PIP ELSAP12
Valve-Regulated Lead-Acid Batteries
PURPOSE AND USE OF PROCESS INDUSTRY PRACTICES

In an effort to minimize the cost of process industry facilities, this Practice has been prepared from the technical requirements in the existing standards of major industrial users, contractors, or standards organizations. By harmonizing these technical requirements into a single set of Practices, administrative, application, and engineering costs to both the purchaser and the manufacturer should be reduced. While this Practice is expected to incorporate the majority of requirements of most users, individual applications may involve requirements that will be appended to and take precedence over this Practice. Determinations concerning fitness for purpose and particular matters or application of the Practice to particular project or engineering situations should not be made solely on information contained in these materials. The use of trade names from time to time should not be viewed as an expression of preference but rather recognized as normal usage in the trade. Other brands having the same specifications are equally correct and may be substituted for those named. All Practices or guidelines are intended to be consistent with applicable laws and regulations including OSHA requirements. To the extent these Practices or guidelines should conflict with OSHA or other applicable laws or regulations, such laws or regulations must be followed. Consult an appropriate professional before applying or acting on any material contained in or suggested by the Practice.

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Data Form

   ELSAP12D - Data Sheet for Valve-Regulated Lead-Acid Batteries
1. **Scope**

This Practice describes the design, inspection, testing, shipment, and documentation for VRLA batteries for application in electrical stations, uninterruptible power supplies (UPS) or other applications located in indoor, non-classified areas.

2. **References**

Applicable parts of the following industry codes and standards shall be considered an integral part of this Practice. The edition in effect on the date of contract award shall be used, except as otherwise noted. Short titles will be used herein where appropriate.

**Industry Codes and Standards**

- American Society of Civil Engineers
  - ASCE/SEI 7 - *Minimum Design Loads for Building and Other Structures*
- Institute of Electrical and Electronics Engineers (IEEE)
  - IEEE 485 - *Recommended Practice for Sizing Lead-Acid Batteries for Stationary Applications*
  - IEEE 1184 - *Guide for Batteries for Uninterruptible Power Systems*
  - IEEE 1188 - *Recommended Practice for Maintenance, Testing, and Replacement of Valve-Regulated Lead-Acid (VRLA) Batteries for Stationary Applications*
  - IEEE 1188A - *Recommended Practice for Maintenance, Testing, and Replacement of Valve-Regulated Lead-Acid (VRLA) Batteries for Stationary Applications*
  - IEEE 1578 - *Recommended Practice for Station Battery Electrolyte Spill Containment and Management*
- National Electric Manufacturers Association (NEMA)
  - NEMA PE 5-1997 (R2003) - *Utility Type Battery Chargers*
- Underwriters Laboratories (UL)
  - UL 94 - *Test for Flammability of Plastic Materials for Parts in Devices and Appliances*
  - UL 1989 - *Standard for Standby Batteries*

3. **Definitions**

*acceptance test:* Capacity test made on a new battery to determine whether it meets specifications or manufacturer’s ratings

*battery duty cycle:* Loads a battery is expected to supply for specified periods

*capacity test:* A discharge of a battery at a constant current or constant power to a specified voltage

*cell container:* Enclosure that contains the plates and electrolyte of a cell

*cell size:* Rated capacity of a lead storage cell or the number of positive plates in a cell

*design margin:* Additional capacity allowance in cell size for unforeseen additions to the DC system and for less than optimum operating conditions of the battery or expected growth rate to the load
**equalizing voltage**: A voltage higher than float voltage, applied to a battery to correct the inequalities among battery cells (voltage or specific gravity) that may develop in service.

**float voltage**: Voltage applied to a battery to maintain it in a fully charged condition during normal operation.

**full float operation**: Operation of a DC system with the battery, battery charger, and load connected in parallel and with the battery charger supplying the normal DC load plus any self-discharge or charging current, or both, required by the battery.

**nominal voltage**: Voltage level utilized to describe the cell, container, or system.

**owner**: Party who owns the facility wherein the VRLA batteries will be used.

**purchaser**: Party who awards the contract to the supplier. The purchaser may be the owner or the owner’s authorized agent.

**rated capacity**: Ampere-hour capacity assigned to a lead storage cell by its manufacturer for a given discharge rate, at a specified electrolyte temperature, to a given end of discharge voltage.

**supplier**: Party responsible for furnishing the VRLA batteries.

**valve regulated lead acid battery (VRLA)**: A cell that is sealed with the exception of a valve that opens to the atmosphere when the internal gas pressure in the cell exceeds atmospheric pressure by a pre-selected amount. VRLA cells provide a means for recombination of internally generated oxygen and the suppression of hydrogen gas evolution to limit water consumption.

### 4. Requirements

#### 4.1 General

4.1.1 Battery shall be designed for the battery location conditions specified on the purchaser’s *PIP ELSAP12D* Data Sheet.

4.1.2 Battery shall be used for electrical station service, UPS, or other applications as specified on the purchaser’s *PIP ELSAP12D* Data Sheet.

4.1.3 Unless otherwise specified on the purchaser’s *PIP ELSAP12D* Data Sheet, all hardware, connectors, accessories, and racks necessary for a complete battery system shall be provided.

4.1.4 Unless otherwise specified on the purchaser’s *PIP ELSAP12D* Data Sheet, the design life of all cells shall be a minimum of 10 years in float service at 25°C (77°F).

4.1.5 Battery shall be connected by the purchaser to a battery charger. The battery shall be in full float operation at the recommended float voltage in normal operation.

4.1.6 Quantity of cells and the nominal voltage of the battery shall be as specified on the purchaser’s *PIP ELSAP12D* Data Sheet.

4.1.7 The following sizing factors shall be applied to the calculated battery capacity:

   a. Design margin (for station batteries only): 10%

   b. Aging factor: 25%
c. If the specified or calculated battery capacity exceeds a manufacturer’s standard rating by more than 5%, the next larger standard rating shall be selected.

4.1.8 Battery shall be UL recognized.

4.1.9 Power connection lugs or terminal block shall accept the quantity and size of incoming cables specified on the purchaser’s PIP ELSAP12D Data Sheet.

4.1.10 Battery shall accommodate a DC output voltage ripple as indicated in NEMA PE 5-1997 (R2003), Table 6 without reduction in battery life or number of full discharge cycles.

4.1.11 Unless otherwise specified on the purchaser’s PIP ELSAP12D Data Sheet, battery charge time to 90% charge shall be 12 hours minimum.

4.1.12 The maximum rate of hydrogen evolution shall be provided by the supplier for all operating conditions at the maximum temperature as defined on the purchaser’s PIP ELSAP12D Data Sheet.

4.1.13 The maximum fault current level from the battery assembly, without charger or any external sources, at the battery terminals if operating at the maximum ambient temperatures defined on the purchaser’s PIP ELSAP12D Data Sheet shall be provided by the supplier.

4.1.14 Battery capacity data for the manufacturer’s standard conditions and the purchaser’s specific conditions shall be as indicated on the purchaser’s PIP ELSAP12D Data Sheet.

4.1.15 Station Service Application

4.1.15.1 Battery shall endure a minimum of 300 cycles (full charge and discharge) during its lifetime at the 1-hour discharge rate.

4.1.15.2 The endurance of a cell or battery shall be stated in terms of the number of full charge/discharge cycles that the cell can sustain during its useful life.

4.1.15.3 Cell shall be considered to have reached the end of its useful life when the ampere-hour capacity drops to 80% of the rated capacity at the 8-hour discharge rate.

4.1.15.4 Battery capacity shall be based on one of the three load options for battery sizing shown on the purchaser’s PIP ELSAP12D Data Sheet. If the load profile option is selected, the calculations used in selecting the battery capacity shall be shown or referenced on the purchaser’s PIP ELSAP12D Data Sheet.

4.1.15.5 Method of determining battery capacity shall be in accordance with IEEE 485 for lead-acid batteries.

4.1.15.6 Battery selection shall be based on 1.75-V minimum per cell.

4.1.16 UPS Application

4.1.16.1 Battery shall endure a minimum of 100 full charge and discharge cycles during its lifetime at the specified discharge time.

4.1.16.2 The endurance of a cell or battery shall be stated in terms of the number of full charge/discharge cycles that the cell can sustain during its useful life.
4.1.16.3 Cell shall be considered to have reached the end of its useful life when the capacity drops to 80% of the rated capacity.

4.1.16.4 The number of full charge and discharge cycles that the battery can provide over its lifetime shall be provided by the supplier on purchaser’s PIP ELSAP12D Data Sheet.

4.1.16.5 Battery capacity shall be based on the load shown on the purchaser’s PIP ELSAP12D Data Sheet.

4.1.16.6 Unless otherwise specified on the purchaser’s PIP ELSAP12D Data Sheet, the method of determining battery capacity shall be in accordance with IEEE 1184 for lead-acid batteries.

4.2 Cells

4.2.1 Unless specified otherwise on the purchaser’s PIP ELSAP12D Data Sheet, cell design shall be absorbed electrolyte.

4.2.2 Batteries shall be of a lead-pasted plate type. Unless otherwise specified on the purchaser’s PIP ELSAP12D Data Sheet, positive and negative plate material shall be manufacturer’s standard.

4.2.3 Batteries shall have electrolyte immobilized with no water or acid replenishing required during its design life.

4.2.4 Cell design shall accommodate the total positive plate growth during the design life of the cell. The plate growth shall not cause cracking, deformation, or failure during the lifetime of the cell under normal operating conditions.

4.2.5 Cell container and cover shall be made of a high-impact, flame-retardant plastic material having a minimum oxygen index of 28% and shall meet the criteria needed to be rated V-0 level where an open flame source is removed in accordance with UL 94.

4.2.6 Cover shall be bonded to the container to form a permanent leak-proof seal.

4.2.7 Each cell shall have a self-sealing pressure relief valve with integral flame arrestor that operates from 0.5 to 50 psig (3.5 to 350 kPa).

4.2.8 Terminal posts shall be cast in lead or lead alloy with solid copper or copper alloy threaded inserts and configured to provide a reliable, low-resistance interface with the inter-cell connectors. Terminal posts shall be provided with a composite seal to prevent acid migration to connectors and container cover.

4.2.9 Connections

4.2.9.1 All cell posts shall have bolted connections.

4.2.9.2 Supplier shall furnish cell-to-cell connection system featuring tin/lead-plated copper bus bars using 316 stainless steel hardware.

4.2.9.3 Bus bar design shall limit stress on battery posts.

4.2.9.4 Where required, step-to-step and tier-to-tier connections shall be made by extra-flexible, insulated copper cables using 316 stainless steel hardware.

4.2.9.5 Unless otherwise specified on the purchaser’s PIP ELSAP12D Data Sheet, all terminal connectors and interconnecting straps shall be
covered with removable, insulating material for protection against inadvertent contact with energized components.

4.2.10 Unless otherwise specified on the purchaser’s PIP ELSAP12D, paralleling of cells shall not be permitted.

4.2.11 Unless otherwise specified on the purchaser’s PIP ELSAP12D Data Sheet, cells shall operate in the vertical position.

4.3 Battery Racks

4.3.1 Unless otherwise specified on the purchaser’s PIP ELSAP12D Data Sheet, battery racks shall be supplied and shall be in accordance with this Section.

4.3.2 Racks shall be constructed of welded structural steel frames with bolted or welded steel runners and braces and with provision for anchoring to the floor and the wall.

4.3.3 Side rails and end rails shall be removable.

4.3.4 Racks shall be suitable for the battery location seismic zone as specified on the purchaser’s PIP ELSAP12D Data Sheet. Seismic design requirements of ASCE/SEI 7 for nonstructural components shall be applied.

4.3.5 Racks shall be painted with acid-resistant epoxy paint or equivalent. One pint of touch-up paint shall be provided.

4.3.6 Rack design shall be a single-tier, two-tier, or two-step arrangement as specified on the purchaser’s PIP ELSAP12D Data Sheet. The width of the racks shall be at least equal to the width of the battery cells. Unless otherwise specified on the PIP ELSAP12D Data Sheet, the maximum installed height of the battery tops above the floor shall be 60 inches (1.52 m).

4.3.7 Supplier shall provide grounding lug at each end of each battery rack to accommodate the purchaser’s grounding conductors.

4.3.8 Unless otherwise specified on the purchaser’s PIP ELSAP12D Data Sheet, an acid-resistant containment pan shall be provided under the battery and rack to collect acid leaks or spills in accordance with IEEE 1578. The pan shall be sized to contain a minimum of the total quantity of electrolyte contained in a one-cell container or 1% of the total volume of all containers, whichever is greater.

4.3.9 Unless otherwise specified on the purchaser’s PIP ELSAP12D Data Sheet, an acid neutralization pillow(s) shall be provided in acid containment pan.

4.3.10 Battery rack assembly instructions shall be provided.

4.4 Accessories

4.4.1 Unless otherwise specified on the purchaser’s PIP ELSAP12D Data Sheet, spare hardware for battery racks and cell terminal connections, including a minimum of three of each type bolt, nut, and washer required for rack assembly, and three sets of hardware for terminal connections shall be provided.

4.4.2 Unless otherwise specified on the PIP ELSAP12D Data Sheet, cell and battery module lifting device or sling for installation and removal of cells and modules weighing more than 50 pounds (22.7 kilograms) shall be provided. Lifting device shall be designed to accommodate cells as installed in battery racks without
disturbing adjacent cells. Dimensions and operating clearances for lifting device shall be provided in the supplier’s documentation.

4.4.3 Unless otherwise specified on the purchaser’s PIP ELSAP12D Data Sheet, online battery-monitoring equipment shall be provided. All material required for the installation of the battery monitoring equipment shall be provided.

4.4.4 Other accessories shall be provided as specified on the purchaser’s PIP ELSAP12D Data Sheet.

4.5 Markings

4.5.1 The following information shall be permanently marked on each cell container:
   a. Supplier’s name
   b. Catalog number or type reference
   c. Nominal voltage
   d. Capacity in amp-hrs or kW for 8-hour nominal period
   e. Date of manufacture
   f. Interconnection torque value(s)

4.5.2 Adhesive number labels shall be provided for the purchaser to use in labeling the cells.

4.6 Inspection and Testing

Unless otherwise specified on the purchaser’s PIP ELSAP12D Data Sheet, an on-site acceptance test of the battery capacity shall be performed in accordance with IEEE 1188 to determine that the battery meets the design specifications.

Note: Battery testing at the factory is not recommended due to the resulting physical damage of the lead.

4.7 Shipping

4.7.1 Supplier shall identify the following on each shipping group:
   a. Purchase order number
   b. Requisition number
   c. Equipment number
   d. Project number

4.7.2 Cells shall be shipped in charged condition.

4.7.3 Individual cells shall be wrapped and sealed against moisture.

4.7.4 Terminal posts shall be insulated.

4.7.5 Individual cell boxes shall be printed with handling instructions including a warning against lifting the cells by the terminal posts.

4.7.6 Shipping crates and individual cell wrappings shall be marked with instructions for storage in cool, dry locations.
4.7.7 Labels on the shipping crate or the outer wrapping shall state the storage conditions, date of shipment, and the date beyond which the product is not permitted to be stored without charging.

4.7.8 Documentation and warning labels on the cell shipping crates shall detail how the crates shall be stored and shall dictate the cell charging schedule. See item 4.8.8 for further details.

4.7.9 The Supplier shall ship the cells on the schedule date agreed at the time of the writing of the Purchase order.

4.8 Documentation

4.8.1 All engineering data provided for this equipment shall represent the actual equipment specified and ordered.

4.8.2 Typical drawings are permitted only if the drawings are revised to specifically identify the equipment, dimensions, wiring, and accessories being provided.

4.8.3 All documentation shall be identified with the purchaser’s name, project number, purchase order number, and item number along with the shop order number.

4.8.4 Drawings shall have a space on the right-hand bottom corner for the purchaser’s title block.

4.8.5 Documentation of the type and quantity shown in Table 1 and the purchaser’s PIP ELSAP12D Data Sheet shall be provided.

4.8.6 One reproducible set of drawings and the number of copies of all documentation and operating manuals as indicated on the purchaser’s PIP ELSAP12D Data Sheet shall be provided.

4.8.7 Unless otherwise specified on the purchaser’s PIP ELSAP12D Data Sheet, the reproducible drawings shall be in AutoCAD .dwg format and Adobe .pdf format.

4.8.8 Documentation shall accompany the shipping crates that details how the crates shall be stored and shall dictate the cell charging schedule for various ambient temperatures.
Table 1: Documentation Requirements

<table>
<thead>
<tr>
<th>A With Bid</th>
<th>B For Review</th>
<th>C Final Certified</th>
<th>D As Built</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>General layout of equipment, showing all dimensions, weights, locations, and outline drawings of the final assembled configuration</td>
</tr>
<tr>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td>Hydrogen evolution</td>
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<tr>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>Available fault current</td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>Full charge and discharge cycles</td>
</tr>
<tr>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td>Copies of certified test reports as required</td>
</tr>
<tr>
<td>X(1)</td>
<td></td>
<td></td>
<td></td>
<td>Installation, operation, and maintenance manuals; and required maintenance schedules</td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>Safety instructions clearly identifying proper and improper operation that might injure personnel and cause damage to operating equipment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td>Dimensions and operating clearances for cell lifting device</td>
</tr>
</tbody>
</table>

Notes:
A. These documents shall be provided with the proposal.
B. These documents shall be provided for the purchaser’s review and authorization to proceed before fabrication.
C. These documents shall be provided as part of the final certified document submittal.
   (1) Equipment shall be shipped with one set of installation, operation, and maintenance manuals in addition to quantity specified in PIP ELSAP12D Data Sheet.
D. The final as-built documents shall be furnished within 2 weeks following shipment.

4.9 Conflict Resolution

Any conflicts between the referenced documents shall be identified to the purchaser in writing for resolution. If resolving conflicts, the following order of precedence shall apply:

a. Purchase order
b. PIP ELSAP12D Data Sheet
c. This Practice, PIP ELSAP12
d. Referenced standards
### GENERAL (4.1):

SERVICE CONDITIONS (4.1.1):
- AMBIENT TEMPERATURE: MIN: _____ °C MAX: _____ °C HUMIDITY: _____ %
- ALTITUDE: _____ M OTHER: 

BATTERY APPLICATION (4.1.2):
- STATION SERVICE
- UPS
- OTHER:

COMPLETE BATTERY SYSTEM (4.1.3):
- REQUIRED
- NOT REQUIRED
- OTHER:

DESIGN LIFE (4.1.4):  
- 10 YEARS @ 25°C
- 20 YEARS @ 25°C
- OTHER: _____ YEARS @ _____ °C

NOMINAL BATTERY VOLTAGE (4.1.6): _____

QUANTITY OF CELLS (4.1.9): _____ AWG QUANTITY: _____

BATTERY CHARGE RATE (4.1.11):  
- 12 HOURS TO 90%
- OTHER:

MAX. HYDROGEN EVOLUTION (4.1.12):  AT MAX AMP CHARGE RATE

MAX. FAULT CURRENT (4.1.13): _____ AMPS AT MAX. AMBIENT TEMP.

BATTERY CAPACITY DATA (4.1.14):

<table>
<thead>
<tr>
<th>SUPPLIER STANDARD CONDITIONS</th>
<th>PURCHASER SPECIFIC CONDITIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>TEMP.: _____ °C</td>
<td>SEE 4.1.1 ABOVE FOR CONDITIONS</td>
</tr>
<tr>
<td>MAX. FLOAT VOLTAGE PER CELL: _____ VOLTS</td>
<td>MAX. FLOAT VOLTAGE PER CELL: _____ VOLTS</td>
</tr>
<tr>
<td>DISCHARGE VOLTAGE PER CELL: _____ VOLTS</td>
<td>DISCHARGE VOLTAGE PER CELL: _____ VOLTS</td>
</tr>
<tr>
<td>8 HR.: _____ AMP-HR 8 HR.: _____ KW</td>
<td>8 HR.: _____ AMP-HR 8 HR.: _____ KW</td>
</tr>
<tr>
<td>5 HR.: _____ AMP-HR 5 HR.: _____ KW</td>
<td>5 HR.: _____ AMP-HR 5 HR.: _____ KW</td>
</tr>
<tr>
<td>1 HR.: _____ AMP-HR 1 HR.: _____ KW</td>
<td>1 HR.: _____ AMP-HR 1 HR.: _____ KW</td>
</tr>
<tr>
<td>0.5 HR.: _____ AMP-HR 0.5 HR.: _____ KW</td>
<td>0.5 HR.: _____ AMP-HR 0.5 HR.: _____ KW</td>
</tr>
</tbody>
</table>
### Station Service Application (4.1.15):

- **Load Options (4.1.15.4):**
  - Continuous Amperes: _____ AMPS for _____ MINUTES
  - Battery Amperage Capacity at 8-HR, Rate: _____ AMPS
  - Load Profile: 
  - Other: 

### UPS Application (4.1.16):

- **UPS Battery Discharge Cycles (4.1.16.4):** _____ at lifetime of _____ YEARS
- **UPS Battery Sizing Criteria (4.1.16.5):**
  - Inverter kW for _____ MINUTES
  - Inverter Efficiency: _____ %
- **UPS Battery Capacity Sizing Method (4.1.16.6):**
  - IEEE 1184
  - Other: 

### Cells (4.2):

- **Cell Design (4.2.1):**
  - Absorbed Electrolyte
  - Gelled Electrolyte
  - Other: 

- **Positive & Negative Plate Material (4.2.2):**
  - MFG. STD.
  - Other: 

- **Battery Connection Covers (4.2.9.5):**
  - Required
  - Not Required

- **Paralleling of Batteries (4.2.10):**
  - Permitted
  - Not Permitted

- **Battery Position (4.2.11):**
  - Horizontal
  - Vertical
  - MFG. STD.
  - Other: 

### Battery Racks (4.3):

- **Battery Racks (4.3.1):**
  - Required
  - Not Required

- **Seismic Design (4.3.4):**
  - Required
  - Not Required

- **Site Location:**
  - Latitude
  - Longitude

- **Risk Category:**
  - IV
  - III
  - Other: 

- **Component Importance Factor (Ic):**
  - 1.5
  - Other: 

- **Site Class:**
  - D
  - Other: 

- **Seismic Certificate:**
  - Required
  - Not Required

- **Battery Rack Design (4.3.6):**
  - Single Tier
  - Two Step
  - Two Tier
  - Other Tier Design: 

- **Maximum Height of Battery Tops Above Floor (4.3.6):**
  - 60 INCHES
  - Other: 

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**Assoc. PIP ELSAP12 Data Sheet**

**Valve-Regulated Lead-Acid Batteries**

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**MAY 2019**
BATTERY RACKS (4.3): CONTINUED
BATTERY RACK CONTAINMENT PAN (4.3.8): X REQUIRED NOT REQUIRED
ACID NEUTRALIZATION PILLOW(S) (4.3.9): X REQUIRED NOT REQUIRED
OTHER:

ACCESSORIES (4.4):
SPARE HARDWARE (4.4.1): X REQUIRED NOT REQUIRED
LIFTING DEVICE (4.4.2): X REQUIRED NOT REQUIRED
ON-LINE BATTERY MONITORING (4.4.3): X REQUIRED NOT REQUIRED
OTHER:

INSPECTION & TESTING (4.6):
ON-SITE BATTERY CAPACITY ACCEPTANCE TESTING: X REQUIRED NOT REQUIRED
TESTING PER IEEE 1188: X REQUIRED NOT REQUIRED OTHER:
OTHER:

DOCUMENTATION (4.8):
ELECTRONIC DOCUMENT FORMAT: X DWG X PDF OTHER:
SUPPLIER TO PROVIDE: 1 REPRODUCIBLE PLUS
OTHER:

OTHER REQUIREMENTS:

LEAD-ACID BATTERIES MAY 2019