Third Party Competitive Field Testing

12V VRLA High Temperature Batteries

Uncontrolled Environment

Phoenix, Arizona

December 2018

ABOUT GS BATTERY (U.S.A.) INC.

GS BATTERY (U.S.A.) INC. is a global leader in energy storage. Our batteries are manufactured to the highest standards and deliver high quality, long life and superior performance in a wide variety of mission critical applications. GS Battery's products deliver reliable battery power for Telecommunications, Energy Storage, Renewable Energy, Uninterruptible Power Supply (UPS), Emergency Lighting, Power Sports, and Automotive industries.

GS YUASA Group Company

Project Overview

In 2016, a tier one carrier engaged a third party engineering company to evaluate battery models from five manufacturers in uncontrolled cabinet sites (no HVAC) at four sites in the Phoenix, AZ area. All five manufacturers' products were marketed as high temperature batteries.

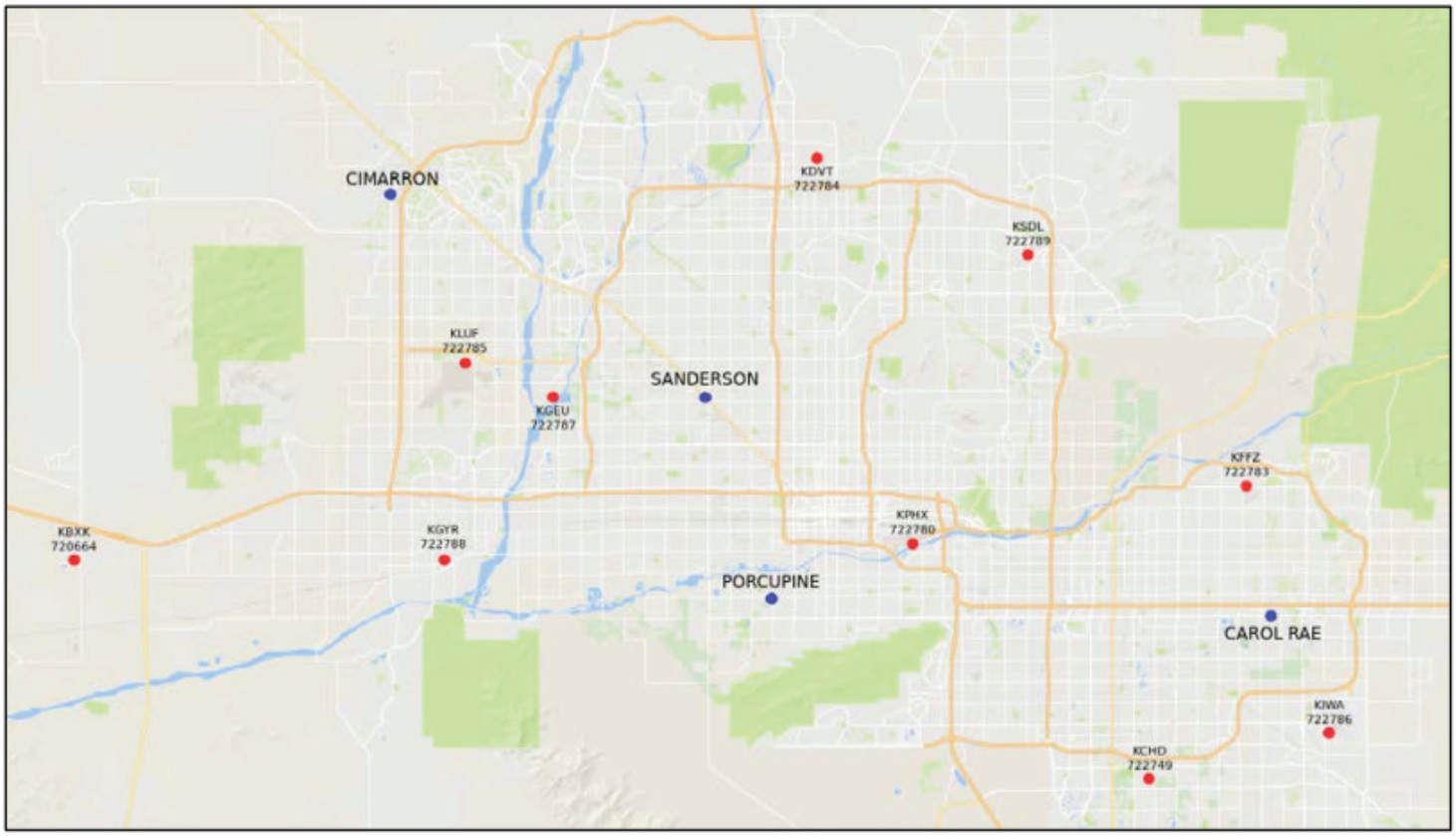

Figure 1: Location of battery installations (blue dots) and weather stations (red dots) in the Phoenix, AZ area.

Project Methodology

- All Manufacturers' Products Were Baselined In The Lab Before Shipping To Site
- Products Were Installed At The Sites In Late 2016
  - Cabinets Did Not Have Air Conditioning
- String Voltage, Current, and Temperature Were Continually Monitored
  - Data Was Periodically Downloaded and Reviewed
- After Approximately One Year and Two Years In Service, Batteries Were Capacity Tested And Results Compared
- ***All Sites Have Experienced Two Summers Without Air Conditioning In Desert Conditions***

Project Discharge Test Results

After Two Years, Capacity Loss On Three Manufacturers' Products Was Between 1% and 23% Approximately.

One Manufacturer's Product Failed And Has Been Replaced

GSB's ***PYL12V185FT*** High Temperature Battery's Capacity Increased By 14%, Yielding Best In Class Performance.

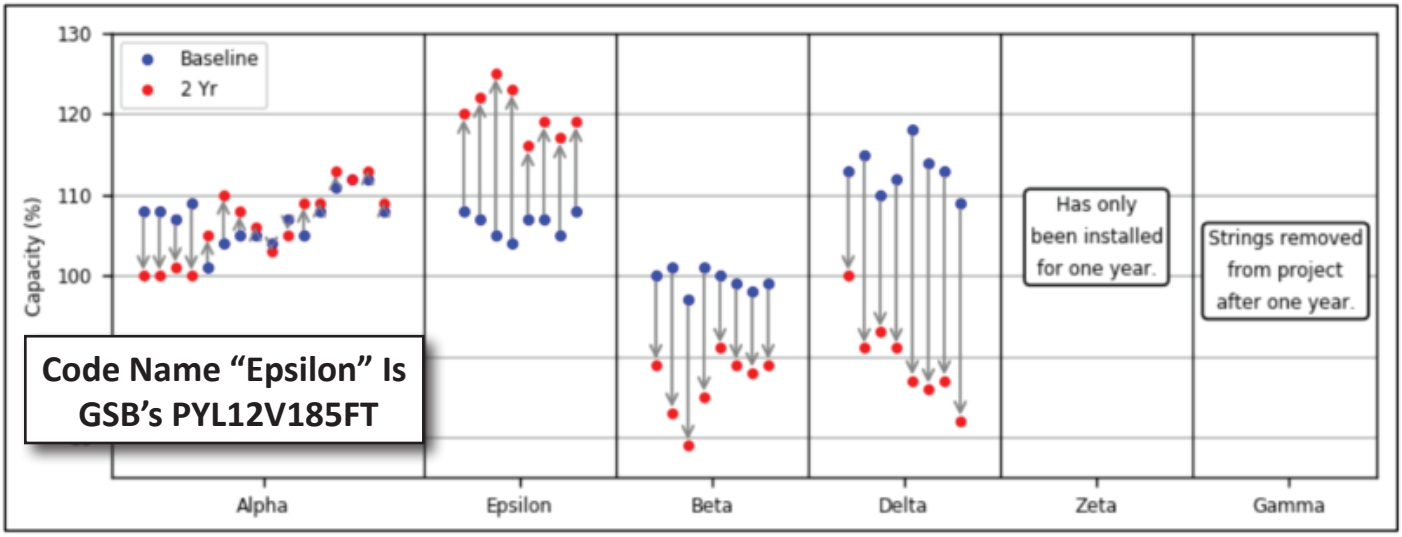

Figure 4: Comparison of baseline and two-year capacity tests

Type	Δ 1 Yr (Avg) Baseline to Year 1	Δ 2 Yr (Avg) Year 1 to Year 2	Δ Total (Avg) Baseline to Year 2
Alpha	3%	-4%	-1%
Beta	-7%	-6%	-13%
Delta	-16%	-8%	-23%
Epsilon	12%	1%	14%
Zeta	-3%	--	--
Gamma	-8%	--	--

Table 2: Average capacity change. Zeta and Gamma do not have two year results.

Thermal Data

- Cabinet Ambient Temperatures Were Between 42°F and 122°F.
- Battery Temperatures Varied From Cabinet Temperature +/-3°F
- Cabinet And Battery Maximum Temp Exceeded 100°F Five of 12 Months.

		Epsilon Temperature Dec. 16- Nov. 17											
		Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Outside Ambient	max	87	90	87	107	108	118	131	128	122	121	110	97
	mean	58	55	62	71	77	84	97	98	96	89	80	71
	min	34	34	35	39	46	55	62	73	70	55	55	53
Cabinet Ambient	max	70	68	77	94	98	109	122	119	112	111	99	85
	mean	58	56	62	71	77	84	97	97	95	89	81	73
	min	43	42	46	50	58	64	70	78	76	68	65	63
String L Epsilon Middle	max	70	69	77	93	96	107	120	118	111	110	97	84
	mean	59	56	62	72	78	85	97	98	96	89	82	73
	min	44	44	48	52	60	65	73	80	79	69	66	64

Summary

After Two Years Of Operation In A Desert Environment Installed In Cabinets Without Air Conditioning, GS Yuasa's ***PYL12V185FT*** Is Delivering 114% Of Rated Capacity While Others Have Dropped As Low As 77% Or Have Even Been Removed From The Trial.

The GS Yuasa Product Is Delivering Best In Class Performance. The Trial Continues And The Results Gathered Corroborate The Data GSB Has Gathered In Our Own Similar High Heat Trials Over The Past Several Years.

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