STANDARD TECHNICAL SPECIFICATION
OPG-M-783-16
Battery Chargers (125 Vdc and Above)

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1. SCOPE OF WORK

1.1 Standard Technical Specification

This Standard Technical Specification covers standard requirements for design and supply of DC Battery Chargers (125 and above) for use indoors at Ontario Power Generation (OPG) hydroelectric generating stations. Battery Chargers supplied shall be ready for connection to circuits belonging to OPG. This standard covers assemblies containing, but not limited to, such devices as rectifiers, interrupting devices, switches, controls, instrumentation, metering, protective equipment, and associated enclosures.

The intent of this Specification is to ensure that equipment described herein is supplied in its entirety and completely functional in every detail of its designated function to the satisfaction of OPG. The equipment Contractor shall be solely responsible for correct and satisfactory design, manufacture, fabrication, factory acceptance testing, delivery and guarantee of the DC Battery Charger systems.

The Contractor must furnish, at no additional cost to OPG, all devices, apparatus, appliances, material and labour not specifically described in this Specification, but that are necessary to complete, perfect and test the specified equipment in compliance with the stated requirements and standards.

When specified, the Contractor also agrees to provide technical direction during installation and field-testing of the battery chargers.

1.2 Supplementary Specification

A Supplementary Specification, OPG-M-783S, and drawings for each specific project shall be read with and form part of this Standard Technical Specification.

The Supplementary Specification and drawings will provide site specific details such as ratings, quantity, physical arrangement, specific operating parameters and single line diagrams. Additional features such as online battery monitoring, online capacity testing, and ground fault detection are discussed in the Supplementary Specification.

Requirements of the Supplementary Specification take precedence over this Standard Technical Specification.

Drawings and specifications are deemed to be complementary to each other so that if anything is shown on the drawing but not mentioned in the specification or vice versa, it shall be furnished and built as if specifically set forth in both. In case of conflict between the Standard Technical Specification, Supplementary Specification and/or the drawings, OPG shall be consulted for clarification.

2. LAWS, STANDARDS, AND CODES

2.1 General

All work shall conform to:

- The laws and regulations of Canada, the Province of Ontario, or local municipalities
- Specific standards listed in the sections below, their latest issues, amendments and supplements of which shall apply unless otherwise indicated in the contract documents
- Any other standards mentioned elsewhere in this document or that apply in general to this work.

The Supplier Group shall clearly state in its proposal any exceptions or deviations it intends to take to these standards and specifications.

Should any law, standard or code be revised, the Supplier Group and the Owner will make each other aware of the revision to discuss adoption of the revision.

Should conflict occur between laws, standards or codes and this Specification, the most stringent requirements shall govern.

2.2 Specific Standards

2.2.1 Ontario Power Generation (OPG) Standards

The following may be supplied in the request for proposal package where applicable:

- OPG-M-377 - Terminal Blocks Used in Manufacturer's Equipment.
- ENG-MAN-001E - Temporary Grounding and Bonding Guide (External Version).
- ENG-MAN-002E - Station Grounding and Bonding Guide (External Version).
- ENG-MAN-013 - DC Distribution Guide
- ENG-MAN-015 - Drawing Requirements Manual for Consultants.

2.2.2 Canadian Standards Association (CSA)

- CSA C22.2 No. 75 Thermoplastic Wires and Cables
- CSA C22.2 No. 107.2-01 Battery Chargers
- CSA C22.2 No. 5.1 Molded Case Circuit Breakers
- CSA C22.1 - Canadian Electrical Code Handbook and CSA C22.2 General.
- CSA C22.2 No. 39: Fuseholder Assemblies.

- CSA C22.2 No. 106: HRC-Miscellaneous Fuses.
- CSA C22.2 No. 127: Equipment and Lead Wires.

2.2.3 Standards Council of Canada

- CAN/ULC-S801-14: Standard on Electric Utility Workplace Electrical Safety for Generation, Transmission, and Distribution.

2.2.4 Institute of Electric and Electronics Engineers (IEEE)

- IEEE 576: Recommended Practice for Installation, Termination, and Testing of Insulated Power Cable as Used in Industrial and Commercial Applications.
- IEEE Std 946, Recommended Practice for the Design of DC Auxiliary Power Systems for Generating Stations

2.2.5 Acoustical Society of America (ASA)

- ANSI/ASA S1.4 Part 1-3: American National Standard Electroacoustics – Sound Level Meters

2.2.6 National Electrical Manufacturers Association (NEMA)

- NEMA 250: Enclosures for Electrical Equipment (1000 Volts Maximum).
- NEMA PE5: Utility Type Battery Chargers

2.2.7 American Society for Testing and Materials (ASTM):

- D635: Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.
- D2863: Standard Test Method for Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index).
- D256: Impact Resistance of Plastics and electrical Insulating Materials

2.2.8 Underwriters Laboratories Inc. (UL):

- UL94: Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.
- UL1012: Power Units other than Class 2

2.2.9 International Organization for Standardization (ISO):

- IS0 9001: Quality Management Standard.

3. DEFINITIONS AND ABBREVIATIONS

The following definitions and abbreviations apply throughout this Specification:

OPG	Ontario Power Generation, Inc.
OPG Representative	Engineer employed by or representing OPG, responsible for ensuring that the Contractor is adhering to the specification
Contractor	The party named in the Contract to whom OPG has awarded the contract to design and supply the equipment (the Supplier, the subcontractor, the Supplier's personnel and any other person the Supplier or a Subcontractor is responsible for at law)
Equipment	The materials, machinery, assemblies, instruments, devices or articles, as the case may be, or components thereof, which form part of the work
Specification	This document and any other addenda, attachments, drawings or tables supplied as part of the Request For Proposal
Work	Is all labour, materials, equipment, structures, services, supplies and acts required to be done, furnished or performed by the Contractor under the contract
OPG Padlock	A padlock with a 50 mm case and an 8 mm shackle
Field Services Representative	A representative of the Contractor who provides technical support during the assembly, installation, testing and commissioning of the low voltage power circuit breaker at the OPG site.

4. GENERAL REQUIREMENTS

All materials shall be new and meet requirements of applicable codes and standards. Where applicable, all electrical products shall be approved for use in Ontario and labelled with a certification mark acceptable by the Electrical Safety Authority (ESA) of Ontario. Workmanship shall be in accordance with best practice and be adequate to ensure satisfactory operation and service life, and ease of maintenance. An ISO certified quality management standard is preferred; however, the Contractor shall supply a copy of their quality management system at no cost to OPG for review.

4.1 Industrial Safety

Equipment and material specified in this Standard Technical Specification shall comply with the requirements of the *Occupational Health and Safety Act and Regulations for Industrial Establishments (Ontario)*, the *Ontario Electrical Safety Code*, the *Canadian Environmental Protection Act*, with all amendments, including regulations and notices, respecting designated

substances as set forth in the Revised Statutes of Ontario and Federal Regulations.

All electrical insulating materials shall not support combustion and will generate minimal acid gas when ignited. Components that contain polychlorinated biphenyl (PCB), asbestos or any toxic substances shall not be used.

Equipment furnished shall not include materials which contain radioactive elements or emit x-ray or other radiation when energized or de-energized.

All equipment shall be grounded and bonded in accordance with ENG-MAN-002E. All temporary grounding and bonding shall be in accordance with ENG-MAN-001E.

4.2 Fire Retardancy

All insulating material shall have a flammability rating of 94 V0 in accordance with *UL94* or an oxygen index of $\geq$ 28 when tested in accordance with *ASTM 2863*.

Gas emission when material is heated shall be minimal. PVC material shall not be used.

5. RELIABILITY AND MAINTAINABILITY

OPG prefers that equipment shall be to the Contractor's existing design standards, i.e. virtually identically designed and rated units are currently in operation in other generating stations. Unique designs specifically made to meet the requirements of this specification or the Supplementary Specification shall be disclosed within the Contractor's proposal.

The Contractor shall provide predicted failure frequency, repair times and associated costs (based on experience of the equipment that is already operating in industry) for major and minor failures involving one or a combination of critical components and shall state the basis for figures provided.

Predicted failure and repair data and any modifying information may be reviewed with the Contractor prior to any award to ensure verification, completeness and accuracy.

Mean time to repair estimates for battery chargers shall be based upon the presumption that all items in the recommended list of spares (see Section 5.3, Spare Parts) are readily available, the Contractor's recommended maintenance schedule is adhered to, and that maintenance personnel are available on a five day, 40-hour work week basis. Time estimates exclude OPG time allocated to issuing work permits and applying work protection to equipment.

The charger shall be installed and arranged to facilitate access for maintenance, testing and removal, with a minimum amount of disturbance to other equipment. Equipment supporting structures shall be designed such that dismantling will not be required to conduct major

maintenance.

5.1 Service Life

The Contractor shall design and manufacture the charger with such high quality material and workmanship to ensure that useful life of the charger is at least 30 years with a mean time between failures of at least 100,000 hours.

The Contractor shall state in its proposal (without altering warranty requirements) the following:

(1) Design life of equipment (in years) before major maintenance is required and design life of equipment before minor maintenance is required. A list of expected maintenance items for both situations is required.

(2) Types and quantities of spare parts recommended to be purchased for a thirty year operating life.

5.2 Common Components and Interchangeability

Over the course of the service life, replacement of several components due to end of life or damage is inevitable. In general, consumable items such as LED lights, covers, switches, fuses and even molded case circuit breakers will likely require replacement. The Contractor, through consideration in the design, should optimize the design by utilizing common components for multiple applications (e.g. the same LED lights, switches, fuses, etc. used throughout) that are readily available as stocked items in Canada.

The Contractor shall also consider the interchangeability of components that are similarly rated or for similar purpose such as switches, molded case circuit breakers, indication lights, etc. Fuses of different ratings are not to be interchangeable.

Keyed door locks may use a single key pattern to unlock all doors.

5.3 Spare Parts

A list of recommended spare parts shall be provided by the Supplier. Required spare parts shall be documented in the Supplementary Specification.

6. DESIGN AND FABRICATION

6.1 Service Conditions

The battery chargers shall be designed for use in an industrial environment. The battery chargers shall be designed for free standing, indoor service mounted on concrete floors unless noted otherwise in the Supplementary Specification. Input side circuit breakers and control wiring may be exposed to normal over voltage (120 % nominal) and frequency variances (±5 Hz of Nominal) typical of hydroelectric generator load rejections.

Typical service conditions inside stations are:

- Ambient Temperature: 40 °C maximum.
- Relative Humidity: 5 % to 90 % non-condensing.

Unusual service conditions (e.g. exposure to extreme heat, EMF, dust, steam, etc.) will be listed in the Supplementary Specification, if applicable.

The chargers shall be solid state construction, filtered output (See Section 6.9, Voltage Ripple Content), and constant voltage type.

6.2 Charger Enclosure

The enclosure shall be rated, at a minimum as a NEMA 2 enclosure.

The chargers shall be completely assembled and wired in an enclosure. The charger enclosure shall minimize the ingress of dust and other airborne particulates. It should be resistant to entry by rodents.

The enclosure shall be arranged such that all operation, maintenance and testing requires front access only. All controls related to the output of the charger must be readily accessible on the outside of the charger enclosure, so as to allow complete configuration of the charger without the need to open the enclosure.

Each charger shall consist of a steel frame and sheet steel for front, rear, sides, top, bottom and doors. A fabricated compartment shall form a rigid self-supporting structure free from twist, warp, weave and magnetically induced vibrations. Self-tapping screws and speed nuts are not acceptable. The assembly shall be capable of being jacked and rolled on the floor or fork lifted without distortion or damage.

Limiting physical dimensions and weights of charger shall be as described in the Supplementary Specification.

6.2.1 Compartments and Doors

The following are requirements for the doors of the charger assembly:

(1) All doors shall fit tightly against their closing surfaces from top to bottom to reduce ingress of dust.

(2) Each door, where applicable, shall be labelled in accordance with Section 6.19, Nameplates and Signage.

(3) Each door shall be lockable with an OPG padlock.

(4) Each door shall be bonded to ground.

(5) Each door shall be equipped with a catch or spring latch. The door shall be limited to a door swing between 90-135° to the enclosure. The stops shall be accessible to allow personnel to disengage the stops to close the doors.

(6) Doors shall be sized to allow easy access to internal equipment and cable terminations.

(7) Doors shall have hinges. Doors shall be secured using a single-throw, single handle multi point latching system

6.2.2 Control Compartment

The controls and terminal strips are the most accessed area of the charger assembly. A well organized control layout is necessary in order to reduce troubleshooting time. The overall layout shall be designed by the Contractor and reviewed by OPG. However, the following are requirements to be applied to the control area design:

(1) Interior painting as stated in Section 6.2.7, Protective Finish – Metal Treatment and Finish.

(2) Control wiring and terminal blocks as stated in Section 6.2.3, Terminal Blocks and Control Circuit Wiring.

(3) Equipment labeling as stated in Section 6.19, Nameplates and Signage.

(4) Grounding bus as stated in Section 6.3, Charger Grounding.

(5) 600 V circuitry is not permitted in the main control compartment. 600 V equipment shall be located in a separate compartment. In the event the design space is limited (i.e. where a separate compartment is unavailable), 600 V equipment located with the enclosure must be clearly identified, segregated and shielded from other equipment and all wiring must be bundled and shielded separately from other control and power wiring. The enclosure door shall include a warning in accordance with Section 6.19, Nameplates and Signage, stating “This equipment contains multiple external sources up to 600 V”.

(6) Ac and dc equipment within the cabinet shall be segregated (e.g. mounted on separate rails) and identified.

(7) Wiring to door mounted equipment shall be guarded against abrasion.

(8) Fuse holders must be “dead front” and lockable in the open position with an OPG

padlock.

(9) Ac and dc moulded case circuit breakers must be lockable in the open position with an OPG padlock and have visible contacts.

6.2.3 Terminal Blocks and Control Circuit Wiring

The charger shall have terminal blocks and control circuit wiring in accordance with OPG Specification OPG-M-377. Blocks shall be mounted on back and side panels of control compartments and shall be readily accessible for maintenance and testing.

Terminal blocks for all external control and indication circuits shall be of 600 V insulation class, and accommodate # 12 through # 8 AWG copper conductors. Terminal numbers must agree with numbers shown on connection wiring diagrams.

Terminal blocks for any outgoing CT circuits shall be equipped with shorting links and be mounted at a convenient location inside the control compartment.

Terminal blocks for different voltage levels shall be mounted on separate rails. Where this is not possible, the Contractor must clearly segregate and identify the terminal blocks for the different voltage levels.

All terminal strips shall contain at least 25 % spare terminal blocks.

Control wiring shall be in accordance with *CSA Standard C22.2 No. 127*, SIS type, and shall have ratings of 600 Vac, 90 °C, be fire retardant, and have thin wall and abrasion-resistant insulation. Control wiring conductors shall be tinned copper, multi-stranded type and sized accordingly. Minimum conductor size for control wiring is # 14 AWG (2 mm^2). Conductor stranding shall be 7 strands or greater for general applications and 19 strands or greater for hinged door wiring. The Charger shall have all control wiring routed in such a way as to minimize exposure to live parts of power equipment.

Grommets, bushings and other mechanical protection shall be provided to control wiring running through metal barriers and near sharp edges.

Control wiring shall be continuous between terminals of various devices with conductors neatly bundled and supported at frequent intervals with self-locking reusable, non-adhesive type wire mounts and ties.

Wire markers shall have sufficient grip on conductor insulation and have permanently printed wire numbers or names protected by clear plastic overcoats.

Interconnecting wiring shall terminate on terminal blocks and, where necessary, be connected by terminal block links.

6.2.4 Cable Openings

The enclosure shall be provided with an opening or openings to accommodate power and/or control cable/bus entry. Location of these openings will be detailed in the Supplementary Specification.

Removable, non-magnetic power cable opening cover plates shall be provided to seal off the complete cable/bus opening areas. Plates shall be cut, drilled or punched in the field to accommodate the size and number of cables/bus and not inflict any lateral pressure on incoming conductors. Plates shall be bolted to the compartment floor/ceiling/wall to permit easy field installation and removal.

6.2.5 600 V Bus/Transformer/Terminal Guarding

All 600 V bus (if included in design), terminals, and transformers, shall be guarded to prevent personnel contact. The guards may contain openings to allow for airflow within the gear, however openings must not allow for fingers to pass through. Preference is for materials that allow personnel to visually see the equipment behind the guards (e.g. polycarbonate resin thermoplastic) and non-flammable. The guards shall be removable for maintenance purposes.

6.2.6 Ventilation

The chargers shall be vented for self-cooling by natural air convention. Forced air designs are not acceptable

Venting shall not reduce the NEMA enclosure rating as specified and shall be coordinated such that the structural integrity of, covers and partitions is maintained.

Vent openings shall not allow for fingers or hand tools to be inserted and/or make contact with live objects.

6.2.7 Protective Finish - Metal Treatment and Finish

All surfaces of the charger enclosure shall be chemically cleaned to remove surface contamination.

The exterior surface colour shall be light grey No. 61. Interior surfaces shall be painted light grey No. 61 as well; however, terminal strips shall be mounted on a mounting panel painted white.

Surfaces shall be either primed and painted, treated with a heavy duty powder-coat process, or treated with a baked epoxy technique.

Interior surfaces shall be treated with a fungus prevention and anti-static coating.

Where an interior surface coating is applied to prevent condensation, this coating and any

interior surface paint shall be fire-retardant and classified 94V-0 according to Standard UL94 and oxygen index of 28 or greater in accordance with ASTM D2863.

A minimum of two litres of light grey No. 61 finish paint shall be shipped with the equipment for site touch-ups. Touch up pens in light grey No. 61 may be substituted.

6.3 Charger Grounding

The Charger shall have an internal ground bus bar of silver-plated, solid, rectangular cross section copper conductor, sized and braced to meet fault current requirements described in the Supplementary Specification. All connections of the ground bus joints, if applicable, shall have silver plated contact surfaces with conductor overlap to be secured, at a minimum, by two bolt NEMA pattern connections.

Ground bus bars shall be pre-drilled, two or four-hole NEMA pattern for connection to the station ground grid with, at a minimum, 4/0 bare copper conductor brought in by OPG. The preferred location is near the cable entry point-immediately behind the door approximately 250 mm above the finished floor for bottom or side entries OR across the top of the charger for cable top entry. The enclosure shall be solidly connected to the ground bus.

For grounding of control cable shields, the switchgear assembly ground bus shall be extended with a 2/0 AWG bare copper conductor connected to a flat silver copper strip, completed with a minimum six pre-drilled holes of 5.5 mm (7/32”) diameter and mounted in a convenient location in each control area where control cables are landed.

6.4 Charger Characteristics

The battery chargers shall have a minimum efficiency of 90 % at rated load. The power factor shall be better than 80 % at full load with rated input voltage.

The chargers shall be protected against voltage or current transients by use of surge suppression techniques to break the current to be installed across the secondary of the input transformer. The charger shall be protected against accidental reverse polarity connection.

The charge noise level should not exceed 80 db for more than one minute with a test record showing that this feature has been checked and is functional as part of the charger documentation.

6.5 Charger Output Current

The battery chargers shall be capable of providing 100 % of rated load current and simultaneously recharge a fully discharged battery in no more than 10 hours.

The current limit shall be user-adjustable from as low as 50% up to 100 % of the rated charger current. The charger shall be delivered with the current limit set at 110 % of the rated current without voltage depression with a test record showing that this feature has been checked and is functional as part of the charger documentation.

6.6 Charger Circuit Breakers

The chargers shall be protected against short-circuit by thermal magnetic circuit breakers provide at both input (ac) and output (dc) circuits. The charger input and output breaker shall be rated at not more than 150 % of maximum "normal" current draw anticipated for the charger design under the ac supply. There shall also be a dedicated circuit breaker in the output terminal for the battery to be isolated.

The circuit breakers shall have an interrupting capacity equal to or greater than the available short-circuit current value as provided in the Supplementary Specification. The breakers shall be capable of being manually operated with the enclosure door closed.

All breakers must be pad-lockable with an OPG padlock and also have visible contacts to allow visual confirmation of breaker position by trades personnel using these breakers as an electrical isolating point.

6.7 Charger Input Voltage

The charger input voltage will be provided from the station's ac station service system. The typical system voltage is 600 Vac, 3 phase, at 60 HZ. Station service supply voltage is typically maintained within $\pm$ 10 % of the nominal value, and the ac supply frequency within $\pm$ 5 % of the nominal value. Please review the Supplementary Specification for station specific deviations in voltage and frequency of the input supply.

6.8 Charger Output Voltage

The charger shall be capable of providing the output voltage regulation for input variances and 0-100% variation in load, and ambient temperature as specified in the supplementary specification.

Unless otherwise specified in the Supplementary Specification, the maximum ripple shall be in accordance with Section 6.9, Voltage Ripple Content, when connected to the battery.

The chargers shall be designed to automatically shut down in the event of high output voltage. The value of the high output voltage will be determined by a set-point (approximately 130 % of output voltage). The set point shall be selectable and consistent with the maximum recharging voltage of the battery.

6.9 Voltage Ripple Content

The charger output voltage must be filtered such that the rms voltage ripple will not exceed 2% of the nominal dc voltage when the charger is connected to a purely resistive load (i.e. with the battery disconnected from the charger, and no filtering provided by the capacitive effects of the parallel battery plates).

Additionally, the voltage ripple shall be 100mV rms or less ripple when the charger is connected to a typical battery 125 Vdc battery, or 200 mV rms or less when the charger is connected to a typical 250 Vdc battery (having approximate capacity in A.h that is 4 times the charger A dc rating).

6.10 Float Voltage Settings

The float voltage shall be adjustable over the range identified in the Supplementary Specification, adjustable to within 0.1 Vdc. The charger shall be delivered set to float as identified in the Supplementary Specification.

The controls for the float voltage set-point must be user-adjustable and accessible from the outside of the cabinet, without requiring workers to be exposed to live, energized components within the charger.

6.11 Equalize Voltage Settings

The equalize voltage shall be adjustable over the minimum range identified in the Supplemental Specification, adjustable to within 0.1 Vdc. The charger shall be delivered set to equalize as identified in the Supplementary Specification.

The controls for the equalize voltage set-point must be user-adjustable and accessible from the outside of the enclosure, without requiring workers to be exposed to live, energized components within the charger.

6.12 Temperature Compensation

The charger output voltage shall be compensated for temperature based on a measurement of the temperature of the battery area.

The temperature compensation function shall allow for an adjustable output voltage between a defined minimum and maximum voltage as outlined in the Supplementary Specification.

The slope of the temperature compensation function shall be fixed with the slope setting at -2.5mV/V/°C cell for deviations from 25 °C. The charger documentation shall include a test

record that demonstrates this compensation function as requested.

The controls for adjustment of the temperature compensation slope and limits must be user-adjustable and accessible from the outside of the enclosure, without requiring workers to be exposed to live, energized components within the charger.

Temperature compensation shall be enabled or disabled from the front of the enclosure via an independent switch or through an HMI. Independent switches must be guarded from inadvertent use.

Please see the Supplemental Specification for cable length requirements for the temperature probe

6.13 Required Charger Accessories

The battery charger shall be equipped with the following accessories:

- AC voltmeter with an accuracy of ± 1% of full scale
- AC ammeter with an accuracy of ± 1% of full scale
- Digital dc voltmeter with an accuracy of ± 1% of full scale
- Digital dc ammeter with an accuracy of ± 1% of full scale
- AC and dc Surge suppression
- Alarm Extension board w/ Individual Form C contacts for remote annunciation
- RS232/RS485 port for Modbus TCP communications

Each component shall be labeled for identification (See Section 6.19, Nameplates and Signage).

6.14 Charger Adjustable Controls

The following adjustments are required to be performed from the outside of the enclosure:

- Float Voltage Adjust/Equalize Voltage Adjust

6.15 Charger Local LED indicator lights

The following indications are required to be displayed on the front of the enclosure either independently or incorporated in an HMI display

- AC “ON” (ON = GREEN).
- Fault (FAULT = RED).

- Alarm (ALARM=RED).
- Float Mode (DISPLAY AMBER in FLOAT MODE).
- Equalizing Mode (DISPLAY AMBER in EQUALIZE MODE).

6.16 Charger Local Display for Measurements

The following measurements are required to be displayed on the front of the enclosure either independently (e.g. meter) or incorporated in an HMI display:

- Measured Battery Temperature
- Equalizing Charge Time Elapsed
- Equalizing Charge Time Remaining
- AC Volts and Amps
- DC Volts and Amps

6.17 Charger Local Alarms

Local alarm shall be displayed on the front of the enclosure either independently or incorporated in an HMI display as well as produce an audible alarm:

- AC Low Voltage
- AC High Voltage
- DC Low Voltage
- DC High Voltage
- Positive Ground Fault
- Negative Ground Fault
- Output Breaker Open
- Rectifier Failure
- Control Board Failure
- Internal Power supply Failure

Please see the Supplemental Specification for any additional requirements

6.18 Remote SCADA Data

The following outputs are required to be wired to terminal blocks for OPG connection to the SCADA system:

- DC Output Voltage (4-20 mA output signal)
- DC Output Current (4-20 mA output signal)
- Measured Battery Temperature (4-20 mA output signal)
- Loss of AC (Dry Form C contacts)
- Charger Trouble Alarm (Dry from C contacts) - This alarm may have multiple cases where the relay will close such as Rectifier failure, control board failure, and power supply failure as detailed in Section 6.17, Charger Local Alarms. The Contractor shall provide a list of all cases where this alarm will be triggered.

Please see the Supplemental Specification for any additional requirements

6.19 Nameplates and Signage

This section describes the requirements for equipment nameplates, warning labels, and control compartment labeling.

Nameplates and signage identifying equipment, ratings, and hazards are required for all chargers. OPG will make every effort to provide the Contractor with accurate equipment operating nomenclature prior to the design review process through documentation or drawings. It is recommended, during the design review process, to create a list of all nameplates, signage, and warning labels for review by OPG to ensure the equipment identification is correct prior to manufacturing.

The general requirements for nameplates and signage are as follows:

(1) Rating nameplates, warning/caution signage and control compartment labeling shall be fastened using screws. Adhesive nameplates are not acceptable.

(2) Nameplate/signage sizes shall be selected by the Contractor. Material thickness and installation method shall prevent the nameplate from bending or warping.

(3) Warning/caution signage and control compartment labels shall be made of engraved Lamacoid.

(4) Caution signage requested by OPG shall be produced with black lettering on yellow background.

(5) Warning signage per *CAN/CSA-Z321-96* requested by OPG shall be produced with white lettering on a red background.

(6) Informational signage, notifications, and instructional labels (e.g. door handle turning direction) may be adhesive labels.

Font sizes shall be clearly legible. As a guide, the equipment nomenclature for the charger itself may be approximately 75 mm in height, while other equipment nomenclature (breakers, control panels) may have a font size of 25 mm. Smaller font sizes due to space constraints on the mounting surface will be discussed during the design review.

6.19.1 Rating Nameplates

Switchgear rating nameplates shall meet the following requirements in addition to those detailed in Section 6.19, Nameplates and Signage:

(1) Rating nameplates shall be made of engraved black anodized aluminum or stainless steel.

(2) The Contractor shall provide rating nameplates for all components of the charger all in accordance with applicable standards. Nameplates will be mounted in a conspicuous location and readable without opening cell doors.

(3) Circuit breaker manufacturer's nameplates shall be clearly visible outside the enclosure.

(4) Data font size shall be a minimum of 5 mm and clearly legible.

(5) Rating Nameplate data required to be shown is as follows:

- Charger Manufacturer.
- Charger Model.
- A Serial Number or other unique identification.
- Date of Manufacture (Month, Year).
- Input Voltage and Current Ratings.
- Output Voltage and Current Ratings.
- Mass of the charger.

6.19.2 Warning Labels

This section describes the requirements for warning labels required to be included with the charger.

"CHARGER MAY BE ENERGIZED EVEN WHEN BREAKER IS OPEN" shall be installed on the charger to visibly warn that the charger may still have live terminals.

"CHARGER CONTAINS MULTIPLE EXTERNAL SOURCES UP TO 600V" shall be installed on the charger door.

"DO NOT USE ON-BOARD METERING FOR CALIBRATION" shall be included.

6.19.3 Control Compartment Labeling

The control compartment labeling shall meet the following requirements:

- Each component, such as fuses, breakers, terminal blocks, communication and control equipment inside of the control compartment shall be identified.
- Components within the control compartment shall be given labels that easily identify the equipment and shall match the Contractors drawings.

6.20 Capacity Test Load Connection for Capacity Testing Option

The majority of OPG sites must comply with *NERC-PRC-005: Protection System Maintenance*. In particular, OPG prefers to perform capacity tests on its battery banks to comply with the required maintenance activities for dc systems.

Historically, station batteries at many OPG sites have been hardwired directly to the load without a means to segregate the battery leads for capacity tests. As equipment is replaced, a means of safely segregating a battery bank to perform capacity tests is introduced-either through disconnects/breakers and transfer switches mounted separately or within the battery charger itself.

OPG emphasizes worker safety and implements a Safety-by-Design approach when designing systems. The Contractor may be asked to collaborate with the Lead Engineer to integrate a disconnect/connect/transfer option into the battery charger to enable employees to safely segregate a battery bank, connect a load bank (test set), and transfer the connection of the battery from the charger to the load bank. Please see the Supplementary Specification for further detail and whether this option is applicable.

7. TESTING AND INSPECTION

OPG reserves the right for inspection of equipment prior to packaging for shipment and witness factory acceptance tests.

Equipment parts and materials failing to meet the requirements of this specification will be replaced by the Contractor at no additional costs to OPG.

The chargers shall be factory tested to demonstrate the performance and functionality of each individual component. The Supplier shall prepare a Factory Inspection and Test Plan (ITP) and Recording Form. These documents shall be issued to OPG for review and acceptance at least two weeks prior to testing. OPG reserves the right to modify the ITP.

All deficiencies observed during the testing process shall be documented, identified to OPG, and corrected prior to shipment by the Contractor.

A complete record of all factory tests performed on the equipment must be supplied.

7.1 Testing Requirements

In addition to testing requirements as outlined in *CSA 22.2 No. 107.2-01*, the Contractor shall perform the following test requirements related to dielectric testing, current limiting, noise testing, temperature compensation, control function and annunciation verification.

7.1.1 Dielectric Testing

The charger inputs shall all be isolated from ground.

Both the positive and negative dc outputs of the charger shall be floating with respect to ground (i.e. the charger output shall be ungrounded).

Additionally, there shall be no direct electrical path connecting the charger supply and charger output (for example, an isolating transformers may be used to separate these two circuits).

The dielectric separation of these components must be tested. With the ac input terminals shorted, and dc terminals shorted together, the following voltage levels shall be applied for a duration of 1 minute without dielectric breakdown:

Test Circuit	60 Hz AC Test Voltage	DC Test Voltage
AC Input terminals to ground bus and charger enclosure	Minimum of 2.2 kV	Minimum of 3.1 kV
DC Output terminals to ground bus and charger enclosure	Minimum of 1.5 kV	Minimum of 2.1 kV
AC Input terminals to DC output terminals	Minimum of 2.2 kV	Minimum of 3.1 kV
Control Circuits		1 kV

Charger test records must include the test voltage applied, a measurement of the leakage current at the end of the 1 minute voltage application, and/or the impedance measured at the end of 1 minute.

7.1.2 Current Limiting

The charger shall be tested to demonstrate the ability to function and limit output current as detailed in Section 6.5, Charger Output Current.

7.1.3 Noise Testing

The test shall be performed with the charger operating at full load and rated voltage (the unit can be mounted on vibration isolators). Measurements shall be made with a standard noise level meter that conforms to the requirements of *ASA S1.4 Parts 1-3*, operated on the "A" weighting network. Readings shall be taken at locations 300 mm (12") from each outside surface (including the top) of the charger. The average of these readings, modified by the appropriate amount shown in the table, shall not exceed the noise level as specified in *NEMA PE5*.

7.1.4 Temperature Compensation

The charger shall be tested to demonstrate the ability to function and compensate for temperature deviations as detailed in Section 6.12, Temperature Compensation.

7.1.5 Control Function

The controls specified in this Specification as well as the Supplementary Specification shall be tested for functionality and accuracy.

8. DRAWINGS AND DOCUMENTATION

All drawings shall be submitted in .dwg format as well as .pdf format for review. OPG will supply the title block/border templates, together with a block of drawing numbers, to be incorporated into all drawings such that they are easily incorporated into OPG's Drawing Management System.

8.1 Drawing and Document Submission with Proposal

IMPORTANT: The Contractor shall submit the following information with the proposal for the new equipment. Absent or partial information (without notes as to the reason the information is missing or incomplete) may render the submittal non-compliant and remove the Contractor from further discussions or considerations for any portion of the defined scope of work.

The drawings and documents submitted with the proposal are intended to demonstrate to OPG an understanding of the overall project scope or work. The intent is to capture key dimensions, ratings, and locations of equipment without going into great detail.

The Contractor shall submit the following technical information within the proposal:

(1) Basic assembly/sectional view of the charger.

(2) Floor plan view showing dimensions and proposed location of the charger as defined in the Supplemental Specification.

(3) A general material list outlining proposed equipment ratings, manufacturers, etc.

(4) A reference list of similar chargers, of equal or greater size, sold in the last five years.

(5) Provide contact name, address, telephone, email address, basic ratings and quantities of equipment.

8.1.1 Drawing Submission after Award of Contract

The Contractor shall submit, in accordance with the applicable clauses in the Standard Commercial Conditions provided by OPG Supply Chain, within four weeks after notification of the award of contract, one electronic copy of all applicable electrical, mechanical and civil drawings for approval before manufacture of the equipment commences. Approval of drawings by OPG does not relieve the Contractor of complying with the Standard Technical Specification in all respects unless such non-compliance is specifically authorized.

The following drawings are required:

(1) General arrangement, overall assembly plan and sectional views to indicate arrangement of the compartments and their components.

(2) Dimensions and approximate weight.

(3) Location of all control and power connections (supply and load).

(4) Connection Wiring Diagrams (CWD) and Elementary Wiring Diagrams (EWD)

(5) Provision for special access, removable access space, etc., for initial installation and future extension of the equipment.

(6) Bill of Material.

(7) Third party auxiliary equipment drawings, if applicable.

8.1.2 Data and Other Information Submission after Award of Contract

(1) A list of all exceptions and variances from this specification and the Supplementary Specification.

(2) Applicable manufacturing and testing standards used.

(3) Type of equipment being offered and its certified design test reports, as specified in the applicable standards.

(4) A list of all changes in design, material, components, procedure, etc., made after the original design tests on the equipment were performed. OPG reserves the right to request a repeat of these tests if any modifications are deemed to affect the performance or ratings of the equipment.

(5) Complete equipment data per the Data Sheets located in the Supplementary Specification. All ratings and capabilities listed in these data sheets shall be guaranteed values.

(6) The recommended surge protection equipment for the affected loads, if required.

(7) Circuit breaker instruction manuals.

(8) Responses to service life details as per Section 5.1, Service Life.

(9) Predicted failure frequency, repair times, associated costs, etc. as per Section 5.1.

(10) Replacement frequency for major components with respect to time of use and number of operations.

(11) A list of recommended spare parts, including unit prices, in compliance with Section 5.3, Spare Parts.

(12) The Contractor's project management office address and contact information servicing the site as indicated in the Supplementary Specification.

(13) The Contractor's closest service centre address and contact information to the site as indicated in the Supplementary Specification.

(14) A statement of the number of weeks of advance notice required by the Contractor for their field services representative to report to project site.

(15) A separate price for conducting formal training for OPG personnel as per Section 11, Training.

8.1.3 Final Drawings

The following final drawings shall be submitted prior to shipping of the charger to the OPG site:

(1) General arrangement and foundation plan drawings, giving complete dimensions and weights. Drawings to detail all locations of cable/bus entrances, mounting bolts, etc.

(2) Section view drawings of the charger detailing arrangement of components. Drawings to include bills of material and cable connection details

(3) All ac and dc schematic and wiring diagrams (e.g. elementary wiring diagrams and connection wiring diagrams).

(4) One set of electronic files in latest version of AUTOCAD by AUTODESK Corporation format. All drawings shall be produced using AUTOCAD or equivalent

Items (1), (2) and (3) shall be submitted bearing the seal and signature of a professional engineer licensed in the province of Ontario and the date upon which it was sealed.

8.1.4 Final Submission Data and Other Information

The following information shall be submitted prior to shipping of the charger to the OPG site:

(1) One complete hard copy and one electronic set of approved maintenance and operation instruction manuals (see Section 8.2, Instruction Manuals) including a spare parts list (see Section 5.3, Spare Parts), reduced size drawings, bills of material, design test reports, and all production test reports. This includes all applicable test reports by non-Contractor produced equipment such as molded case circuit breakers and any associated special tests.

(2) Shipping dimensions and weights.

(3) A complete set of Material Safety Data Sheets (MSDSs) for all chemicals, lubricants, etc.

(4) Test reports on production tests (when available).

8.2 Instruction Manuals

Qualified OPG operations and maintenance personnel will operate, maintain and repair equipment with aid of the Contractor's instruction manuals. Therefore, detailed, accurate, well organized and easy to use instruction manuals are of vital importance.

The final approved version of instruction manuals shall be provided in electronic format, along with one hardcopy per charger for OPG use (See Section 8.1.4, Final Submission Data and Other Information).

8.2.1 Contents of Instruction Manual

Instruction manuals for switchgear shall contain the following:

- Title of equipment, station name, equipment ratings, OPG purchase order, requisition and Contractor’s reference numbers. This information shall appear on the outside of the binder hardcopy and on the first page.
- Section 1:
  - Title page.
  - Table of contents - sections shall be sequentially numbered.
  - List of drawings and summaries - by number and title, including serial numbers of equipment to which manuals are applicable.
- Section 2 - Installation Instructions:
  - Shipping, receiving, and manoeuvring instructions.
  - Storage instructions - indoor, outdoor and special information for equipment storage.
  - Alignment, erection and dimensional tolerances for preparation of start-up and commissioning, if applicable.
  - Provide inspection procedures for before and after unloading, pre-erection tests, etc.
- Section 3 - Testing:
  - Provide functional testing, dielectric testing and operating instructions, operating limits and start up instructions complete with drawings.
  - Provide a separate set of production test record sheets showing all test values and measurements including tolerances for each test made on the charger.

- Section 4 - Operation and Maintenance:
    - Provide commissioning and maintenance instructions complete with photographs and drawings on how to disassemble and assemble, repair, set critical tolerances and adjustments of the charger including circuit breakers.
    - Provide instructions on use of special tools.
    - Provide an inspection frequency guide
    - Provide data on all gaskets, seals and O-rings, which must be replaced during routine maintenance, or after a specified period of time or number of operations.
    - Include procedures for safe discharge of all stored energy apparatus if applicable (mechanical and electrical)
    - Provide a trouble-shooting guide and procedures for all systems of the charger. The trouble-shooting guide shall list a number of symptoms, and give the corresponding inspection area of trouble or fault, probable cause or defect and remedy.
- Section 5 - Spare and Renewal Parts:
    - Provide a complete Spare Parts List indicating quantity, part description, Contractor's part and catalogue number. Cross-reference all part and component numbers with drawings in the instruction manual.
    - Identify every part listed in the Spare Parts List and Renewal Parts List of the equipment and sub-assemblies on drawings. Drawings shall include sectional and exploded views. Include part and component description, Contractor’s part number and applicable replacement part numbers.
    - The Contractor must update reissue drawings, and inform OPG of every modification of the equipment and sub-assembly for the 30-year life of the equipment. This will facilitate easy identification of parts or replacement parts when ordering or maintaining spare parts inventory.
- Section 6 - Drawings and Equipment Data:
    - The Contractor shall provide a complete set of drawings specific to the equipment being supplied showing layout, dimensions, tolerances of major components, and schematic, interconnection and single line diagrams. A complete reduced set of drawings shall form part of the instruction manuals. Provide operational instructions, operating limits, and other equipment data complete with drawings. Include applicable general bulletins, but clearly indicate the specific equipment being supplied by arrow or other means.

9. SHIPPING, HANDLING AND STORING

The charger shall be designed, manufactured and prepared to prevent defects due to normal and abnormal impacts, vibrations and movements during shipping and handling. Removable components may be shipped in separate crates.

Adequately sized lifting eyebolts shall be provided. See Section 6.2, Charger Enclosure. Chargers and components, which are not ready to be placed into service, shall be stored in a clean, dry and heated building by either OPG or the Contractor as per the Supplementary Specification.

10. ASSEMBLY / INSTALLATION

When required in the Supplementary Specification, the Contractor's field services representative shall be responsible for furnishing technical direction to OPG for the purposes of ensuring equipment is correctly assembled, field tested and installed to permit commencement of service.

During performance of duties at site, the field services representative shall comply with relevant federal, provincial and municipal statues, regulations, bylaws and codes, as well as OPG safety requirements. The installation contractor shall participate in any required OPG site Safety and Work Protection Code training, obtain OPG security clearance and shall use all personal protective equipment as specified by OPG and follow all OPG safety related instructions while on site. Without limiting the generality of the foregoing, the contractor shall comply with all regulations made under the Ontario Occupational Health and Safety Act and shall co-operate with safety associations operating under the authority of the Worker's Compensation Act.

All special tools required for site installation shall be supplied with the shipment.

11. TRAINING

The Contractor shall include in its proposal a separate price for conducting a formal training session for OPG personnel for one business day. Schedule of the session shall be at a mutually agreeable time and the instructor must be fluent in the English language. Prior to commencement of the session, the Contractor shall submit a detailed outline of the training session for approval.

As an alternate, the Contractor may propose a separate price for conducting training via webinar training. However, the Contractor must be able to present a working model of the finished product to be able to perform the training as if in the field.

The training session shall be a combination of theory of operation and 'hands on', with a strong emphasis on the latter. The session shall include, as a minimum, the following:

- An overview of a charger and its operation, including control circuit testing requirements for commissioning and major and routine maintenance of the charger
- A thorough walkthrough of the controls and adjustments.

12. WARRANTY

Refer to the commercial documents for warranty information.