AVR45 / HT45 SINGLE CELL SERIES
RAILWAY / UTILITY APPLICATIONS

Installation and Operation Manual

California Proposition 65 Warning:	Batteries, battery posts, terminals and related accessories contain lead and lead compounds, and other chemicals known to the state of California to cause cancer and birth defects or other reproductive harm. **Wash hands after handling.**

TABLE OF CONTENTS

IN REFERENCE TO THIS MANUAL:

– “Cell” is defined as an individual 2-volt unit.

– “Battery string” is defined as a series connected electrical system comprised of cells (individual 2-volt units)

For Energy Storage applications following UL 1973 requirements, Appendix A must be reviewed.

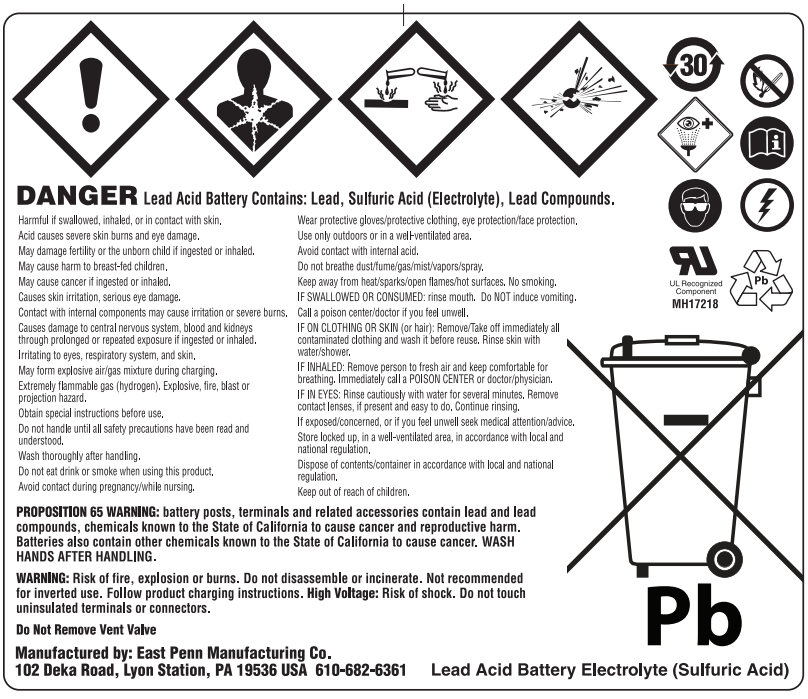


Fig. 1-1

SAFETY PRECAUTIONS

Although all valve-regulated cells have the electrolyte immobilized within the cell, the electrical hazard associated with batteries still exists. **Work performed on these batteries should be done with the tools and the protective equipment listed below.** Valve-Regulated cell installations should be supervised by personnel familiar with batteries and battery safety precautions.

WARNING: Risk of fire, explosion or burns. Do not disassemble, heat above 40°C, or incinerate.

Protective Equipment

Although VRLA cells can vent or leak small amounts of electrolyte, electrical safety is the principle but not the only concern for safe handling. Per IEEE 1188 recommendations, the following minimum set of equipment for safe handling of the cells and protection of personnel shall be available:

1. **Safety glasses with side shields, or goggles, or face shields as appropriate. (Consult application specific requirements)**
2. Electrically insulated gloves, appropriate for the installation.
3. Protective aprons and safety shoes.
4. Portable or stationary water facilities in the battery vicinity for rinsing eyes and skin in case of contact with acid electrolyte.
5. Class C fire extinguisher.
6. Acid neutralizing agent.
7. Adequately insulated tools (as defined by ASTM F1505 “Standard Specification for Insulated and Insulating Hand Tools)
8. Lifting devices of adequate capacity, when required.

Procedures

The following safety procedures should be followed during installation:

Always wear safety glasses or face shield when working on or near batteries.

1. These cells are sealed and contain no free electrolyte. Under normal operating conditions, they do not present any acid danger. However, if the cell jar or cover is damaged, acid could be present. **Sulfuric acid is harmful to the skin and eyes. Flush affected area with water immediately and consult a physician if splashed in the eyes. Consult SDS for additional precautions and first aid measures. SDS sheets can be obtained at www.eastpennmanufacturing.com**
2. **Prohibit smoking and open flames, and avoid arcing in the immediate vicinity of the battery.**
3. Do not wear metallic objects, such as jewelry, while working on batteries. Do not store un-insulated tools in pockets or tool belt while working in vicinity of battery.
4. Keep the top of the battery dry and clear of all tools and other foreign objects.
5. Provide adequate ventilation **(per IEEE standard 1187 and/or local codes)** and follow recommended charging voltages.
6. **Never** remove or tamper with the pressure relief valves. Warranty void if vent valve is removed.
7. Inspect all flooring and lifting equipment for functional adequacy.
8. Adequately secure battery modules, racks, or cabinets to the floor.
9. Connect support structures to ground system in accordance with applicable codes.

Procedures *continued*

10. The IEEE Standards contain additional information. Other standards may be relevant to your specific application.

    IEEE 1184 – Guide for Batteries for UPS Systems
    IEEE1187 – Recommended Practice for Installation Design of VRLA Batteries.
    IEEE 1188 – Recommended Practice for Maintenance, Testing, of VRLA Batteries.
    IEEE 1189 – Selection of VRLA Batteries for Stationary Applications

RECEIVING & STORAGE

Receiving Inspection

Upon receipt, and at the time of actual unloading, each package should be visually inspected for any possible damage or electrolyte leakage. If either is evident, a more detailed inspection of the entire shipment should be conducted and noted on the bill of lading. Record receipt date, inspection data, and notify the carrier of any damage.

Unpacking

1. **Always wear eye protection.**
2. Check all batteries for visible defects such as cracked containers, loose terminal posts, or other unrepairable problems. Batteries with these defects must be replaced.
3. Check the contents of the package against the packaging list. Report any missing parts or shipping damage to your East Penn agent or East Penn Mfg. Co. immediately.
4. Never lift the batteries by the terminal posts.
5. When lifting batteries, the proper equipment is needed such as a forklift or a portable crane. Always check the lifting capacities of the equipment being used and never lift more than one cell at a time by the handles in the metal sleeve.

Storage / Refresh

Cells should be installed, and float charged upon delivery. If cells are to be stored, the below requirements shall be followed.

1. Cells shall be stored indoors in a clean, level, dry, cool location.
2. Store, charge, and ship in horizontal position only.
3. Recommended storage temperature is 50°F (10°C) to 77°F (25°C). Acceptable storage temperature is 0°F (-18°C) to 90°F (32°C).
4. The cells shall be given a refresh charge at regular intervals as detailed below:

   0°F(-18°C) to 77°F (25°C)

   Cells shall be charged by the “battery charge date” marked on pallet.

   Successive recharges shall be performed every 6 months.

   78°F (26°C) to 90°F (32°C)

   Cell voltage readings shall be taken monthly. Cells must be given a refresh charge within 3 months from date of receipt or if any cell voltage falls below 2.12 vpc, whichever occurs first.

   Successive refresh charges shall be performed every 3 months.
5. Whenever a refresh charge is required, it’s important that all batteries to be installed in the same series string receive a charge at the same time to ensure continuity once placed in their intended application.
6. Each cell shall be charged for 24 hours at a constant voltage equal to 2.40 volts per cell. To ensure the cells are fully charged within 24hrs, the charger used for this refresh charge must have the capacity to provide at least the minimum charge current specification and not exceed the maximum charge current for the given cell type (model), as called out in Appendix D.

Storage / Refresh *continued*

7. All requested information on “Refresh Record Form” in Appendix B should be completed for each refresh charge.
8. Cells shall not be stored beyond 12 months. Storing beyond 12 months will affect warranty.
9. If the storage / refresh requirements cannot be met, contact East Penn Reserve Power Product Support Department for alternate instructions.

INSTALLATION

General

Caution should be taken when installing batteries to ensure no damage occurs. The battery string cabinet, tray, rack, etc. shall be inspected for sharp edges that could cause damage to the battery casing. Batteries shall not be dropped, slid, or placed on rough or uneven surfaces such as tray lips or grated flooring. Mishandling of batteries could result in equipment damage or human injury. East Penn will not be liable for damage or injury as a result of mishandling or misuse of the product.

Electrical Connections

When making electrical connections to the battery string, proper techniques should be applied per electrical standards such as NEC and/or Federal, State and Local codes, as well as User Manual of specific application.

Grounding

When grounding the battery string, proper techniques should be applied per electrical standards, such as NEC and/or local codes as well as User Manual of specific application.

Note: Battery system grounding and/or individual module grounding, if required, is the installer’s responsibility.

Racks

Assemble racks in accordance with intended arrangement, align with a level and bolt to floor. Consult applicable rack assembly instructions for specifics.

Electric Code for Maintenance Access

Refer to ANSI/NFPA-70 National Electric Code for access and working space requirements around the battery. A minimum of 36" aisle space is required in front of the battery system for service and inspection.

Hardware Torque/Retorque Requirements

Bolt Size	Torque / Re-torque	
1/4-20	125 in lb	14.1 Nm

SYSTEM INSTALLATION

Cell Installation

Assemble system per the following details.

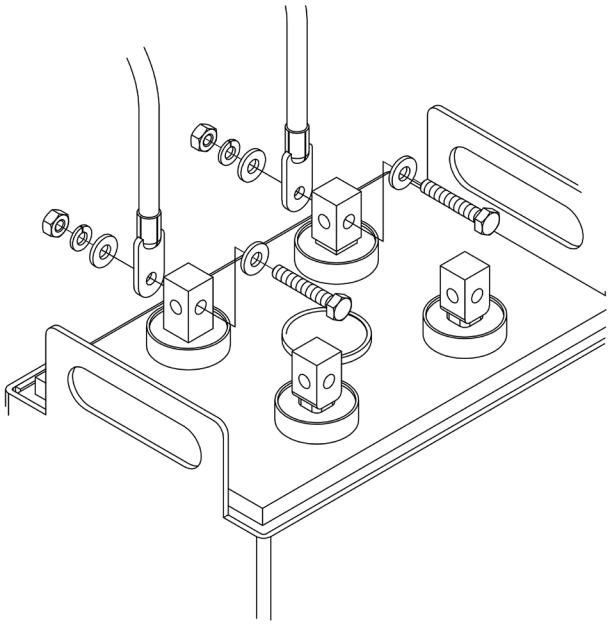
CAUTION: Never lift more than one cell at a time.

1. Ensure sufficient space has been allowed for proper and safe battery installation and maintenance.
2. If cells are to be installed on a rack or cabinet, follow rack/cabinet manufactures instructions for correct installation.
3. Batteries may be installed with posts in a vertical or horizontal position. When installing in horizontal or vertical position, ensure battery post are provided with ample clearance from metal parts of rack/cabinet.

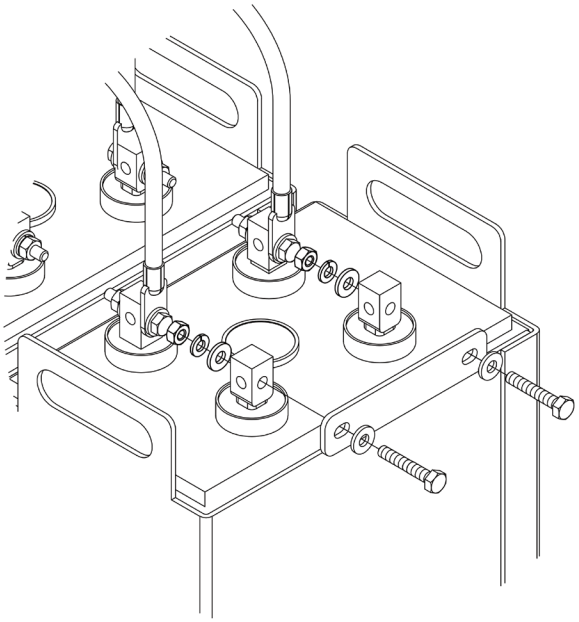
ELECTRICAL CONNECTION

Connector / Cable Assembly

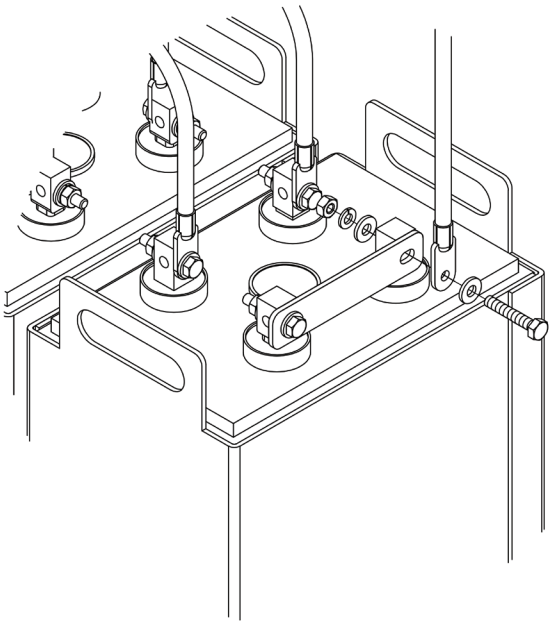
1. The contact surfaces of each individual post on every cell has been cleaned and coated with a thin film of NO-OX-ID “A” grease at the factory. Ensure the contact surfaces are free of dust or dirt prior to assembly. Re-application of NO-OX-ID “A” grease may be required if post cleaning is required.
2. Connectors/cable lugs supplied with cells. It is recommended all connectors/cables be coated with a thin film of NO-OX-ID “A” grease.
3. Install the cables loosely to allow for final alignment. Spacing between cells should be a minimum of 0.50” (12.7mm) for even airflow around cells.



4. For multipost batteries (17 to 33 plate) a connector is to be installed at the battery system positive and negative end of each multiple cell configuration. This connector is used to electrically tie all same polarity posts together.



5. Charging / load cable(s) should be tin or lead plated copper lugs able to accept a 1/4 –20 bolt. Cable lugs should be coated with a thin film of NO-OX-ID "A" grease. System connecting cables can be attached to any battery post of the multipost connector. System connecting cable(s) supplied by others.
   Select cable size based on current carrying capability and voltage drop.



6. Reference Appendix G for layout drawings detailing cable and connector quantity and placement.
7. Upon completion of installing, all connectors / cables hardware should be torqued to 125 ± 5 inch pounds (14.1 ± .5 Nm).

FINAL ASSEMBLY CHECK PROCEDURE

1. For future identification of all cells, number individual cells in sequence, beginning with number one (1) at the positive end of the battery. The last cell of the battery string is located at the negative output terminal.
2. Read and record the voltages of the cells to assure that they are connected properly. The total battery string voltage should be approximately equal to the number of cells connected in series multiplied by the measured voltage of one cell. If the measurement is less, recheck the connections for proper polarity. Verify that all cell and battery string connections have been properly torqued.
3. Measure and record the intercell connection resistance using a micro-ohms meter. This helps determine the adequacy of initial connection installation and can be used as a reference for future maintenance requirements. Refer to the recording forms in Battery Maintenance Report in Appendix F of this manual. Review the records of each connection and detail resistance measurements. Clean, remake, and re-measure any connection that has a resistance measurement greater than 10% of the average of all the same type connections (i.e. intercell, intermodule, etc.).
4. Battery string performance is based on the output at the battery terminals. Therefore, the shortest electrical connection between the battery system and the operating equipment results in maximum total system performance.

Select cable size based on current carrying capability and voltage drop.

Cable size should not provide a greater voltage drop between the battery string and operating equipment than required. Excessive voltage drop in cables will reduce the desired reserve time and power from the battery string.

Cable sizing is the responsibility of site electrical engineer.

SYSTEM OPERATIONS – FLOAT SERVICE

Charger Voltage

2.25 V per battery ± 0.01 @ 77°F (25°C)

When setting the float voltage on the charger, the battery string should be set to float at the required cell float voltage times the number of cells per battery string. The charger must be able to maintain the battery string voltage within ± 0.5% of the desired level at all times.

Charge Current

Charge current should not exceed the recommended minimum and maximum requirements as detailed in Appendix E.

Temperature Compensation

Battery voltage should be adjusted for ambient temperature variations.

2mV per °C (1.8°F) per 2V cell.

Consult **Voltage Compensation Chart (Appendix D)** for temperature compensation voltage maximum and minimum limits.

Cell Voltage

Although the charger must maintain the battery string voltage within ± 0.5%, individual cell voltages may vary by ± 0.05 volts of the average cell float voltage.

Equalizing

Upon installation of the battery string, an optional charge at a constant voltage equal to 2.40V per cell ± 0.01 @ 77°F (25°C) for a maximum of 24hrs may be performed. (NOTE: Verify that the higher cell voltage will not adversely affect any other connected equipment). If this is done, be sure to reset the charging equipment to the proper float voltage.

Battery Operation

Battery string operating temperature will affect battery string capacity and operating life.

Discharging at temperatures less than 77°F (25°C) will reduce the capacity of the battery and require longer charging time to become fully charged.

If operating temperatures are expected to be less than 50°F (10°C) contact East Penn for recommendations.

The battery string must be located in a manner that the individual cells do not vary by more than 5°F (2.8°C) between the lowest and highest individual cell temperature.

Temperatures greater than 77°F (25°C) will reduce the operating life of the battery.

Deka Unigy II**

The battery string should not exceed 105°F (40.5°C) for more than 8 hrs and should never exceed 95°F (35°C). If the above limits are not able to be followed, contact East Penn for recommendations.

Deka Fahrenheit 2V**

The battery string should not exceed 140°F (60°C). If the above limit is not able to be followed, contact East Penn for recommendations.

** Review warranty documents for details.

NOTE: The battery system should not be discharged below published EOD (end of discharge) ratings.

SYSTEM OPERATIONS - CYCLIC

These batteries are able to be used in cyclic type applications including but not limited to PV and wind power. When setting the system voltages on the charger/inverter, the system should be set to the voltage limits as called out in the below chart multiplied by the number of batteries per string. The charger must be able to maintain the system voltage within ± 0.5% of the desired level at all times. The desired voltage settings vary with temperature.

Cyclic Charging Parameters

Bulk Charge Stage

Max. Current — 15% of C20 1.75 V.P.C.
or
3 times 120 1.75 V.P.C.

End Condition — Max. Time (Hr) = Ahr x 1.2 / Avg. Current (A)
Voltage limit equal to "Absorption (Regulation) Stage" limits

Absorption (Regulation) Stage

Constant Voltage — 2.35 to 2.40 V.P.C.

End Condition — Charge until change in current < 0.10A per Hr
Max. Time: 12 Hr

Float Charge

Constant Voltage — 2.24 to 2.26 V.P.C.

End Condition — Charge until change in current < 0.10A per Hr
Max. Time: 12 Hr

Equalize Charge

Constant Voltage — 2.40 to 2.43 V.P.C.

End Condition — Charge until change in current < 0.10A per Hr
Max. Time: 12 Hr

Cut-off parameters per charge and equalize intervals are application specific and will vary dependent upon site specific characteristics such as: temperature, days of autonomy, array to load ratio.

Temperature Compensation

Battery voltage should be adjusted for ambient temperature variations.

3mV per °C (1.8°F) per 2V battery

Consult **Voltage Compensation Chart (pg. 10 – Appendix D)** for temperature compensation voltage maximum and minimum limits.

Rectifier Ripple Voltage

FREQUENCY

Ripple that has a frequency greater than 667Hz (duration less than 1.5ms) is acceptable, unless it is causing additional cell heating.
Ripple that has a frequency less than 667Hz (duration greater than 1.5ms), must meet the following voltage specification to be acceptable.

VOLTAGE

Ripple voltage shall be less than 0.5% peak to peak (0.177% rms) of the manufacturer's recommended battery string voltage. **Failure to comply can void the warranty.**

RECORD KEEPING

Voltages, Temperatures & Ohmic Readings

Record keeping is an important part of stationary battery maintenance and warranty coverage. This information will help in establishing a life history of the battery string and inform the user if and when corrective action needs to be taken.
All measuring equipment should be in good operating condition and accuracy should be confirmed on an annual basis to NIST traceable standards.
After installation and when the battery string has been on float charge for one week, the data as detailed in the "Maintenance Section" should be recorded. Battery Maintenance Report worksheet provided in Appendix F. Failure to maintain proper records including information as detailed below may result in voiding any applicable warranty.

ACCEPTANCE TESTING

Each cell should be at 100% State of Charge prior to performing an acceptance test on the battery system. To ensure the cells are fully charged the following charge schedule should be followed.

Cells should be charged at the equalization rate of 2.40 volts per cell for 24 hours. Temperature compensated charging parameters shall be applied as detailed in "Temperature Compensation" in Appendix D of this manual.

To ensure the cells are fully charged within 24hrs; the charger used for this charge must have the current equal to the maximum charge current for the given cell type (model), as called out in Appendix C.

If these requirements cannot be met, contact East Penn Reserve Power's Product Support group for alternate instructions.

Upon completion, the charge voltage should be lowered to the float voltage of 2.25 volts per cell for a minimum period of 72 hours. Reference: IEEE 1188-2005 Section 7.2 for additional acceptance test requirements.

Upon completion of the above charge, the desired acceptance test can be performed.

NOTE: There shall be no discharges of any duration between the start of the equalization and the completion of the float period. If a discharge does occur, the charging regime detailed above shall be repeated.

Upon completion of the acceptance test, the battery system should be placed on float charge at 2.25 volts per cell to restore the battery to its' rated capacity.

Batteries should not require an equalization charge once they have passed their initial acceptance test. Consult with East Penn Reserve Power Product Support Department before performing additional equalizing charges on batteries that have successfully passed their initial acceptance test.

MAINTENANCE

Always wear eye protection when working on or near batteries. Keep sparks and open flames away from batteries at all times. See Safety Precautions on pg. 3.

Annual Inspection[1]

1. Conduct a visual inspection of each cell.
2. Record the battery string voltage.
3. Record the charger voltage.
4. Record the individual cell voltages. The accuracy of the DMM (Digital Multimeter) must be .05% (on dc scale) or better. The DMM must be calibrated to NIST traceable standards. Because float readings are affected by discharges and recharges, these readings must be taken when batteries have been on continuous, uninterrupted float for at least one month. Cells should be within ± 0.05 volts of the average cell float voltage.
5. Record the ambient temperatures.
6. Record individual cell ohmic readings.
7. Record all intercell, interunit, and terminal connection resistances. Micro-ohm readings should be taken during this inspection. If any reading differs by more than 20% from initial readings taken, retorque the connection. Recheck the micro-ohm reading. If the reading remains high, clean the contact surface according to installation portion of this manual.

[1] Other maintenance inspection intervals follow IEEE 1188

Battery Cleaning

1. Disconnect battery system from power source.
2. Dust accumulation can be removed with cloth dampened with clean water.
3. Corrosion buildup should be neutralized using a mixture of baking soda and water or East Penn Mfg supplied battery cleaner (part # 00321).
4. Use cloth dampened with clean water to remove residue.

   Never use solvents to clean the battery.

Capacity Testing

Per **IEEE 1188** "Capacity testing is used to trend battery aging. The result of a capacity test is a calculation of the capacity of the battery. The calculated capacity is also used to determine if the battery requires replacement".

When performing capacity testing and recording data refer to IEEE 1188 recommendations.

NOTE: When discharging at higher rates, extra connectors may be needed to be added to prevent excessive voltage drop and / or excessive temperature rise.

Should it be determined that and battery(ies) need to be replaced contact your nearest East Penn agent or East Penn Service Center.

APPENDIX A

For Energy Storage Applications Following UL 1973 the following shall be reviewed:

1. Batteries and components shall be installed in accordance with Article 480 or Article 706 of NFPA 70 or Section 64 of CSA C22.1.

2. The charger shall comply with one of the following standards: UL 1012, UL 1741, UL 60335-2-29/CSA C22.2 No. 60335-2-29, CAN/CSA C22.2 No. 107.2, or UL 62368-1/CSA C22.2 No. 62368-1

3. If the batteries are being installed in a system greater than 60V, a disconnecting mean shall be provided for all ungrounded conductors in accordance with Article 480 of NFPA 70 or Section 64 of CSA C22.1.

4. Service disconnects shall be provided as applicable to the end product battery system in accordance with Article 480 of NFPA 70 or Section 64 of CSA C22.1.

5. Protection devices supplied with the battery should be installed prior to use. Consult electrical standards such as NEC and/or Federal, State and Local codes for additional protection device requirements, as well as User Manual of specific application.

6. The grounding and bonding system shall be checked after the completion of the assembly to ensure that the resistance is less than or equal to 0.1 Ω.

7. The maximum battery system voltage should not exceed a nominal 960 VDC. If this voltage is exceeded, a repeat of the dielectric voltage withstand test of the assembly of the higher voltage shall be performed.

8. Recommended minimum spacing of 0.50” (12.7mm) from adjacent battery, walls and / or equipment.

APPENDIX B

EastPenn	REFRESH RECORD FORM								
	EPM Order Number*		Pallet ID Number		Individual Performing Test (Full Name)			Date of Refresh	Refresh Duration
Model Number	Information Prior to Refresh				Information within 1 hour of Refresh Completion			Notes & Comments	
	Date Code	Cell Serial Number	Open Circuit Voltage		Cell Voltage Reading	Charging Current	Cell Temperature		
Cell 1									
Cell 2									
Cell 3									
Cell 4									
Cell 5									
Cell 6									
Cell 7									
Cell 8									
Cell 9									
Cell 10									
Cell 11									
Cell 12									
Cell 13									
Cell 14									
Cell 15									
Cell 16									
Cell 17									
Cell 18									
Cell 19									
Cell 20									
Cell 21									
Cell 22									
Cell 23									
Cell 24									

ALL FIELDS TO THE RIGHT OF THE CELL NUMBER ABOVE MUST BE COMPLETED

EPM ORDER NUMBER WILL APPEAR ON THE SHIPPING LABEL ON THE CARTON COVERING EACH PALLET OF CELLS

TO ENSURE CONTINUATION OF WARRANTY, SUBMIT FORMS TO: East Penn Mfg. Co, Inc.,
Reserve Power Division, Product Support & Warranty Dept. (reservepowerwarranty@dekabatteries.com)

APPENDIX C

Unigy II AVR45 Series Battery Weight & Acid Volumes

Battery Type	Cell Weight		Electrolyte (per cell)				Pure Acid (per battery	
			Volume		Weight		Weight	
	lb	kg	gal	liter	lb	kg	lb	kg
AVR45-5	18	8	0.37	1.40	4.00	1.81	1.60	0.72
AVR45-7	25	11	0.52	1.96	5.60	2.54	2.24	1.02
AVR45-9	32	15	0.67	2.52	7.22	3.28	2.89	1.31
AVR45-11	39	18	0.81	3.08	8.83	4.00	3.53	1.60
AVR45-13	46	21	0.96	3.64	10.43	4.73	4.17	1.89
AVR45-15	53	24	1.11	4.20	12.04	5.46	4.81	2.18
AVR45-17	60	27	1.26	4.76	13.65	6.19	5.46	2.47
AVR45-19	67	30	1.41	5.32	15.26	6.92	6.10	2.77
AVR45-21	74	34	1.55	5.89	16.87	7.65	6.74	3.06
AVR45-23	81	37	1.70	6.45	18.47	8.38	7.39	3.35
AVR45-25	88	40	1.85	7.01	20.08	9.11	8.03	3.64
AVR45-27	95	43	2.00	7.57	21.69	9.84	8.67	3.93
AVR45-29	102	46	2.15	8.13	23.30	10.57	9.31	4.22
AVR45-31	109	49	2.30	8.69	24.91	11.30	9.96	4.52
AVR45-33	116	53	2.44	9.25	26.51	12.03	10.60	4.81

***Data subject to change without notice*

Deka Fahrenheit HT45 Series Battery Weights & Acid Volumes

Battery Type	Cell Weight		Electrolyte (per cell)				Pure Acid (per battery				
			Volume		Weight		Volume		Weight		% - Total Cell Weight
	lb	kg	gal	liter	lb	kg	gal	liter	lb	kg	
HT45-5	18	8	0.37	1.40	4.00	1.81	0.10	0.40	1.60	0.72	8.9%
HT45-7	25	11	0.52	1.96	5.60	2.54	0.15	0.55	2.24	1.02	9.0%
HT45-9	32	15	0.67	2.52	7.22	3.28	0.19	0.71	2.89	1.31	9.0%
HT45-11	39	18	0.81	3.08	8.83	4.00	0.23	0.87	3.53	1.60	9.0%
HT45-13	46	21	0.96	3.64	10.43	4.73	0.27	1.03	4.17	1.89	9.1%
HT45-15	53	24	1.11	4.20	12.04	5.46	0.31	1.19	4.81	2.18	9.1%
HT45-17	60	27	1.26	4.76	13.65	6.19	0.36	1.35	5.46	2.47	9.1%
HT45-19	67	30	1.41	5.32	15.26	6.92	0.40	1.51	6.10	2.77	9.1%
HT45-21	74	34	1.55	5.89	16.87	7.65	0.44	1.67	6.74	3.06	9.1%
HT45-23	81	37	1.70	6.45	18.47	8.38	0.48	1.83	7.39	3.35	9.1%
HT45-25	88	40	1.85	7.01	20.08	9.11	0.52	1.98	8.03	3.64	9.1%
HT45-27	95	43	2.00	7.57	21.69	9.84	0.57	2.14	8.67	3.93	9.1%
HT45-29	102	46	2.15	8.13	23.30	10.57	0.61	2.30	9.31	4.22	9.1%
HT45-31	109	49	2.30	8.69	24.91	11.30	0.65	2.46	9.96	4.52	9.1%
HT45-33	116	53	2.44	9.25	26.51	12.03	0.69	2.62	10.60	4.81	9.1%

***Data subject to change without notice*

APPENDIX D

VOLTAGE COMPENSATION CHARTS

Float Applications

°C	Float	°F
>35	2.230	>95
34	2.232	93.2
33	2.234	91.4
32	2.236	89.6
31	2.238	87.8
30	2.240	86.0
29	2.242	84.2
28	2.244	82.4
27	2.246	80.6
26	2.248	78.8
25	**2.250**	**77.0**
24	2.252	75.2
23	2.254	73.4
22	2.256	71.6
21	2.258	69.8
20	2.260	68.0
19	2.262	66.2
18	2.264	64.4
17	2.266	62.6
16	2.268	60.8
15	2.270	59.0
14	2.272	57.2
13	2.274	55.4
12	2.276	53.6
11	2.278	51.8
<10	2.280	<50

2mV per ˚C

Cyclic Applications

°C	Float	Absorption		Equalize	°F
		Min.	Max.		
>35	2.220	2.320	2.370	2.400	>95
34	2.223	2.323	2.373	2.403	93.2
33	2.226	2.326	2.376	2.406	91.4
32	2.229	2.329	2.379	2.409	89.6
31	2.232	2.332	2.382	2.412	87.8
30	2.235	2.335	2.385	2.415	86.0
29	2.238	2.338	2.388	2.418	84.2
28	2.241	2.341	2.391	2.421	82.4
27	2.244	2.344	2.394	2.424	80.6
26	2.247	2.347	2.397	2.427	78.8
25	**2.250**	**2.350**	**2.400**	**2.430**	**77.0**
24	2.253	2.353	2.403	2.433	75.2
23	2.256	2.356	2.406	2.436	73.4
22	2.259	2.359	2.409	2.439	71.6
21	2.262	2.362	2.412	2.442	69.8
20	2.265	2.365	2.415	2.445	68.0
19	2.268	2.368	2.418	2.448	66.2
18	2.271	2.371	2.421	2.451	64.4
17	2.274	2.374	2.424	2.454	62.6
16	2.277	2.377	2.427	2.457	60.8
15	2.280	2.380	2.430	2.460	59.0
14	2.283	2.383	2.433	2.463	57.2
13	2.286	2.386	2.436	2.466	55.4
12	2.289	2.389	2.439	2.469	53.6
11	2.292	2.392	2.442	2.472	51.8
<10	2.295	2.395	2.445	2.475	<50

3mV per ˚C

APPENDIX E

CHARGE CURRENT LIMITS

Cell Type	Max. Charge Current (A)	Min. Charge Current (A)**
AVR45-5	16.5	4.9
AVR45-7	24.7	7.4
AVR45-9	32.9	9.9
AVR45-11	41.1	12.3
AVR45-13	49.4	14.8
AVR45-15	57.6	17.3
AVR45-17	65.8	19.7
AVR45-19	74.1	22.2
AVR45-21	82.3	24.7
AVR45-23	90.5	27.2
AVR45-25	98.7	29.6
AVR45-27	107	32.1
AVR45-29	115	34.5
AVR45-31	123	37.0
AVR45-33	132	39.5

Cell Type	Max. Charge Current (A)	Min. Charge Current (A)**
HT45-5	16.5	4.9
HT45-7	24.7	7.4
HT45-9	32.9	9.9
HT45-11	41.1	12.3
HT45-13	49.4	14.8
HT45-15	57.6	17.3
HT45-17	65.8	19.7
HT45-19	74.1	22.2
HT45-21	82.3	24.7
HT45-23	90.5	27.2
HT45-25	98.7	29.6
HT45-27	107	32.1
HT45-29	115	34.5
HT45-31	123	37.0
HT45-33	132	39.5

*** = Using minimum charge current will extend recharge time and increase risk of battery being undercharged*

BATTERY MAINTENANCE REPORT

Company: _____ Service Date: _____

Address: _____ Battery Dwg. # _____

Connector Pkg. _____ (See Manual)

Battery Location & Room #: _____ Battery I.D. #: _____

Total No. of Cells: _____ Charger Output Voltage: _____ Float Current: _____ Ambient Air Temperature: _____ °F

Battery Type [2]: _____ Total Battery Voltage: _____ *(To be read @ battery terminals)* Installer: _____

Date of Mfg. [2]: _____ Panel Meter Voltage: _____ *(Display Voltage)* Date Installed: _____

Site Load IN KVA: _____ *KVA* Power Factor of Load: _____ Conductance / Impedance Meter: _____ (Mfg. & Model)

UPS Mfg. & Model: _____ AC Ripple Voltage:

Battery's Environment): _____

[2] *Consult Cell type / Battery Type Label - Found on Retaining Bar or Left Side of Each Module.*

Cell / Jar No.	Serial Number	Cell Temp.	Volts (Float)	Cell Ohmic Value [1]	Connector Ohmic Value 1	2	3	Cell / Jar No.	Serial Number	Cell Temp.	Volts (Float)	Cell Ohmic Value ^	Connector Ohmic Value 1	2	3
1								31							
2								32							
3								33							
4								34							
5								35							
6								36							
7								37							
8								38							
9								39							
10								40							
11								41							
12								42							
13								43							
14								44							
15								45							
16								46							
17								47							
18								48							
19								49							
20								50							
21								51							
22								52							
23								53							
24								54							
25								55							
26								56							
27								57							
28								58							
29								59							
30								60							

[1] CONSULT I & O MANUAL, "RECORD KEEPING", FOR ADDITIONAL INFORMATION INCLUDING PROPER LOCATION OF PROBES FOR MULTI-TERMINAL JARS.

Remarks and Recommendations: _____

Readings Taken By: _____

Notation: This form must be completed and submitted with any product warranty claim.

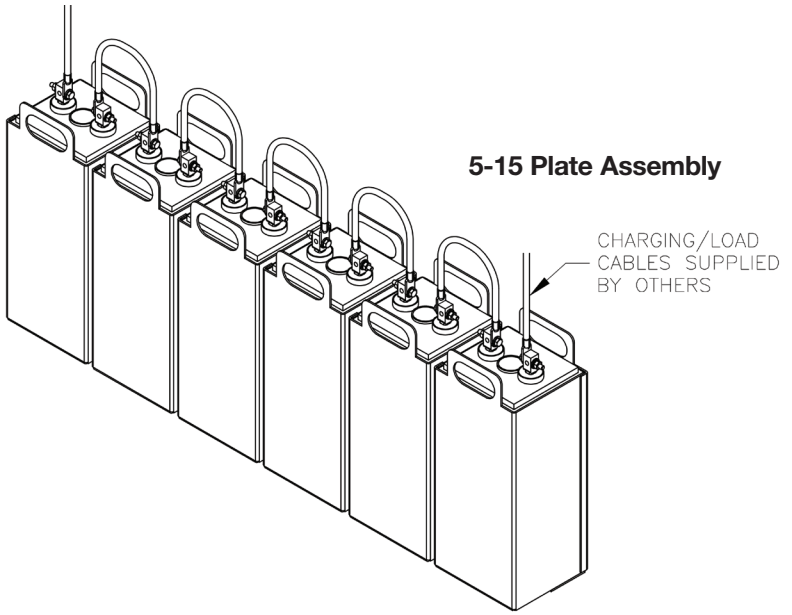
Readings should be taken at Installation and at least annually thereafter.

EPM Form: XXXX 2-3-09 (Form available as an Excel Spreadsheet. Consult your EPM Representative.)

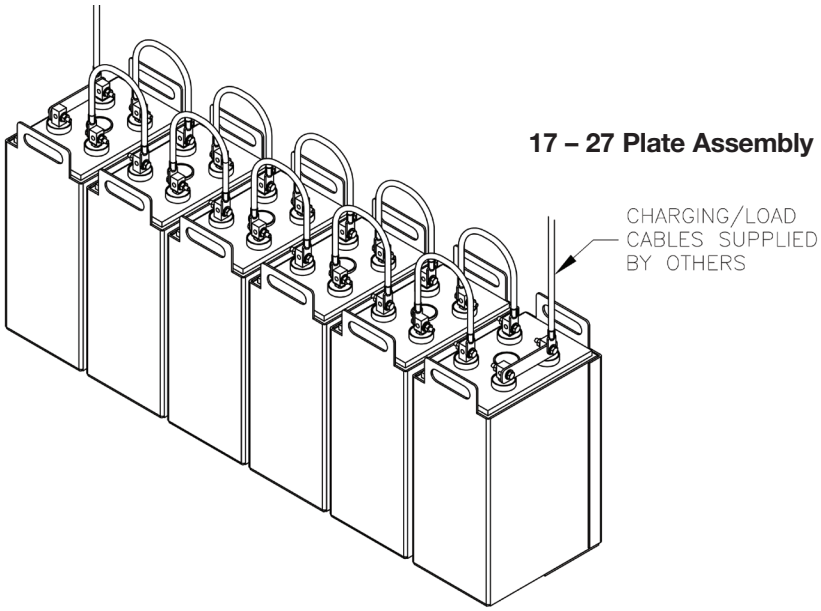
APPENDIX G

SYSTEM LAYOUT DRAWINGS

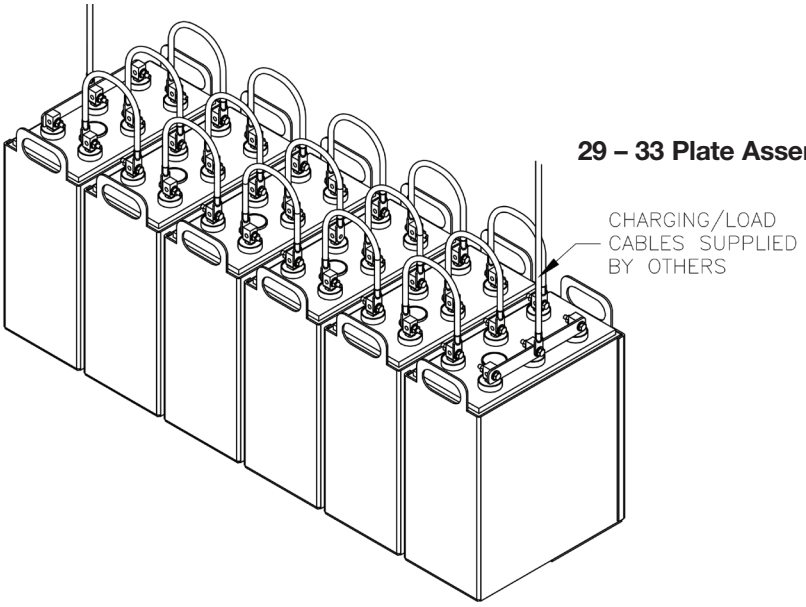
Drawing are representation of a 12V (6-cell) system



5-15 Plate Assembly



17 – 27 Plate Assembly



29 – 33 Plate Assembly

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