 Energize High

.1 Ground Low (GST), (CH + CHL)

.2 Guard Low (GST), (CH)

.3 Unground Low (UST), (CHL) (UST)

.2 Energize Low

.1 Ground High (GST), (CL + CHL)

.2 Guard High (GST), (CL)

.3 Unground High (UST), (CHL) (UST)

.3 AC test voltages shall be equivalent to but not exceed equipment nameplate nominal ratings and never exceed 10 kVac. Capacitance values for each test shall be recorded. Accepted insulation power factor/dissipation test sets are Doble M2-H units.

.5 Perform a power-factor or dissipation-factor tip-up test. Perform test at 2000 VAC for 8 to 15 kV rated equipment.

.6 Perform turns-ratio tests at each designated tap position.

.7 Perform an excitation-current test on each phase.

.8 Measure the resistance of each winding with an approved winding resistance tester, on all primary windings in each tap changer positions and on each secondary winding.

.9 Measure core insulation-resistance at 500 volts dc if the core ground strap is removable.

.3 Test Values

.1 Compare bolted connection resistances to values of similar connections.

.2 Bolt-torque levels should be in accordance with NETA Standard Table 10.12 unless otherwise specified by manufacturer.

.3 Microhm or millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's data is not available, investigate any values which deviate from similar connections by more than 50 percent of the lowest value.

.4 Insulation-resistance test values at one minute should be in accordance with NETA Standard Table 10.5.

.5 The polarization index should be compared to previously obtained results. Polarization Index calculations range from 2 to 5. Investigate any values which deviate from range.

.6 Turns-ratio test results should not deviate more than one half percent from either the adjacent coils or the calculated ratio.

.7 CH and CL power-factor or dissipation-factor values will vary due to support insulators and bus work utilized on dry transformers. The following should be expected on CHL power factors:

.1 Power transformers: 2.0 percent or less

.2 Distribution transformers: 5.0 percent or less

.3 Consult transformer manufacturer's or test equipment manufacturer's data for additional information.

.8 Tip-up test watts loss values should indicate no significant increase in power factor.

.9 Temperature corrected winding-resistance test results should compare within one percent of previously obtained results.

.10 Typical excitation current test data pattern for three-legged core transformer is two similar current readings and one lower current reading.

.11 Core insulation-resistance values should be comparable to previously obtained results but not less than one megohm at 500 volts dc.

2.12 CABLES, LESS THAN 750V

.1 Visual and Mechanical Inspection, provide all typical inspections and cleaning, plus:

.1 Inspect exposed sections of cables for physical damage and evidence of overheating and corona.

.2 Inspect terminations and splices for evidence of overheating and corona.

.3 Verify tightness of accessible bolted electrical connections by calibrated torque-wrench in accordance with NETA standard Table 10.12.

.4 Inspect for shield grounding, cable support, and termination.

.5 Verify that visible cable bends meet or exceed ICEA and/or manufacturers minimum allowable bending radius.

.6 If cables are terminated through window type current transformers, make an inspection to verify that neutral and ground conductors are correctly placed and that shields are correctly terminated for operation of protective devices.

.2 Electrical Tests

.1 If required by electrical tests, disconnect all conductors prior to testing and ensure that all phases are properly identified (Phase A – Red, Phase B – Black, Phase C – Blue, Neutral – White). After testing, re-connect equipment and conductors in the original phasing order.

.2 Perform an insulation resistance test utilizing a megohmmeter with a voltage output of at least 500 volts DC for cables up to 250 volts, and at 1000 volts DC for cables rated from 250 to 600 volts AC. Individually test each conductor with all other conductors and shields grounded. Test duration shall be one minute.

.3 Test Values

.1 Minimum insulation resistance values should be comparable to previously obtained results, but not less than two megohms. Investigate values that differ from other phases by more than 50%.

2.13 CIRCUIT BREAKER TRIP UNITS, THERMAL MAGNETIC

.1 Visual and Mechanical Inspection, provide all typical inspections and cleaning, plus:

.1 Record as-found settings.

.2 Electrical Tests

.1 Verify functionality of trip unit by tripping using the trip button of the trip unit, if present.

.2 If requested by contract documents, provide primary injection of the circuit breaker trip unit.

.3 Test Values

.1 When not otherwise specified, use manufacturer's recommended tolerances.

.2 When critical test points are specified, the relay should be calibrated to those points.

2.14 PANELBOARDS AND MCCS, EITHER BREAKER OR FUSIBLE DISCONNECT (DISTRIBUTION, LIGHTING, EMERGENCY, ETC.)

.1 Visual and Mechanical Inspection, provide all typical inspections and cleaning, plus:

.1 Note the position of all circuit breakers or disconnects. Operate all circuit breakers or disconnects to ensure proper mechanical operation. Ensure that all devices are left in the original position.

.2 Inspect all wires for evidence of damage, chafing, or pinching in the panel board covers.

.3 Check tightness of all connections.

.2 Electrical Tests

.1 Perform insulation resistance tests on the main bus with all breakers open and control wiring disconnected. Energize each phase with the correct test voltage ensuring the opposing two phases and neutral (4 wire only) are grounded. Each test shall occur for a duration of one (1) minute. Electrical equipment rated from 120 volts AC to 250 volts AC shall be tested at 500 volts DC. Electrical equipment rated above 250 volts AC to 600 volts DC shall be tested at 1000 volts DC.

.2 If required for electrical testing, disconnect all equipment and conductors that are not part of the equipment assembly prior to testing and ensure that all phases are properly identified (Phase A – Red, Phase B –Black, Phase C – Blue, Neutral – White). After testing re-connect equipment and conductors in the original phasing order.

.3 Test Values

.1 Insulation resistance values for bus shall be in accordance with manufacturers published data. In the absence of manufacturers published data, use NETA Standard Table 10.1. (Note: Do not use test voltage levels in NETA Table 10.1) Values of insulation resistance less than this table or manufacturers minimum should be investigated.

2.15 SPLITTER TROUGHS

.1 Visual and Mechanical Inspection, provide all typical inspections and cleaning, plus:

.1 Inspect all wires for evidence of damage, chafing, or pinching in the panel board covers.

.2 Check tightness of all connections.

.2 Electrical Tests

.1 Perform insulation resistance tests on the main bus. Energize each phase with the correct test voltage ensuring the opposing two phases and neutral (4 wire only) are grounded. Each test shall occur for a duration of one (1) minute. Electrical equipment rated from 120 volts AC to 250 volts AC shall be tested at 500 volts DC. Electrical equipment rated above 250 volts AC to 600 volts DC shall be tested at 1000 volts DC.

.2 If required by electrical testing, disconnect all equipment and conductors that are not part of the equipment assembly prior to testing and ensure that all phases are properly identified (Phase A – Red, Phase B –Black, Phase C – Blue, Neutral – White). After testing re-connect equipment and conductors in the original phasing order.

.3 Test Values

.1 Insulation resistance values for bus shall be in accordance with manufacturers published data. In the absence of manufacturers published data, use NETA Standard Table 10.1. (Note: Do not use test voltage levels in NETA Table 10.1) Values of insulation resistance less than this table or manufacturers minimum should be investigated.

2.16 TRANSFORMERS, AIR COOLED, SMALL (LESS THAN 167 KVA SINGLE PHASE OR 500 KVA THREE PHASE)

.1 Visual and Mechanical Inspection, provide all typical inspections and cleaning, plus:

.1 Inspect core and coil for evidence of insulation breakdown due to excessive heating.

.2 Check tightness of all connections.

.2 Electrical Tests

.1 Verify correct secondary voltage phase to phase and phase to neutral after energization and loading.

.2 If testing requires cable disconnection, disconnect all equipment and conductors that are not part of the equipment assembly prior to testing and ensure that all phases are properly identified (Phase A – Red, Phase B – Black, Phase C – Blue, Neutral – White). After testing, re-connect equipment and conductors in the original phasing order.

2.17 DISCONNECTS (FUSED AND UNFUSED), LESS THAN 750V

.1 Visual and Mechanical Inspection, provide all typical inspections and cleaning, plus:

.1 Inspect physical and mechanical condition, including:

.1 Blade and Jaw - verify correct blade alignment, blade penetration, travel stops, and mechanical operation.

.2 Operating Arm – free movement, break over

.3 Operating Mechanism – sprockets, chain, pushrod arms, lubrication.

.4 Door interlock – verify door unable to open when switch closed.

.2 Inspect fuses if present.

.3 Check tightness of all connections.

.4 Note position and exercise switch, returning switch to original position.

2.18 DC BATTERY SYSTEMS

.1 Ensure adequate protective equipment is used during all following tests, which shall include at least the following:

.1 Goggles and face shields

.2 Acid-resistant gloves

.3 Protective aprons

.4 Portable or stationary water facilities for rinsing eyes and skin in case of contact with electrolyte

.5 Bicarbonate of soda solution, mixed 100 grams bicarbonate of soda to 1 litre of water, to neutralize acid spillage. NOTE - the removal and/or neutralization of an acid spill may result in production of hazardous waste. The user should comply with appropriate governmental regulations.

.6 Class C fire extinguisher

.7 Adequately insulated tools

.2 The following protective procedures shall be observed during maintenance:

.1 Use caution when working on batteries since they represent a shock hazard.

.2 Prohibit smoking and open flames, and avoid activities that increase the chances of arcing in the immediate vicinity of the battery.

.3 Ensure that the load test leads are clean, in good condition, and connected with sufficient length of cable to prevent accidental arcing in the vicinity of the battery.

.4 Ensure that all connections to load test equipment include appropriate short-circuit protection.

.5 Ensure that battery area ventilation is operating per its design.

.6 Ensure unobstructed egress from the battery area.

.7 Avoid the wearing of metallic objects such as jewellery.

.8 Neutralize static build up just before working on the battery by contacting the nearest effectively grounded surface.

.9 If installed, ensure that the battery monitoring system is operational.

.3 Provide the following visual, mechanical, and electrical inspections, noting that all inspections should be made under normal float conditions.

.1 Inspect the battery rack/cabinet and anchors for rusting, corrosion, and other deterioration that could affect the battery rack structural or seismic integrity and strength and inspect approximately 10% of the battery rack fasteners for tightness.

.2 Perform the following steps for seismic installations.

.1 Inspect the battery to ensure an intercell spacer is present between each battery jar.

.2 Inspect the intercell spacers in place for deterioration (broken, warped, crumbling, etc.).

.3 Verify that the space between each of the end-rails and the end battery jars is less than or equal to 3/16” or a value specified by the manufacturer.

.3 Verify that the rail insulators are in place and in good condition.

.4 Verify that the electrolyte level of each cell is between the high- and low-level marks imprinted on the cell case. When any cell electrolyte reaches the low-level line, distilled or other approved-quality water should be added to bring the cells to the manufacturer’s recommended full level line. Water quality should be in accordance with the manufacturer’s instructions.

.5 Inspect each battery cell jar, cell jar cover, and seals (jar to cover seal, post to cover seal) for deterioration (acid leakage, cracking, crazing-spider web effect, distortion, etc.).

.6 Examine the plates in each cell for sulfation. NOTE - sulfation can sometimes be detected on the plate edges by shining a light source on the plates, which will reflect off the yellowish sulfate crystals.

.7 Examine the plates in each cell for the proper color that indicates a fully charged battery based on the manufacturer's information. NOTE - normally, fully-charged, positive plates are coloured a deep chocolate-brown color. Negative plates are normally a medium grey. A horizontal ring of white deposits around the plates and on the inside of the jar indicates hydration. This is a result of the lead sulfate precipitating out of solution after the recharge of an over discharged cell or the recharge of a discharged cell that has not been promptly recharged. Consult your manufacturer's maintenance instructions for further guidelines in this area. If any negative plates are reddish in color, this indicates copper contamination, and the cell should be replaced as soon as practical.

.8 Examine through the clear battery jar case, the plates, bus bar connection to each plate, and bus bar connection to the post of each battery cell for corrosion and other abnormalities. Inspect the lower part of the post seals and the underside of the cover for cracking or distortion.

.9 Examine the cell plates, spacers, and sediment space of each cell to determine if any deterioration (warped plates and spacers, lifted cell posts, pieces of plate material that have fallen off, shorted plates, excessive sediment in the bottom of the cell, plates that have dropped lower than the other plates, etc.) has occurred that could affect a cell relative to the rest of the cells in the battery.

.10 Examine the cell posts of each cell to determine if any of them have grown or lifted to a larger degree than the rest of the posts of the battery. NOTE - the positive plates of lead-acid batteries normally swell or grow with age and use. Most manufacturers claim that 5% growth is the expected maximum limit during the life of the battery.

.11 Inspect each electrical cell-to-cell and terminal connection to ensure they are clean (no significant corrosion or foreign matter) and the connection surfaces remain coated with a thin layer of anti-corrosion material. If corrosion is noted, remove the visible corrosion and check the resistance of the connection as per item 2.18.3.25 below. NOTE - unless corrosion is cleaned off of battery terminals periodically, it will spread into the area between the posts and the connectors.

.12 Verify that all cells of the battery remain properly numbered.

.13 Verify that each battery cell vent, flame arrestors, and dust caps are present and inspect each for damage.

.14 Examine the general condition of the battery, battery rack and/or cabinet, and the battery room to determine if they are clean and in good order. When excessive dirt is noted on cells or connectors, remove it with a water-moistened clean wipe. Remove electrolyte spillage on cell covers and containers with a solution of bicarbonate of soda mixed with 100 grams of soda to 1 liter of water. Avoid the use of hydrocarbon-type cleaning agents (oil distillates) and strong alkaline cleaning agents, which may cause containers and covers to crack or craze. Do not allow the cleaning compound to enter the cell.

.15 Inspect for unintentional battery grounds

.16 Record float voltage measured at battery terminals. When the float voltage measured at the battery terminals is outside of its recommended operating range, it should be adjusted. Nominal float voltage should be as recommended by manufacturer. Maximum float voltage or Nominal Equalize voltage should be as recommended by manufacturer.

.17 Record charger output current and voltage. Maximum provided voltage from the charger should be as recommended by manufacturer.

.18 Record ambient temperature and ventilation

.19 Check approximately 10% of the battery rack fasteners for tightness.

.20 Measure and record the voltage of each cell

.21 Measure and record specific gravity of 10% of the cells of the battery if battery float charging current is not used to monitor state of charge.

.22 Measure and record electrolyte temperature of 10% or more of the battery cells. When cell temperatures deviate more than 3°C from each other during a single inspection, determine the cause and correct the problem. If sufficient correction cannot be made, contact the manufacturer for allowances that must be taken. NOTE - when working with large multi-tier installations, the 3°C allowable deviation may not be achievable, especially when relating the bottom to top tier temperature measurements. Typically, the deviation limit should be maintained within tiers.

.23 Measure and record specific gravity and temperature of each cell. Please note, specific gravity values are based on a temperature of 25°C, and should be corrected for the actual electrolyte temperature and level. For each 1.67°C above 25°C add 1 point (0.001) to the value. Subtract 1 point for each 1.67°C below 25°C.

.24 Check all battery rack connection fasteners for tightness.

.25 Cell-to-cell and terminal connection resistance. (NOTE – do not take measurements across the cell. This improper action could cause personal injury, damage to the test equipment, and damage the cell.) If resistance measurements obtained are more than 20% above the installation value, or the greater of 20% or 5 micro-ohms above the average value, or if loose connections are noted, torque and re-test. If retested resistance value remains unacceptable, the connection should be disassembled, cleaned, reassembled, and retested. Typically, this will involve the following steps:

.1 Clean posts and connectors and apply a thin coat of heated (between 71 and 85°C) no-oxide grease.

.2 Re-Install existing inter-cell and inter-tier connectors, and hand tighten nuts in accordance with manufacturer's instructions.

.3 Using torque wrenches, tighten nuts in accordance with manufacturer's recommended value.

.4 Refer to IEEE Std. 484-1996 for detailed procedures and IEEE Std. 450-2002 D.2 and Annex F for further discussions.

.26 Structural integrity of the battery rack and/or cabinet.

.4 Equalizing Charge

.1 An equalizing charge should be given in any of the following conditions:

.1 If the voltages measured under item 2.18.3.19 above are deviating from the average value by an amount greater than that recommended by the manufacturer, typically +/- 0.05V for lead calcium batteries.

.2 If the specific gravity, corrected for temperature, of an individual cell falls below the manufacturer's lower limit.

.3 If any cell voltage is below the manufacturer's recommended minimum cell voltage.

2.19 GROUND ELECTRODE

.1 Visual and Mechanical Inspection

.1 Inspect expose ground conductor and connections.

.2 Inspect ground rod viewport.

.3 Dig to expose to underground ground rods and connections, review condition

.4 Ensure proper connections are made to all exposed switchgear, structures, transformers, fences, gates, and other items per OESC section 36.

.2 Electrical Tests

.1 Perform fall of potential or alternative test in accordance with IEEE Standard 81 on the main grounding electrode or system.

.2 Perform point-to-point tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and/or derived neutral points.

.3 Test Values

.1 The resistance between the main grounding electrode and ground should be no greater than five ohms for commercial or industrial systems and one ohm or less for generating or transmission station grounds unless otherwise specified by the owner. (Reference ANSI/IEEE Standard 142)

.2 Investigate point-to-point resistance values which exceed 0.5 ohm.

PART 3 - FIELD TAPING PROCEDURE

3.1 MATERIALS FOR TAPING

.1 Use acceptable high voltage acceptable filler such as Kearney Air Seal or 3M Scotchfil Electrical Insulation Putty. Standard duct seal is not acceptable.

.2 Use an acceptable high voltage insulating tape such as Scotch 130C.

3.2 APPLICATION

.1 Elongate insulating tape 10 to 25 percent during application to ensure a smooth, tight fit. On pads elongate corners only.

.2 Should a tape roll expire, start the new role by overlapping the previous end by 1/2 turn.

.3 Apply one layer of insulating tape, lapping as specified in the taping chart; overlap any pre-insulation by 1-1/2 inches.

3.3 APPLICATION ON JOINTS WITH HARDWARE

.1 Clean area of dirt and foreign matter.

.2 Apply filler over bare conductor and hardware to cover and smooth out the surface. Blend contour into pre-insulation surfaces. Cover conductors and hardware with at least 1/8 inch of filler.

.3 Apply pad(s) of insulating tape of sufficient width to overlap pre-insulation by one inch or more.

.4 Apply one layer of insulating tape, lapping as specified in the chart, overlapping any pre-insulation or pads by 1-1/2 inches.

3.4 TAPING CHART

Taping Chart

Rated kV of Equipment	Pre-insulation or Pad Overlap Min. Inches	Insulating Tape Lap of Tape	Min. Layers	No. of Pads
Up to 5	1-1/2	1/2	1	1
Up to 15	1-1/2	2/3	2	2
Up to 27	1-1/4	2/3	3	3
Up to 46	1-1/4	2/3	4	4

3.5 DEFINITIONS

.1 Joint: Area to be covered with tape which consists of bare conductor and 1-1/2 inches of any pre-insulation next to the bare conductor.

.2 Pre-Insulation: Any insulating tape applied which is wider than one inch, which includes a band of tape consisting of one or more turns wrapped directly on top of each other.

.3 Layer: Insulating tape, 1 inch wide, wrapped from one end of the joint to the other (or to a pad) so each succeeding turn laps the previous turn by the amount specified in the chart.

.4 Overlap: A specified distance measured along the pre-insulation starting from where the pre-insulation ends and the exposed conductor begins.

PART 4 - EXECUTION

4.1 GENERAL REQUIREMENTS

.1 Testing to be completed on all equipment supplied under this contract.

.2 Keep working area clean and safe, all testing and maintenance areas are to be cleaned after usage.

.3 The contractor is responsible for verifying all types of distribution equipment to be tested, and ensuring they have the proper equipment to test equipment, especially proprietary trip units, relays, controllers, and other similar items.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CSA-C22.2 No. 131-07, Type TECK 90 Cable.

.2 National Electrical Manufacturers' Association (NEMA)/Insulated Cable Engineers Association (ICEA)

.1 ICEA S-93-639/NEMA WC74-06, 5-46 KV Shielded Power Cable for Use in the Transmission and Distribution of Electrical Energy.

PART 2 - PRODUCTS

2.1 RUBBER INSULATED CABLES (1001 - 5000 V)

.1 Conductors: copper size as indicated.

.2 Insulation: cross-linked polyethylene compound rated RWU90.

.3 Insulation shielding: semi-conducting non-metallic tape over insulation, and served wire shield over tape.

.4 Cable jacket: thermosetting with separator tape between shield and jacket.

2.2 COPPER TAPE SHIELDED POWER CABLE 15,000 V

.1 Single copper conductor, Class B stranded, size as indicated.

.2 Semi-conducting crosslinked polyolefin conductor shield .

.3 Manufactured to CSA C68.5

.4 Insulation: 133% tree retardant crosslinked polyethylene (TRXLPE) rated for 90ºC, for 15,000V.

.5 Semi-conducting crosslinked polyolefin conductor insulation shield .

.6 Metallic Shield: 0.06mm annealed copper shield tape applied helically with 20% overlap over insulation shield.

.7 Jacket: Low friction, lead free, flame-retardant, moisture and sunlight-resistant, PVC jacket rated minus 35ºC.

2.3 TECK POWER CABLE (1001 - 15000 V)

.1 Cable: to CAN/CSA-C22.2 No. 131.

.2 Ground: Annealed bare copper Class B stranding.

.3 Copper circuit conductors, size and number as indicated.

.4 Extruded Strand Shield: Thermoset semi-conducting extruded stress control layer over conductor.

.5 Insulation: Cross-linked polyethylene (XLPE).

.6 Extruded Insulation shield: Thermoset semi-conducting polymeric layer free stripping from insulation.

.7 Shield: 5mil annealed copper tape with a minimum 25% overlap.

.8 Armor: Aluminum Interlocked Armor (AIA)

.9 Jacket: Flame-retardant, moisture and sunlight-resistant, PVC, colored red.

.10 Acceptable manufacturers: General Cable, Nexans, Prysmian, or equivalent

2.4 AIRGUARD POWER CABLE (1001 – 15000 V)

.1 Cable: to CAN/CSA-C68.10, CSA C22.2 No.230, CSA-C96.1

.2 Conductor: Class B compact concentric stranded soft drawn annealed copper, sized as indicated on drawings.

.3 Insulation: Natural high dielectric strength EPR-based insulation, 133% rated.

.4 Conductor Shield: Extruded thermosetting semi-conducting shield which is free stripping from the conductor and bonded to the insulation.

.5 Insulation Shield: Extruded thermosetting semi-conducting shield with controlled adhesion to the insulation.

.6 Metallic Shield: Helically applied non-magnetic copper tape over the insulation shield with a minimum overlap of 15%. A Mylar ribbon must be longitudinally applied under the copper tape shield for phase identification.

.7 Grounding Conductors: Bare stranded copper conductor, one in each interstice.

.8 Assembly: Phase identified shielded conductors cabled with fillers and grounding conductors, forming a firm and cylindrical cable core. Binder tape to be applied to maintain core symmetry and mechanical stability.

.9 Mechanical protection: High strength and high crush resistant Airbag Layer extruded over the core assembly.

.10 Chemical protection: A layer of Drylam which consists of aluminum tape and a chemical resistant extruded polymer layer must be applied.

.11 Jacket: Sunlight-resistant, PVC, colored red.

.12 Acceptable manufacturers: Prysmian, or approved equivalent.

2.5 NON-SHIELDED JUMPER CABLE 15,000V

.1 Cable: to ICEA S-96-659.

.2 Copper circuit conductors, size and number as indicated.

.1 Conductor to be flexible, rope stranded, annealed, uncoated copper.

.3 Copper Shield: Nylon semi-conducting tape.

.4 Insulation: Heat, moisture, and ozone resistant ethylene propylene rubber (EPR) 90°C per ICEA S-96-659(NEMA WC 71), part 4

.5 Acceptable manufacturers: BICC, Phillips, Pirelli, or equivalent.

.6 Note: this cable is only to be installed from ceiling IPS through free air down to transformer primary bushings. Cable must not be near any grounded metal or other installations at other than rated voltage.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Obtain detailed cable pull design from cable manufacture prior to installation of cables. Cable pull design to be submitted to engineer for review prior to installation of cable.

.2 Install power cable in ducts and manholes as indicated and in accordance with manufacturer's cable pull design.

.3 Provide supports and accessories for installation of high voltage power cable.

.4 Install stress cones, terminations and splices in accordance with manufacturer's instructions

.5 Install grounding in accordance with local inspection authority having jurisdiction.

.6 Provide cable identification tags and identify each phase conductor of power cable every 15 meters where the cable is not installed in duct.

3.2 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Section 26 05 10.

.2 Use of qualified tradespersons for installation, splicing, termination and testing of high voltage power cables.

.3 Engage an independent testing agent to test high voltage power cable. Submit test result and inspection certificate.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED SECTIONS

.1 Section 001000

.2 Section 260500 - Electrical General Requirements.

1.2 REFERENCES

.1 Canadian Standards Association (CSA International)

- .1 CSA C22.2 No. 47-M90 (R2012), 'Dry-Type Transformers'
- .2 CSA C9-M1981(R2001), 'Dry-Type Transformers'
- .3 CSA C802.2-00, 'Minimum Efficiency Values for Dry-Type Transformers'

.2 National Electrical Manufacturers Association (NEMA)

1.3 SHOP DRAWINGS

.1 Submit shop drawings in accordance with Section 00 10 00.

.2 Include:

- .1 Dimensioned drawing showing enclosure, mounting devices, terminals, taps, internal and external component layout.
- .2 Technical data:
  - .1 kVA rating.
  - .2 Primary and secondary voltages.
  - .3 Frequency.
  - .4 Three phase.
  - .5 Polarity or angular displacement.
  - .6 Full load efficiency.
  - .7 Regulation at unity pf.
  - .8 BIL.
  - .9 Insulation type.
  - .10 Sound rating.

1.4 CONTROL SUBMITTALS

.1 Submit to Engineer 6 copies of standard factory test certificates of each transformer and type test of each transformer in accordance with CSA C9 or C22.2 No. 47.

1.5 CLOSEOUT SUBMITTALS

.1 Provide operation and maintenance data for dry type transformers for incorporation into manual specified in Section 00 10 00.

.2 Operation and maintenance instructions to include:

.1 Tap changing.

.2 Recommended environmental conditions.

.3 Recommended periodic inspection and maintenance.

.4 Bushing replacement.

1.6 DELIVERY, STORAGE AND HANDLING

.1 Store transformers indoors in dry location.

.2 Transformers to be shipped fully plywood crated complete with shrink-wrap and desiccant packs. Ensure that the transformers are properly packaged prior to shipping.

.3 Include all shipping and storage charges required to send equipment to the site. Include charges for on and off loading of the equipment into storage areas designated by the client.

1.7 EXTRA MATERIALS

.1 Provide maintenance materials in accordance with Section 00 10 00 .

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Dry-type transformers: to CSA C22.2 No. 47 and CSA C802.2.

2.2 TRANSFORMER CHARACTERISTICS > 500 kVA 3 PHASE

.1 Type: ANN/(Provisional ANF).

.2 Rating: as indicated, 3 phase, provisions only for fan forced air cooling, 60 Hz.

.3 220 insulation system class, 115 degrees C temperature rise.

.4 Impedance (STD): 5.5% to 7.5%

.5 Primary winding: 13,200V delta, BIL 95 kV.

.6 Secondary winding: 600V, wye, BIL 10 kV, four wire with neutral brought out for solidly grounded or impedance grounding.

.7 No load and Full load losses to meet CSA standard C802.2.

.8 Sound rating: 66dB.

.9 ENCLOSURE

.1 NEMA 1 enclosure

.2 Fabricated from sheet steel.

.3 Bolted removable panels for access to tap connections, enclosed terminals.

.4 Conductor entry:

.1 Side entry for primary cables.

.2 Exit for secondary conductors through side of transformer enclosure such that cables do not need to be de-rated.

.3 Transformer manufacturer to provide flexible connectors for primary connections and coordinate with primary switchgear manufacturer to insure location of primary switchgear bus and transformer primary bus allows for close coupling of transformer to primary switchgear.

.5 Designed for floor mounting.

.6 Indoor, ventilated, self cooled type. Temperature of exposed metal parts not to exceed 65 degrees C rise.

.7 The transformer enclosure must be knock down type to allow for transformer disassembly to insert into room through access hatch. Contractor to ensure size of core and coil is acceptable for insertion into vault through the ventilation airway and vault door.

.8 Enclosure height must not exceed 2750mm in height.

.10 VOLTAGE TAPS

.1 11 taps, one at nominal voltage, 5 at 2.5% intervals above nominal, 5 at 2.5% intervals below nominal.

.11 TAP CHANGER

.1 Bolted-link type.

.12 WINDINGS

.1 Primary and secondary coils:

.1 Copper.

.2 Mechanical Coil Supports

.3 Epoxy Vacuum Impregnation (E.V.I.).

.4 Primary Winding Construction – Self supporting disk wound with insulation dielectric impulse surge capacity rated at 4000 volts turn to turn equivalent to Nomex.

.5 Secondary Winding Construction – Self supporting barrel wound with insulation dielectric impulse surge capacity rated at 4000 volts turn to turn equivalent to Nomex.

.2 Coil and core assembly:

.1 Taps located at front of coils for accessibility.

.13 ACCESSORIES TO BE INCLUDED

.1 Winding temperature detector relay and sensing elements with two sets of SPDT contacts to allow for future fan control and high temperature alarming.

.2 Wiring and terminal box for protective devices.

.3 Grounding terminal: inside of enclosure.

.4 Lightning arrestors mounted on primary of transformer

2.3 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section 260500 - Electrical General Requirements.

.2 Equipment labels: nameplate size 7.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Locate, install and ground transformers in accordance with manufacturer's instructions.

.2 Set and secure transformers in place, rigid plumb and square.

.3 Connect primary terminals to high voltage circuit.

.4 Connect secondary terminals to secondary circuit.

.5 Use flexible conduit to make connections to transformer.

.6 Energize transformers and check secondary no-load voltage.

.7 Adjust primary taps as necessary to produce rated secondary voltage at no-load.

.8 Use torque wrench to adjust internal connections in accordance with manufacturers' recommended values.

.9 Check transformer for dryness before putting it into service and if it has not been energized for some considerable time.

.10 Provided dedicated system ground to transformer neutral point if present.

.11 Contractor to provide control power to transformer temperature detector.

3.2 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Section 260510 – Electrical Testing.

.2 Energize transformers and apply incremental loads:

.1 0% for 4 hours.

.2 10% for next 1 hour.

.3 25% for next 2 hours.

.4 50% for next 3 hours.

.5 Full load.

.6 At each load change, check ambient and winding temperatures.

END OF SECTION