

Competitive Testing

INDUSTRIAL LINE (FLAT PLATE) VS. 2V OPZS (TUBULAR)

Product group: Trojan Industrial Line with Smart Carbon™

High-capacity, flat-plate, vented, deep-cycle

OPzS Competitors

High-capacity, tubular plate, vented, deep-cycle

Endurance in cycles according to Test Chapter: IEC 61427:2005-05: Secondary cells and batteries for PV energy systems General requirements and methods of test Chapter 8.4: Cycle endurance test in photovoltaic application (extreme conditions)

Test laboratory: Trojan Battery Company

Test temperature: 40°C ± 3°C (104°F ± 5.4°F)

Test started: June 2013

Test ended: Dependent on battery manufacturer's model (See Test Results)

Test Description

Today, lead acid batteries remain the most common and widely available battery technology for solar photovoltaic (PV) systems in which batteries are cycled regularly under extreme climates and conditions. Industrial lead acid batteries are used for off-grid systems in different applications such as off-grid homes, microgrids and commercial buildings.

Globally, there are many different test methods and parameters used by various battery companies to determine cycle life at different depth of discharges (DOD). Because of the variability in these test methods, it is difficult to accurately compare the expected life of different lead acid batteries in an off-grid solar application by comparing cycle life charts on manufacturers' data sheets.

The IEC 61427 test standard for batteries used in solar PV applications where batteries are cycled regularly in extreme conditions, allows for a more accurate comparison between different lead acid battery technologies, and is recommended by Battery Council International (BCI) and Eurobat. It is a standard test developed with specific operating parameters, and is designed to show life of a battery in a solar cyclic application.

Trojan performed the IEC 61427 test to demonstrate performance of the Trojan Industrial Line of flooded flat plate batteries versus OPzS flooded tubular batteries from other manufacturers. These test results are intended to help customers make informed decisions when purchasing high-capacity, industrial-type batteries for photovoltaic systems in which batteries are cycled regularly.



BAE

Hoppecke

Exide/Tudor

Trojan Solar Industrial Line

Battery	OPzS	Trojan SIND 02 1990*
Rated Capacity	2V 1420Ah @ C ₁₀ - Hr	2V 1368Ah @ C ₁₀ - Hr

Test Process

The IEC 61427 is the most accurate test to compare the lifespan of batteries in a photovoltaic system. The test simulates the load profile under extreme conditions of the battery operation in a PV energy system. The test is performed at high temperatures, 40°C ± 3°C (104°F ± 5.4°F)

It's very common in a solar PV application for batteries to operate at partial states of charge (PSOC) due to the intermittency of sunlight, as well as being installed in areas of extreme temperatures. The IEC 61427 test protocol mimics irregular charging, and tests the batteries at low state of charge and high state of charge in elevated temperatures.

Testing is conducted by alternating two charging phases by a specific number of cycles

- 1. Shallow cycling at low state of charge at 50 cycles**
- 2. Shallow cycling at high state of charge at 100 cycles.**

Batteries Tested

Trojan performed the IEC 61427 test on three of the most well-known OPzS tubular batteries in the industry to compare their performance with the performance of the Trojan Industrial flat-plate flooded battery.

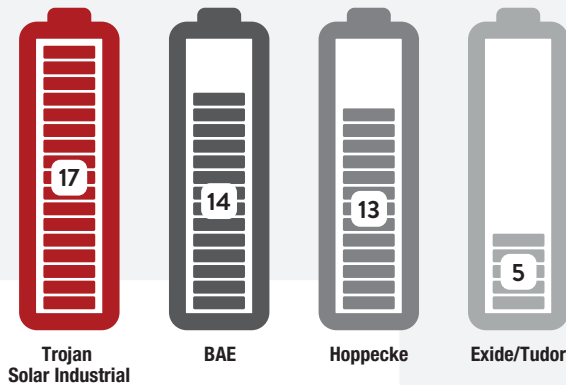
The test began in June 2013 and ended at different times for each brand.

Test Results

Battery Brand	Test Date Start/Stop	# Months the test lasted	IEC 61427 # Total Cycles	IEC 61427 Equivalent Years of service life
Trojan Industrial	12/18/13 - 4/29/16	28 months	2,550	17 years
BAE	6/3/13 - 6/5/15	24 months	2,100	14 years
Hoppecke	6/3/13 - 6/15/15	24 months	1,950	13 years
Exide/Tudor	6/3/13 - 2/24/15	9 months	750	5 years

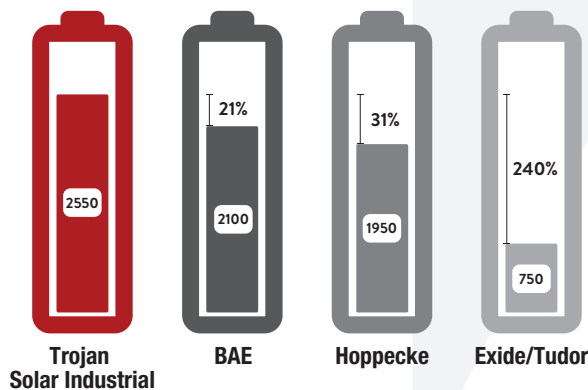
NOTE: 150 cycles is equivalent to one-year service life. The end of life criteria being 80% remaining capacity at a 10 hr. rate.

IEC 61427 EQUIVALENT YEARS OF LIFE



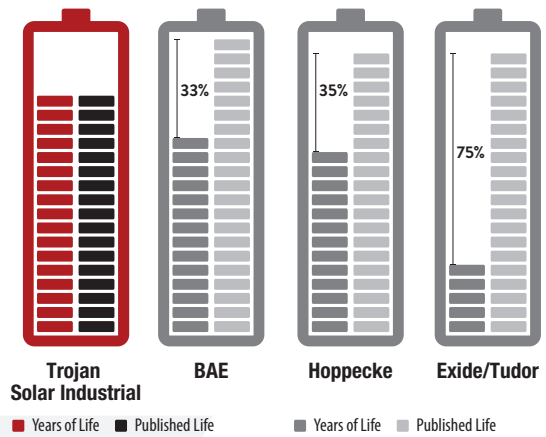
The graph above shows the equivalent years of life. Every 150 cycles under the IEC 61427 test is equal to 1 year of life in the field. The Trojan Industrial Line testing shows it to last 17 years versus the BAE of 14 years, Hoppecke of 13 years and Exide/Tudor of 5 years.

IEC 61427 TOTAL NUMBER OF CYCLES



The graph above shows that the Trojan Industrial Line outperformed the three OPzS batteries tested, and depicts 21% more cycles than the BAE, 31% more cycles than the Hoppecke, and 240% than the Exide/Tudor.

IEC 61427 YEARS OF LIFE VS PUBLISHED LIFE



The graph above shows the equivalent years of life versus the published life. Trojan Industrial Line testing resulted in the same 17 years of life as Trojan reports in its product data.

Based on the test performed, the Trojan Industrial Line provides 20% to 30% more life than the top performing Hoppecke battery in the market today, and it can also provide 2.5 times more life than a standard OPzS battery. In the case of the three OPzS batteries tested, the published manufacturer data shows much higher years of life than the actual results of the IEC 61427 test.

BAE the manufacture states that the battery lasts 21 years, however, the actual test results show only 14 years, indicating 33% less life.

Hoppecke the manufacture states that the battery lasts 20 years, however, the actual test results show only 13 years indicating 35% less life.

Exide/Tudor the manufacturer data states the battery should last 20 years, however, it lasted only five years in testing, indicating 75% less life.

Conclusion

Testing indicates that Trojan Industrial flooded batteries with Smart Carbon, flat-plate technology last 20 - 30% longer in comparison with the top performing OPzS batteries offered for renewable energy applications based on the IEC 61427 test.

The IEC 61427 test results show that the OPzS batteries tested have 30% to 75% lower cycle life than the data reported by the manufacturers of these tubular battery models.

Note: Manufacturers publish the results of the IEC 61427 testing in specific reports. This information is not always available in the data sheets.

*The Solar Industrial SIND 02 1990 battery was previously the IND27-2V battery.

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