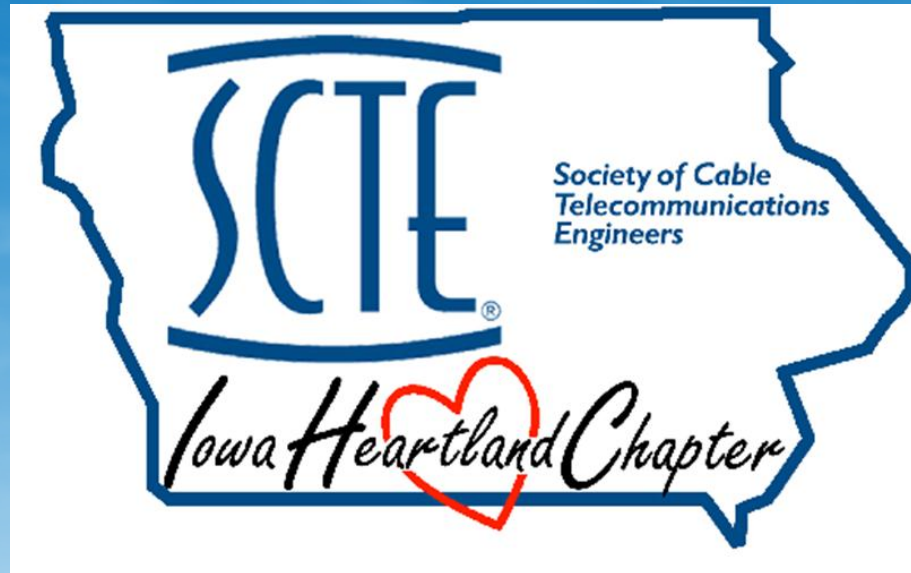




Total Power Solutions

member of The Alpha Group™

Iowa Heartland Chapter



HFC Plant Power Supplies

Power



Lowell Anderson
Sr. Sales Engineer
Alpha Technologies

landerson@alpha.com

(609) 625 7288

www.alpha.com

Power Supplies



Batteries



Battery Cell Basics

**Battery Voltage is
the result of a
chemical reaction
between Lead
and Sulfuric Acid**

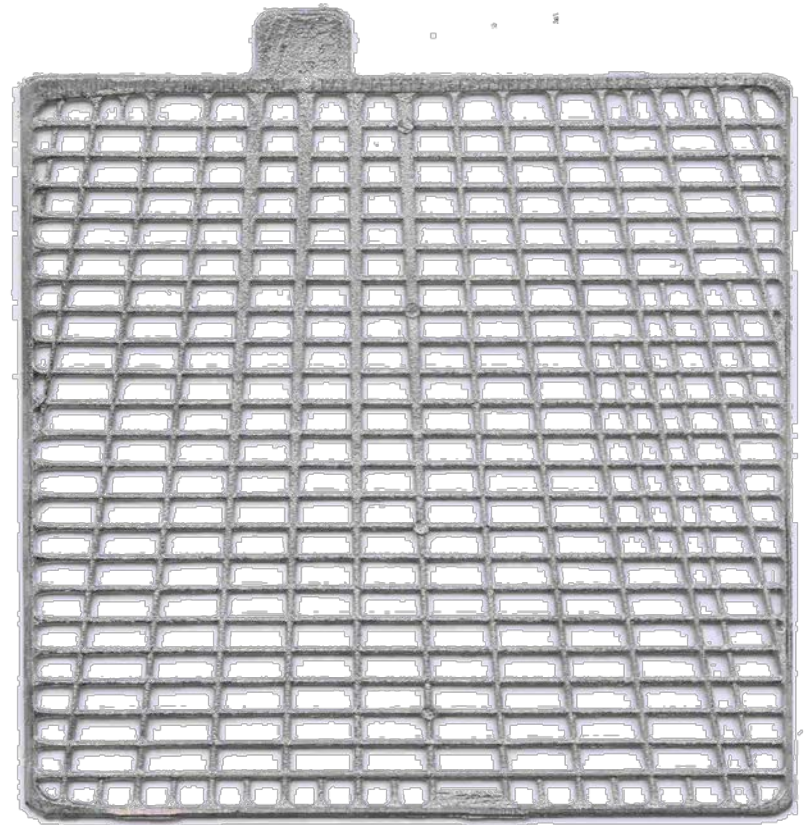
**Typical
Lead-Acid Cell
produces 2 VDC**



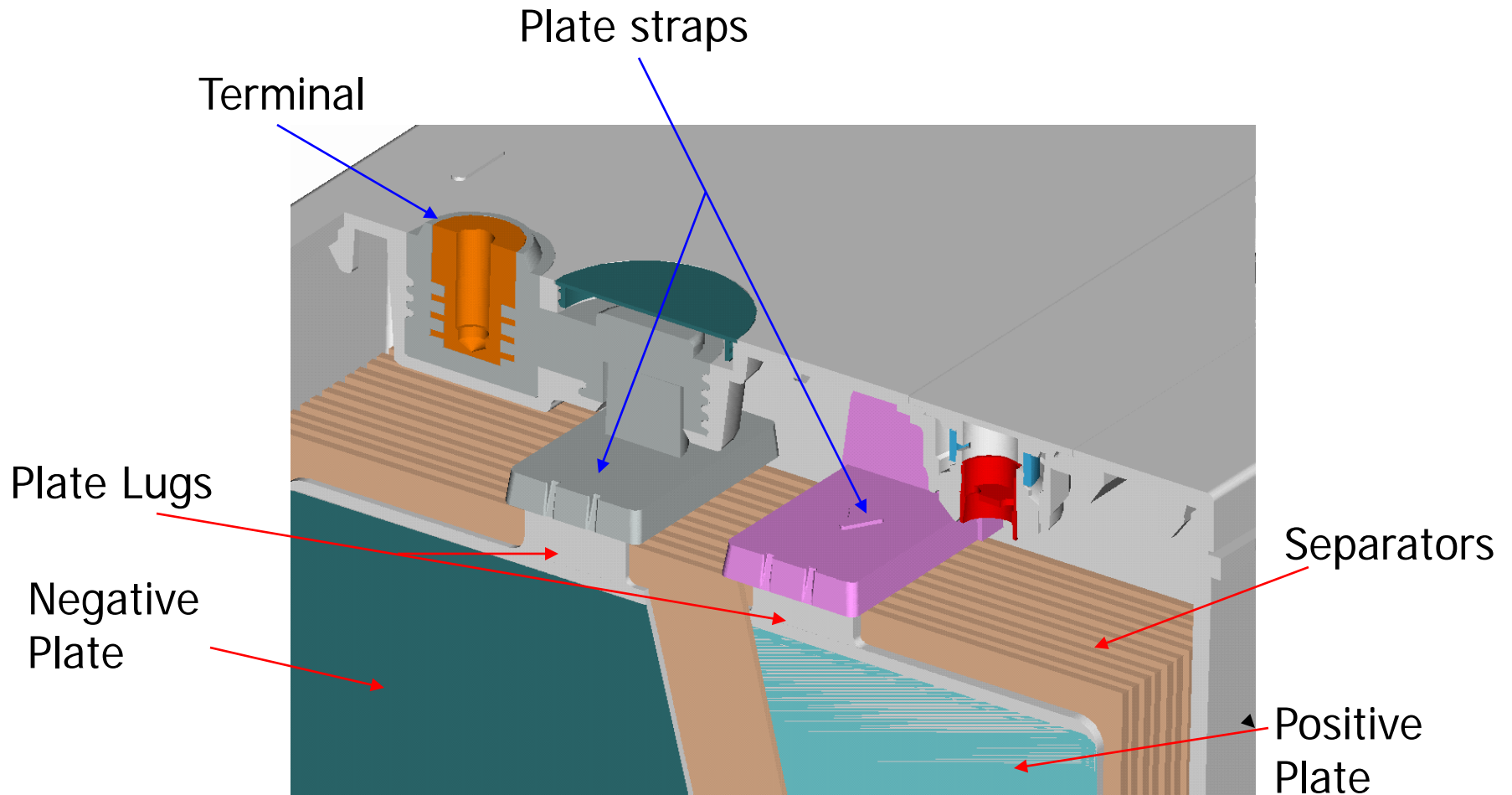
Battery Cell Basics

Each 2 volt Cell

- Positive Charged Plate
- Negative Charged Plate
- Non-Conductive Separator
- Acid – Gel or Absorbed



Battery Cell Basics





Battery Basics

A Battery is a collection of Cells

- **12 volt Battery = Six 2 volt cells in one Jar**

Battery Basics

**A Battery String is a collection of
Batteries wired in Series**

- **36 volt Battery = Three 12 volt Battery Jars**
- **36 volt Battery = Eighteen 2 volt Cells**

Battery Basics

Effect of Temperature on Run Time

Rules of thumb

- Batteries are rated at 77°F **4 hours (100%)**
- Traditional HFC @32°F
- Traditional HFC @ 0°F

Battery Basics

Effect of Temperature on Run Time

Rules of thumb

- Batteries are rated at 77°F **4 hours (100%)**
- Traditional HFC @32°F **3 hours (75%)**
- Traditional HFC @ 0°F

Battery Basics

Effect of Temperature on Run Time

Rules of thumb

- Batteries are rated at 77°F **4 hours (100%)**
- Traditional HFC @32°F **3 hours (75%)**
- Traditional HFC @ 0°F **2 hours (50%)**

Battery Basics

Effect of Temperature on Run Time

Rules of thumb

- Batteries are rated at 77°F **4 hours (100%)**
- Traditional HFC @32°F **3 hours (75%)**
- Traditional HFC @ 0°F **2 hours (50%)**
- Pure Lead @32°F
- Pure Lead @ 0°F

Battery Basics

Effect of Temperature on Run Time

Rules of thumb

- Batteries are rated at 77°F **4 hours (100%)**
- Traditional HFC @32°F **3 hours (75%)**
- Traditional HFC @ 0°F **2 hours (50%)**
- Pure Lead @32°F **3 Hr 24 min (85%)**
- Pure Lead @ 0°F

Battery Basics

Effect of Temperature on Run Time

Rules of thumb

- Batteries are rated at 77°F **4 hours (100%)**
- Traditional HFC @32°F **3 hours (75%)**
- Traditional HFC @ 0°F **2 hours (50%)**
- Pure Lead @32°F **3 Hr 24 min (85%)**
- Pure Lead @ 0°F **2 Hr 48 min (70%)**

**Making
Batteries
Last Longer**



Making Batteries Last Longer

Pick the Right Battery

- **Match the Battery Technology to the Job**
 - *Environment – outside / unregulated*
 - *Charge method – under constant charge*
 - *Load profile – constant WATTAGE*
 - *Run time – multiple hours*
 - *Discharge frequency and depth – utility failures*

Making Batteries Last Longer

Pick the Right Battery

- **Float Service**
- **Wide Temperature Range**
 - *Remember effect of cold temperatures on capacity*
- **Constant Wattage Discharge**
 - *Do not use amp-hours*
- **Need 100% out-of-box performance**
 - *IEEE allows 80% shipment*
- **Run time to include mean-time-to-repair MTTR**

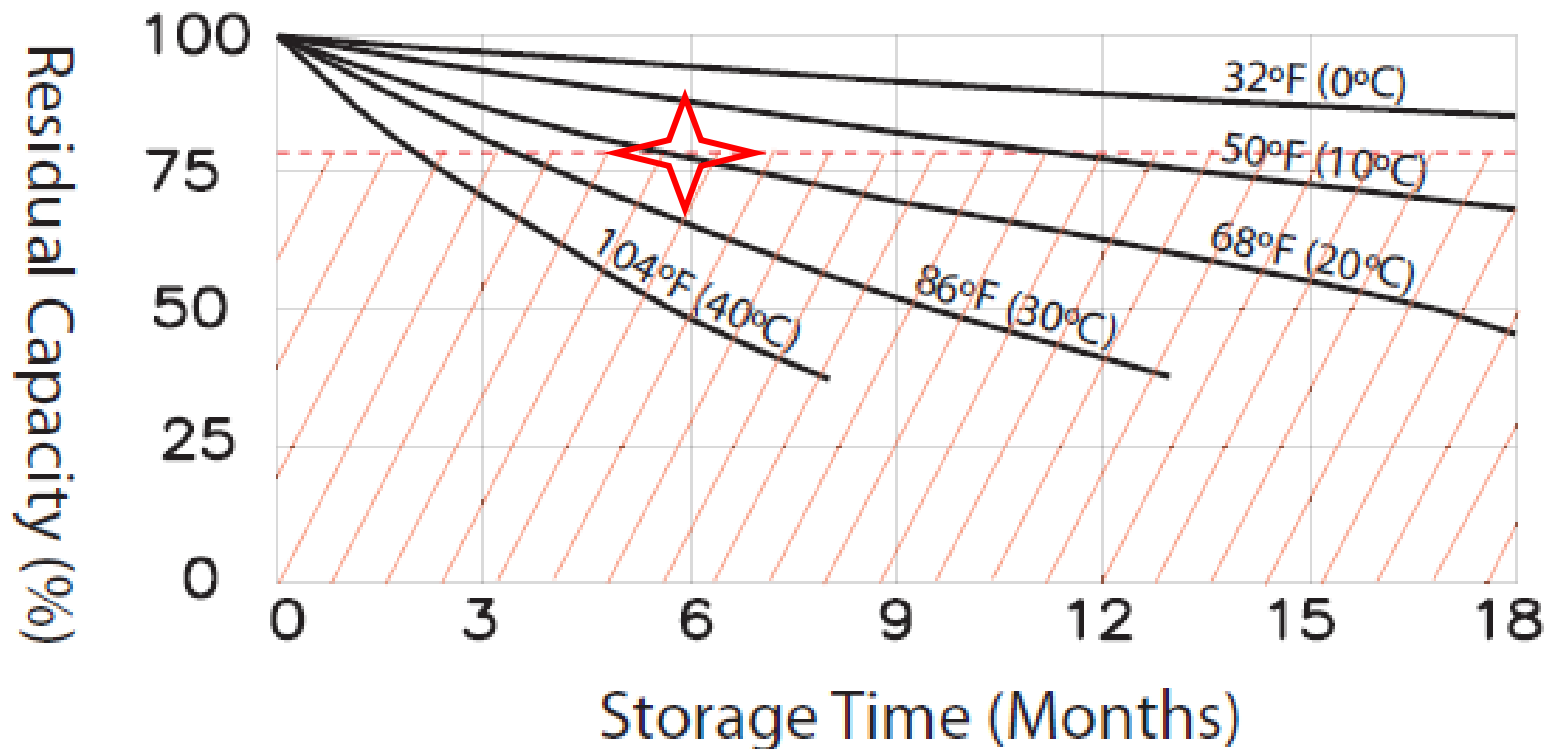
Making Batteries Last Longer

Storage and Handling

- Cold is Good / Hot is Bad
 - *Think Broccoli*

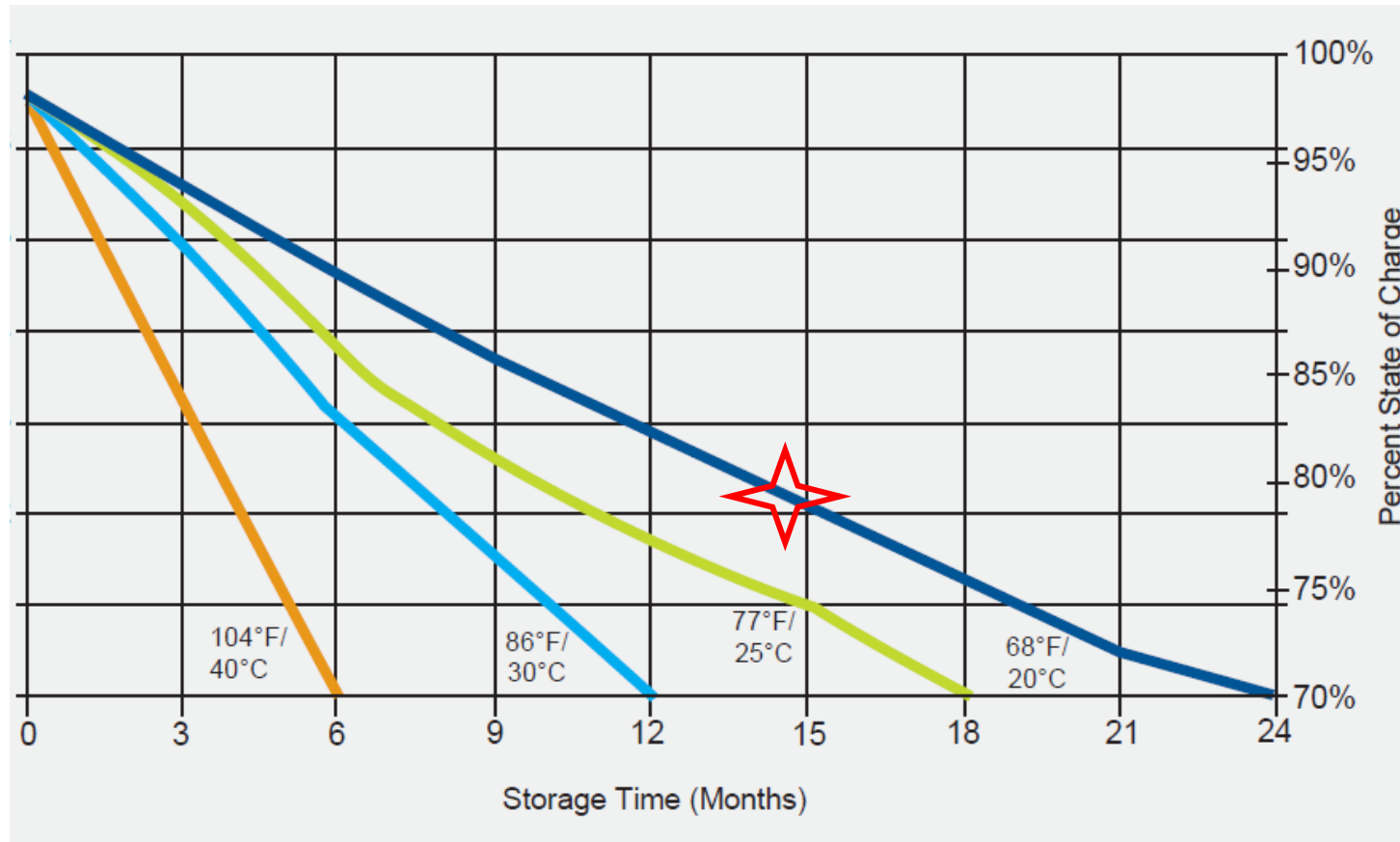
Self-Discharge Rate vs. Temperature

Standard Lead Calcium HFC Battery



Self-Discharge Rate vs. Temperature

Pure Lead HFC Battery



Making Batteries Last Longer

Storage and Handling

- Cold is Good / Hot is Bad
- **Protected Storage**





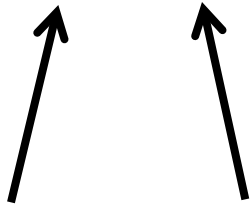
Making Batteries Last Longer

Storage and Handling

- Cold is Good / Hot is Bad
- Protected Storage
- **Rotate Stock – Use Oldest First**

DATE CODE

0304



Month Year

03

04

March 2004



Making Batteries Last Longer

Storage and Handling

- Cold is Good / Hot is Bad
- Protected Storage
- Rotate Stock – Use Oldest First
- **Re-Charge to Protect Shelf Life**

You *WILL* Recycle



Making Batteries Last Longer

Battery Installation

- **Start with a Good Battery**
 - *Visual Inspection*
 - *Check for 12.5VDC Minimum Battery Voltage*

What is JOB # 1?

Safety

What is JOB # 1?

You go home at the end of the day with all your body parts intact !!



Safety

Work SMART

Don't give your co-workers the opportunity to say
“well, that was stupid”

- Put brain in gear
- Safety Glasses
- Personal Protective Equipment – PPE

Safety

Avoid Shorts

- **Watches / Rings / Belt Buckles**
- **Insulate tools**



Making Batteries Last Longer

Battery Installation

- Start with a Good Battery
- **Transport Safely**
 - *In the box !*

Making Batteries Last Longer

Battery Installation

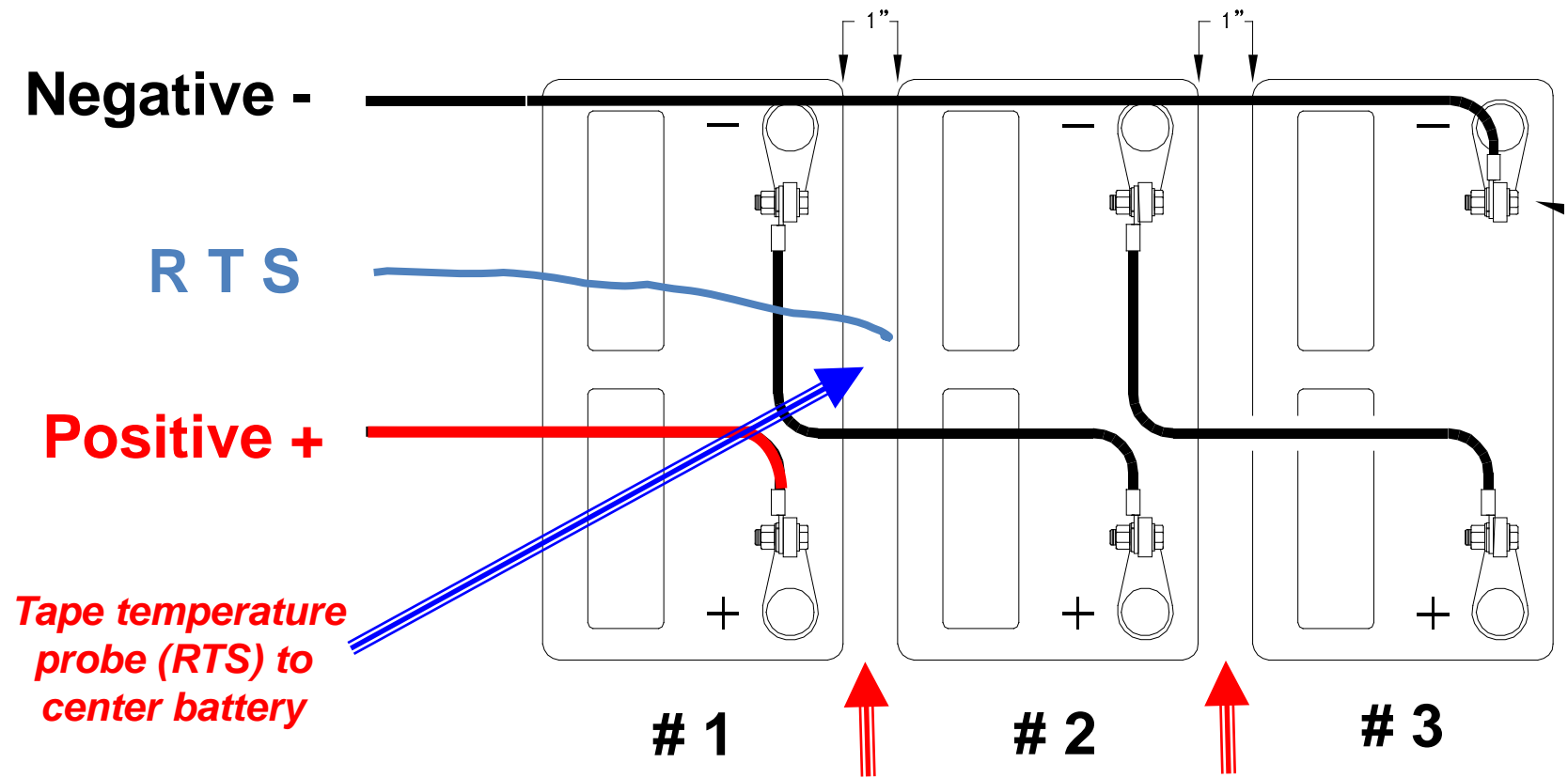
- Start with a Good Battery
- Transport Safely
- **All Batteries in String (shelf):**
 - **Within 12 Months from Oldest to Newest**
 - **All Same Manufacture and Model**

Making Batteries Last Longer

Battery Installation

- Start with a Good Battery
- Transport Safely
- All Batteries in String Same Mfg / Size and within 12 mo.
- **Shelf Layout Matters**

Typical 3 Battery Layout



Battery Temperature Probe

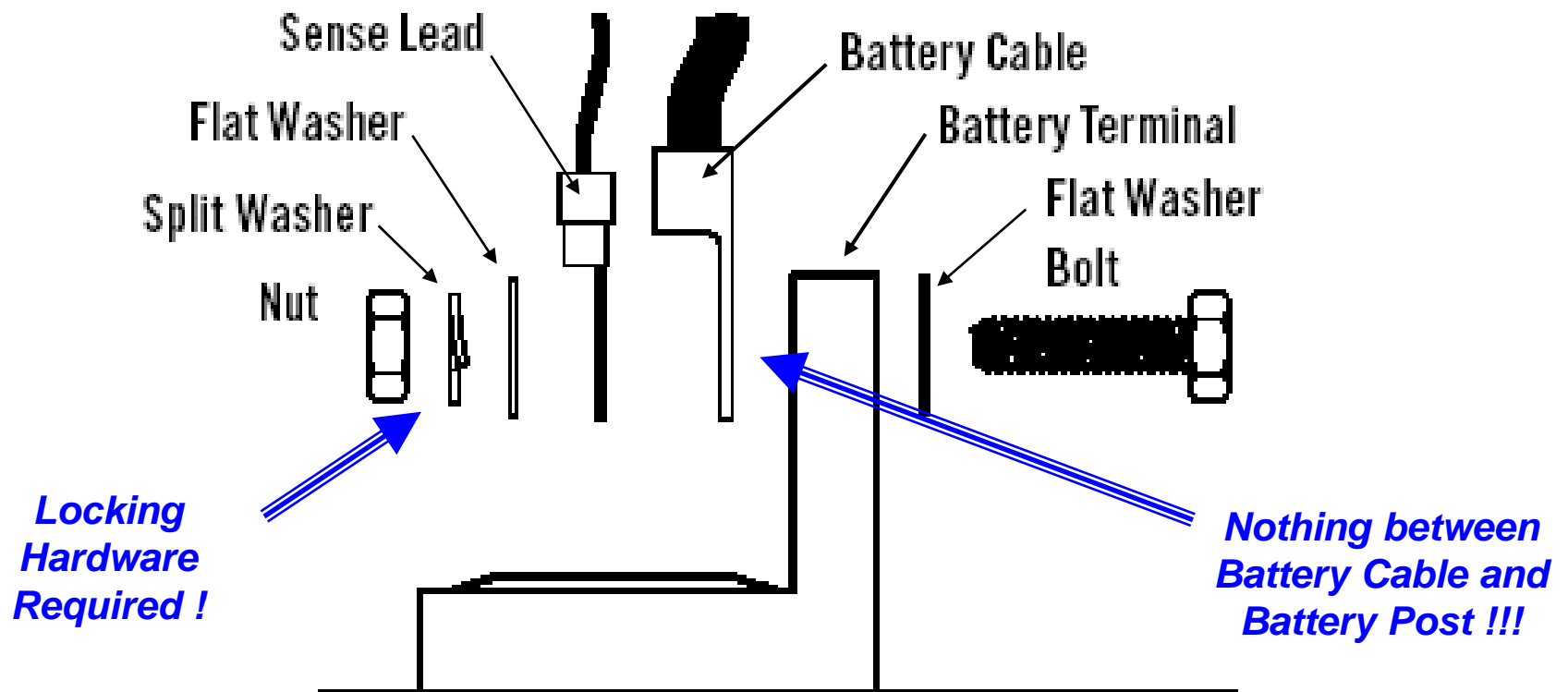


Making Batteries Last Longer

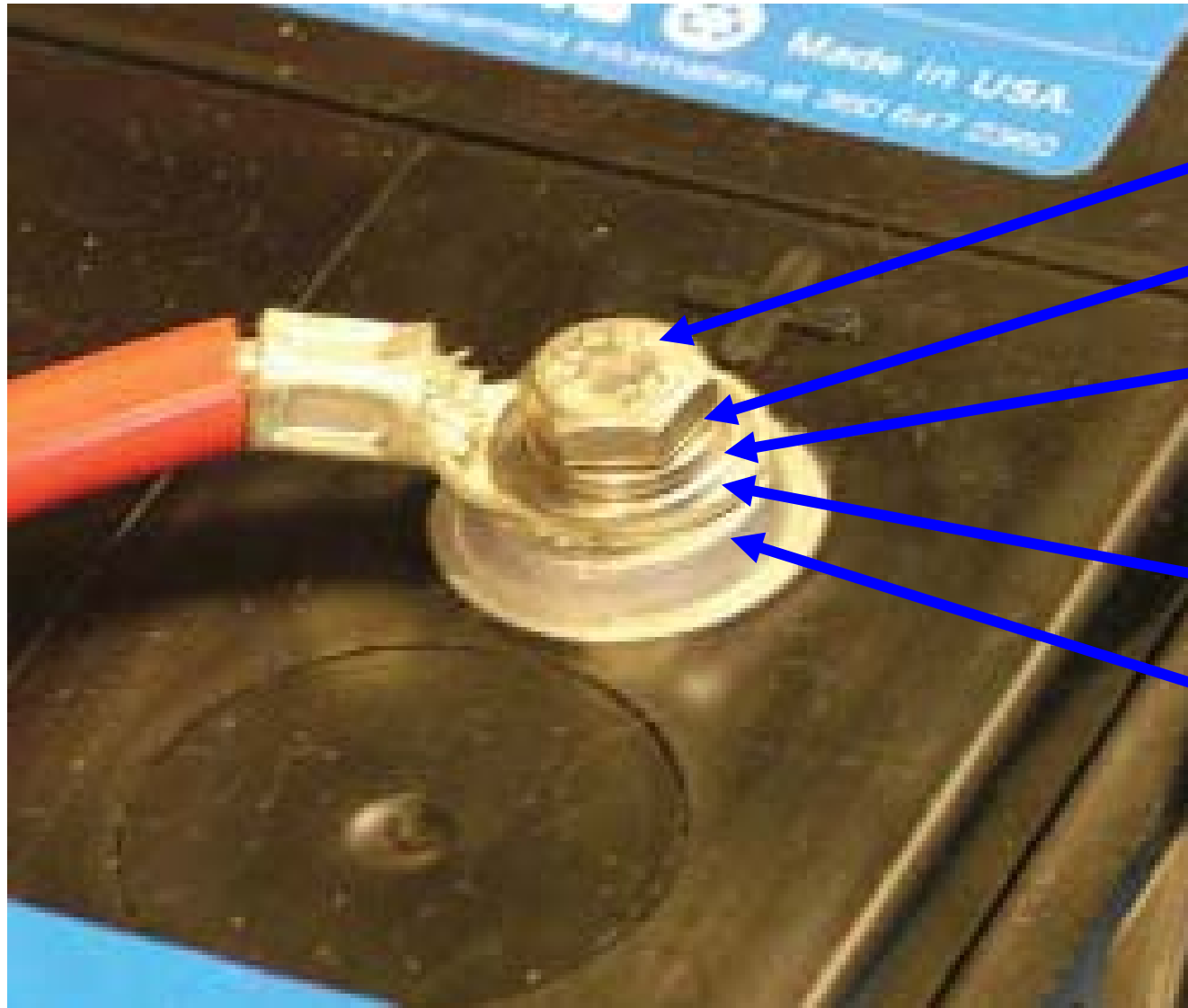
Battery Installation

- Start with a Good Battery
- Transport Safely
- All Batteries in String Same Mfg / Size and within 12 mo.
- Shelf Layout Matters
- **Correct Terminal Hardware Stack-Up**

Chair Style Terminal Hardware



Copper Insert Style Terminal Hardware

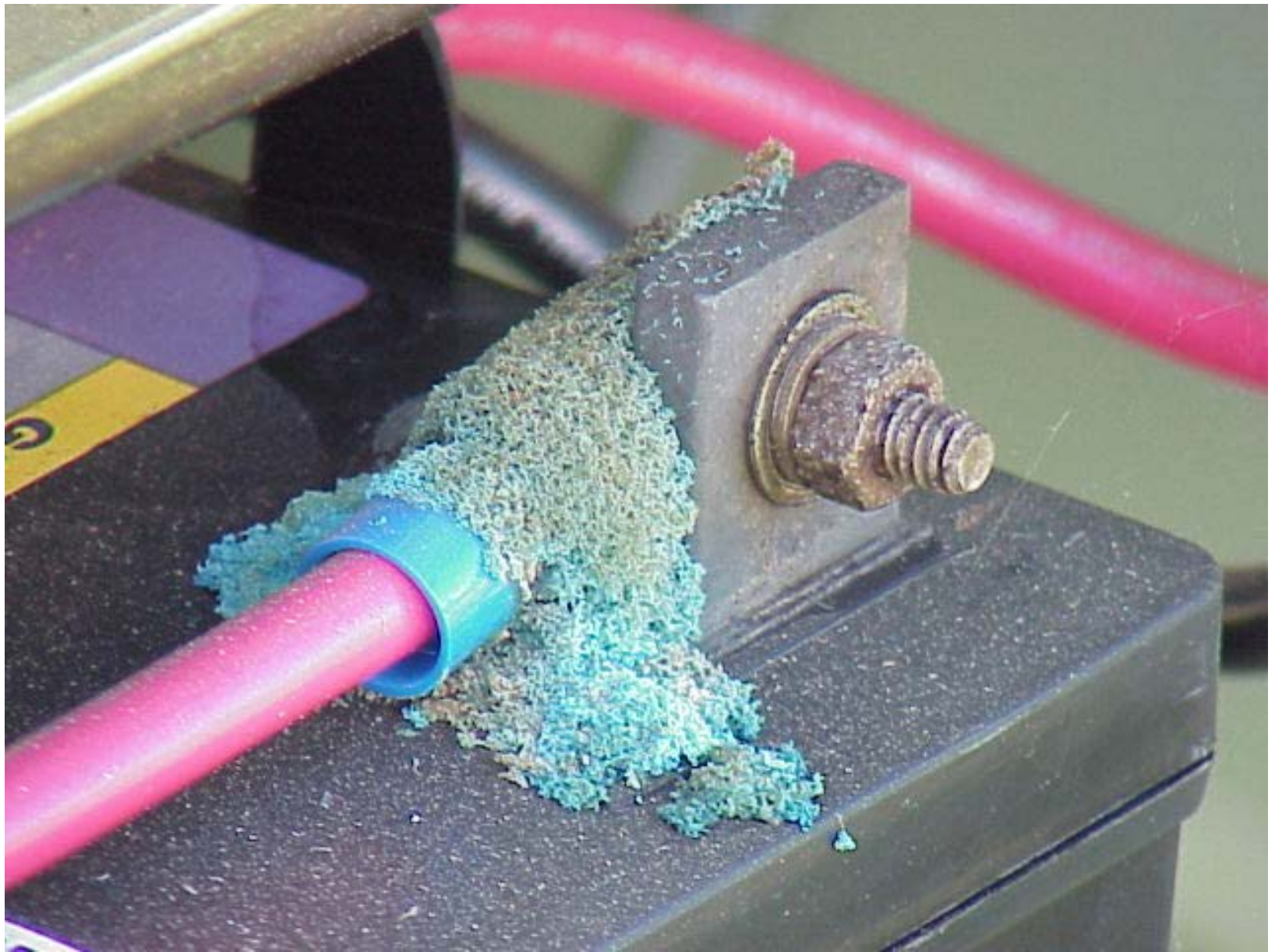


- Bolt
- Lock
- Flat
- (sense wire)
- Battery cable
- Battery terminal

Making Batteries Last Longer

Battery Installation

- Start with a Good Battery
- Transport Safely
- All Batteries in String Same Mfg / Size and within 12 mo.
- Shelf Layout Matters
- Correct Terminal Hardware Stack-Up
- **Terminal Corrosion Protection**



Battery Maintenance

*Oh God, do I really
HAVE to?*



Battery Maintenance

WHY ?

- **Avoiding Unplanned Outages**
 - Think upset customers
 - Think working in bad weather
 - Think always easier when problem is still small

Battery Maintenance

WHEN ?

- **Base on System Health and Metrics**
 - Phone and Business Data Customers?
 - Age of Batteries?
 - Lack of Previous Successful Maintenance History?
 - Status Monitored?
 - Performance History?

Battery Maintenance

HOW ?

- **Visual Inspection**
 - Corroded Terminals?
 - Cracked or Swollen Jars?
 - Date Codes

Battery Maintenance

HOW ?

- Visual Inspection
- **Verify Battery String Fully Charged**
 - Power supply in Float Mode

Battery Maintenance

HOW ?

- Visual Inspection
- Verify Battery String Fully Charged
- **Check Open Circuit Battery Voltage**
 - Replace any less than 12.5VDC

Battery Maintenance

HOW ?

- Visual Inspection
- Verify Battery String Fully Charged
- Check Open Circuit Battery Voltage
- **Conductance Test**
 - Replace when less than 50% of brand new

Battery Maintenance

HOW ?

- Visual Inspection
- Verify Battery String Fully Charged
- Check Open Circuit Battery Voltage
- Conductance Test
- **Load Test**
 - Max range 0.3VDC under load

Battery Maintenance

HOW ?

- Visual Inspection
- Verify Battery String Fully Charged
- Check Open Circuit Battery Voltage
- Conductance Test
- Load Test
- **Document Document Document**

Battery Basics

A Nasty Little Secret about Battery Strings

- Individual Cells do NOT all charge the same, even when they appear to be identical (model, age, etc)

Battery Basics

2.25

+

2.25

+

2.25

+

2.25

+

2.25

+

2.25

=====

13.50 VDC



**Ideal or “on paper”
Charging Voltages**

Battery Basics

2.25

+

2.25

+

2.25

+

2.25

+

2.25

+

2.25

=====

13.50 VDC

2.20

+

2.23

+

2.30

+

2.25

+

2.27

+

2.25

=====

13.50 VDC

← undercharged

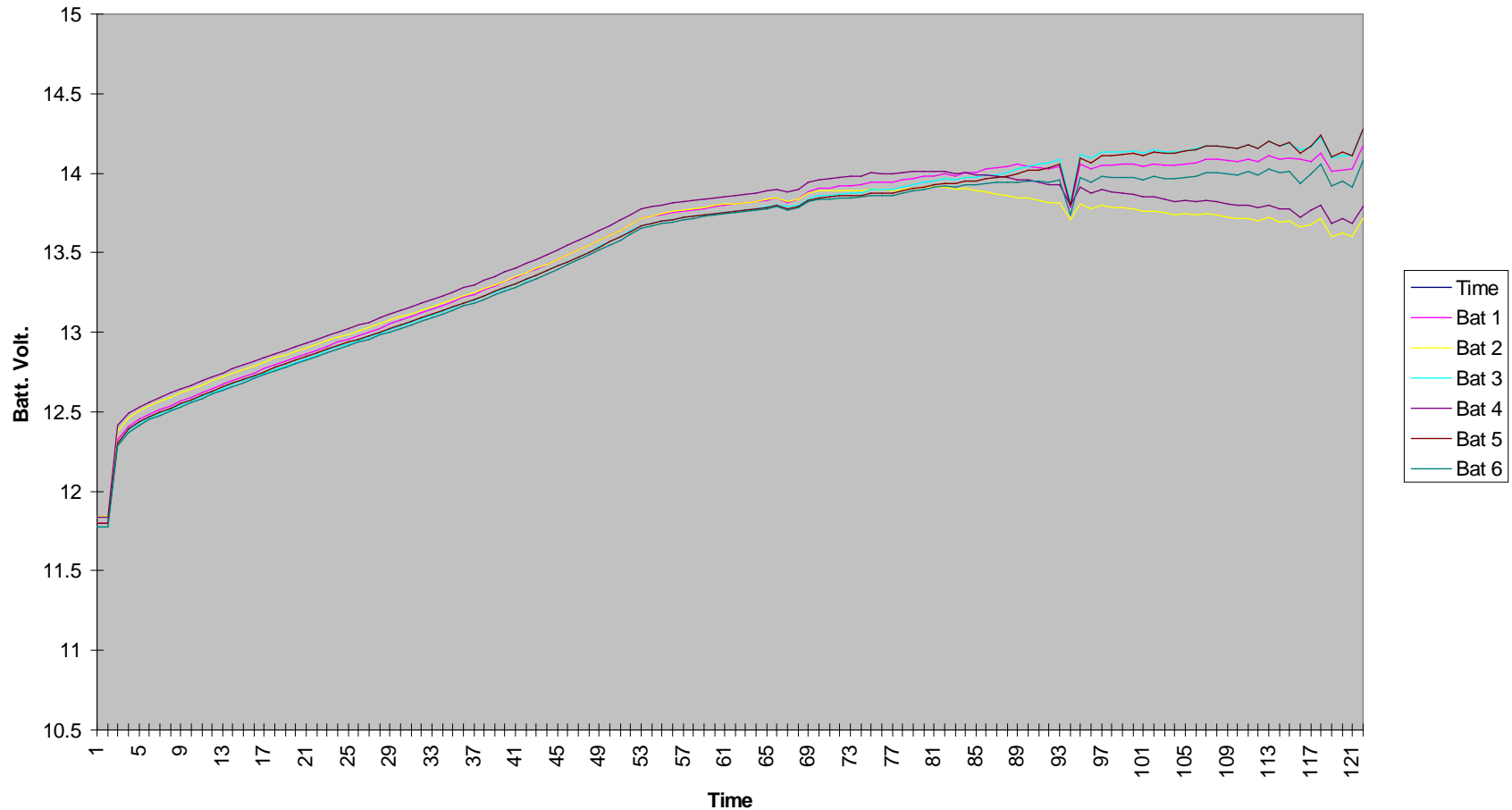
← overcharged

Real World

Charging Voltages

Battery Charging

Six 165GXL batteries in two parallel strings



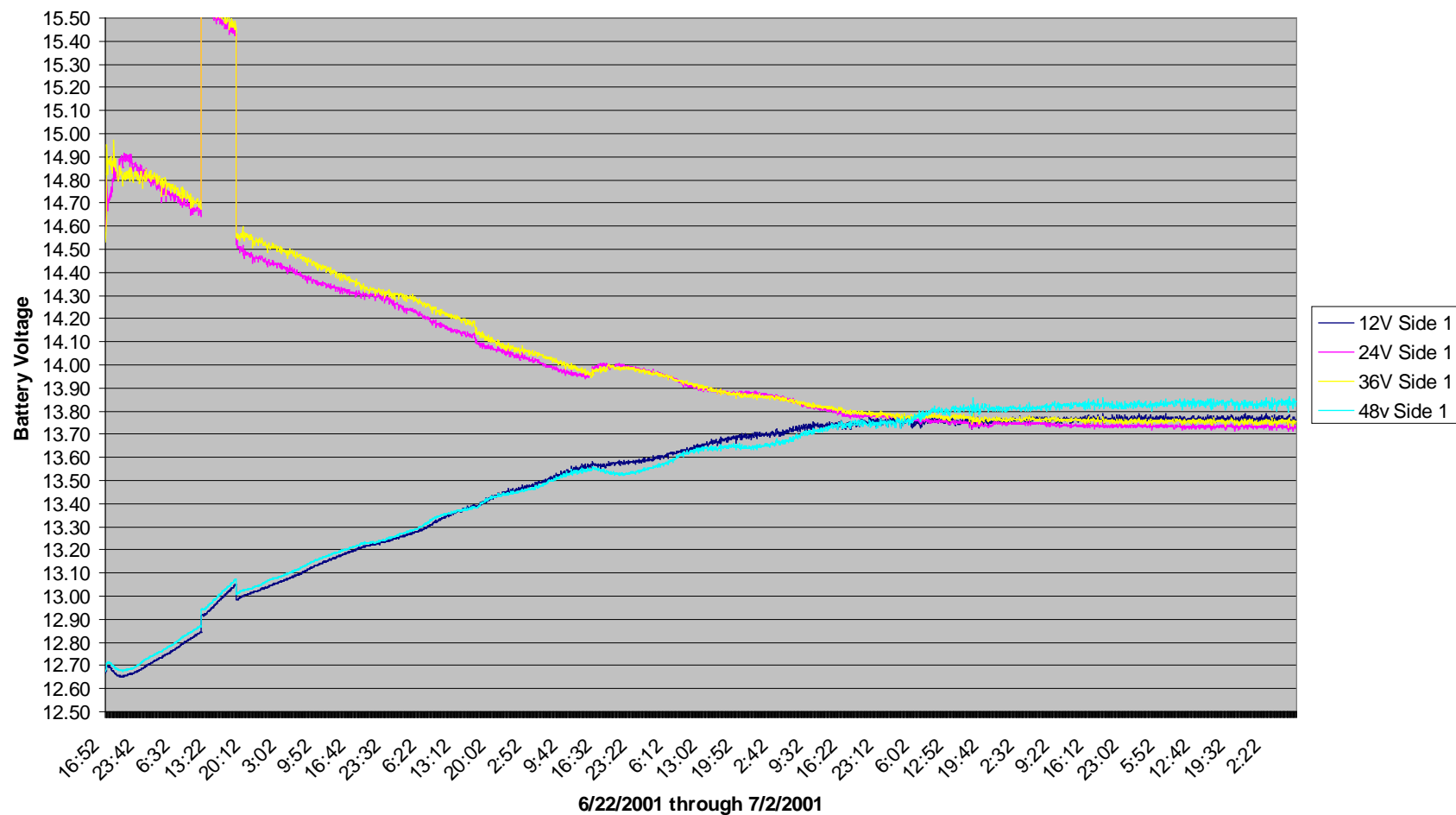
Battery Charging

AlphaGuard Charge Management



Battery Charging

2 old and 2 new batteries in single string



Battery Basics

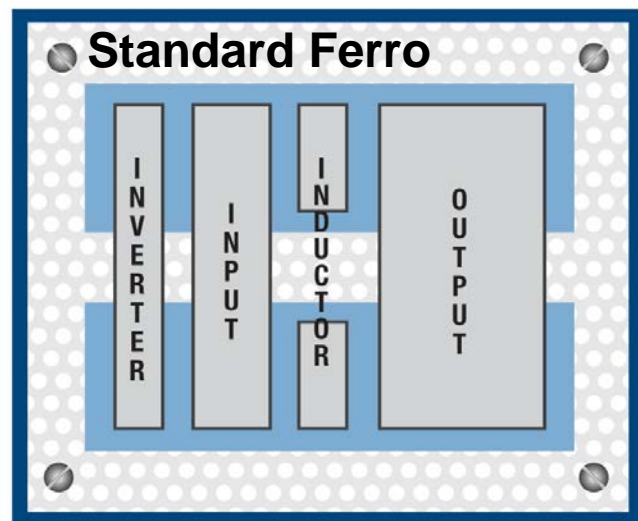
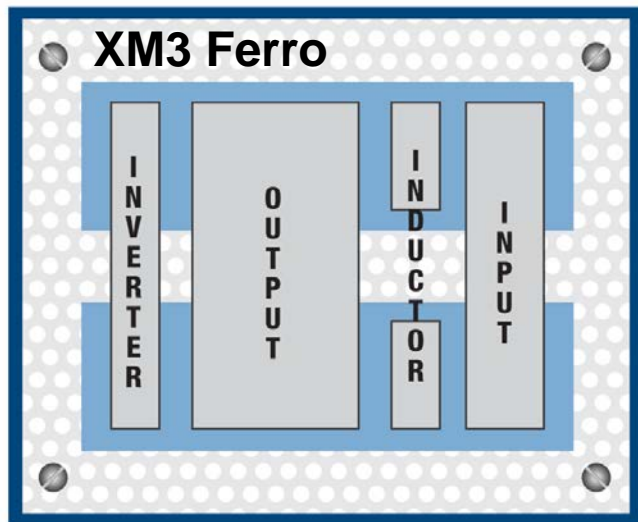
What does Battery Charge Balancing do for *ME*?

- Extends life of battery
- Provides rated run times
- Eliminates false battery alarms in status monitoring

What's New In Power Supplies ??



The Next Generation is Here !



New E³ Ferro Design Topology

Inductor Protects Electronic Loads on Output 1000:1 Attenuation

Inductor Protects Inverter Circuitry 1000:1 Attenuation

1. High Efficiency Line Mode Operation – Reduced Utility Costs
2. Tight High Output Voltage Regulation – Reduced I²R losses and More Reach
3. High Efficiency Inverter Mode Operation – More Battery Runtime

(Product Family 8,10,15,18 Amps. Load Matching → Reduced Utility Costs)

Standard Ferro Designs

Inductor Protects Electronic Loads on Output 1000:1 Attenuation

MOV protection for Inverter Circuitry

Alpha Factor *(line mode & output voltage)*

Your Formula for OpEx Reduction

$$\text{Utility Power kW} = \left(\frac{\begin{array}{c} P_{\text{Network Load}} + \sum \left[\left(\frac{P_{\text{@ Active}}}{V_{\text{@ Active}}} \right)^2 \times \frac{\Omega_{\text{Feet of cable}}}{\text{Feet Distance}} \right] \end{array}}{\text{Power Supply Efficiency}} \right)$$

I²R Power Losses in Cable

Utility Savings Review

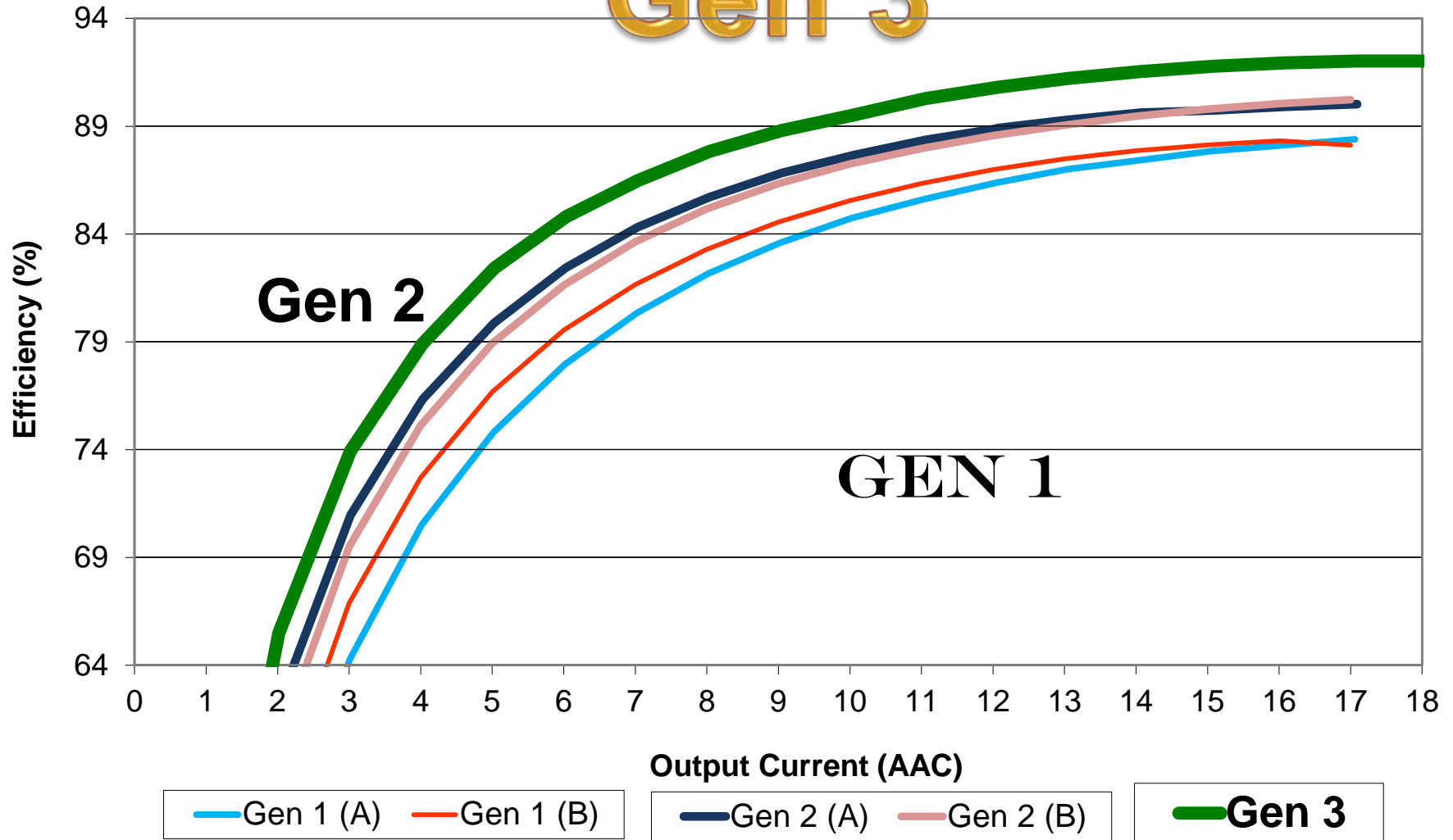
Output Amps 10
Output Voltage (Vac) 90

Gen 1 to XM3 Yearly Utility Savings			
kWh Rate	GEN1 Utility Cost	XM3 Utility Cost	Savings
\$ 0.070	\$651.25	\$578.18	\$73.07
\$ 0.100	\$930.35	\$825.97	\$104.39
\$ 0.125	\$1,162.94	\$1,032.46	\$130.48
\$ 0.150	\$1,395.53	\$1,238.95	\$156.58
\$ 0.200	\$1,860.71	\$1,651.94	\$208.77
\$ 0.250	\$2,325.88	\$2,064.92	\$260.96
\$ 0.350	\$3,256.24	\$2,890.89	\$365.35
\$ 0.400	\$3,721.41	\$3,303.87	\$417.54

Gen 2 to XM3 Yearly Utility Savings			
kWh Rate	GEN2 Utility Cost	XM3 Utility Cost	Savings
\$ 0.070	\$629.56	\$597.45	\$32.11
\$ 0.100	\$899.37	\$853.50	\$45.87
\$ 0.125	\$1,124.21	\$1,066.87	\$57.33
\$ 0.150	\$1,349.05	\$1,280.25	\$68.80
\$ 0.200	\$1,798.73	\$1,707.00	\$91.74
\$ 0.250	\$2,248.42	\$2,133.75	\$114.67
\$ 0.350	\$3,147.79	\$2,987.25	\$160.54
\$ 0.400	\$3,597.47	\$3,414.00	\$183.47

Transformer Efficiency Power Supplies

Gen 3



Summary - CableOne Utility Savings

System #1 – \$ 845/Year and System #2 – \$ 372/Year

Cable Operator System #1 GEN1 to GEN3

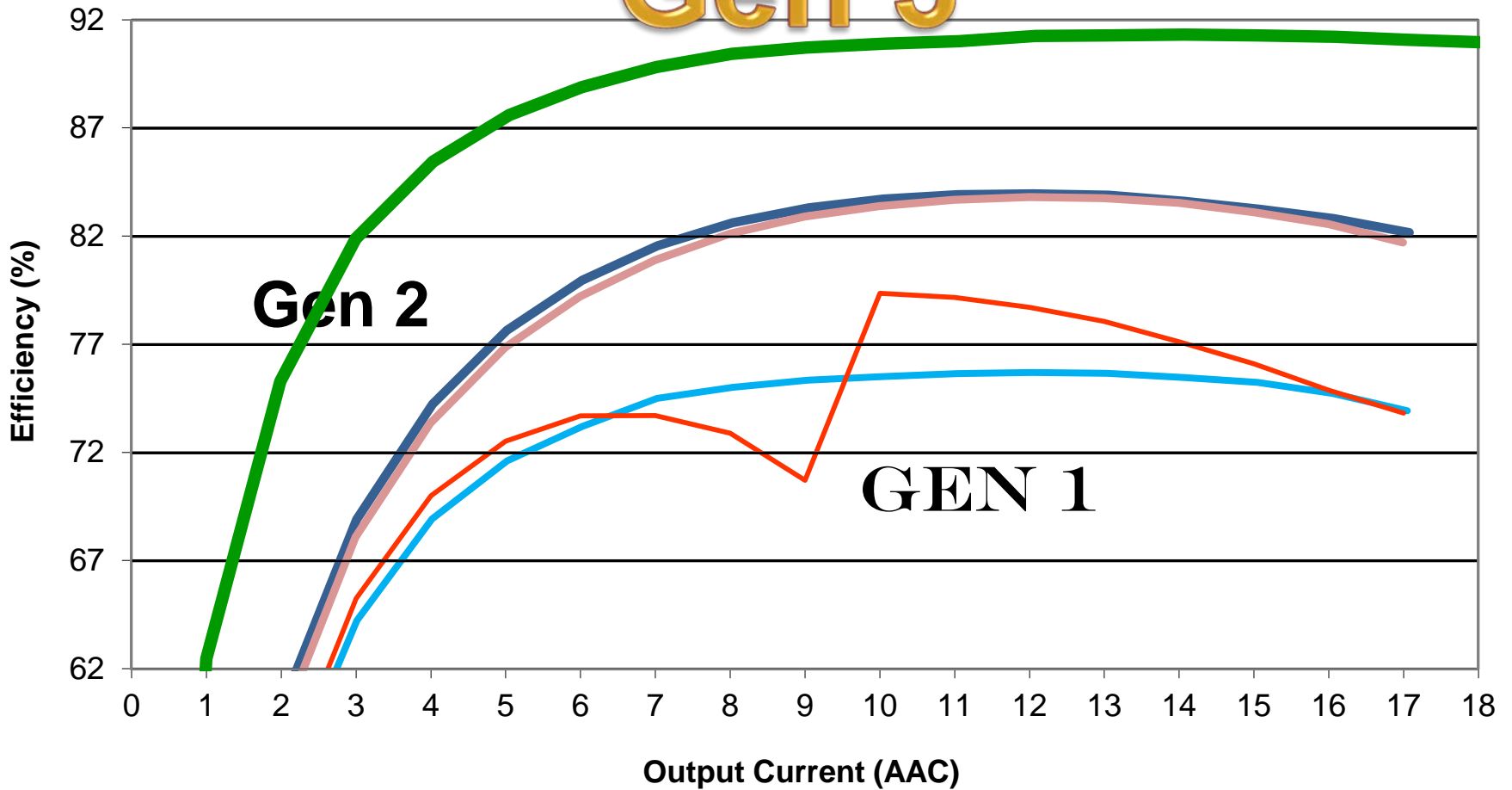
	<u>GEN1 Utility</u> <u>Power</u>	<u>GEN3 Utility</u> <u>Power</u>	<u>% Utility</u> <u>Reduction</u>
Site 1	1.2 kW	1.03 kW	14.17%
Site 2	.7 kW	.64 kW	8.57%
Site 3	.88 kW	.78 kW	11.36%
Site 4	.78 kW	.7 kW	10.26%
Site 5	.65 kW	.58 kW	10.77%
Site 6	.96 kW	.91 kW	5.21%
Site 7	.89 kW	.82 kW	7.87%
Site 8	.35 kW	.3 kW	14.29%
Site 9	.94 kW	.81 kW	13.83%
Site 10	.79 kW	.7 kW	11.39%
Site 11	.78 kW	.66 kW	15.38%
Site 12	.53 kW	.46 kW	13.21%
Total	9.45 kW	8.39 kW	11.22%

Cable Operator System #2 GEN2 to GEN3

	<u>GEN2 Utility</u> <u>Power</u>	<u>GEN3 Utility</u> <u>Power</u>	<u>% Utility Reduction</u>
Site 1	.29 kW	.25 kW	13.8%
Site 2	.35 kW	.32 kW	8.6%
Site 3	.47 kW	.44 kW	6.4%
Site 4	.48 kW	.45 kW	6.2%
Site 5	.5 kW	.47 kW	6.0%
Site 6	.59 kW	.55 kW	6.8%
Site 7	.84 kW	.8 kW	4.8%
Site 8	.61 kW	.57 kW	6.6%
Site 9	.74 kW	.71 kW	4.1%
Site 10	.52 kW	.5 kW	3.8%
Site 11	.77 kW	.72 kW	6.5%
Site 12	.77 kW	.74 kW	3.9%
Site 13	.82 kW	.78 kW	4.9%
Site 14	.56 kW	.54 kW	3.6%
Site 15	.84 kW	.81 kW	3.6%
Site 16	.92 kW	.88 kW	4.3%
Site 17	.81 kW	.78 kW	3.7%
Site 18	.89 kW	.83 kW	6.7%
Site 19	.96 kW	.94 kW	2.1%
Total	12.73 kW	12.08 kW	5.1%

Inverter Efficiency Power Supplies

Gen 3



Gen 1 (A) Gen 1 (B)

Gen 2 (A) Gen 2 (B)

Gen 3

Summary – CableOne Runtime Improvement

System #1 – 16.1 to 24.6%, System #2 – 9.7 to 22.1%

Cable Operator System #1 GEN1 to GEN3

	<u>Power</u> <u>Draw</u>	<u>GEN1</u> <u>Runtime</u>	<u>GEN3</u> <u>Runtime</u>	<u>Increased</u> <u>Runtime</u>	<u>Increased</u> <u>Runtime %</u>	<u>GEN 1 PS</u> <u>Age</u>
Site 1	12.5 Amp	118	146	28	23.7%	1997
Site 6	9.2 Amp	161	187	26	16.1%	1997
Site 8	2.6 Amp	561	699	138	24.6%	1997

Cable Operator System #2 GEN2 to GEN3

	<u>Power</u> <u>Draw</u>	<u>GEN2</u> <u>Runtime</u>	<u>GEN3</u> <u>Runtime</u>	<u>Increased</u> <u>Runtime</u>	<u>Increased</u> <u>Runtime %</u>	<u>GEN 2 PS</u> <u>Age</u>
Site 2	3 Amp	520	635	115	22.1%	2007
Site 7	8.1 Amp	196	215	19	9.7%	2009
Site 19	10.1 Amp	157	175	18	11.5%	2007



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Questions ?

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➤ **Thank you for your time.**

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