STANDARD TECHNICAL SPECIFICATION
OPG-M-784 R00
Station Batteries

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1. SCOPE OF WORK

1.1 Standard Specification

This Standard Technical Specification covers standard requirements for design, supply, testing and shipment of Vented Lead Acid (VLA) or Valve Regulated Lead Acid (VRLA) storage batteries for use indoors at Ontario Power Generation (OPG) generating stations. Batteries supplied shall be a complete system ready for connection to circuits belonging to OPG. This standard covers systems containing, but not limited to, such equipment as lead acid batteries, battery racks, spill containment, and slip resistant mats.

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 Station Batteries.

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 and test the specified equipment in compliance with the stated requirements and standards.

When specified, the Contractor shall provide technical direction during installation and field-testing of the station batteries.

1.2 Supplementary Specification

A Supplementary Specification OPG-M-784S and drawings for each specific project shall accompany, be read with and form part of this Technical Specification. The requirements of the applicable Supplementary Specification shall take precedence over the Standard Specification for the specific project under discussion.

All drawings supplied by the OPG Representative as part of the Supplementary Specification to the Contractor shall form part of this Specification. The drawings and specifications shall be 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 Specification, Supplementary Specification and/or the drawings, the OPG Representative 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 Contractor 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 Contractor 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 Canadian Standards Association (CSA) Standards

- CSA C22.1 – Canadian Electrical Code, Part 1 Safety Standard for Electrical Installations

2.3 Institute of Electrical and Electronics Engineers (IEEE) Standards

- IEEE Std. 484 – Recommended Practice for Installation Design and Installation of Vented Lead-Acid Batteries for Stationary Applications.
- IEEE Std. 485 – Recommended Practice for Sizing Lead-Acid Batteries for Stationary Applications.
- IEEE Std. 450 – Recommended Practice for Maintenance, Testing and Replacement of Vented Lead-Acid Batteries for Stationary Applications.
- IEEE Std. 946 – Recommended Practice for the Design of DC Auxiliary Power Systems for Generating Stations.
- IEEE Std. 1187 – Recommended Practice for Installation Design and Installation of Valve-Regulated Lead-Acid Batteries for Stationary Applications.
- IEEE Std. 1188 – Recommended Practice for Maintenance, Testing, and Replacement of Valve-Regulated Lead-Acid (VRLA) Batteries for Stationary Applications.
- IEEE Std. 1189 – Guide for Selection of Valve-Regulated Lead-Acid (VRLA) Batteries

for Stationary Applications.

- IEEE Std. 1375- Guide for the Protection of Stationary Battery Systems.
- IEEE Std. 1578- Recommended Practice for Stationary Battery Electrolyte Spill Containment and Management.
- IEEE Std. 1635- Guide for the Ventilation and Thermal Management of Batteries for Stationary Applications.

2.4 American Society for Testing and Materials (ASTM) Standards

- D256 - 10e1 Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics.
- D2863 - 13 Standard Test Method for Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index).

2.5 International Organization for Standardization (ISO)

- ISO 9001: Quality Management Systems.

2.6 Underwriters' Laboratories Incorporated (ULI) Standards

- UL 94 Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.
- UL 746A Polymeric Materials - Short Term Property Evaluations.

3. DEFINITIONS AND ABBREVIATIONS

The following definitions and abbreviations apply throughout this Specification:

Contractor	The Contractor, the Subcontractor, the Contractor's Personnel or any other Person the Contractor or a Subcontractor is responsible for at law
OPG	Ontario Power Generation, Inc.
OPG Representative	Engineer, employed by or representing OPG, responsible for ensuring that the Contractor is adhering to the specification
SG	Specific Gravity
UPS	Uninterrupted Power Supply
VLA	Vented Lead Acid
VRLA	Valve Regulated Lead Acid

4. OPERATING CONDITIONS

New battery cells will be installed either on new tiered seismically qualified battery racks or on the existing battery racks within the generating station powerhouse. If required new, the battery manufacturer shall supply new battery racks (See Supplementary Specification). The batteries shall be mounted with the cell plates positioned at right angles to the major axis of each rack so that the plate edges are visible. The intention is to maintain similar battery room arrangements.

Each battery rack shall be properly grounded to the station's grounding system (See Section 8.1).

The battery will be floated at a constant voltage per cell, in accordance with the manufacturer's recommendation. The average cell voltage will be maintained between 2.17 V and 2.25 V per cell for lead calcium cells.

The minimum and maximum dc system voltages for 125 volts battery system will be 101.5 volts and 135 volts respectively. The minimum and maximum dc system voltages for 250 volts battery system shall be 203 volts and 270 volts, respectively.

The battery will be charged with a constant voltage charger supplied by OPG that meets the battery requirements (refer to the Supplementary Specification).

Although batteries are rated for operation at 25°C, generating station battery rooms across Ontario vary significantly in ambient temperature. The physical locations of the plants range from extreme northern Ontario to the extreme south of the Niagara region. Battery room location may be the top floor or basement of the powerhouse, and climate control may or may not be present. Refer to the Supplementary Specification for site specific environmental conditions.

The batteries will be operated, inspected and maintained in accordance with normal OPG maintenance procedures and/or as recommended in the manufacturer's battery operation and maintenance manual.

The relative density of the electrolyte (SG) will be allowed to follow the usual variation that occurs during the life of the battery.

5. MATERIAL AND CONSTRUCTION OF VLA CELLS

For VLA battery types, positive and negative grid plates shall be constructed of a Lead-Calcium alloy. Lead-Antimony, Nickel-Cadmium and UPS type cells are unacceptable for stationary application.

The internal structure shall be a plated design rather than a tubular design unless otherwise stated in the Supplementary Specification.

5.1 Cell Jars - VLA

Cell jars and covers shall be manufactured of materials satisfying the following properties:

- Transparency.
- Fire Retardant in accordance with ASTM D2863.
- Stress Crack Resistant (Contractor to provide details).
- High Strength (Contractor to provide details).
- Impact Resistant in accordance with ASTM D 256.

Preference will be given to fire retardant material for both jars and covers having an oxygen index of not less than 25 as per ASTM D2863. The Contractor shall provide a price for the battery having jars manufactured from polycarbonate material when requested in the Supplementary Specification.

The jar-cover seal shall be tongue and groove type construction providing full positive closure. Materials of jars and of covers shall be compatible with regard to coefficient of expansion and ability to be adequately sealed for the rated life against leakage or migration of electrolyte.

The cell plates shall be adequately supported to allow for normal cell plate growth and movement, due to aging and charging/discharging, for the rated life of the cell. Plate growth shall not initiate cracking of the jar or cover, affect the integrity of the plates, or impair the expected capacity of the cell.

The high and low electrolyte-level lines, 2 mm to 3 mm wide, shall be molded into or permanently marked on the container, so as to be visible on the sides of each cell installed parallel to the major axis of the rack. The liquid level shall be clearly visible in the vicinity of the level line.

Polarity shall be permanently marked on the jar and/or cover and clearly visible adjacent to the terminals.

5.2 Terminal Post Seals - VLA

The seals provided between terminal posts and jar covers shall be designed as to prevent leakage of electrolyte and resultant corrosion of the post, for the rated life of the cell. Cracking of the jar covers or of jars, from stress brought about by post growth or other cause internal to the cell, shall be sufficient cause to justify cell replacement under warranty at no cost to OPG.

5.3 Terminal Posts and Inter-cell Connectors - VLA

The terminals shall be either lead or lead-plated. Terminal posts shall be designed to accommodate externally bolted connections. Each terminal post shall have, at a minimum, two bolt holes of the same diameter with each at right angles to the other. The bottom hole shall be for termination of the inter-cell connector. The top hole shall be for OPG use.

Inter-cell connectors shall be either lead or tin plated copper connectors. Inter-cell connectors shall be designed to meet the requirements of the discharge load cycle of the battery, with each exhibiting a maximum allowable voltage drop of 0.02 V, (as measured from post to post, over the length of the connector) at the 1 min. rate with connectors torqued to the values recommended by the Contractor. In addition, the Contractor shall provide connectors of sufficient length to provide a required minimum spacing between cells for seismically qualified two-tier rack assembly installation (See Section 8). Where OPG does not specify spacing between cells in the Supplementary Specification, then a minimum spacing between cells at the top of the jar, shall not be less than 12.5 mm (0.5 inch).

Assembly hardware for lead alloy posts and lead plated connections shall be lead encapsulated brass. Hardware for tin plated inter-cell connectors shall be type 316 stainless steel. Galvanized steel hardware is unacceptable. Application of grease prior to assembly shall be explicitly stated in the installation instruction if required. All torque specifications shall be based on un-lubricated threads. Details for the recommended hardware arrangement (e.g., number and location of washers, nuts and bolts) shall be provided by the Contractor.

All lead plating shall be at a minimum thickness of 2 mils (.002 inch).

Inter-cell connectors and hardware shall be supplied new and shall not be used in the factory for test purposes.

Terminal and connector covers shall be supplied to prevent personnel contact with the terminals and connectors as well as to protect the terminals and reduce surface contamination.

5.4 Accessories - VLA

Accessories to be supplied for each battery lineup shall be as follows:

- Two hydrometers complete with holders. The holder shall have means to catch electrolyte drips.
- One Celsius thermometer equipped to mount in the filler hole of any cell.
- Minimum of 2 extra sets of intercell connectors and fasteners per 58 cells or less to accommodate field loss or spoilage.
- Corrosion inhibiting grease where prescribed by the Contractor.
- Lifting sling and spreader bar.

5.5 Nameplate and Cell Identification-VLA

The following information shall be provided on a nameplate label to be affixed on each cell cover. The material, including the engraving and adhesive shall be resistant to the electrolyte and compatible with the cover or the cell container. Lead nameplates are unacceptable.

Example

Manufacturer's name	---
Type	XYZ – 11
Nominal ampere hour capacity of complete battery (at 8 hour rate)	302A h
Nominal Specific Gravity at 25°C	1.215
Serial number	123456
Date of manufacture (mm/yyyy)	01/2016
year of warranty expiration	2036

The manufacturer shall supply adhesive labels that can be attached to the side of the cell bearing battery cell numbers serially for each battery supplied per bank. These numbers shall be supplied separately and will be attached by OPG at time of installation. Numerals shall be of uniform height between 30 to 50 mm.

6. MATERIAL AND CONSTRUCTION OF VRLA CELLS

For VRLA battery types, positive and negative grid plates shall be constructed of a Lead-Calcium alloy. Lead-Antimony, Nickel-Cadmium and UPS type cells are unacceptable for stationary application.

6.1 Cell Casing - VRLA

Cell casing and covers shall be manufactured of materials satisfying the following properties:

- Fire Retardant in accordance with ASTM D2863.
- Stress Crack Resistance (Contractor to provide details).
- High Strength (Contractor to provide details).
- Impact Resistant in accordance with ASTM D256.

Preference will be given to fire retardant material for casing and covers having an oxygen index of not less than 25 as per ASTM D2863.

The Contractor shall provide a price for the battery having jars manufactured from

polycarbonate material when requested in the Supplementary Specification.

The case-cover seal shall be tongue and groove type construction providing full positive closure. Materials of case and of cover shall be compatible with regard to coefficient of expansion and ability to be adequately sealed for the rated life against leakage or migration of electrolyte.

The cell plates shall be adequately supported to allow for normal cell plate growth and movement, due to aging and charging/discharging, for the rated life of the cell. Plate growth shall not initiate cracking of the jar or cover, affect the integrity of the plates, or impair the expected capacity of the cell.

Polarity shall be permanently marked on the jar and/or cover and clearly visible adjacent to the terminals.

6.2 Terminal Post Seals - VRLA

The seals provided between terminal posts and case covers shall be designed as to prevent cracking and resultant corrosion of the post, for the rated life of the cell. Cracking of the covers or of casing, from stress brought about by post growth or other cause internal to the cell, shall be sufficient cause to justify cell replacement under warranty at no cost to OPG.

6.3 Terminal Posts and Inter-cell Connectors - VRLA

The terminals shall be either lead or lead-plated. Terminal posts shall be designed to accommodate externally bolted connections. Each terminal post shall have, at a minimum, two bolt holes of the same diameter with each at right angles to the other. The bottom hole shall be for termination of the inter-cell connector. The top hole shall be for OPG use.

Inter-cell connectors shall be either lead or tin plated copper connectors. Flexible connectors may be proposed for VRLA installations. Inter-cell connectors shall be designed to meet the requirements of the discharge load cycle of the battery, with each exhibiting a maximum allowable voltage drop of 0.02 V, (as measured from post to post, over the length of the connector) at the 1 min. rate with connectors torqued to the values recommended by the Contractor. In addition, the Contractor shall provide connectors of sufficient length to provide a required minimum spacing between cells for seismically qualified two-tier rack assembly installation (See Section 8). Where OPG does not specify spacing between cells, then a minimum spacing between cells at the top of the case, shall not be less than 12.5 mm (0.5 inch).

Assembly hardware for lead alloy posts and lead plated connections shall be lead encapsulated brass. Hardware for tin plated inter-cell connectors shall be type 316 stainless steel. Galvanized steel hardware is unacceptable. Application of grease prior to assembly shall be explicitly stated in the installation instruction if required. All torque specifications shall be based on un-lubricated threads. Details for the recommended hardware arrangement (e.g. number and

location of washers, nuts and bolts) shall be provided by the Contractor.

All lead plating shall be at a minimum thickness of 2 mils (.002 inch).

Intercell connectors and hardware shall be supplied new and shall not be used in the factory for test purposes.

Terminal and connector covers/guards shall be supplied to prevent personnel contact with the terminals and connectors as well as to protect the terminals and reduce surface contamination.

6.4 Accessories - VRLA

Accessories to be supplied for each battery lineup shall be as follows:

- Minimum of 2 extra sets of inter-cell connectors and fasteners per 58 cells or less to accommodate field loss or spoilage.
- Corrosion inhibiting grease where prescribed by the Contractor.
- Lifting sling and spreader bar.

6.5 Nameplate and Cell Identification-VRLA

The following information shall be provided on a nameplate label to be affixed on each cell cover. The nameplate shall be of a material approved by OPG. Lead is unacceptable. The material, including the engraving and adhesive shall be resistant to the electrolyte and compatible with the cover or the cell container.

Example

Manufacturer's name	---
Type	XYZ – 11
Nominal ampere hour capacity of complete battery (at 8 hour rate)	302A h
Serial Number	123456
Date of manufacture (mm/yyyy)	01/2016
year of warranty expiration	2036

The manufacturer shall supply adhesive labels that can be attached to the side of the cell bearing battery cell numbers serially for each battery supplied per bank. These numbers shall be supplied separately and will be attached by OPG at time of installation. Numerals shall be of uniform height between 30 to 50 mm.

7. BATTERY SIZE REQUIREMENTS

The Contractor shall size the battery using the positive plate method of Hoxie as per the IEEE 485 Standard. See the Supplementary Specification for the applicable parameters.

The initial capacity, which is the capacity of the cells when shipped from the factory, shall be not less than 100 percent of rated capacity at all discharge rates.

The Contractor shall select and propose cells that can meet the load profile provided in the Supplementary Specification. The Contractor shall state in its proposal the constant discharge current available for these cells for each discharge time of interest. The typical discharge characteristic curves submitted with the battery data sheets shall match the stated discharge currents for each discharge time. The rated Ampere-hours (A.h) capacity is the product of the stated discharge current, in Amperes, and the time duration, in hours, for which each current can be sustained without reaching the end voltage. This value of current shall have been used in the Contractor's sizing calculations and the same values, when temperature corrected (if required), shall be used in the Acceptance Test and throughout the design life of the battery for subsequent performance tests to determine the remaining capacity.

The rated capacity at the 8-hour discharge rate shall be used on the nameplate.

8. BATTERY RACKS

New battery racks assembly shall be constructed to meet the National Building Code of Canada seismic conditions for the site (See Supplementary Specification). The racks shall be a maximum two-tier type of steel frame and rails construction. Each support and restraint rail shall be insulated from the battery cells with acid resistant and non-combustible material. Drawings showing typical construction details shall be submitted at the time of proposal.

The racks shall provide means of restraint so that the cells cannot shift due to minor earth tremors. The design of the restraint system shall be specific to the number of cells per row in the proposal. The restraints shall impose minimum restriction on the ability to clean and wipe the cell jar walls. The restraints shall be removable to facilitate cell replacement.

All joints in the rack frames or uprights are to be welded and ground smooth. Each upright shall have provision for two half- inch diameter floor anchor bolts. Where more than one rack section is used, the rack sections should be rigidly joined, or the adjacent end cells in each rack should be connected with flexible connectors (cables). Connections between cells at different levels of the same rack should also be flexible connections (cables) and secured to minimize stress exerted on the battery terminals.

All surfaces of the battery racks shall be chemically cleaned to remove surface contamination. Surfaces shall be either primed and painted, treated with a heavy duty powder-coat process, or treated with a baked epoxy technique in light grey No. 61.

Fastening hardware shall be non-corrosive or treated to have these properties.

Small parts such as fastener hardware, rail insulation, etc. required for assembly shall be in surplus by approximately two percent (2%) to cover field loss or spoilage.

8.1 Grounding and Bonding Provisions

Battery bank racks should be insulated from the floor and mounting hardware.

Each section of battery rack must have provisions for connection of a minimum of two AWG 4/0 grounding conductors. Two connectors shall be welded to the battery rack frame, mounted diagonally opposite one another. The ground connectors shall consist of two copper faced steel pads with a minimum copper facing thickness of 0.380 mm or two stainless steel pads without copper facing. Each pad shall be at least 50 mm x 80 mm, with two holes on 45 mm centres and drilled and tapped for M14-2 thread (NEMA 2-bolt pattern). The minimum thread depth shall be 13 mm.

The ground pads shall be installed above the maximum height of the spilled containment barrier as detailed in Section 8.2 to minimize damage to the bare copper conductors from electrolyte.

8.2 Electrolyte Spill Containment and Neutralization

For both VLA and VRLA installations, a spill containment and neutralization system is required for all new rack and battery systems. The Contractor shall propose the method of spill containment based on the proposed battery rack design (See Section 8)

The spill containment system, at a minimum, shall consist of a spill control barrier, an acid resistant liner, and passive electrolyte neutralizing pillows to absorb and neutralize spilled electrolyte.

The control barrier shall be, at a minimum, 100 mm in height. The barrier shall not allow liquid seepage, and shall not fail due to extended contact with battery electrolyte. The Contractor shall provide the overall capacity of the containment area and how many cells of electrolyte may be captured in the event of complete loss.

The acid resistant liner shall prevent electrolyte from contacting the floor in the event of a spill. Where the battery rack is set down into the liner, the Contractor shall provide details of how the system will prevent leaks where the rack bolts to the floor.

The Contractor shall provide all Material Safety Data Sheets (MSDSs) pertaining to the electrolyte neutralizing pillows.

The overall spill containment design shall be such that the installation shall not interfere with or create ergonomic difficulty with maintenance activities. However, the barrier must extend beyond the overall footprint of the battery rack to ensure spilled electrolyte is captured.

Note that the placement of the connection point for the grounding conductor(s), as described in section 8.1 above, should not be inside the containment area (e.g. lower than the top of the spill barrier). This is to avoid potential damage to the bare-copper grounding conductor in the event of an electrolyte leak into the contained area.

8.3 Slip Resistant Mats

Slip resistant mats are required to be placed around the perimeter of the battery racks/spill containment to provide a safe working surface when around the battery. The mats shall be manufactured using a material resistant to the electrolyte. The mats shall be 900 mm in width or the maximum aisle width available where applicable. The outer perimeter of the mats is preferred to be painted yellow to increase indication of the hazardous area.

8.4 Battery Installation Layout

The Contractor is asked to submit a sketch of their suggested battery room layout including the racks, spill containment and batteries they are proposing. The layout shall meet the considerations provided in IEEE 484. A drawing or sketch may be provided in the Supplementary Specification for reference however accurate measurements of the area are the responsibility of the Contractor to incorporate into the proposed layout.

The aisle spacing between battery rows shall not be less than 900 mm (36 inches). The aisle space between the wall and row should not be less than 762 mm (30 inches). At least 18 inches should be maintained between the end of the rack and the nearest wall. For Vented Lead-Acid battery installations, the batteries must be mounted with the cell plates positioned at right angles to the major axis of each rack so that the edges of all the plates are plainly visible. There must be convenient access to the vents and electrolyte withdrawal tubes/filler holes. The intention of this is to facilitate routine maintenance, such as conducting visual inspections, measuring specific gravity or adding distilled water, and to achieve a battery room arrangement consistent with past practice and other OPG installations.

9. ACCEPTANCE TESTS

An acceptance test of each battery's capacity shall be made at the factory in accordance with test procedures defined in IEEE 450 or IEEE 1188 depending on battery type.

A serial number described in Section 5.5 shall be affixed to each cell prior to final Acceptance Testing. Test results must be recorded according to the unique cell identification such that test results of specific gravity and/or capacity can be related to individual cells at a later date.

As a condition of acceptance, the ampere-hour capacity as determined by the Acceptance Test shall equal (at least 100% of the rated value at the time of delivery) or exceed the value submitted by the Contractor in the proposal.

The battery acceptance tests are to confirm the manufacturer's ratings to the specified voltage per cell for the discharge rate as defined in the Supplementary Specification. The specified load current for test shall be constant at the manufacturer's rating for that discharge duration, suitably corrected for temperature as per IEEE 450 or IEEE 1188. Acceptance tests shall not be terminated prior to the cell reaching the specified voltage even if the required capacity of 100% has been successfully demonstrated.

An OPG representative shall witness all factory tests unless permission is obtained to continue the tests without a witness.

9.1 Method of Test and Failure Criteria

All the cells of a battery shall be tested either connected as a whole battery or in parts, connected in smaller series strings. Each partial string of cells must pass the test as defined in the failure criteria below.

The acceptance test shall be conducted with each cell voltage continuously monitored and with the cells connected as in normal service, i.e., with acceptable equivalent inter-cell connectors and fasteners torqued to recommended values.

The Contractor may prepare the battery in accordance with its standard procedure. However, for the 24 hours immediately prior to the test, the complete battery shall be on float voltage, in the range recommended by the Contractor.

The cell voltages measured shall include the voltage drops across the inter-cell connectors.

The capacity test requirements of this specification are based on an electrolyte temperature of 25 °C. If the monitored temperature at the start of the discharge test differs from 25 °C, the test discharge current shall be adjusted in accordance with Table I - Temperature correction factors of IEEE 450 or IEEE 1188.

The criteria of failure in the Acceptance Test shall be:

- Failure of the average cell voltage to remain above the minimum cell voltage as specified in the Supplementary Specification.
- Failure of any individual cell to remain above the minimum cell voltage.

In the case of the one-minute test, the above minimum voltages shall apply for any time within the one-minute period.

In the case of failure to meet the test, the failed cell or cells may be prepared for one more repeat test, subject to the same testing method and pass/fail criteria as the first test. A third test will not be allowed. The Contractor shall supply new cells at no additional cost to OPG. New cells are subject to the same testing method and pass/fail criteria as described above.

After a successful test, the cells shall be given an equalize charge and placed on float voltage for 72 hours. The Contractor shall then verify the levels of the electrolyte in each cell and record the final voltage and specific gravity of each cell prior to shipment.

10. DOCUMENTATION

OPG requires the Contractor to provide the following documentation.

OPG recognizes that manuals and battery data sheets are often generic and readily available. Therefore the Contractors are encouraged to submit this documentation for consideration along with their proposals.

10.1 Drawings

10.1.1 Drawing and Documentation Submission with Proposal

IMPORTANT: The Contractor shall submit the following information with the proposal for the new battery, rack and other accessories. 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, sizing and locations of equipment without going into great detail.

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

(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 battery.

(5) Basic assembly/sectional view of the proposed battery rack.

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

(7) Battery size, rating, quantity, etc.

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

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

10.1.2 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:

- General arrangement, overall assembly plan and sectional views of the battery, racks, intercell connections and spill containment system.
- Dimensions and approximate weight.
- Bill of Material.
- Third party auxiliary drawings, if applicable.

10.1.3 Final Drawings

The following final drawings shall be submitted prior to shipment of the batteries to the OPG site:

(1) General arrangement and plan drawings, giving complete dimensions and weights. Drawings to detail all locations of cables, intercell connectors, mounting bolts, etc.

(2) Section view drawings of the battery rack arrangement. Drawings to include bills of material.

(3) 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 and 2 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.

10.2 Data and Other Information Submission after Award of Contract

- Complete battery data per the Data Sheets located in the Supplementary Specification. All ratings and capabilities listed in these data sheets shall be guaranteed values.
- The Contractor's project management office address and contact information servicing the site as indicated in the Supplementary Specification.
- The Contractor's closest service centre address and contact information to the site as indicated in the Supplementary Specification.

10.3 Final Submission Data and Other Information

The following information shall be submitted prior to shipping of the battery and racks to the OPG site:

10.3.1 Installation and Handling Manual

The Contractor shall provide at least two (2) complete paper copies and one (1) electronic copy (preferably in .pdf file format) of the Installation and Handling Manual with each battery.

The Installation and Handling Manual shall provide a description of the battery and rack installation procedure and handling requirements, and shall explain any necessary hardware preparations required (e.g. burnishing, application of anti-oxidation compounds, etc.) and must state the Contractor's recommended torque for any connector bolts that will be installed by OPG. This Manual must have adequate detail to allow appropriately qualified OPG staff to carry out the installation of this equipment by following the instructions in the Manual.

10.3.2 Operation and Maintenance Manual

The Contractor shall provide at least two (2) complete paper copies and one (1) electronic copy (preferably in .pdf file format) of an Operation and Maintenance Manual with each battery.

The Operation and Maintenance Manual shall include the Contractor's recommendation regarding float voltage and equalize charge voltage ranges, equalize charge duration and frequency (e.g. for 12 hours every 2 months), recommended charger temperature compensation slope (if applicable), and appropriate charger current limit settings for use with the newly supplied batteries.

This manual shall also provide detailed instructions about how the battery installation is to be maintained throughout the warranty period and remaining design life.

Particular testing that is recommended, test results that should be expected in those tests, and actions to take when abnormal results are found should all be detailed in this manual. For example, one appropriate test might be to take voltage readings on each cell, or on a sampling of cells, on a quarterly basis. A minimum voltage on one cell or a maximum spread of voltage readings may then trigger an equalize charge.

10.3.3 Battery Data Sheets

Manufacturer Data Sheets shall be provided, giving technical details about the following:

- Battery model, including features and characteristics.
- Capacity information including, as a minimum, hourly discharge rates up to eight hours in one hour increments, the 30 minute rate, the 15 minute rate, and the 1 minute rate, all to an end voltage of the minimum cell voltage (see Supplementary Specification).
- Typical discharge characteristic curves that support the stated rates and durations.

- Maximum short circuit current capability of a cell that is short circuited at its terminals.
- Typical range of battery float current at nominal voltage and temperature.
- Typical rate of hydrogen evolution when floated according to Contractor recommendations.
- Physical dimensions of a cell including width, height, length and total mass (including electrolyte).
- The mass of lead contained in a cell, for use in the eventual disposal of cells.
- Nominal specific gravity of the electrolyte.
- Volume of electrolyte contained in a cell.
- A Material Safety Data Sheet (MSDS) for the battery electrolyte.

10.3.4 Acceptance Test Records

The Contractor shall complete battery test data sheets that contain a tabulation of the observations and results of the Acceptance Test that is required in Section 9. If available, Contractors are encouraged to submit in their proposals a sample data collection form that would be used in factory Acceptance Testing.

If an OPG representative witnesses the test, then that representative should sign the test data sheets.

The factory Acceptance Test record shall include the following data:

- Specified current and expected test duration to 100% capacity.
- Temperature at the start of the test.
- Temperature correction factor and, if applicable under the agreed-to testing methodology, the calculated temperature-corrected current.
- Actual observed current during the test.
- Test duration at which each cell's voltage dropped to the minimum cell voltage.
- Capacity achieved by each cell in the Acceptance Test.

It must be noted with the test records whether each cell passed on the first test, or on the second test after being prepared a second time.

Additionally, voltage and specific gravity readings should be taken and recorded for each cell following the equalize charge and 72-hour float charge, which are to be done at the conclusion of the Acceptance Test and prior to shipment.

On shipment of the battery, a completed copy of these test results shall be sent to OPG.

11. WARRANTY

The terms described in the following sections are requested to form components of the Warranty.

The Contractor is requested to state whether Warranty is offered on racking and components of the installation other than battery cells, along with any additional terms or limitations to the Warranty for OPG's consideration in the evaluation of proposals.

Additionally, the Contractor is requested to state any expectations for OPG to provide justification for Warranty claims, such as maintenance or other records demonstrating the history of the battery installation.

Please note that OPG is requesting at least a 10 year design life for the installation, and will treat Warranty terms and conditions as a measure of expected reliability.

11.1 Warranty Resolution

The Contractor shall state in its proposal the Warranty Period and guarantee that during the Warranty Period each cell of the battery will meet at least 80 percent of its rated discharge capacity and be free of cracking on containers and covers due to stress brought about by plate growth or post growth or from any other cause internal to the cell. OPG expects that the Contractor will provide evidence that the stated Warranty Period will be met by the proposed battery model.

The Contractor is asked to state the intended resolution method for cells that are found to not meet these requirements during the Warranty Period, for example, out-right cell replacement or pro-rated replacement cost. For consistency in evaluating proposals, OPG prefers for the Contractor to provide proposals that state their usual resolution method and, if it is different from their usual practice, also state a separately itemized cost for the Warranty conditions to include complete replacement, at no cost to OPG, of cells that do not meet these guaranteed performance measures.

11.2 Warranting the Battery Capacity During the First Five Years of Service

The Contractor is asked to provide a battery design and a Warranty that includes the following provision. In the first five years after delivery of the battery bank to the OPG site, the capacity of the battery shall not be less than 95 percent of what the capacity was when delivered, as found in the Acceptance Testing. OPG may, at its discretion, conduct a Performance Test, following IEEE procedures, within this 5-year period. A failing result, i.e. a capacity of less than 95 percent on any cell, may be used to initiate a Warranty claim. The Contractor is asked to provide costing for a Warranty that allows full replacement of any failed cell with a new cell of equivalent characteristic and nominal capacity at no cost to OPG upon exercise of this condition

of the Warranty.

If this differs from the Contractor's standard Warranty offering, the Contractor is asked to state the conditions of their standard Warranty, state whether the above described condition can be offered, and provide in their proposal a separately itemized cost associated with offering this condition in the Warranty instead of the standard one.

11.3 Determination of Battery Capacity During the Warranty Period

OPG may, at its discretion, conduct a Performance Test according to IEEE procedures at any time over the warranted life of the battery installation. Any test rate and duration provided in the Contractor's data sheets may be chosen for use in this test. Failing test results, i.e. cells that demonstrate less than 80 percent of the rated capacity, during the Warranty Period shall be directed to the Contractor for resolution according to the warranty resolution method proposed by the Contractor and accepted by OPG.

12. SHIPPING

The following are requirements for shipping batteries, racks and accessories. Please refer to the Supplementary Specification for site specific requirements.

(1) The Contractor shall be responsible for the shipping arrangements and costs, and the safe delivery of the products to the OPG site. OPG may unload the delivery vehicle at site. The complete, specific details of the delivery and receipt can be defined between OPG and the successful Contractor after the award of a contract.

(2) The batteries shall be shipped charged (specific gravity of 1.215 ± 0.005 at 25°C), and filled with electrolyte. The electrolyte shall be at the correct level.

(3) Shipping containers shall be so constructed as to ensure acceptance and safe delivery by common carrier or the carrier used by the Contractor for this delivery. Containers shall be constructed to permit removal of the cells without stressing the top cover or terminal posts.

(4) The type of pallets shall permit use of a forklift.

(5) Each container shall be marked with the following minimum information:

   a) Shipping Address (refer to Purchase Order).

   b) Purchase Order number (refer to Purchase Order).

   c) Contractor's name.

   d) The orientation of the plates with respect to the line of travel of the van/carrier.

(6) Each battery shipment shall include the documentation as outlined in Section 10.3.