CGT Standard 4293
CGT Station Battery Maintenance and Testing

TALKING POINTS SUMMARY

Who does this standard affect?	The standard primarily affects the district and GC personnel involved in the routine maintenance and testing of station batteries.
What are the CGT standard's mandatory requirements?	Outlines required maintenance, inspection, testing, and recordkeeping requirements for all batteries listed in Appendix 2.
Is this CGT standard new or revised? If this is a revised standard, what will change?	This is a new standard.
When is this CGT standard to be implemented?	Portions of the standard are already being practiced, and nearly two full cycles of battery inspection and testing have already been completed.
What will this standard accomplish?	Adherence to this standard will: ensure uniformity in the approach to battery and DC system maintenance will improve DC and UPS systems reliability by scheduling batteries for replacement prior to failure based on test results will help maximize the life of our batteries will provide the required documentation when seeking warranty recovery from battery manufacturers
How is this CGT standard going to be implemented?	Maintenance, inspection, and testing intervals are outlined in section 5 and in Appendix 2. GC is responsible to coordinate the annual testing schedule with each district and maintain the test equipment. Each district is responsible for completing the maintenance and inspection requirements in the standard. Station Engineering and GC are available to assist in this effort as well.

Pacific Gas and Electric Company
California Gas Transmission
PG&E **Standard**

Number: 4293
Revision: 1

☐ *Engineering Design* ☒ *Maintenance, Operation, & Construction*

Issuing Department: GAS SYSTEM MAINTENANCE AND TECHNICAL SUPPORT
Manager: B. D. Davis

Effective Date: 01 May 2000
Review Date: 01 May 2002

SUBJECT: CGT Station Battery Maintenance and Testing

Objective

The purpose of this standard is to describe routine maintenance and testing procedures and required documentation for gas transmission station batteries.

Scope

This standard covers the maintenance and testing of 10-year and 20-year design life station batteries. Some types of batteries typically found in small uninterruptible power supply (UPS) systems are not designed to be tested or maintained and, as such, are not addressed herein.

Applies To

This standard applies to GSM&TS Facility Engineers, and construction, maintenance, and operations personnel involved in the testing and maintenance of gas transmission station batteries.

Rescission

No CGT documents are superseded by this standard.

Related Standard

There are no related CGT standards developed at this time.

Originator

This standard is sponsored by Station Engineering.

Business Risk

Not following the maintenance, testing, and documentation procedures described in this standard may result in: premature aging or failure of battery backup systems; lack of confidence in the ability of battery backup systems to operate as intended during loss of the AC sources; and, increased difficulty in claiming warranty treatment for failed batteries.

Responsibility for Implementation

GSM&TS Director, Station Engineering and District Superintendents.

Contact for Further Information

GSM&TS Station Engineering, Sr. Electrical Engineer
[redacted] Co. 583-4136, Outside (925) 974-4136

Exhibits or Appendices

Appendix 1 - Battery Maintenance Log Sheets
Appendix 2 - List of Station Batteries and Testing Intervals
Appendix 3 - Battery Discharge Test Parameters
Exhibit 1 - Sample Battery Load Test Report
Exhibit 2 - Sample Battery Database Input Form
Supplement 1 - CGT Battery Capacity Testing Procedure

References

IEEE Std 446-1995, "Emergency and Standby Power."

IEEE Std 450-1995, "IEEE Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications."

IEEE Std 1188-1996, "IEEE Recommended Practice for Maintenance, Testing, and Replacement of Valve-Regulated Lead-Acid Storage Batteries for Stationary Applications."

Deviations

Permission to deviate from the requirements of this standard must be obtained in writing from the Director of Station Engineering.

Approvals and Authorizations

B. D. Davis Date

Manager, Gas System Maintenance and Technical Support

1.0 GENERAL

Proper and regular maintenance will help maximize the life of a battery. Regular testing will detect weak cells before they fail, thereby improving overall DC system reliability. Good record keeping will also be invaluable when warranty recovery is sought.

2.0 DEFINITIONS

Acceptance Test — A constant current or power capacity test made on a new battery to determine that it meets specifications or manufacturer's ratings.

Capacity Test — A discharge of a battery at a constant current or power to a specified terminal voltage (a typical value is 1.75 volts-per-cell (VPC) for most gas transmission station batteries).

Equalizing Voltage — The voltage, higher than float, applied to a battery to correct inequalities among individual cell voltage or specific gravity readings that may develop in service (a typical value is 2.35 VPC for flooded cell batteries).

Float Voltage — The voltage applied to a battery to maintain it fully charged during normal operation (a typical value is 2.25 VPC).

Flooded Cell Battery — Also known as "wet" cell, or "vented" cell batteries. The products of electrolysis and evaporation are allowed to escape to the atmosphere, through vented caps in the jar, as they are generated.

Jar — The container holding the battery plates and electrolyte (sulfuric acid).

Module — Multiple cells or units in a single assembly (terminology is unique to VRLA batteries which are packaged in modular assemblies).

Pilot Cell — This is one cell selected that is considered representative of the entire battery.

String — A series grouping of individual jars/cells/modules to achieve the nominal voltage rating of the battery bank. Depending on the battery type selected, some banks will be designed with two or more strings in parallel.

Unit — Multiple cells in a single jar.

Valve-Regulated Lead-Acid (VRLA) Battery — A battery that is sealed with the exception of a valve that opens to the atmosphere when the internal gas pressure in the jar exceeds atmospheric pressure by a designed amount (set at the factory). VRLA batteries provide a means for recombination of internally generated oxygen and the suppression of hydrogen gas evolution to

limit water consumption.

3.0 PERSONNEL SAFETY

3.1 Safety Equipment

The following equipment shall be worn when taking specific gravity and/or electrolyte temperature readings on flooded cell batteries:

- Goggles, safety glasses with side-shields, or face shields;
- Acid-resistant gloves;
- Protective apron.

Portable or stationary eyewash equipment shall be located in the battery storage area or immediate vicinity for rinsing eyes and skin following contact with electrolyte.

3.2 Precautions

- Use caution when working on batteries since they present an electric shock hazard;
- Smoking, open flames, or arc-producing equipment are prohibited in the immediate vicinity of the battery;
- Neutralize static buildup before working on a battery by contacting the nearest effectively grounded surface; and,
- Avoid the use of metallic objects such as jewelry or non-insulated tools when performing battery maintenance.

4.0 ELECTROLYTE SPILL CLEANUP

4.1 "Small" spill cleanup – non-hazardous

Small amounts (approximately one pint or less) of spilled electrolyte can be neutralized with a water/baking soda mixture (1lb/gallon of water). Neutralization of the sulfuric acid electrolyte will be indicated by rapid bubbling of the acid/baking soda mixture. If the addition of further neutralizer does not result in further bubble generation, the acid can be considered neutralized. This neutralized mixture, consisting of carbon dioxide gas, water, and sodium sulfate, can then be disposed of using absorbent materials and disposed of as normal waste.

4.2 "Large" spill cleanup

For cleanup of spilled electrolyte in excess of one pint, please contact your assigned environmental engineer or specialist for

proper cleanup procedures.

5.0 ROUTINE INSPECTIONS AND MAINTENANCE

This section describes inspections and procedures to be followed by district maintenance personnel.

5.1 What to Check and Record (see Maintenance Log Sheet, Appendix 1)

1. Record overall float voltage ***measured at the battery terminals***. (see section 5.5 for further details)
2. Record cell voltages.
3. Record cell temperatures at the negative terminal using an infrared temperature detector (VRLA only).
4. Record the ambient temperature in the battery storage area.
5. Record the charger/rectifier output current and voltage.
6. Record cell-to-cell interconnection resistance using an Alber Cellcorder or micro-ohmmeter.
7. Record cell/unit internal resistance using an Alber Cellcorder or micro-ohmmeter.
8. Record any ***cracks*** in cells or ***leakage*** of electrolyte.
9. Record any excessive jar/cover distortion (VRLA only).
10. Check for ***corrosion*** at terminals, connectors, or racks. Clean as per manufacturer instructions.
11. Intercell resistance measurements should be similar for similar connections. If not, or if values have increased from earlier measurements, remove connectors, clean, and re-apply corrosion inhibitor. Re-assemble the connections and re-torque to manufacturer's specifications using an appropriate insulated torque wrench (typical torque values are 100 in-lb).
12. Check the general appearance and cleanliness of the battery, rack, and surrounding area.
13. Ensure the ventilation system is operating properly and vents are unobstructed.
14. Check for unintentional battery grounds (if charging equipment includes the DC ground detection feature).

5.2 Additional Items for Flooded Cell Batteries

Note: *Specific gravity measurements should be taken before adding necessary water. If the electrolyte level is too low to take the reading before adding water, wait at least 72 hours after adding water to take the readings. This allows adequate time for the water to mix properly with the acid.*

1. Measure and Record specific gravity and electrolyte temperature. Electrolyte temperatures are measured with a thermometer inserted into the jar.
2. Check electrolyte levels. Add distilled water to keep the level between the Hi and Lo marks on each jar.
3. Check all flame arrestors to ensure they are not clogged.
4. Inspect battery plates for cracks, sulfate formation, swelling, and sediment accumulation.
5. Check for excessive gassing. There should be little or no visible gassing during normal operation.

5.3 Special Inspections

If the battery has experienced one or more of the following conditions, perform inspection and maintenance tasks as indicated in Table 1 under "Special":

- Extended power outage resulting in long discharge on the battery;
- Routine capacity testing (typically, the entire battery system will be checked and documented during this testing);
- One or more battery jars is/are replaced; or,
- Extremely high (sustained) ambient temperature in battery area.

5.4 Frequency of Inspection and Maintenance Tasks

See Table 1 on page 8.

5.5 Pilot Cell Selection

When selecting a pilot cell, select one that is:

- not at either end of a rack step or tier;
- not the first or last cell in a string;
- neither the closest to nor the farthest from any ventilation source, such as a wall-mounted air conditioner/heater, doorway, etc.

For flooded cell batteries, it is recommended that the cell with the lowest specific gravity reading be selected as the pilot cell (also

considering the other factors listed above). However, because a slight amount of electrolyte is lost each time a hydrometer reading is taken, ***it is advisable to change pilot cells annually for flooded cell batteries***.

For VRLA batteries, select the cell with the ***lowest float voltage***, also considering the other factors listed above.

Table 1: Maintenance Frequencies for Flooded and VRLA Batteries

Task Description	Flooded Cells				VRLA Cells			
	Initial	Monthly	Annually	Special (1)	Initial	Quarterly	Annually	Special (1)
Measurements								
Record overall float voltage of battery (measured at battery terminals)	X	X	X	X	X	X	X	X
Record Pilot cell voltage.	X	X	X	X				
Record Individual Cell Voltages	X		X	X	X		X	X
Record the ambient temperature in the battery storage area.	X	X	X	X	X	X	X	X
Record Pilot cell temperature.	X	X	X	X				
Record individual cell temperatures (2).	X		X	X	X		X	X
Record the charger/rectifier output current and voltage (3).	X	X	X	X	X	X	X	X
Record cell-to-cell interconnection resistance using an Alber Cellcorder or micro-ohmmeter.	X		X	X	X		X	X
Record cell/unit internal resistance using an Alber Cellcorder.	X		X	X	X		X	X
Record Pilot cell specific gravity.	X	X	X	X				
Record specific gravity of electrolyte of individual cells.	X		X	X				
Visual Inspections								
Check the general appearance and cleanliness of the battery, rack, and surrounding area.	X	X	X	X	X	X	X	X
Check for corrosion at terminals, connectors, or racks. Clean as per manufacturer's instructions.	X	X	X	X	X	X	X	X
Torque intercell connectors (4).	X			X	X			X
Ensure the ventillation system is operating properly and vents are unobstructed.	X	X	X	X	X	X	X	X
Check for cracks in jars and/or electrolyte leakage. Check for gassing.	X	X	X	X	X	X	X	X
Check electrode plates for cracks, sulfate formation, and sediment formation.	X	X	X	X				
Check electrolyte levels. Add distilled water as necessary.	X	X	X	X				
Check for clogged flame arrestors.	X		X	X				
Check for excessive jar/cover distortion.					X	X	X	X
Check for unintentional battery grounds (5).	X		X		X	X	X	

Notes

(1) Special task category is as indicated in section 5.3.

(2) Cell temperatures are checked with a thermometer (Flooded) or infrared detector (VRLA).

(3) Charger/rectifier output voltage varies with temperature (temperature-compensated equipment only). See section 5.5 for evaluation of readings.

(4) As indicated by intercell resistance readings (see section 5.1, item 11 for more information).

(5) This can be easily checked for charging equipment having a DC ground detection feature.

5.5 Setting the Float Voltage

Improper float voltage settings are a major contributor to the premature aging of batteries, especially the VRLA type. Therefore, strict attention should be paid to proper adjustment. Even though most charging equipment contains temperature-compensation circuitry, the proper setting should be calculated at least annually, using the formula below[1], to confirm this circuitry is working properly and, if not, to make the proper adjustment to the float voltage level.

Note: *Float voltage measurements must be taken at the battery terminals with a calibrated digital voltmeter. Do not rely on the voltmeter on the charging equipment panel for this measurement.*

Sample Calculations:

Battery Type: GNB Absolyte IIP (VRLA), 60 Cells

Ambient Temperature[2]: 65°F

Nominal Voltage @ 77°F: 2.23 - 2.27 VPC

$V_{corrected} = V_{77F} - [(T_{actual} - 77°F) \times (0.003\ V/°F)]$

Using the data and formula given above:

$V_{corrected} = 2.25 - [(65 - 77)] \times 0.003] = 2.286$ VPC

$V_{float} = (2.286) \times 60 = 137.16$ Volts

Compare this with the nominal value at 2.25 VPC = 135 volts, a 2.16 volt difference.

5.6 Equalizing Charge

Note: *Equalize charging is not normally recommended for most VRLA type batteries. Allowable variations among cell voltages in VRLA batteries can be much greater than for flooded-cell batteries. Consult the manufacturer's literature for specific instructions for your battery type.*

Perform an equalize charge on a flooded cell battery when any of the following are noted during routine maintenance and inspection:

1. Cell voltage readings vary from the average value by more than ±0.04 V for lead-calcium cells or ±0.02 V for lead-antimony

[1] Formula is taken from, "Absolyte IIP, Installation and Operating Instructions", Section 8-20, p.20. Consult appropriate manufacturer's literature for temperature correction formulae for batteries other than GNB Absolyte.
[2] Ambient temperature for this calculation is the average temperature in the battery storage area.

cells;

2. The specific gravity of any individual cell falls below the manufacturer's lower limit; or,
3. An individual cell voltage reading falls below the minimum recommended voltage set by the manufacturer (typically 2.13 V for 1.215 specific gravity cells).
4. Following battery capacity testing.

6.0 Required Testing and Replacement

Testing will be done by a minimum of one GC M&C Technician and one district technician. GC M&C shall have primary responsibility for overall test schedule coordination.

6.1 VRLA Batteries.

Capacity testing is required for these batteries at time of installation and ***annually*** thereafter.

6.2 Flooded Cell Batteries

Capacity testing is required for these batteries at time of installation, two years thereafter, and at subsequent intervals of ***five years.***

Testing ***every two years*** is required when the battery has reached 85 percent of its service life (typically 17 years for a 20-year battery).

Annual testing is required when any or all of the following conditions exist:

1. Battery has reached 85 percent of its service life AND has a tested capacity below 100 percent of nameplate; OR,
2. Battery capacity falls 10 percent or more from the prior tested capacity; OR,
3. Battery capacity is below 90 percent.

6.3 Testing Procedures.

Testing procedures are documented as a supplement to this standard. The following documents are also included as attachments to this standard:

- Appendix 2 - List of Station Batteries and Testing Intervals
- Appendix 3 - Battery Discharge Test Parameters

Battery testing software and hardware have been purchased from AlberCorp and should be used to properly document the test results.

The advantages of using this equipment over other "manual" methods are:

1. Discharge test parameters are entered into the capacity testing program and allow for precise and automatic control of the discharge current through the load bank throughout the test.
2. Voltage readings for each cell are taken continuously, displayed, and recorded to a data file for later analysis. This saves time and allows closer evaluation of each individual cell's performance throughout the test.
3. Very robust reporting and analysis tools are available following testing that give a precise picture of the battery's condition.
4. Test reports using the AlberCorp software have proven very useful in obtaining warranty support on failed batteries.
5. The ability to compensate for temperature variations from nominal (77°F) is built into the program. No correction factor tables are needed.
6. In most cases, the discharge tests can be completed more quickly using the computer-controlled equipment rather than the old manual methods.

6.4 Test Results.

Copies of annual load test results shall be mailed (or emailed) to:

[redacted]
Station Engineering
375 N. Wiget Lane, Suite 130
Walnut Creek, CA 94598

The test results will be used to write a final test report for each location at which testing was performed. This report will include observations and recommendations to the district along with a detailed printout of the test results for each battery tested. A sample battery load test printout, generated by the AlberCorp software, is included as Exhibit 1 of this standard.

6.5 Replacement Criteria

It has been demonstrated that battery capacity deteriorates rapidly after falling to the 80 percent level. Therefore, batteries testing below 80 percent of rated nameplate capacity should be replaced within twelve months.

7.0 Recordkeeping Requirements

Maintenance personnel shall use a copy of the sample battery maintenance log sheet included as Appendix 1 of this standard to record maintenance on each battery bank. Log sheets shall be kept in a binder at each facility along with copies of past capacity test reports and manufacturers literature. These log sheets and reports shall be kept on file until a battery is removed or replaced.

BATTERY MAINTENANCE LOG SHEET - Page 1

Date		Battery Mfr		Installation Job#	
Station Name		Battery Model		Maint. Techn.	
Battery Name		Date Installed		Pilot Cell #	

The following visual inspections are to be completed MONTHLY.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Inspect cleanliness of battery, rack, and surrounding area. Clean as necessary.												
Inspect terminals, connectors, and racks for corrosion. Clean as per mfr's instructions.												
Ensure ventilation system is operating properly.												
Check for cracks in jars and/or electrolyte leakage.												
Check for gassing (flooded cells)												
Check electrode plates for cracks, sulfating, or sediment formation (flooded cells).												
Check electrolyte levels. Add distilled water as necessary.												

The following measurements are to be recorded MONTHLY.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Overall Float Voltage												
Pilot Cell Voltage												
Pilot Cell Temperature												
Pilot Cell Specific Gravity												
Battery Room Temperature												
Charger Output Voltage												
Charger Output Current												

Notes/Comments/Recommendations/Corrective Actions:

BATTERY MAINTENANCE LOG SHEET - Page 2

This table to be completed following installation, ANNUALLY, and following SPECIAL events for all cells.

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

Notes: (1) Temperature of flooded cells to be taken with a thermometer inserted into the electrolyte. VRLA cell temperatures are taken at the negative terminal using a thermal infrared detector.
(2) S.G. stands for Specific Gravity. Measurements can only be taken on flooded cells.

This checklist to be completed ANNUALLY

Check inter-cell resistance using an Alber Cellcorder or micro ohmmeter.	
Torque inter-cell connectors as necessary and re-check intercell resistance. If still high, see CGT Std 4293, Section 5.1, item 11.	
Check for clogged flame arrestors (flooded cells)	
Check for excessive jar/cover distortion (VRLA)	
Check for unintentional battery grounds	

Notes/Comments/Recommendations/Corrective Actions:

LIST OF STATION BATTERIES AND TESTING INTERVALS – Page 1

Location	Designation	Manuf	Model	Installed	Volts	Test Interval	Last Test
Antioch	46 Volt Telecom	GNB	85A17	05/01/92	46	Annual	12/28/99
Antioch	UPS Battery A	GNB	6-MSA-2010	05/01/95	125	Annual	04/12/00
Antioch	UPS Battery B	GNB	6-MSA-2010	05/01/95	125	Annual	04/13/00
Bethany	46 Volt Telecom	GNB	75A09	12/01/92	46	Annual	12/22/99
Bethany	UPS Battery	Yuasa	DD40-17	05/20/99	125	Annual	04/05/00
Brentwood	48 Volt Telecom	GNB	75A11	09/01/92	48	Annual	12/01/99
Brentwood	UPS Battery A	GNB	MSA-2460	06/01/95	125	Annual	04/11/00
Brentwood	UPS Battery B	GNB	MSA-2460	06/01/95	125	Annual	
Burney	Station Battery	C&D	KCR-11	09/29/90	125	5 Year	11/30/99
Delevan	48 Volt Telecom	Exide	DMP-9	01/01/65	48	Annual (1)	11/17/99
Delevan	Station Battery	C&D	KC-11	09/07/86	125	5 Year (2)	
Gerber	48 Volt Telecom	Exide	DMP-9	01/01/65	48	Annual (1)	11/18/99
Gerber	UPS Battery 1	GNB	6-MSA-1140	04/01/97	125	Annual	04/23/97
Gerber	UPS Battery 2	GNB	6-MSA-1140	04/01/97	125	Annual	04/23/97
Hermann	Station Battery	GNB	45A05R	01/01/93	24	5 Year	04/10/00
Hershey Jct	unknown	GNB	unknown		125	Annual	
Hinkley	24 Volt Battery	GNB	90A17	12/15/99	24	Annual	12/21/99
Hinkley	UPS Battery	GNB	90A09	12/01/99	125	Annual	12/22/99
Irvington	UPS Battery 1	GNB	MSA-1140	01/01/96	125	Annual	
Irvington	UPS Battery 2	GNB	MSA-1140	01/01/96	125	Annual	
Kettleman	24-volt Station Battery	GNB	75A23	04/01/89	24	Annual (3)	12/07/99
Kettleman	UPS Battery	Dynasty	UPS 12-475	12/03/99	125	Annual (3)	12/07/99
Los Medanos	24 Volt Telecom	GNB	50A09	09/30/93	24	Annual (1)	11/30/99
Los Medanos	UPS Battery	GNB	50A09	09/30/93	125	Annual (1)	11/04/99
McDonald Compressor Sta	48 Volt Telecom	C&D	LS-12-100	06/21/94	48	Annual	11/16/99
McDonald Compressor Sta	UPS Battery 1	Dynasty	UPS 12-370	01/01/98	240	Annual	03/22/00
McDonald Compressor Sta	UPS Battery 2	Dynasty	UPS 12-370	01/01/98	240	Annual	03/22/00
Milpitas	48 Volt Telecom	GNB	45A09	08/01/88	48	Annual (1)	06/22/99
Milpitas	UPS Battery 1	Power	PRC12120X		125	Annual	

LIST OF STATION BATTERIES AND TESTING INTERVALS – Page 2

Location	Designation	Manuf	Model	Installed	Volts	Test Interval	Last Test
Milpitas	UPS Battery 2	Power	PRC12120X		125	Annual	
Santa Rosa	24 Volt Station	Yuasa	ES-5	06/30/00	24	2 Year (4)	
Tionesta	28 Volt Station Battery	C&D	LCR-13	11/09/90	28	5 Year	04/19/00
Tionesta	48 Volt Telecom	GNB	45A07	01/01/89	48	Annual (1)	10/14/99
Tionesta	UPS Battery 1	Dynasty	UPS 12-300	03/13/95	125	Annual	
Tionesta	UPS Battery 2	Dynasty	UPS 12-300	03/13/95	125	Annual	
Topock	24-volt Emerg. Lighting	GNB	75A23	04/01/89	24	Annual	12/09/99
Topock	24-volt Station Battery	GNB	90A23	12/01/99	24	Annual	12/08/99
Topock	48 Volt Telecom	C&D	HD-400	01/15/00	48	Annual	03/21/00
Topock	UPS Battery	GNB	75A09	01/01/91	125	Annual (1)	12/08/99
Turner Cut	48 Volt Telecom	GNB	45A07	09/01/90	48	Annual (1)	12/14/99
Turner Cut	Gen 1 Starting Battery	GNB	90A25	04/01/94	32	Annual	11/01/99
Turner Cut	Gen 2 Starting Battery	GNB	90A25	04/01/94	32	Annual	10/28/99
Turner Cut	Station Battery	GNB	90A17	04/01/94	125	Annual	10/27/99
Walnut Creek	48 Volt Telecom	GNB	75A13	01/01/91	48	Annual	12/29/99
Whiskey Slough	48 Volt Telecom	C&D	HD300	04/01/93	48	Annual (1)	12/21/99
Whiskey Slough	Gen 1 Starting Battery	GNB	90A25	04/06/94	32	Annual (1)	11/22/99
Whiskey Slough	Gen 2 Starting Battery	GNB	90A25	04/05/94	32	Annual (1)	11/23/99
Whiskey Slough	UPS Battery	GNB	90A17	04/11/94	125	Annual	04/06/00
Notes:							
1. Batteries to be replaced in 2000/2001							
2. Interval may change to 2-year pending test results in 2000.							
3. Batteries will be removed from service in 2001.							
4. Batteries to be replaced in 2000. Will receive acceptance test at time of installation. Next test in 2002.							

BATTERY DISCHARGE TEST PARAMETERS – Page 1

Location	Designation	Manuf	Model	Installed	Volts	Discharge Current (amperes)	Discharge Duration (hours)
Antioch	46 Volt Telecom	GNB	85A17	05/01/92	46	116	5
Antioch	UPS Battery A	GNB	6-MSA-2010	05/01/95	125	48	1
Antioch	UPS Battery B	GNB	6-MSA-2010	05/01/95	125	48	1
Bethany	46 Volt Telecom	GNB	75A09	12/01/92	46	48	5
Bethany	UPS Battery	Yuasa	DD40-17	05/20/99	125	116	2
Brentwood	48 Volt Telecom	GNB	75A11	09/01/92	48	70	5
Brentwood	UPS Battery A	GNB	MSA-2460	06/01/95	125	68	1
Brentwood	UPS Battery B	GNB	MSA-2460	06/01/95	125	68	1
Burney	Station Battery	C&D	KCR-11	09/29/90	125	109	3
Delevan	48 Volt Telecom	Exide	DMP-9	01/01/65	48	14	5
Delevan	Station Battery	C&D	KC-11	09/07/86	125	97	3
Gerber	48 Volt Telecom	Exide	DMP-9	01/01/65	48	14	5
Gerber	UPS Battery 1	GNB	6-MSA-1140	04/01/97	125	31	1
Gerber	UPS Battery 2	GNB	6-MSA-1140	04/01/97	125	31	1
Hermann	Station Battery	GNB	45A05R	01/01/93	24	51	1
Hershey Jct	unknown	GNB	unknown		125		
Hinkley	24 Volt Battery	GNB	90A17	12/15/99	24	185	3
Hinkley	UPS Battery	GNB	90A09	12/01/99	125	124	2
Irvington	UPS Battery 1	GNB	MSA-1140	01/01/96	125	31	1
Irvington	UPS Battery 2	GNB	MSA-1140	01/01/96	125	31	1
Kettleman	24-volt Station Battery	GNB	75A23	04/01/89	24	153	5
Kettleman	UPS Battery	Dynasty	UPS 12-475	12/03/99	125	88	1
Los Medanos	24 Volt Telecom	GNB	50A09	09/30/93	24	75	2
Los Medanos	UPS Battery	GNB	50A09	09/30/93	125	75	2
McDonald Compressor Sta	48 Volt Telecom	C&D	LS-12-100	06/21/94	48	69	1
McDonald Compressor Sta	UPS Battery 1	Dynasty	UPS 12-370	01/01/98	240	62	1
McDonald Compressor Sta	UPS Battery 2	Dynasty	UPS 12-370	01/01/98	240	62	1
Milpitas	48 Volt Telecom	GNB	45A09	08/01/88	48	30	5

BATTERY DISCHARGE TEST PARAMETERS – Page 2

Location	Designation	Manuf	Model	Installed	Volts	Discharge Current (amperes)	Discharge Duration (hours)
Milpitas	UPS Battery 1	Power	PRC12120X		125	67	1
Milpitas	UPS Battery 2	Power	PRC12120X		125	67	1
Santa Rosa	24 Volt Station	Yuasa	ES-5	06/30/00	24	53	2
Tionesta	28 Volt Station Battery	C&D	LCR-13	11/09/90	28	215	4
Tionesta	48 Volt Telecom	GNB	45A07	01/01/89	48	23	5
Tionesta	UPS Battery 1	Dynasty	UPS 12-300	03/13/95	125	61	1
Tionesta	UPS Battery 2	Dynasty	UPS 12-300	03/13/95	125	61	1
Topock	24-volt Emerg. Lighting	GNB	75A23	04/01/89	24	153	5
Topock	24-volt Station Battery	GNB	90A23	12/01/99	24	173	5
Topock	48 Volt Telecom	C&D	HD-400	01/15/00	48	23	5
Topock	UPS Battery	GNB	75A09	01/01/91	125	105	2
Turner Cut	48 Volt Telecom	GNB	45A07	09/01/90	48	76	1
Turner Cut	Gen 1 Starting Battery	GNB	90A25	04/01/94	32	189	5
Turner Cut	Gen 2 Starting Battery	GNB	90A25	04/01/94	32	189	5
Turner Cut	Station Battery	GNB	90A17	04/01/94	125	149	4
Walnut Creek	48 Volt Telecom	GNB	75A13	01/01/91	48	83	5
Whiskey Slough	48 Volt Telecom	C&D	HD300	04/01/93	48	60	5
Whiskey Slough	Gen 1 Starting Battery	GNB	90A25	04/06/94	32	223	4
Whiskey Slough	Gen 2 Starting Battery	GNB	90A25	04/05/94	32	223	4
Whiskey Slough	UPS Battery	GNB	90A17	04/11/94	125	149	4
Notes:							
1. Discharge current is based on a standard temperature of 77°F. In the BCT Setup, Test Setup screen, make sure to enter the average ambient temperature of the battery room and select IEEE correction. This will automatically apply the appropriate temperature correction factor.							

SAMPLE BATTERY LOAD TEST REPORT

Battery Information

Name: 120 Vdc Station Battery

Manufacturer: Yuasa

Model: DD40-17

ID: Bethany 120 Vdc UPS

Installed: 05/20/99

Next Test: 12/17/99

Number of strings: 1

Number of cell/string: 60

String Names:

1) String 1

Test Setup

Date of Test: 12/17/99

Start Time of Test: 08:52:06 am

Ending Time of Test: 10:43:59 am

Test Type: PerFormance

Load Type: Constant Current

Rated Time: 02:00:00

Cell Voltage Warning: 1.800

Battery Voltage Warning: 108.0

Cell Voltage Shutdown: 1.750

Battery Voltage Shutdown: 105.000

Temperature at Time of Test: 72° F

TEST was Temperature Corrected to IEEE Standards

Total Programmed Test Time: 02:00:00

Actual Discharge Time: 01:49:16

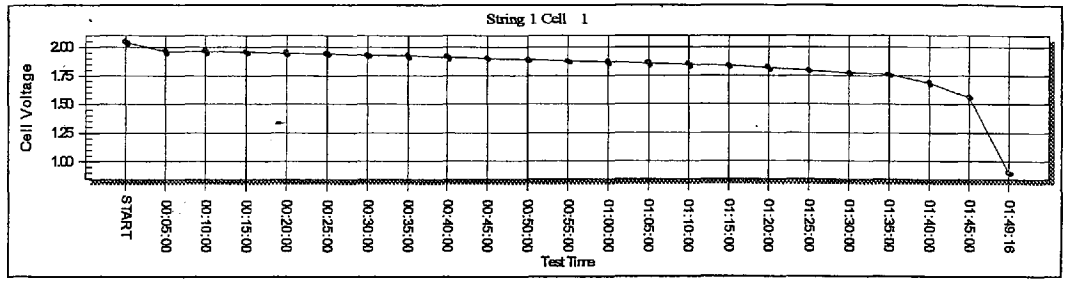
Number of Test Steps: 1

Step 1 duration = 02:00:00 @ 116 Amps TEMPERATURE CORRECTED TO 113 Amps

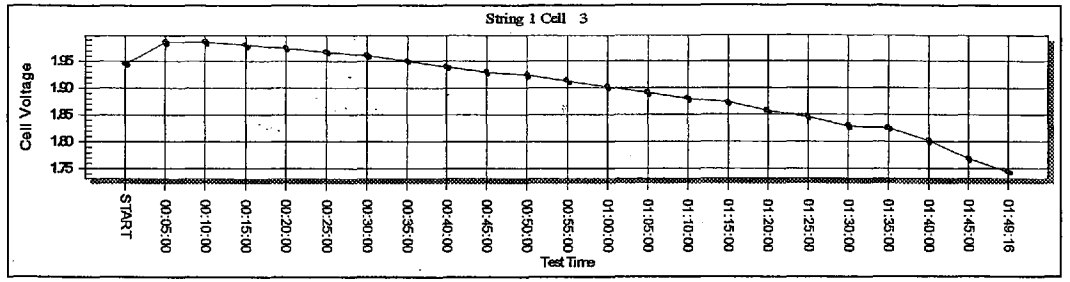
Test Results

The Following cells dropped below the low threshold level of 1.750 Vs

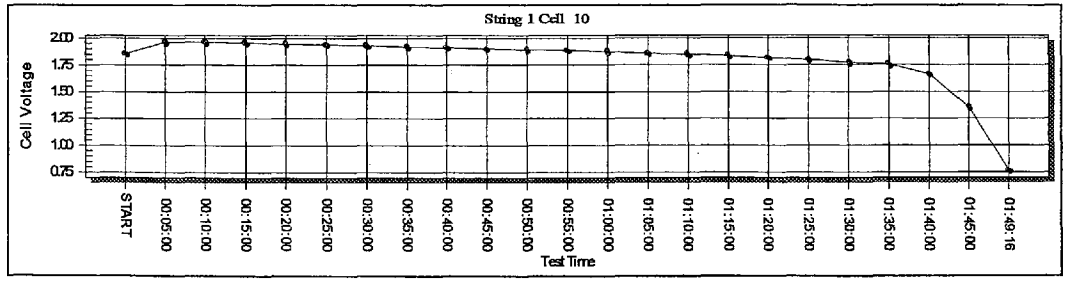
String	Cell	Step	Step Time	Test Time	Capacity(%)
1	1	1	01:34:55	01:34:55	79.1



String	Cell	Step	Step Time	Test Time	Capacity(%)
1	3	1	01:48:21	01:48:21	90.3



String	Cell	Step	Step Time	Test Time	Capacity(%)
1	10	1	01:33:21	01:33:21	77.8

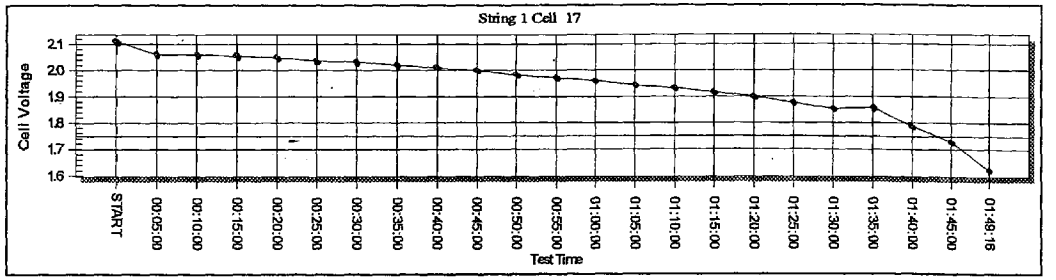


String	Cell	Step	Step Time	Test Time	Capacity(%)
1	17	1	01:44:05	01:44:05	86.7

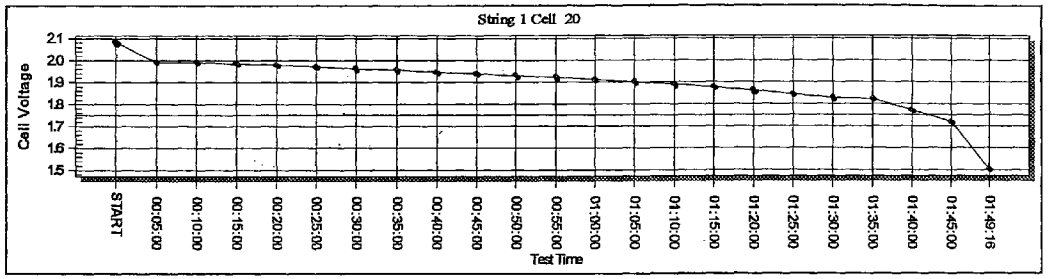
Test Results

The Following cells dropped below the low threshold level of 1.750 Vs

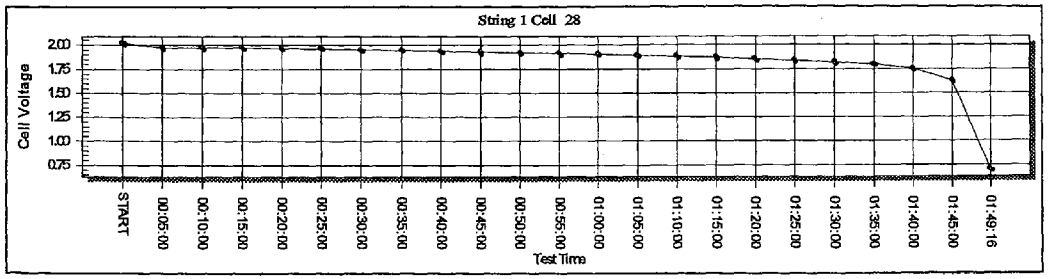
String	Cell	Step	Step Time	Test Time	Capacity(%)



1	20	1	01:42:40	01:42:40	85.6



1	28	1	01:40:43	01:40:43	83.9



The Following Cells Failed the CAPACITY TEST (BELOW 80%):

String	Cell	Capacity(%)
1	1	79.1
1	10	77.8

Battery string results:

Test Activity

Step	Step Time	Test Time	Activity
1	00:24:17	00:24:17	TEST PAUSED by user/shutdown
0			TEST RESUMED after 00:00:19
1	00:43:09	00:43:09	TEST PAUSED by user/shutdown
0			TEST RESUMED after 00:00:07
1	01:14:11	01:14:11	TEST PAUSED by user/shutdown
0			TEST RESUMED after 00:00:09
1	01:33:21	01:33:21	TEST PAUSED by user/shutdown
1	01:33:21	01:33:21	CELL SHUTDOWN String = 1 Cell = 10 @ 1.748 Vs
0			TEST RESUMED after 00:00:24
1	01:34:59	01:34:59	TEST PAUSED by user/shutdown
1	01:34:59	01:34:59	CELL SHUTDOWN String = 1 Cell = 1 @ 1.748 Vs
0			TEST RESUMED after 00:00:10
1	01:40:23	01:40:23	TEST PAUSED by user/shutdown
1	01:40:23	01:40:23	CELL SHUTDOWN String = 1 Cell = 28 @ 1.751 Vs
0			TEST RESUMED after 00:00:07
1	01:42:49	01:42:49	TEST PAUSED by user/shutdown
1	01:42:49	01:42:49	CELL SHUTDOWN String = 1 Cell = 20 @ 1.749 Vs
0			TEST RESUMED after 00:00:05
1	01:43:45	01:43:45	TEST PAUSED by user/shutdown
1	01:43:45	01:43:45	CELL SHUTDOWN String = 1 Cell = 17 @ 1.751 Vs
0			TEST RESUMED after 00:00:07
1	01:48:05	01:48:05	TEST PAUSED by user/shutdown
1	01:48:05	01:48:05	CELL SHUTDOWN String = 1 Cell = 3 @ 1.751 Vs
0			TEST RESUMED after 00:00:06
1	01:49:16	01:49:16	TEST PAUSED by user/shutdown
1	01:49:16	01:49:16	BATTERY OV SHUT DOWN @ 104.9 Vs
1	01:49:16	01:49:16	TEST ABORTED BY USER

Intertiers

Intertier # 1

Step	Step Time	Test Time	Voltage
1	00:00:02	00:00:02	0.014
1	01:43:45	01:43:45	0.000
1	01:43:47	01:43:47	0.015
	Intertier End Voltage:		0.015

Intertier # 2

Step	Step Time	Test Time	Voltage
1	00:00:00	00:00:00	0.046
1	00:00:02	00:00:02	0.014
	Intertier End Voltage:		0.014

Cell Summary

String	Cell	Float V	Start V	V @30 Sec	End V
1	1	2.235	2.044	1.950	0.901
1	2	2.210	2.049	1.963	1.794
1	3	2.233	1.945	1.986	1.744
1	4	2.314	2.053	2.055	1.805
1	5	2.313	2.035	2.052	1.806
1	6	2.287	1.996	2.048	1.768
1	7	2.305	2.018	2.047	1.826
1	8	2.234	1.961	2.000	1.844
1	9	2.228	1.940	1.972	1.781
1	10	2.213	1.859	1.952	0.764
1	11	2.233	1.976	1.985	1.828
1	12	2.209	1.939	1.984	1.843
1	13	2.228	2.049	1.989	1.795
1	14	2.286	2.109	2.057	1.807
1	15	2.291	2.119	2.060	1.802
1	16	2.306	2.140	2.054	1.794
1	17	2.314	2.111	2.060	1.621
1	18	2.231	2.076	1.996	1.803
1	19	2.203	2.045	1.971	1.790
1	20	2.233	2.083	1.971	1.502
1	21	2.243	2.089	1.995	1.825
1	22	2.200	2.070	1.965	1.825
1	23	2.210	2.072	1.977	1.822
1	24	2.232	2.086	1.981	1.801
1	25	2.205	2.066	1.976	1.836
1	26	2.206	2.059	1.966	1.755
1	27	2.234	2.092	1.979	1.808
1	28	2.194	2.022	1.957	0.700
1	29	2.200	2.061	1.973	1.802
1	30	2.243	2.101	2.006	1.852
1	31	2.243	2.097	2.002	1.816
1	32	2.201	2.053	1.972	1.820
1	33	2.201	2.059	1.961	1.798
1	34	2.231	2.078	1.974	1.813

Cell Summary

String	Cell	Float V	Start V	V @30 Sec	End V
1	35	2.208	2.006	1.961	1.801
1	36	2.213	2.008	1.979	1.823
1	37	2.229	1.961	1.976	1.780
1	38	2.198	1.969	1.969	1.821
1	39	2.204	1.980	1.973	1.817
1	40	2.239	2.027	2.018	1.830
1	41	2.231	1.906	1.963	1.786
1	42	2.229	1.943	1.976	1.790
1	43	2.235	1.995	2.004	1.859
1	44	2.235	1.973	2.012	1.829
1	45	2.249	2.093	2.014	1.861
1	46	2.228	2.087	2.005	1.882
1	47	2.239	2.091	2.008	1.830
1	48	2.243	2.110	2.011	1.854
1	49	2.230	2.030	1.979	1.805
1	50	2.232	2.098	1.985	1.815
1	51	2.230	2.081	1.969	1.791
1	52	2.228	2.092	1.986	1.815
1	53	2.253	2.123	2.016	1.846
1	54	2.241	2.108	2.014	1.847
1	55	2.242	2.100	2.008	1.786
1	56	2.245	2.096	2.008	1.780
1	57	2.238	2.100	2.004	1.852
1	58	2.236	2.098	2.005	1.825
1	59	2.229	2.078	1.969	1.764
1	60	2.228	2.069	1.977	1.782

Cell General

Starting Float Voltages (No Load)

Test Time: 00:00:00	Battery Voltage: 134.2	Amps: 0	Kw: 0.0

String #: 1 String 1

1 =	2.235	2 =	2.210	3 =	2.233	4 =	2.314	5 =	2.313	6 =	2.287
7 =	2.305	8 =	2.234	9 =	2.228	10 =	2.213	11 =	2.233	12 =	2.209
13 =	2.228	14 =	2.286	15 =	2.291	16 =	2.306	17 =	2.314	18 =	2.231
19 =	2.203	20 =	2.233	21 =	2.243	22 =	2.200	23 =	2.210	24 =	2.232
25 =	2.205	26 =	2.206	27 =	2.234	28 =	2.194	29 =	2.200	30 =	2.243
31 =	2.243	32 =	2.201	33 =	2.201	34 =	2.231	35 =	2.208	36 =	2.213
37 =	2.229	38 =	2.198	39 =	2.204	40 =	2.239	41 =	2.231	42 =	2.229
43 =	2.235	44 =	2.235	45 =	2.249	46 =	2.228	47 =	2.239	48 =	2.243
49 =	2.230	50 =	2.232	51 =	2.230	52 =	2.228	53 =	2.253	54 =	2.241
55 =	2.242	56 =	2.245	57 =	2.238	58 =	2.236	59 =	2.229	60 =	2.228

Starting Voltage (Load)

Test Time: 00:00:00	Battery Voltage: 134.2	Amps: 114	Kw: 15.3

String #: 1 String 1

1 =	2.044	2 =	2.049	3 =	1.945	4 =	2.053	5 =	2.035	6 =	1.996
7 =	2.018	8 =	1.961	9 =	1.940	10 =	1.859	11 =	1.976	12 =	1.939
13 =	2.049	14 =	2.109	15 =	2.119	16 =	2.140	17 =	2.111	18 =	2.076
19 =	2.045	20 =	2.083	21 =	2.089	22 =	2.070	23 =	2.072	24 =	2.086
25 =	2.066	26 =	2.059	27 =	2.092	28 =	2.022	29 =	2.061	30 =	2.101
31 =	2.097	32 =	2.053	33 =	2.059	34 =	2.078	35 =	2.006	36 =	2.008
37 =	1.961	38 =	1.969	39 =	1.980	40 =	2.027	41 =	1.906	42 =	1.943
43 =	1.995	44 =	1.973	45 =	2.093	46 =	2.087	47 =	2.091	48 =	2.110
49 =	2.030	50 =	2.098	51 =	2.081	52 =	2.092	53 =	2.123	54 =	2.108
55 =	2.100	56 =	2.096	57 =	2.100	58 =	2.098	59 =	2.078	60 =	2.069

Test Time: 00:05:00	Battery Voltage: 120.4	Amps: 114	Kw: 13.7

String #: 1 String 1

1 =	1.962	2 =	1.987	3 =	1.986	4 =	2.061	5 =	2.063	6 =	2.053
7 =	2.058	8 =	2.011	9 =	1.984	10 =	1.965	11 =	1.996	12 =	1.997
13 =	1.994	14 =	2.056	15 =	2.060	16 =	2.054	17 =	2.060	18 =	2.001
19 =	1.989	20 =	1.990	21 =	2.006	22 =	1.990	23 =	1.989	24 =	1.987
25 =	1.988	26 =	1.983	27 =	1.996	28 =	1.974	29 =	1.984	30 =	2.023
31 =	2.021	32 =	1.989	33 =	1.987	34 =	1.990	35 =	1.987	36 =	1.996
37 =	1.981	38 =	1.986	39 =	1.989	40 =	2.030	41 =	1.974	42 =	1.981
43 =	2.020	44 =	2.018	45 =	2.025	46 =	2.022	47 =	2.020	48 =	2.024
49 =	1.991	50 =	1.996	51 =	1.987	52 =	1.991	53 =	2.027	54 =	2.025
55 =	2.019	56 =	2.014	57 =	2.022	58 =	2.022	59 =	1.983	60 =	1.983

Cell General

Test Time: 00:10:00 **Battery Voltage:** 120.4 **Amps:** 114 **Kw:** 13.7

String #: 1 String 1

1 = 1.962	2 = 1.987	3 = 1.986	4 = 2.061	5 = 2.063	6 = 2.053
7 = 2.058	8 = 2.011	9 = 1.984	10 = 1.965	11 = 1.996	12 = 1.997
13 = 1.994	14 = 2.056	15 = 2.060	16 = 2.054	17 = 2.060	18 = 2.001
19 = 1.989	20 = 1.990	21 = 2.006	22 = 1.990	23 = 1.989	24 = 1.987
25 = 1.988	26 = 1.983	27 = 1.996	28 = 1.974	29 = 1.984	30 = 2.023
31 = 2.021	32 = 1.989	33 = 1.987	34 = 1.990	35 = 1.987	36 = 1.996
37 = 1.981	38 = 1.986	39 = 1.989	40 = 2.030	41 = 1.974	42 = 1.981
43 = 2.020	44 = 2.018	45 = 2.025	46 = 2.022	47 = 2.020	48 = 2.024
49 = 1.991	50 = 1.996	51 = 1.987	52 = 1.991	53 = 2.027	54 = 2.025
55 = 2.019	56 = 2.014	57 = 2.022	58 = 2.022	59 = 1.983	60 = 1.983

Test Time: 00:15:00 **Battery Voltage:** 120.2 **Amps:** 113 **Kw:** 13.6

String #: 1 String 1

1 = 1.957	2 = 1.981	3 = 1.980	4 = 2.061	5 = 2.058	6 = 2.048
7 = 2.058	8 = 2.011	9 = 1.984	10 = 1.959	11 = 1.996	12 = 1.997
13 = 1.989	14 = 2.056	15 = 2.054	16 = 2.054	17 = 2.054	18 = 2.001
19 = 1.983	20 = 1.984	21 = 2.000	22 = 1.990	23 = 1.989	24 = 1.987
25 = 1.988	26 = 1.983	27 = 1.996	28 = 1.974	29 = 1.984	30 = 2.023
31 = 2.015	32 = 1.989	33 = 1.987	34 = 1.990	35 = 1.987	36 = 1.996
37 = 1.981	38 = 1.986	39 = 1.989	40 = 2.030	41 = 1.974	42 = 1.981
43 = 2.020	44 = 2.018	45 = 2.025	46 = 2.022	47 = 2.020	48 = 2.018
49 = 1.991	50 = 1.996	51 = 1.987	52 = 1.991	53 = 2.021	54 = 2.019
55 = 2.014	56 = 2.014	57 = 2.022	58 = 2.017	59 = 1.983	60 = 1.983

Test Time: 00:20:00 **Battery Voltage:** 120.0 **Amps:** 114 **Kw:** 13.7

String #: 1 String 1

1 = 1.946	2 = 1.981	3 = 1.974	4 = 2.055	5 = 2.052	6 = 2.042
7 = 2.052	8 = 2.006	9 = 1.979	10 = 1.948	11 = 1.996	12 = 1.991
13 = 1.983	14 = 2.045	15 = 2.049	16 = 2.049	17 = 2.049	18 = 1.996
19 = 1.978	20 = 1.979	21 = 1.994	22 = 1.984	23 = 1.989	24 = 1.981
25 = 1.988	26 = 1.978	27 = 1.990	28 = 1.969	29 = 1.984	30 = 2.018
31 = 2.010	32 = 1.983	33 = 1.981	34 = 1.985	35 = 1.981	36 = 1.991
37 = 1.976	38 = 1.980	39 = 1.984	40 = 2.025	41 = 1.968	42 = 1.976
43 = 2.014	44 = 2.012	45 = 2.019	46 = 2.022	47 = 2.015	48 = 2.027
49 = 1.986	50 = 1.996	51 = 1.982	52 = 1.991	53 = 2.016	54 = 2.014
55 = 2.008	56 = 2.008	57 = 2.017	58 = 2.011	59 = 1.978	60 = 1.978

Cell General

Test Time: 00:25:00 **Battery Voltage:** 119.6 **Amps:** 114 **Kw:** 13.6

String #: 1 String 1

1 = 1.940	2 = 1.975	3 = 1.967	4 = 2.049	5 = 2.046	6 = 2.037
7 = 2.042	8 = 2.002	9 = 1.974	10 = 1.942	11 = 1.990	12 = 1.989
13 = 1.982	14 = 2.041	15 = 2.045	16 = 2.042	17 = 2.037	18 = 1.990
19 = 1.973	20 = 1.972	21 = 1.992	22 = 1.980	23 = 1.983	24 = 1.978
25 = 1.982	26 = 1.972	27 = 1.984	28 = 1.963	29 = 1.979	30 = 2.012
31 = 2.004	32 = 1.978	33 = 1.976	34 = 1.978	35 = 1.979	36 = 1.982
37 = 1.970	38 = 1.975	39 = 1.981	40 = 2.019	41 = 1.964	42 = 1.970
43 = 2.007	44 = 2.008	45 = 2.016	46 = 2.016	47 = 2.008	48 = 2.011
49 = 1.980	50 = 1.990	51 = 1.977	52 = 1.985	53 = 2.012	54 = 2.011
55 = 2.001	56 = 2.000	57 = 2.011	58 = 2.006	59 = 1.971	60 = 1.971

Test Time: 00:30:00 **Battery Voltage:** 119.2 **Amps:** 114 **Kw:** 13.6

String #: 1 String 1

1 = 1.929	2 = 1.964	3 = 1.961	4 = 2.043	5 = 2.041	6 = 2.025
7 = 2.036	8 = 1.991	9 = 1.963	10 = 1.931	11 = 1.984	12 = 1.983
13 = 1.971	14 = 2.030	15 = 2.034	16 = 2.031	17 = 2.032	18 = 1.984
19 = 1.968	20 = 1.961	21 = 1.986	22 = 1.974	23 = 1.978	24 = 1.972
25 = 1.977	26 = 1.967	27 = 1.979	28 = 1.952	29 = 1.973	30 = 2.001
31 = 1.999	32 = 1.972	33 = 1.970	34 = 1.972	35 = 1.973	36 = 1.977
37 = 1.959	38 = 1.969	39 = 1.976	40 = 2.008	41 = 1.952	42 = 1.965
43 = 2.001	44 = 1.997	45 = 2.005	46 = 2.010	47 = 1.997	48 = 2.006
49 = 1.975	50 = 1.985	51 = 1.971	52 = 1.979	53 = 2.007	54 = 2.006
55 = 1.990	56 = 1.989	57 = 2.006	58 = 2.000	59 = 1.966	60 = 1.966

Test Time: 00:35:00 **Battery Voltage:** 118.8 **Amps:** 113 **Kw:** 13.4

String #: 1 String 1

1 = 1.923	2 = 1.959	3 = 1.950	4 = 2.032	5 = 2.030	6 = 2.014
7 = 2.025	8 = 1.985	9 = 1.958	10 = 1.920	11 = 1.973	12 = 1.978
13 = 1.965	14 = 2.019	15 = 2.023	16 = 2.020	17 = 2.021	18 = 1.973
19 = 1.957	20 = 1.956	21 = 1.975	22 = 1.969	23 = 1.972	24 = 1.961
25 = 1.971	26 = 1.961	27 = 1.968	28 = 1.947	29 = 1.962	30 = 1.995
31 = 1.988	32 = 1.967	33 = 1.965	34 = 1.967	35 = 1.962	36 = 1.971
37 = 1.954	38 = 1.964	39 = 1.965	40 = 2.003	41 = 1.947	42 = 1.959
43 = 1.996	44 = 1.991	45 = 1.999	46 = 2.005	47 = 1.991	48 = 1.995
49 = 1.969	50 = 1.973	51 = 1.960	52 = 1.968	53 = 1.996	54 = 1.995
55 = 1.985	56 = 1.984	57 = 1.995	58 = 1.989	59 = 1.955	60 = 1.955

Cell General

Test Time: 00:40:00 **Battery Voltage:** 118.1 **Amps:** 114 **Kw:** 13.5

String #: 1 String 1

1 = 1.912	2 = 1.953	3 = 1.939	4 = 2.021	5 = 2.019	6 = 2.003
7 = 2.014	8 = 1.980	9 = 1.952	10 = 1.915	11 = 1.968	12 = 1.967
13 = 1.954	14 = 2.008	15 = 2.012	16 = 2.009	17 = 2.010	18 = 1.968
19 = 1.951	20 = 1.945	21 = 1.970	22 = 1.958	23 = 1.961	24 = 1.955
25 = 1.965	26 = 1.955	27 = 1.962	28 = 1.936	29 = 1.957	30 = 1.990
31 = 1.977	32 = 1.961	33 = 1.954	34 = 1.961	35 = 1.957	36 = 1.966
37 = 1.948	38 = 1.958	39 = 1.959	40 = 1.991	41 = 1.941	42 = 1.948
43 = 1.990	44 = 1.980	45 = 1.993	46 = 1.999	47 = 1.986	48 = 1.989
49 = 1.958	50 = 1.968	51 = 1.955	52 = 1.963	53 = 1.990	54 = 1.989
55 = 1.973	56 = 1.972	57 = 1.989	58 = 1.983	59 = 1.949	60 = 1.949

Test Time: 00:45:00 **Battery Voltage:** 117.7 **Amps:** 113 **Kw:** 13.3

String #: 1 String 1

1 = 1.901	2 = 1.948	3 = 1.930	4 = 2.011	5 = 2.008	6 = 1.992
7 = 2.004	8 = 1.973	9 = 1.944	10 = 1.903	11 = 1.963	12 = 1.961
13 = 1.951	14 = 1.998	15 = 2.001	16 = 2.003	17 = 1.999	18 = 1.957
19 = 1.940	20 = 1.939	21 = 1.959	22 = 1.952	23 = 1.955	24 = 1.950
25 = 1.960	26 = 1.944	27 = 1.957	28 = 1.930	29 = 1.951	30 = 1.979
31 = 1.971	32 = 1.955	33 = 1.948	34 = 1.955	35 = 1.954	36 = 1.961
37 = 1.937	38 = 1.952	39 = 1.956	40 = 1.986	41 = 1.935	42 = 1.942
43 = 1.983	44 = 1.977	45 = 1.987	46 = 1.993	47 = 1.975	48 = 1.983
49 = 1.952	50 = 1.962	51 = 1.949	52 = 1.957	53 = 1.979	54 = 1.978
55 = 1.962	56 = 1.961	57 = 1.978	58 = 1.972	59 = 1.944	60 = 1.944

Test Time: 00:50:00 **Battery Voltage:** 117.2 **Amps:** 114 **Kw:** 13.3

String #: 1 String 1

1 = 1.890	2 = 1.937	3 = 1.924	4 = 2.000	5 = 1.996	6 = 1.981
7 = 1.993	8 = 1.962	9 = 1.933	10 = 1.892	11 = 1.952	12 = 1.955
13 = 1.940	14 = 1.992	15 = 1.990	16 = 1.992	17 = 1.982	18 = 1.951
19 = 1.934	20 = 1.928	21 = 1.953	22 = 1.947	23 = 1.950	24 = 1.939
25 = 1.949	26 = 1.939	27 = 1.945	28 = 1.919	29 = 1.945	30 = 1.973
31 = 1.960	32 = 1.944	33 = 1.942	34 = 1.944	35 = 1.942	36 = 1.950
37 = 1.931	38 = 1.947	39 = 1.945	40 = 1.975	41 = 1.924	42 = 1.937
43 = 1.972	44 = 1.966	45 = 1.976	46 = 1.982	47 = 1.964	48 = 1.972
49 = 1.947	50 = 1.951	51 = 1.938	52 = 1.946	53 = 1.973	54 = 1.972
55 = 1.957	56 = 1.956	57 = 1.972	58 = 1.961	59 = 1.932	60 = 1.932

Cell General

Test Time: 00:55:00 **Battery Voltage:** 116.8 **Amps:** 114 **Kw:** 13.3

String #: 1 String 1

1 = 1.879	2 = 1.931	3 = 1.913	4 = 1.994	5 = 1.991	6 = 1.970
7 = 1.988	8 = 1.957	9 = 1.928	10 = 1.887	11 = 1.947	12 = 1.944
13 = 1.934	14 = 1.981	15 = 1.979	16 = 1.981	17 = 1.971	18 = 1.940
19 = 1.923	20 = 1.922	21 = 1.942	22 = 1.941	23 = 1.944	24 = 1.933
25 = 1.943	26 = 1.933	27 = 1.940	28 = 1.913	29 = 1.934	30 = 1.962
31 = 1.954	32 = 1.939	33 = 1.931	34 = 1.938	35 = 1.937	36 = 1.945
37 = 1.920	38 = 1.936	39 = 1.939	40 = 1.964	41 = 1.918	42 = 1.926
43 = 1.967	44 = 1.955	45 = 1.970	46 = 1.977	47 = 1.958	48 = 1.966
49 = 1.936	50 = 1.946	51 = 1.932	52 = 1.940	53 = 1.962	54 = 1.967
55 = 1.946	56 = 1.945	57 = 1.961	58 = 1.956	59 = 1.927	60 = 1.927

Test Time: 01:00:00 **Battery Voltage:** 116.1 **Amps:** 113 **Kw:** 13.1

String #: 1 String 1

1 = 1.868	2 = 1.920	3 = 1.902	4 = 1.983	5 = 1.974	6 = 1.959
7 = 1.977	8 = 1.945	9 = 1.916	10 = 1.876	11 = 1.941	12 = 1.939
13 = 1.923	14 = 1.964	15 = 1.968	16 = 1.970	17 = 1.960	18 = 1.929
19 = 1.918	20 = 1.911	21 = 1.937	22 = 1.930	23 = 1.933	24 = 1.922
25 = 1.938	26 = 1.922	27 = 1.929	28 = 1.902	29 = 1.929	30 = 1.957
31 = 1.943	32 = 1.933	33 = 1.926	34 = 1.927	35 = 1.926	36 = 1.939
37 = 1.915	38 = 1.930	39 = 1.934	40 = 1.958	41 = 1.907	42 = 1.920
43 = 1.956	44 = 1.949	45 = 1.959	46 = 1.971	47 = 1.947	48 = 1.956
49 = 1.930	50 = 1.935	51 = 1.921	52 = 1.929	53 = 1.957	54 = 1.956
55 = 1.935	56 = 1.934	57 = 1.956	58 = 1.945	59 = 1.916	60 = 1.916

Test Time: 01:05:00 **Battery Voltage:** 115.5 **Amps:** 114 **Kw:** 13.2

String #: 1 String 1

1 = 1.857	2 = 1.914	3 = 1.891	4 = 1.966	5 = 1.963	6 = 1.947
7 = 1.965	8 = 1.934	9 = 1.904	10 = 1.859	11 = 1.930	12 = 1.933
13 = 1.912	14 = 1.953	15 = 1.956	16 = 1.959	17 = 1.943	18 = 1.918
19 = 1.907	20 = 1.900	21 = 1.925	22 = 1.924	23 = 1.928	24 = 1.916
25 = 1.927	26 = 1.916	27 = 1.923	28 = 1.891	29 = 1.918	30 = 1.945
31 = 1.932	32 = 1.922	33 = 1.915	34 = 1.921	35 = 1.920	36 = 1.928
37 = 1.904	38 = 1.919	39 = 1.922	40 = 1.947	41 = 1.901	42 = 1.909
43 = 1.950	44 = 1.938	45 = 1.954	46 = 1.960	47 = 1.936	48 = 1.945
49 = 1.919	50 = 1.929	51 = 1.910	52 = 1.924	53 = 1.946	54 = 1.945
55 = 1.924	56 = 1.922	57 = 1.945	58 = 1.934	59 = 1.905	60 = 1.905

Cell General

Test Time: 01:10:00 **Battery Voltage:** 115.0 **Amps:** 114 **Kw:** 13.1

String #: 1 String 1

1 = 1.846	2 = 1.903	3 = 1.880	4 = 1.955	5 = 1.952	6 = 1.931
7 = 1.954	8 = 1.929	9 = 1.899	10 = 1.848	11 = 1.924	12 = 1.922
13 = 1.901	14 = 1.942	15 = 1.945	16 = 1.942	17 = 1.932	18 = 1.912
19 = 1.895	20 = 1.889	21 = 1.914	22 = 1.913	23 = 1.916	24 = 1.906
25 = 1.921	26 = 1.905	27 = 1.912	28 = 1.880	29 = 1.912	30 = 1.934
31 = 1.921	32 = 1.916	33 = 1.909	34 = 1.910	35 = 1.909	36 = 1.922
37 = 1.893	38 = 1.914	39 = 1.917	40 = 1.936	41 = 1.890	42 = 1.898
43 = 1.939	44 = 1.927	45 = 1.942	46 = 1.955	47 = 1.930	48 = 1.939
49 = 1.908	50 = 1.918	51 = 1.905	52 = 1.913	53 = 1.935	54 = 1.939
55 = 1.913	56 = 1.911	57 = 1.939	58 = 1.928	59 = 1.894	60 = 1.899

Test Time: 01:15:00 **Battery Voltage:** 114.4 **Amps:** 114 **Kw:** 13.0

String #: 1 String 1

1 = 1.835	2 = 1.895	3 = 1.873	4 = 1.941	5 = 1.941	6 = 1.920
7 = 1.943	8 = 1.921	9 = 1.888	10 = 1.837	11 = 1.914	12 = 1.916
13 = 1.894	14 = 1.932	15 = 1.932	16 = 1.931	17 = 1.915	18 = 1.901
19 = 1.890	20 = 1.878	21 = 1.909	22 = 1.908	23 = 1.911	24 = 1.894
25 = 1.915	26 = 1.894	27 = 1.901	28 = 1.869	29 = 1.901	30 = 1.929
31 = 1.910	32 = 1.905	33 = 1.898	34 = 1.904	35 = 1.904	36 = 1.913
37 = 1.887	38 = 1.908	39 = 1.907	40 = 1.925	41 = 1.879	42 = 1.893
43 = 1.932	44 = 1.920	45 = 1.937	46 = 1.946	47 = 1.920	48 = 1.930
49 = 1.903	50 = 1.907	51 = 1.894	52 = 1.907	53 = 1.929	54 = 1.928
55 = 1.901	56 = 1.900	57 = 1.928	58 = 1.917	59 = 1.883	60 = 1.888

Test Time: 01:20:00 **Battery Voltage:** 113.8 **Amps:** 114 **Kw:** 12.9

String #: 1 String 1

1 = 1.818	2 = 1.884	3 = 1.857	4 = 1.930	5 = 1.924	6 = 1.903
7 = 1.926	8 = 1.910	9 = 1.877	10 = 1.815	11 = 1.903	12 = 1.905
13 = 1.883	14 = 1.915	15 = 1.915	16 = 1.920	17 = 1.899	18 = 1.890
19 = 1.879	20 = 1.861	21 = 1.898	22 = 1.897	23 = 1.900	24 = 1.889
25 = 1.904	26 = 1.883	27 = 1.890	28 = 1.852	29 = 1.895	30 = 1.918
31 = 1.899	32 = 1.900	33 = 1.893	34 = 1.893	35 = 1.893	36 = 1.901
37 = 1.876	38 = 1.897	39 = 1.896	40 = 1.914	41 = 1.874	42 = 1.881
43 = 1.921	44 = 1.909	45 = 1.926	46 = 1.935	47 = 1.909	48 = 1.919
49 = 1.891	50 = 1.896	51 = 1.883	52 = 1.896	53 = 1.918	54 = 1.917
55 = 1.890	56 = 1.889	57 = 1.917	58 = 1.906	59 = 1.871	60 = 1.877

Cell General

Test Time: 01:25:00 **Battery Voltage:** 112.9 **Amps:** 114 **Kw:** 12.9

String #: 1 String 1

1 =	1.796	2 =	1.873	3 =	1.846	4 =	1.913	5 =	1.908	6 =	1.887
7 =	1.910	8 =	1.899	9 =	1.866	10 =	1.798	11 =	1.892	12 =	1.894
13 =	1.867	14 =	1.904	15 =	1.899	16 =	1.903	17 =	1.875	18 =	1.879
19 =	1.868	20 =	1.845	21 =	1.887	22 =	1.885	23 =	1.889	24 =	1.872
25 =	1.893	26 =	1.872	27 =	1.879	28 =	1.835	29 =	1.879	30 =	1.907
31 =	1.887	32 =	1.889	33 =	1.876	34 =	1.881	35 =	1.881	36 =	1.890
37 =	1.859	38 =	1.886	39 =	1.885	40 =	1.903	41 =	1.857	42 =	1.870
43 =	1.910	44 =	1.898	45 =	1.915	46 =	1.929	47 =	1.898	48 =	1.908
49 =	1.880	50 =	1.885	51 =	1.871	52 =	1.885	53 =	1.907	54 =	1.906
55 =	1.879	56 =	1.878	57 =	1.905	58 =	1.895	59 =	1.860	60 =	1.866

Test Time: 01:30:00 **Battery Voltage:** 112.2 **Amps:** 113 **Kw:** 12.7

String #: 1 String 1

1 =	1.774	2 =	1.857	3 =	1.829	4 =	1.897	5 =	1.897	6 =	1.870
7 =	1.899	8 =	1.888	9 =	1.849	10 =	1.770	11 =	1.881	12 =	1.889
13 =	1.856	14 =	1.888	15 =	1.882	16 =	1.887	17 =	1.853	18 =	1.862
19 =	1.851	20 =	1.828	21 =	1.875	22 =	1.874	23 =	1.878	24 =	1.861
25 =	1.882	26 =	1.861	27 =	1.868	28 =	1.818	29 =	1.868	30 =	1.895
31 =	1.875	32 =	1.878	33 =	1.865	34 =	1.870	35 =	1.870	36 =	1.879
37 =	1.848	38 =	1.875	39 =	1.874	40 =	1.891	41 =	1.846	42 =	1.854
43 =	1.899	44 =	1.887	45 =	1.904	46 =	1.918	47 =	1.887	48 =	1.897
49 =	1.864	50 =	1.874	51 =	1.860	52 =	1.874	53 =	1.896	54 =	1.895
55 =	1.863	56 =	1.861	57 =	1.899	58 =	1.884	59 =	1.849	60 =	1.849

Test Time: 01:35:00 **Battery Voltage:** 112.2 **Amps:** 113 **Kw:** 12.7

String #: 1 String 1

1 =	1.759	2 =	1.847	3 =	1.825	4 =	1.877	5 =	1.875	6 =	1.862
7 =	1.891	8 =	1.878	9 =	1.844	10 =	1.754	11 =	1.877	12 =	1.904
13 =	1.879	14 =	1.911	15 =	1.871	16 =	1.901	17 =	1.857	18 =	1.867
19 =	1.853	20 =	1.823	21 =	1.878	22 =	1.875	23 =	1.878	24 =	1.852
25 =	1.882	26 =	1.844	27 =	1.854	28 =	1.796	29 =	1.858	30 =	1.885
31 =	1.866	32 =	1.867	33 =	1.854	34 =	1.857	35 =	1.856	36 =	1.867
37 =	1.836	38 =	1.864	39 =	1.863	40 =	1.880	41 =	1.841	42 =	1.842
43 =	1.898	44 =	1.908	45 =	1.925	46 =	1.934	47 =	1.877	48 =	1.906
49 =	1.868	50 =	1.876	51 =	1.859	52 =	1.874	53 =	1.898	54 =	1.898
55 =	1.865	56 =	1.861	57 =	1.888	58 =	1.881	59 =	1.829	60 =	1.838

Cell General

Test Time: 01:40:00 **Battery Voltage:** 110.9 **Amps:** 114 **Kw:** 12.6

String #: 1 String 1

1 = 1.686	2 = 1.830	3 = 1.802	4 = 1.854	5 = 1.853	6 = 1.828
7 = 1.863	8 = 1.867	9 = 1.821	10 = 1.663	11 = 1.854	12 = 1.867
13 = 1.829	14 = 2.010	15 = 1.849	16 = 1.849	17 = 1.787	18 = 1.835
19 = 1.842	20 = 1.772	21 = 1.847	22 = 1.852	23 = 1.856	24 = 1.835
25 = 1.860	26 = 1.822	27 = 1.849	28 = 1.751	29 = 1.841	30 = 1.874
31 = 1.849	32 = 1.850	33 = 1.837	34 = 1.846	35 = 1.839	36 = 1.850
37 = 1.819	38 = 1.853	39 = 1.846	40 = 1.864	41 = 1.819	42 = 1.825
43 = 1.881	44 = 1.858	45 = 1.885	46 = 2.001	47 = 1.860	48 = 1.877
49 = 1.868	50 = 1.846	51 = 1.829	52 = 1.863	53 = 1.889	54 = 1.875
55 = 1.834	56 = 1.843	57 = 1.884	58 = 1.866	59 = 1.813	60 = 1.822

Test Time: 01:45:00 **Battery Voltage:** 108.5 **Amps:** 114 **Kw:** 12.3

String #: 1 String 1

1 = 1.558	2 = 1.810	3 = 1.769	4 = 1.830	5 = 1.828	6 = 1.802
7 = 1.842	8 = 1.850	9 = 1.798	10 = 1.353	11 = 1.839	12 = 1.854
13 = 1.812	14 = 1.830	15 = 1.826	16 = 1.821	17 = 1.729	18 = 1.818
19 = 1.805	20 = 1.718	21 = 1.836	22 = 1.836	23 = 1.833	24 = 1.818
25 = 1.847	26 = 1.794	27 = 1.825	28 = 1.628	29 = 1.825	30 = 1.857
31 = 1.832	32 = 1.832	33 = 1.815	34 = 1.829	35 = 1.818	36 = 1.834
37 = 1.797	38 = 1.832	39 = 1.828	40 = 1.847	41 = 1.803	42 = 1.807
43 = 1.870	44 = 1.840	45 = 1.867	46 = 1.888	47 = 1.842	48 = 1.859
49 = 1.820	50 = 1.829	51 = 1.807	52 = 1.826	53 = 1.857	54 = 1.858
55 = 1.807	56 = 1.805	57 = 1.859	58 = 1.836	59 = 1.790	60 = 1.797

Test End Voltages

Test Time: 01:49:16 **Battery Voltage:** 104.9 **Amps:** 0 **Kw:** 0.0

String #: 1 String 1

1 = 0.901	2 = 1.794	3 = 1.744	4 = 1.805	5 = 1.806	6 = 1.768
7 = 1.826	8 = 1.844	9 = 1.781	10 = 0.764	11 = 1.828	12 = 1.843
13 = 1.795	14 = 1.807	15 = 1.802	16 = 1.794	17 = 1.621	18 = 1.803
19 = 1.790	20 = 1.502	21 = 1.825	22 = 1.825	23 = 1.822	24 = 1.801
25 = 1.836	26 = 1.755	27 = 1.808	28 = 0.700	29 = 1.802	30 = 1.852
31 = 1.816	32 = 1.820	33 = 1.798	34 = 1.813	35 = 1.801	36 = 1.823
37 = 1.780	38 = 1.821	39 = 1.817	40 = 1.830	41 = 1.786	42 = 1.790
43 = 1.859	44 = 1.829	45 = 1.861	46 = 1.882	47 = 1.830	48 = 1.854
49 = 1.805	50 = 1.815	51 = 1.791	52 = 1.815	53 = 1.846	54 = 1.847
55 = 1.786	56 = 1.780	57 = 1.852	58 = 1.825	59 = 1.764	60 = 1.782

Cell Detail

String #: 1 Cell: 1

String 1

Float Voltage (No Load): 2.235
Start Voltage (Load): 2.044

Test Time	Battery Voltage	Load	Cell Voltage
00:05:00	120.4	114	1.962
00:10:00	120.4	114	1.962
00:15:00	120.2	113	1.957
00:20:00	120.0	114	1.946
00:25:00	119.6	114	1.940
00:30:00	119.2	114	1.929
00:35:00	118.8	113	1.923
00:40:00	118.1	114	1.912
00:45:00	117.7	113	1.901
00:50:00	117.2	114	1.890
00:55:00	116.8	114	1.879
01:00:00	116.1	113	1.868
01:05:00	115.5	114	1.857
01:10:00	115.0	114	1.846
01:15:00	114.4	114	1.835
01:20:00	113.8	114	1.818
01:25:00	112.9	114	1.796
01:30:00	112.2	113	1.774
01:35:00	112.2	113	1.759
01:40:00	110.9	114	1.686
01:45:00	108.5	114	1.558
		End Voltage: 0.901	

Cell Detail

String #: 1 Cell: 3

String 1

Float Voltage (No Load): 2.233
Start Voltage (Load): 1.945

Test Time	Battery Voltage	Load	Cell Voltage
00:05:00	120.4	114	1.986
00:10:00	120.4	114	1.986
00:15:00	120.2	113	1.980
00:20:00	120.0	114	1.974
00:25:00	119.6	114	1.967
00:30:00	119.2	114	1.961
00:35:00	118.8	113	1.950
00:40:00	118.1	114	1.939
00:45:00	117.7	113	1.930
00:50:00	117.2	114	1.924
00:55:00	116.8	114	1.913
01:00:00	116.1	113	1.902
01:05:00	115.5	114	1.891
01:10:00	115.0	114	1.880
01:15:00	114.4	114	1.873
01:20:00	113.8	114	1.857
01:25:00	112.9	114	1.846
01:30:00	112.2	113	1.829
01:35:00	112.2	113	1.825
01:40:00	110.9	114	1.802
01:45:00	108.5	114	1.769
End Voltage: 1.744			

Cell Detail

String #: 1 Cell: 10

String 1

Float Voltage (No Load): 2.213
Start Voltage (Load): 1.859

Test Time	Battery Voltage	Load	Cell Voltage
00:05:00	120.4	114	1.965
00:10:00	120.4	114	1.965
00:15:00	120.2	113	1.959
00:20:00	120.0	114	1.948
00:25:00	119.6	114	1.942
00:30:00	119.2	114	1.931
00:35:00	118.8	113	1.920
00:40:00	118.1	114	1.915
00:45:00	117.7	113	1.903
00:50:00	117.2	114	1.892
00:55:00	116.8	114	1.887
01:00:00	116.1	113	1.876
01:05:00	115.5	114	1.859
01:10:00	115.0	114	1.848
01:15:00	114.4	114	1.837
01:20:00	113.8	114	1.815
01:25:00	112.9	114	1.798
01:30:00	112.2	113	1.770
01:35:00	112.2	113	1.754
01:40:00	110.9	114	1.663
01:45:00	108.5	114	1.353
End Voltage: 0.764			

Cell Detail

String #: 1 Cell: 17

String 1

Float Voltage (No Load): 2.314
Start Voltage (Load): 2.111

Test Time	Battery Voltage	Load	Cell Voltage
00:05:00	120.4	114	2.060
00:10:00	120.4	114	2.060
00:15:00	120.2	113	2.054
00:20:00	120.0	114	2.049
00:25:00	119.6	114	2.037
00:30:00	119.2	114	2.032
00:35:00	118.8	113	2.021
00:40:00	118.1	114	2.010
00:45:00	117.7	113	1.999
00:50:00	117.2	114	1.982
00:55:00	116.8	114	1.971
01:00:00	116.1	113	1.960
01:05:00	115.5	114	1.943
01:10:00	115.0	114	1.932
01:15:00	114.4	114	1.915
01:20:00	113.8	114	1.899
01:25:00	112.9	114	1.875
01:30:00	112.2	113	1.853
01:35:00	112.2	113	1.857
01:40:00	110.9	114	1.787
01:45:00	108.5	114	1.729
End Voltage: 1.621			

Cell Detail

String #: 1 Cell: 20

String 1

Float Voltage (No Load): 2.233
Start Voltage (Load): 2.083

Test Time	Battery Voltage	Load	Cell Voltage
00:05:00	120.4	114	1.990
00:10:00	120.4	114	1.990
00:15:00	120.2	113	1.984
00:20:00	120.0	114	1.979
00:25:00	119.6	114	1.972
00:30:00	119.2	114	1.961
00:35:00	118.8	113	1.956
00:40:00	118.1	114	1.945
00:45:00	117.7	113	1.939
00:50:00	117.2	114	1.928
00:55:00	116.8	114	1.922
01:00:00	116.1	113	1.911
01:05:00	115.5	114	1.900
01:10:00	115.0	114	1.889
01:15:00	114.4	114	1.878
01:20:00	113.8	114	1.861
01:25:00	112.9	114	1.845
01:30:00	112.2	113	1.828
01:35:00	112.2	113	1.823
01:40:00	110.9	114	1.772
01:45:00	108.5	114	1.718
		End Voltage: 1.502	

Cell Detail

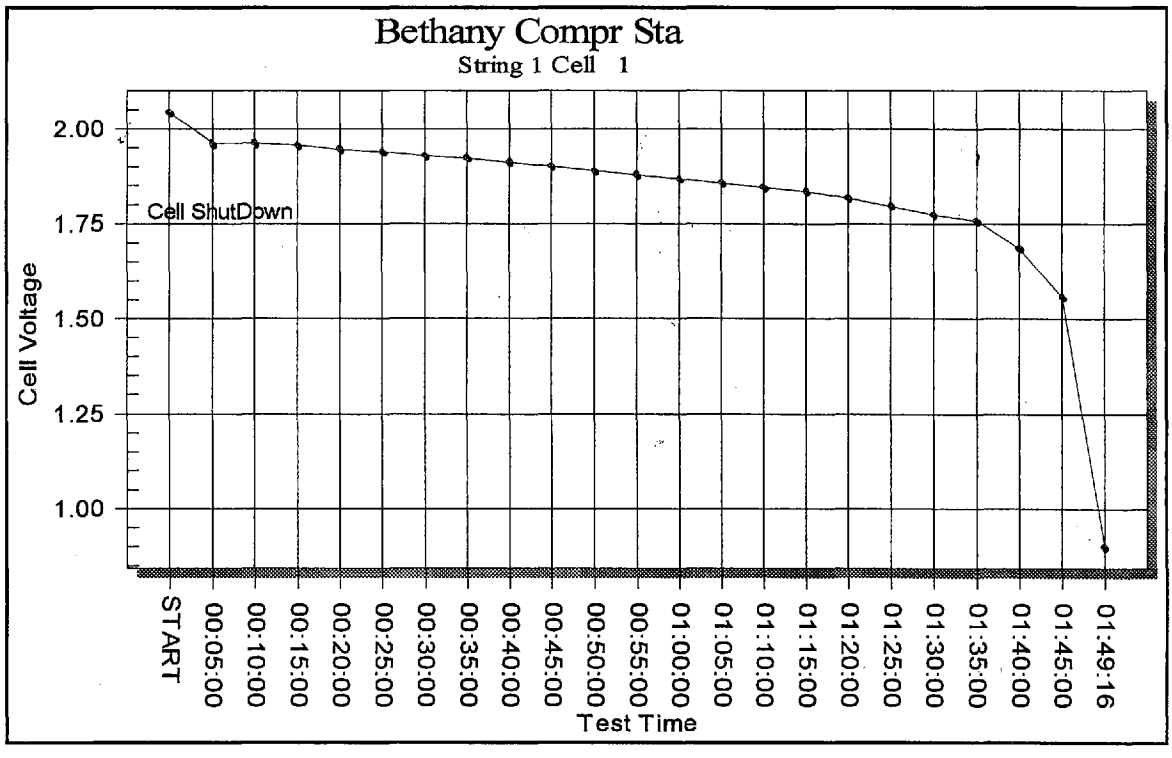
String #: 1 Cell: 28

String 1

Float Voltage (No Load): 2.194
Start Voltage (Load): 2.022

Test Time	Battery Voltage	Load	Cell Voltage
00:05:00	120.4	114	1.974
00:10:00	120.4	114	1.974
00:15:00	120.2	113	1.974
00:20:00	120.0	114	1.969
00:25:00	119.6	114	1.963
00:30:00	119.2	114	1.952
00:35:00	118.8	113	1.947
00:40:00	118.1	114	1.936
00:45:00	117.7	113	1.930
00:50:00	117.2	114	1.919
00:55:00	116.8	114	1.913
01:00:00	116.1	113	1.902
01:05:00	115.5	114	1.891
01:10:00	115.0	114	1.880
01:15:00	114.4	114	1.869
01:20:00	113.8	114	1.852
01:25:00	112.9	114	1.835
01:30:00	112.2	113	1.818
01:35:00	112.2	113	1.796
01:40:00	110.9	114	1.751
01:45:00	108.5	114	1.628
End Voltage: 0.700			

Cell Detail Graph

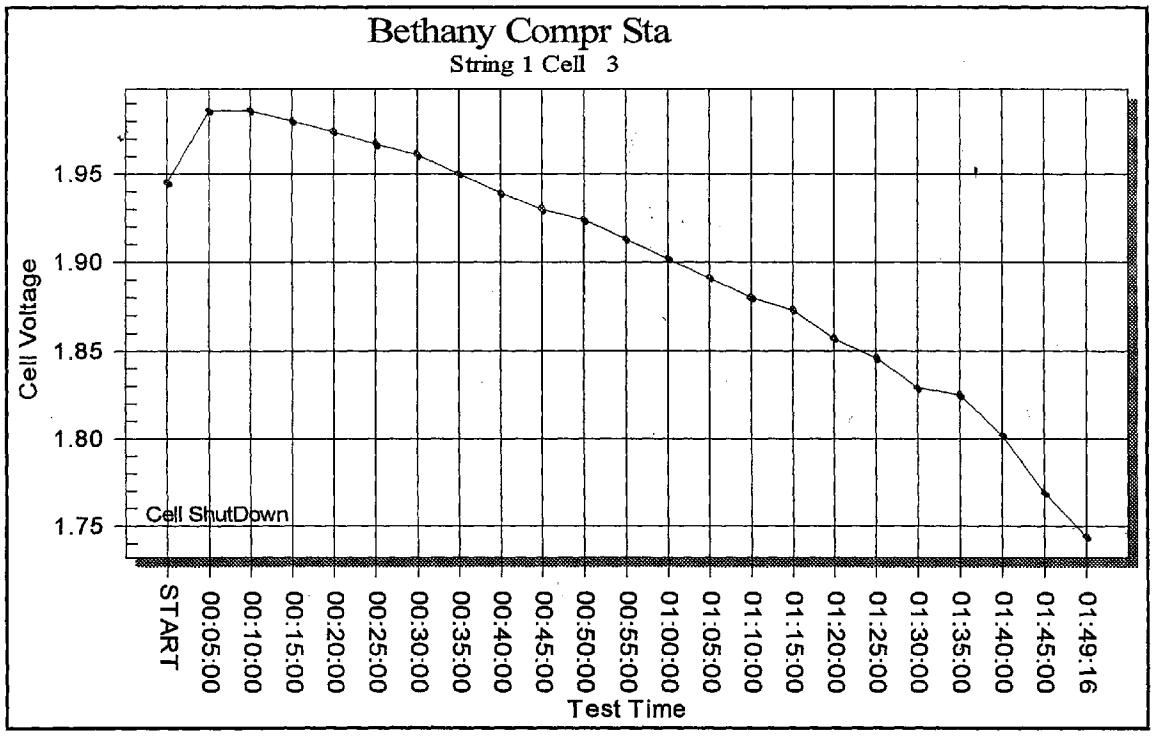


String #: 1 **Cell:** 1 **String Name:** String 1

Float Voltage: 2.235 **Start Voltage:** 2.044 **Voltage @ 30 sec.:** 1.950 **End Voltage:** 0.901

1/12/2000 **battery:** 120 vdc station battery **test type:** performance **tested:** 12/17/99

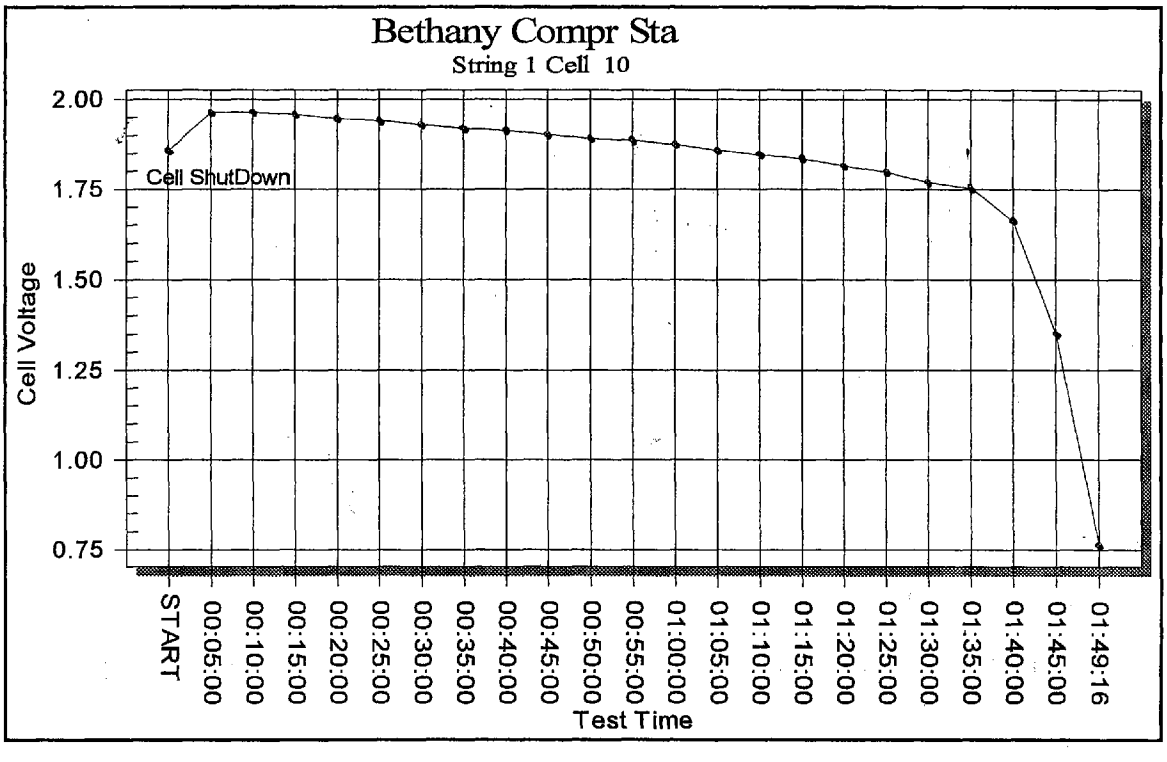
Cell Detail Graph



String #: 1 **Cell:** 3 **String Name:** String 1

Float Voltage: 2.233 **Start Voltage:** 1.945 **Voltage @ 30 sec.:** 1.986 **End Voltage:** 1.744

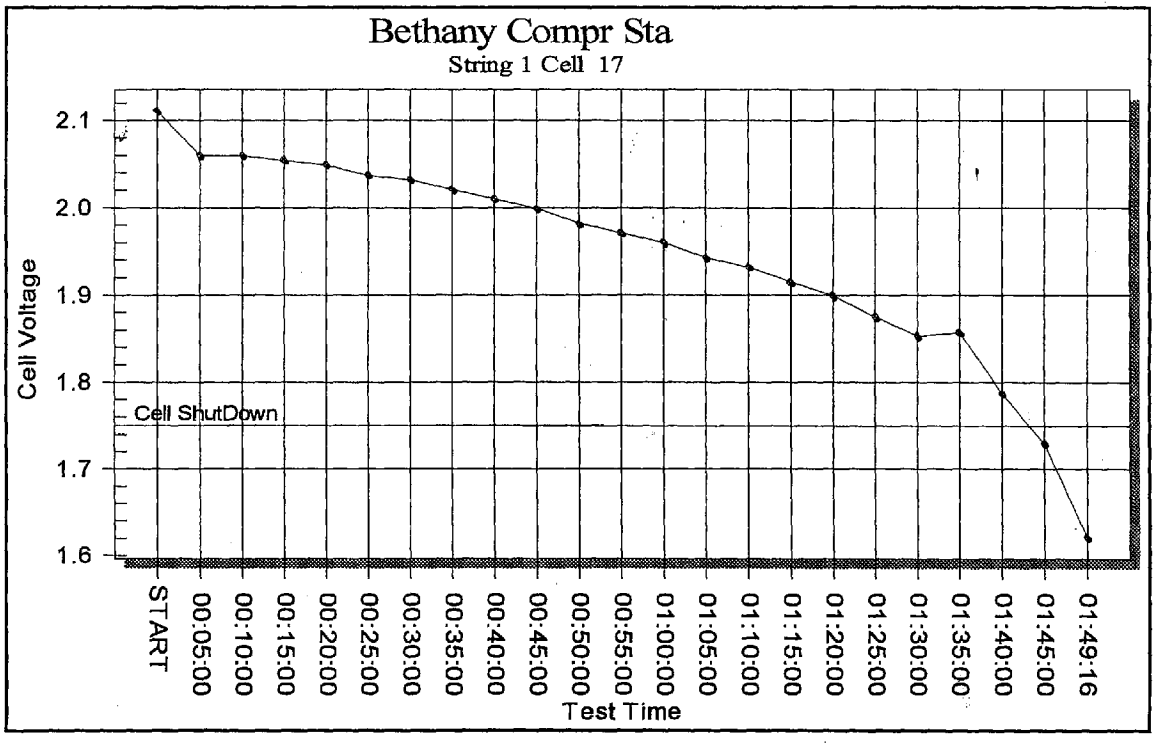
Cell Detail Graph



String #: 1 **Cell:** 10 **String Name:** String 1

Float Voltage: 2.213 **Start Voltage:** 1.859 **Voltage @ 30 sec.:** 1.952 **End Voltage:** 0.764

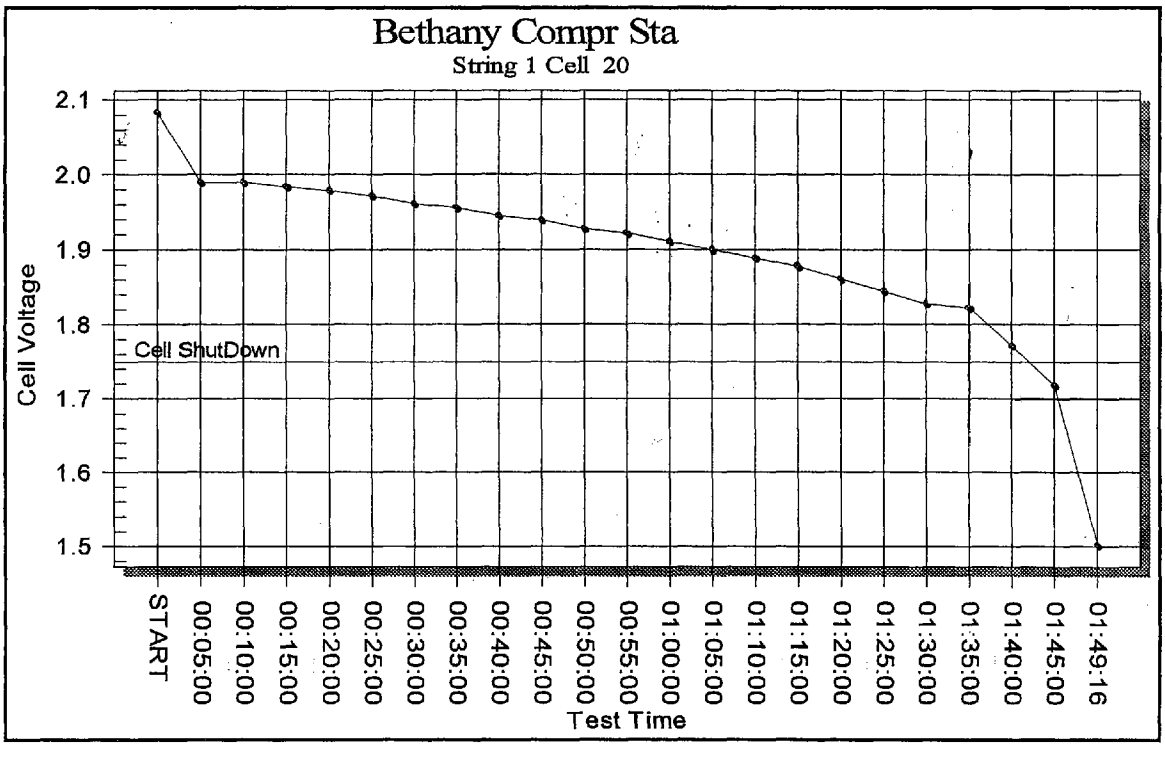
Cell Detail Graph



String #: 1 Cell: 17 String Name: String 1

Float Voltage: 2.314 Start Voltage: 2.111 Voltage @ 30 sec.: 2.060 End Voltage: 1.621

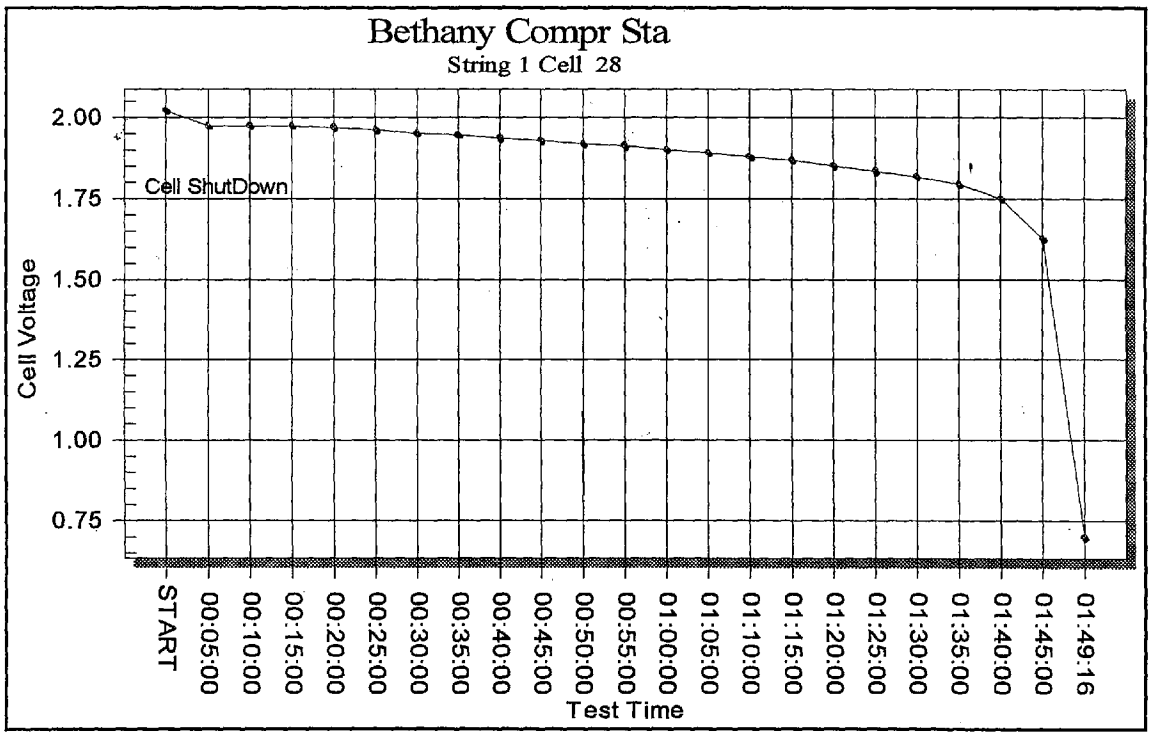
Cell Detail Graph



String #: 1 **Cell:** 20 **String Name:** String 1

Float Voltage: 2.233 **Start Voltage:** 2.083 **Voltage @ 30 sec.:** 1.971 **End Voltage:** 1.502

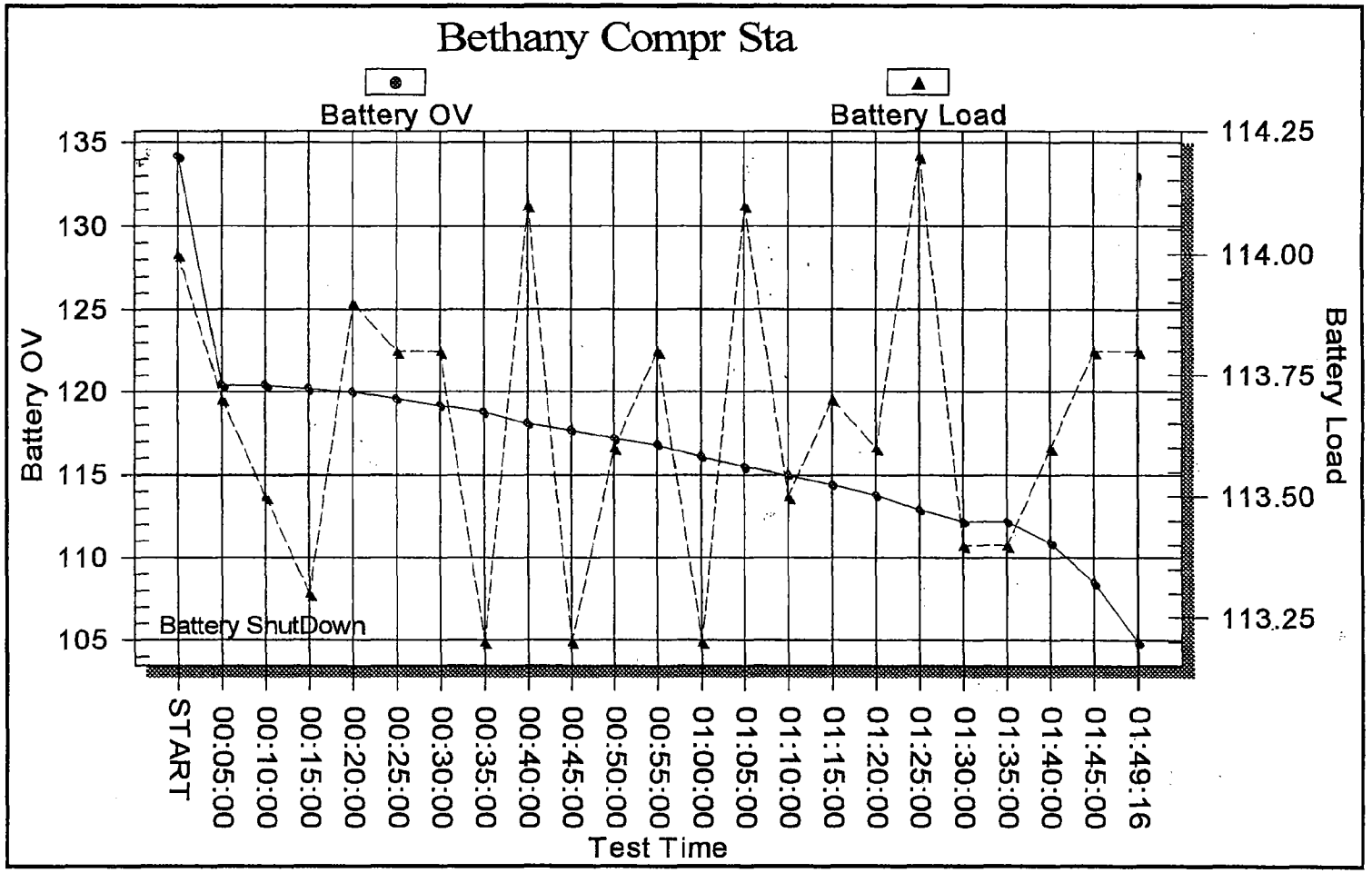
Cell Detail Graph



String #: 1 **Cell:** 28 **String Name:** String 1

Float Voltage: 2.194 **Start Voltage:** 2.022 **Voltage @ 30 sec.:** 1.957 **End Voltage:** 0.700

Battery OV & I Graph



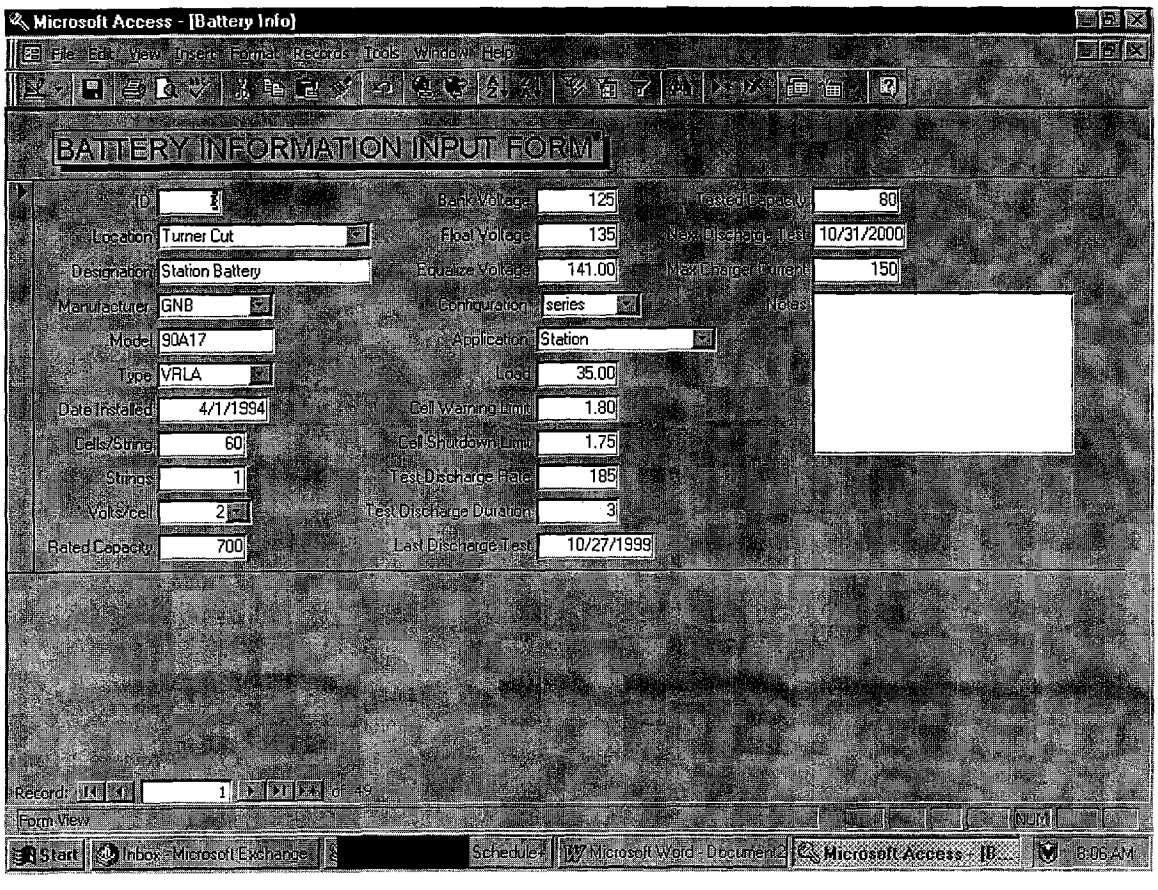
Test Notes

Persons involved in the battery testing were:

[redacted]

There were significant deviations in cell voltages at the conclusion of the discharge test. Following four days of normal float operation, the battery bank was equalize charged, and voltage readings taken which indicated acceptable cell voltage deviations.

[redacted] is seeking warranty replacement of cells 1 and 10 which failed the capacity test.


Microsoft Access - [Battery Info]
File Edit View Insert Format Records Tools Window Help
BATTERY INFORMATION INPUT FORM
ID: 1
Location: Turner Cut
Designation: Station Battery
Manufacturer: GNB
Model: 90A17
Type: VRLA
Date Installed: 4/1/1994
Cells/String: 60
Strings: 1
Volts/cell: 2
Rated Capacity: 700
Bank Voltage: 125
Float Voltage: 135
Equalize Voltage: 141.00
Configuration: series
Application: Station
Load: 35.00
Cell Warning Limit: 1.80
Cell Shutdown Limit: 1.75
Test Discharge Rate: 185
Test Discharge Duration: 3
Last Discharge Test: 10/27/1999
Tested Capacity: 80
Next Discharge Test: 10/31/2000
Max Charger Current: 150
Notes:
Record: 1 of 49
Form View
Start
Inbox - Microsoft Exchange
Schedule+
Microsoft Word - Document2
Microsoft Access - [B...
8:06 AM

CGT BATTERY CAPACITY TESTING PROCEDURE

1.0 PRE-TEST REQUIREMENTS

a) Equalize charge the battery (unless manufacturer recommends otherwise) between 3 to 30 days prior to capacity testing.

b) Perform complete monthly/annual inspection and maintenance items as per CGT Std 4293, Table 1 and Appendix 1.

c) If cell resistance measurements have been taken, wait at least 1 hour before continuing with the capacity test.

d) Take appropriate precautions when arranging clearances to isolate the battery from any sources and loads during testing.

2.0 SPECIAL REQUIREMENTS – NEW BATTERIES AND BATTERIES WITH BUILT-IN LOAD BANKS

2.1 New Batteries

New batteries shall only be required to meet ninety (90) percent of rated capacity when first installed. It is very important that manufacturer's instructions be followed when installing new banks and performing the initial charge of the batteries.

2.2 Batteries with Built-in Load Banks

Batteries with built-in load banks are still subject to the maintenance and testing requirements of CGT Standard 4293. Special load testing instructions should be available and may be substituted for this supplement in the following locations: Antioch, Brentwood, Gerber, Irvington, and Milpitas.

However, strong consideration should be given to substituting the built-in load bank with the AlberCorp test equipment (advantages are outlined in CGT Std 4293, Section 6.3). Because of the two-tier rack design at these stations, testing will be greatly simplified since manual voltage readings need not be taken. If this option is chosen, only the electronic data file need be submitted to Station Engineering.

CGT BATTERY CAPACITY TESTING PROCEDURE

3.0 REQUIRED TEST EQUIPMENT

All test equipment used shall be properly calibrated.

a) Digital Voltmeter

b) DC clamp-on Ammeter

c) AlberCorp 5-N Load Continuous Load Unit

d) BCT-128 with test lead looms and interconnecting cables

e) Laptop computer loaded with BCT-2000 software

f) Floppy diskette, 3 1/2"

g) AlberCorp Cellcorder

h) Insulated torque wrench, in-lb

i) Infrared temperature detector

j) Jumper cables appropriately rated for the intended discharge current.

4.0 TEST EQUIPMENT AND BCT SOFTWARE CONFIGURATION

4.1 Test Equipment Setup

Setup AlberCorp test equipment and laptop computer as per the "System Block Diagram" and "General Arrangement Sense Lead Connections" found in the "BCT-2000 Software and BCT-128 and BCT-256 User's Guide".

It is very important that all connections to the laptop computer be made before the laptop is turned on. Otherwise, communications with the other equipment will not be properly established.

4.2 Jumpering Cells

Any weak cells identified by cellcorder readings taken in the maintenance inspection shall be considered for jumpering prior to the start of any load test. Jumpered cells shall have terminal connectors to adjacent cells removed before any load is applied to the battery bank.

JUMPERING SHALL NOT BE PERFORMED ON ANY CELL

CGT BATTERY CAPACITY TESTING PROCEDURE

ONCE THE CAPACITY TEST HAS BEGUN.

NO CELL VOLTAGE SHALL BE ALLOWED TO FALL BELOW 1.5 VOLTS DURING A CAPACITY TEST.

Cells falling below the shutdown voltage established in the test setup (typical value is 1.75 VPC), shall remain connected in the battery and closely monitored using the infrared temperature detector. ***Should the temperature detector indicate a significant or rapid increase in cell temperature, the load test shall be immediately terminated to prevent equipment damage and personnel injury.***

4.3 BCT-2000 Software Setup

Detailed instructions for BCT-2000 software setup are contained in the "BCT-2000 Software and BCT-128 and BCT-256 User's Guide." Only a few important points are highlighted in this supplement. Specific page references below are to this user's guide.

Discharge test parameters can be found in CGT Std 4293, Appendix 3.

Battery Strings setup (pp. 17-18). Most CGT batteries contain only one string. Batteries with more than one string shall have each string tested separately.

DO NOT TEST PARALLEL STRINGS TOGETHER.

The software will automatically configure the BCT-128 to accept the proper inputs from the sense leads based on the number of cells entered on this screen.

Test Setup (pp. 22-23). The test type selected will always be "Performance" and "Constant Current".

"Rated time" comes from Appendix 3. Make sure the proper cell voltage is selected. Select "IEEE" correction.

Set the alarm levels as follows:

2 volt cells

Warning = 1.80
Shut Down = 1.75

12 volt jars

Warning = 10.8
Shut Down = 10.5

CGT BATTERY CAPACITY TESTING PROCEDURE

Intertier connections. Select the intertier desired (1-8) and repeat settings for each:

Warning = 0.1
Shut Down = 0.2

"Test Steps" setup. A performance test only allows one test step.

Highlight the "duration" field and type in hh:mm:ss that is 1-hour greater than the rated time entered earlier.

Enter "Amps" from Appendix 3. The software will automatically correct the value entered based on the temperature input and IEEE correction selected.

Intertier Setup (pp. 24-25). Select intertier (1-8) and then use the cell list to select the two cells between which the intertier connection is made. Repeat for all intertiers.

Load Bank Setup (pp. 25-26). DO NOT CHANGE THE DEFAULT SETTINGS.

Exit the setup screens by clicking on the "x" in the upper right-hand corner of the window.

5.0 THE CAPACITY TEST

5.1 Starting the Test

Once all the settings have been entered in section 4.0, start the test by clicking on "Test" on the BCT-2000 main menu. If the settings and test equipment connections are correct, and the equipment is operating properly, the "BCT Test" screen will appear. There should be a green vertical bar showing in the middle of the screen corresponding to each battery cell. If this does not happen, there is a problem with either the test setup or the equipment.

Double-check to ensure that the test duration and Amps (lower left corner) are correct. If everything looks fine, click on the "F1 Start" button or press F1 on the keyboard. You will hear the load bank start hunting for the optimum combination of load resistors to achieve the desired discharge current.

CGT BATTERY CAPACITY TESTING PROCEDURE

5.2 Stopping the Test

Stop the test by clicking on "F1 Stop Test" or pressing F1 on the keyboard when any of the following occur:

- Approximately half of the cells fall below 1.75 volts. *When a cell falls below the shutdown limit setting, the test is automatically halted.*
- The overall battery voltage drops to 1.75 VPC:

  21 Volts for a 24 Volt battery
  28 Volts for a 32 Volt battery
  42 Volts for a 48 Volt battery
  105 Volts for a 120 Volt battery
- Cell overheating is indicated by the infrared gun.
- Any cell falls below 1.5 Volts (or 9 V for a 12 Volt jar).

6.0 POST-TEST REQUIREMENTS

6.1 Equalize Charging

Allow the battery approximately 10 minutes to stabilize following the end of the capacity test. Then reconnect to the charging equipment and equalize charge at the appropriate setting (consult manufacturer's literature for recommended durations and voltage levels).

6.2 Return to Service

Remove any jumpers installed in section 4.2 above, or install permanent jumpers if cell needs to remain disconnected. *Readjust the float voltage if any cells are removed.*

Reconnect battery to system loads when voltage has recovered to approximately 2.2 VPC (132 Volts for a 120 Volt battery) or when the charger is capable of supplying both the battery charging requirement plus its normal load.

6.3 Load Test Results

Copies of annual load test results shall be mailed (or emailed) to:

[redacted], Station Engineering
375 N. Wiget Lane, Suite 130
Walnut Creek, CA 94598