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**PRODUCT GUIDE**

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# Introduction

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*The principle of gas recombination, which limits the release of gas, allows the batteries to be installed in the widest possible range of sites ensures it is compatible with modern technology.*

*The purpose of this operating guide is to provide you with technical information to gain a better understanding of the PowerSafe® OPzV battery gas-recombination range and will enable you to use it more effectively.*

# I/ The principle of the gas recombination tubular gel battery

## 1 - Operating principle

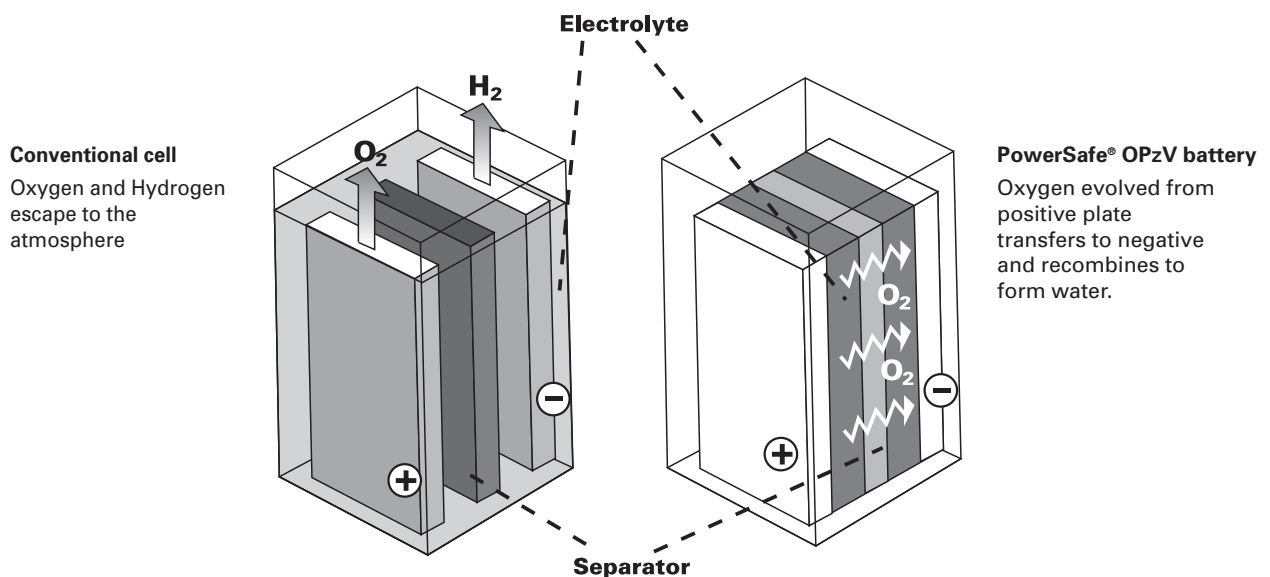
In a traditional lead – acid battery, overcharging leads to a release of hydrogen and oxygen, a certain amount of water is lost and has to be replaced regularly by topping up.

In a gas recombination battery, the internal design of the cell allows the oxygen produced at the positive plates to diffuse toward the negative plates :

- The oxygen reacts chemically with the spongy lead of the active material to form lead oxide.
- The sulphuric acid of which the electrolyte is composed then reacts with this lead oxide to form lead sulphate and water.
- The lead sulphate thus formed is transformed electro-chemically into lead, to return sulphuric acid.
- As long as the battery remains fully charged, this equilibrium is maintained.

Schematically, we then have the following reactions :

At the end of the charge or if overcharging, oxygen gas is released at the positive plate.	$H_2O \rightarrow 2H^+ + 1/2O_2 + 2e^-$
The oxygen diffuses across the gelled electrolyte and the micro-porous separator to the negative plate.	
The oxygen reacts chemically with the spongy lead of the negative plate to form lead oxide. The sulphuric acid reacts with this lead oxide, giving lead sulphate and water. Part of the spongy lead is thus chemically discharged to the lead sulphate state and the water consumed at the positive plate is regenerated.	$Pb + 1/2O_2 \rightarrow PbO$  $PbO + H_2SO_4 \rightarrow PbSO_4 + H_2O$
The spongy lead which was chemically discharged at the negative plate is recharged chemically.	$PbSO_4 + 2H^+ + 2e^- \rightarrow Pb + H_2SO_4$



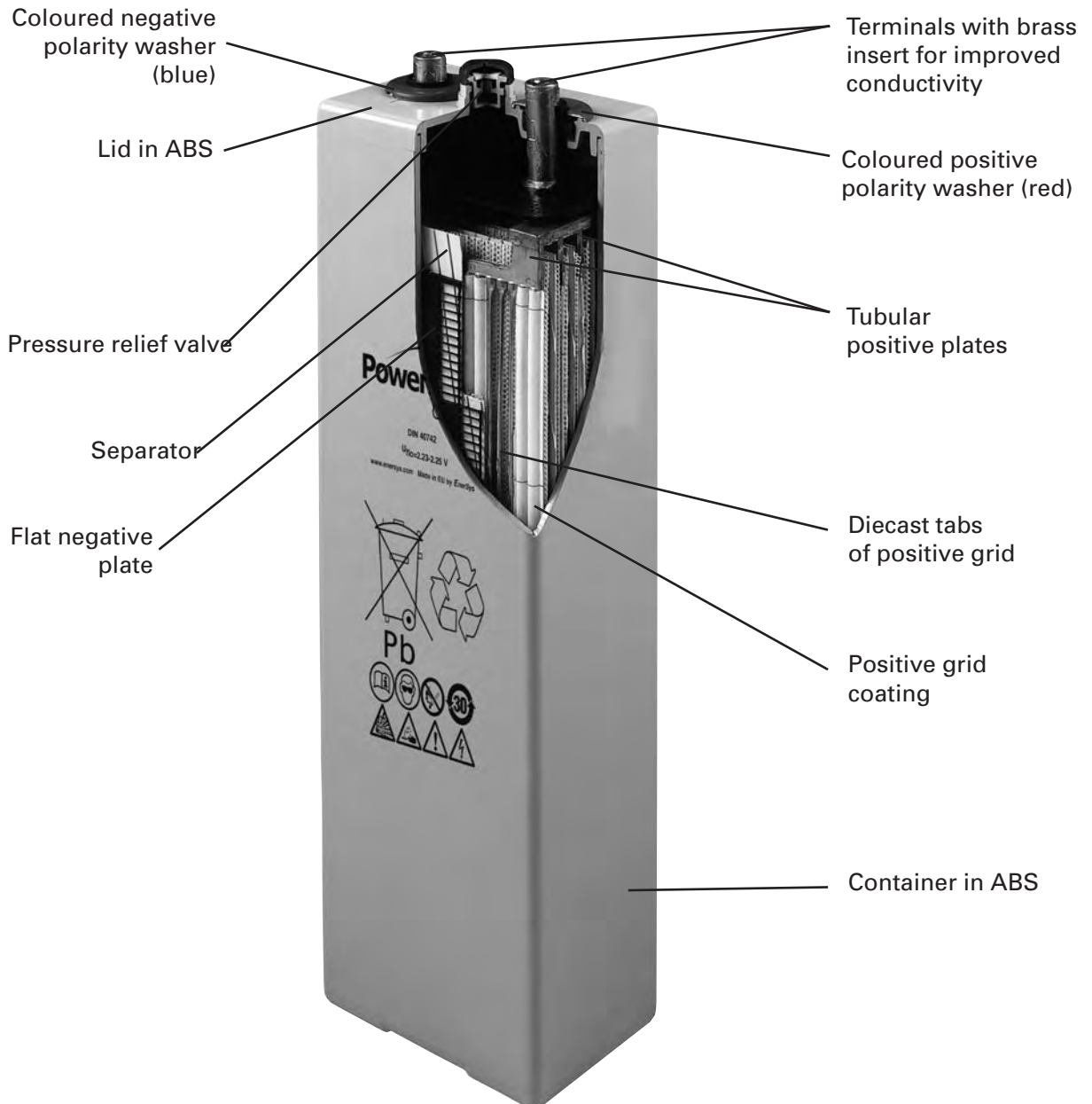
## 2 - Conclusion

Due to the gas recombination reaction in the PowerSafe® OPzV battery, water is recombined nearly at the same rate as it is consumed under float charge conditions and no topping up water during the lifetime of the cells is required.

### 3 - Construction

These reactions can take place only by using :

- plates composed of a special lead calcium alloy which provides the grids with high mechanical strength and a high level of hydrogen overextension.
- microporous separators
- A capillary network gelled electrolyte :  
To retain the electrolyte in a thixotropic gel  
To help oxygen penetration into the negative plate.
- A pressure relief valve which allows gas to be released if necessary in the case of an accidental overcharge.

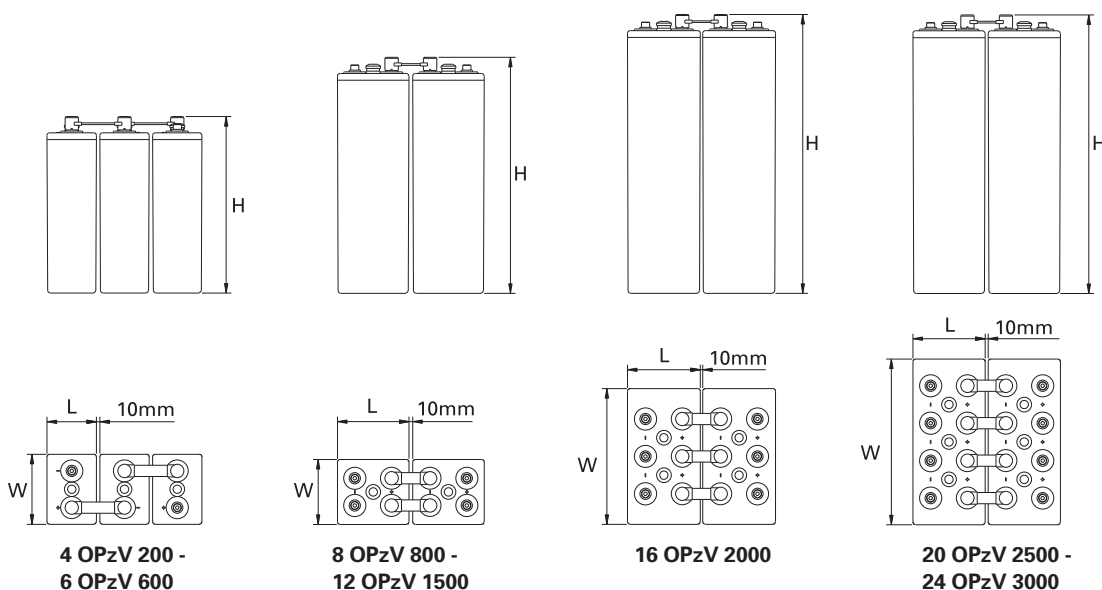


## 4 - The PowerSafe® OPzV Battery range

Comprises 14 cells with capacities from 200 Ah to 3000 Ah.

Type designation	No of terminal per pole	Capacity Ah acc. to DIN 40742	Capacity Ah					Internal resistance (m ohm /cell)	Short circuit current	Dimensions (mm)			Weight (kg) cell	Type
			C <sub>10</sub>	C <sub>8</sub>	C <sub>5</sub>	C <sub>3</sub>	C <sub>1</sub>			Length	Width	Height		
			at final voltage											
			1.80V	1.75V	1.77V	1.75V	1.67V							
4 OPzV 200	1	200	215	210	190	170	130	0.95	2195	103	206	403	19.5	4 OPzV 200
5 OPzV 250	1	250	265	260	235	210	160	0.76	2737	124	206	403	23.5	5 OPzV 250
6 OPzV 300	1	300	320	315	285	255	195	0.66	3175	145	206	403	28.0	6 OPzV 300
5 OPzV 350	1	350	385	375	340	305	230	0.61	3410	124	206	520	31.0	5 OPzV 350
6 OPzV 420	1	420	460	450	410	365	275	0.51	4043	145	206	520	36.5	6 OPzV 420
7 OPzV 490	1	490	540	525	475	430	320	0.45	4607	166	206	520	42.0	7 OPzV 490
6 OPzV 600	1	600	705	680	615	545	395	0.55	3796	145	206	695	50.0	6 OPzV 600
8 OPzV 800	2	800	940	910	820	730	525	0.40	5200	210	191	695	68.2	8 OPzV 800
10 OPzV 1000	2	1000	1170	1135	1020	915	655	0.32	6460	210	233	695	82.0	10 OPzV 1000
12 OPzV 1200	2	1200	1410	1370	1225	1095	790	0.27	7675	210	275	695	97.0	12 OPzV 1200
12 OPzV 1500	2	1500	1580	1530	1395	1260	890	0.28	7510	210	275	845	120.0	12 OPzV 1500
16 OPzV 2000	3	2000	2110	2040	1855	1680	1190	0.21	10048	212	397	820	165.0	16 OPzV 2000
20 OPzV 2500	4	2500	2640	2550	2320	2100	1485	0.17	12606	212	487	820	200.0	20 OPzV 2500
24 OPzV 3000	4	3000	3170	3065	2785	2515	1785	0.14	14964	212	576	820	240.0	24 OPzV 3000

All dimensions and weights shown are subject to the usual manufacturing tolerances  
Height shown is overall height, including connectors and shrouds.



# II/ Application and use of the PowerSafe® OPzV batteries

*The application possibilities are multiple - as back-up supplies in telecom-munications, telephony, power generating stations and distribution systems, railway, airport or seaport signalling, computing, lighting, the armed forces, in the medical field, etc. - giving independent operation between 1 hour and 24 hours to such installations.*

## 1 - Standby applications

### 1-1 Float voltage :

The batteries are kept under a floating voltage of 2.23 volts per cell at a temperature of 20°C (tolerance 2.23-2.25 Vpc.

This float voltage should be set to match the prevailing temperature, in accordance with the following table.

Temperature (C°)	Float voltage (volt)
-10°C	2.37 Vpc
0°C	2.33 Vpc
10°C	2.29 Vpc
20°C	2.25 Vpc
30°C	2.23 Vpc
40°C	2.21 Vpc

Due to the phenomena of gas recombination a difference of  $\pm 4.5\%$  for an individual cell voltage can be observed.

However the total voltage of the battery shall be within the limits stated above.

### 1-2 Charging Current :

Limitation of the charging current is not required under float charge condition at 2.25 Vpc. At higher charge voltages the charge current shall be limited to  $0.4C_{10}$ .

### 1.3 Discharging : End of discharge voltage according to the discharge time

Discharge Time (t)	End voltage (volt)
1 h < t < 5 h	1.70 V
5 h < t < 8 h	1.75 V
8 h < t < 24 h	1.80 V

Although the tables of characteristics show end voltages down to 1.60 volts, the voltage values shown above are recommended in order to avoid a too-deep discharge of the battery.



## 1.4 Recharging :

The PowerSafe® OPzV battery should be recharged by using a unique floating and recharge voltage at 2.23-2.25 V/cell at 20°C. No current limitation is required in the majority of application cases.

If the PowerSafe OPzV battery has to be charged more quickly, a recharge voltage of 2.35 volts (boost charge) per cell can be used with current limited to  $0.4C_{10}$

Mean charging time in accordance with percentage discharge and recharging voltage per cell with current limited to $0.4C_{10}$								
Percentage discharge	Recharging voltage	State of charge						
		50%	60%	70%	80%	90%	95%	100%
10%	2.23V	-	-	-	-	-	2 <sup>h</sup> 00	12 <sup>h</sup> 00
	2.35V	-	-	-	-	-	1 <sup>h</sup> 45	7 <sup>h</sup> 00
30%	2.23V	-	-	-	1 <sup>h</sup> 15	4 <sup>h</sup> 00	8 <sup>h</sup> 00	24 <sup>h</sup> 00
	2.35V	-	-	-	1 <sup>h</sup> 00	3 <sup>h</sup> 00	6 <sup>h</sup> 00	14 <sup>h</sup> 00
50%	2.23V	-	0 <sup>h</sup> 45	1 <sup>h</sup> 30	4 <sup>h</sup> 00	8 <sup>h</sup> 30	15 <sup>h</sup> 00	38 <sup>h</sup> 00
	2.35V	-	0 <sup>h</sup> 30	1 <sup>h</sup> 15	3 <sup>h</sup> 00	5 <sup>h</sup> 30	10 <sup>h</sup> 00	22 <sup>h</sup> 00
80%	2.23V	1 <sup>h</sup> 00	1 <sup>h</sup> 30	3 <sup>h</sup> 00	7 <sup>h</sup> 00	13 <sup>h</sup> 00	25 <sup>h</sup> 00	56 <sup>h</sup> 00
	2.35V	1 <sup>h</sup> 00	1 <sup>h</sup> 30	2 <sup>h</sup> 30	5 <sup>h</sup> 00	9 <sup>h</sup> 15	15 <sup>h</sup> 00	34 <sup>h</sup> 00
100%	2.23V	2 <sup>h</sup> 00	2 <sup>h</sup> 30	4 <sup>h</sup> 30	10 <sup>h</sup> 00	20 <sup>h</sup> 00	35 <sup>h</sup> 00	80 <sup>h</sup> 00
	2.35V	2 <sup>h</sup> 00	2 <sup>h</sup> 30	4 <sup>h</sup> 00	7 <sup>h</sup> 15	14 <sup>h</sup> 00	24 <sup>h</sup> 00	50 <sup>h</sup> 00

## Recharging voltage according to temperature :

Temperature (C°)	Charging voltage (volt)
0°C	2.45 V
10°C	2.40 V
20°C	2.35 V
30°C	2.32 V
35°C	2.30 V

### \* Note :

If the charger does not permit an adjustment of the float voltage in relation with the temperature, it is possible to set a float voltage value in recharging voltage value according to the temperature ranges as indicated in the table hereafter.

Temperature (C°)	Float voltage (Vpc)	Recharging voltage (Vpc)
-10°C to 5°C	2.40 V	2.50 V
5°C to 15°C	2.30 V	2.40 V
15°C to 30°C	2.25 V	2.35 V
30°C to 45°C	2.20 V	2.30 V

## 1.5 Ripple current :

Unacceptable levels of ripple current from the charger of the load can cause permanent damage and a reduction in service life. It is recommended to

limit the continuous ripple current to  $0.05C_{10}$  (in amperes) as recommended value, never exceed  $0.1 C_{10}$ .

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## 2 - Battery cycling

### Definition

Battery cycling implies use in a regular cycle, with full discharge followed by re-charging on a daily or weekly basis for example.

The number of such cycles which can be obtained is typically over 1200, in conformity with the IEC896-2 (1995).

**Important note :** For all applications which use the PowerSafe® OPzV type battery in a cycling system, it is recommended that the technical department of EnerSys® should be contacted so that the technical parameters can be specified for the precise cycling programme in question.

## 3 - Effect of temperature on battery capacity

The temperature has an effect on the battery capacity available. The following table gives the relevant details for a temperature of 20°C.

Discharge time (hours)	Correction factor for capacity calculation according to temperature (the reference temperature is 20°C)					
	-10°C	0°C	10°C	20°C	30°C	40°C
1	0.37	0.61	0.82	1.00	1.05	1.07
3	0.51	0.70	0.85	1.00	1.05	1.06
5	0.55	0.73	0.87	1.00	1.04	1.06
10	0.58	0.75	0.88	1.00	1.04	1.05
12 to 24	0.60	0.78	0.91	1.00	1.03	1.05

## 4 - Temperature range

The ideal ambient temperature for PowerSafe OPzV batteries is 20°C ± 5°C (best performance and service life) The operating temperature shall be in the range of 10 and 35°C

The maximum and minimum permissible temperature is 45°C and -10°C.

## 5 - Effect of temperature on life

Operation of valve regulated batteries at temperatures higher than 20°C will reduce life expectancy. Higher temperature increases the speed of chemical reactions resulting in reduction of service life. A temperature increase of 10°C decreases the service life to half (law of Arrhenius)

# III/ Electrical performances at 20°C

## Constant current discharge in amperes

Voltage end of discharge : 1.60 V/cell

Type	15'	30'	1h	2h	3h	4h	5h	6h	7h	8h	9h	10h	12h	20h	Type
4 OPzV 200	302	215	133	79,1	57,7	46,1	38,4	33,3	29,4	26,3	23,9	21,9	18,9	12,3	4 OPzV 200
5 OPzV 250	375	268	167	98,8	72,1	57,6	48,0	41,6	36,7	32,9	29,9	27,4	23,7	15,4	5 OPzV 250
6 OPzV 300	448	321	200	119	86,5	69,1	57,7	49,9	44,1	39,5	35,8	32,9	28,4	18,5	6 OPzV 300
5 OPzV 350	467	359	237	141	103	82,8	69,2	59,7	52,5	46,9	42,7	39,2	33,8	21,9	5 OPzV 350
6 OPzV 420	556	429	284	170	124	99,4	83,0	71,6	63,1	56,3	51,2	47,0	40,6	26,3	6 OPzV 420
7 OPzV 490	644	498	331	198	145	116	96,8	83,6	73,6	65,7	59,7	54,9	47,4	30,7	7 OPzV 490
6 OPzV 600	718	595	424	255	187	150	125	108	95,5	85,4	77,6	71,3	61,6	40,0	6 OPzV 600
8 OPzV 800	989	809	569	340	250	200	167	145	127	114	104	95,1	82,2	53,4	8 OPzV 800
10 OPzV 1000	1225	1005	710	425	312	250	209	181	159	142	129	119	103	66,7	10 OPzV 1000
12 OPzV 1200	1457	1199	851	510	375	300	251	217	191	171	155	143	123	80,1	12 OPzV 1200
12 OPzV 1500	1458	1271	971	593	431	342	283	244	215	191	173	158	137	88,9	12 OPzV 1500
16 OPzV 2000	1983	1720	1303	790	574	456	378	326	286	255	231	211	183	118	16 OPzV 2000
20 OPzV 2500	2454	2134	1624	988	718	570	472	407	358	319	289	264	228	148	20 OPzV 2500
24 OPzV 3000	2916	2542	1942	1186	862	683	566	488	429	383	347	317	274	178	24 OPzV 3000

## Constant power in watts per cell

Voltage end of discharge : 1.60 V/cell

Type	15'	30'	1h	2h	3h	4h	5h	6h	7h	8h	9h	10h	12h	20h	Type
4 OPzV 200	494	365	238	146	108	87	73	63	56	50	45	42	36	23	4 OPzV 200
5 OPzV 250	614	456	298	183	135	108	91	79	70	62	57	52	45	29	5 OPzV 250
6 OPzV 300	732	545	357	219	162	130	109	94	84	75	68	63	54	35	6 OPzV 300
5 OPzV 350	757	595	417	260	193	155	131	113	100	90	81	75	65	42	5 OPzV 350
6 OPzV 420	901	711	500	312	231	187	157	136	120	108	98	90	78	51	6 OPzV 420
7 OPzV 490	1042	826	582	363	270	218	183	159	140	126	114	105	91	59	7 OPzV 490
6 OPzV 600	1156	973	722	461	345	280	236	205	181	163	148	136	118	77	6 OPzV 600
8 OPzV 800	1594	1326	974	617	462	374	315	273	242	217	197	181	157	103	8 OPzV 800
10 OPzV 1000	1973	1647	1213	771	577	468	394	342	303	271	246	227	196	129	10 OPzV 1000
12 OPzV 1200	2346	1964	1452	924	692	561	473	410	363	326	296	272	236	155	12 OPzV 1200
12 OPzV 1500	2341	2061	1616	1063	790	636	533	461	408	365	332	304	263	172	12 OPzV 1500
16 OPzV 2000	3184	2791	2176	1420	1055	849	712	616	544	488	442	406	351	230	16 OPzV 2000
20 OPzV 2500	3940	3462	2707	1773	1318	1061	889	770	680	610	553	507	438	288	20 OPzV 2500
24 OPzV 3000	4682	4123	3233	2126	1581	1272	1066	923	816	731	664	608	526	345	24 OPzV 3000

**Constant current discharge in amperes**

**Voltage end of discharge : 1.65 V/cell**

Type	15'	30'	1h	2h	3h	4h	5h	6h	7h	8h	9h	10h	12h	20h	Type
4 OPzV 200	278	206	133	79,1	57,7	46,1	38,4	33,3	29,4	26,3	23,9	21,9	18,9	12,3	4 OPzV 200
5 OPzV 250	345	257	166	98,8	72,1	57,6	48,0	41,6	36,7	32,9	29,9	27,4	23,7	15,4	5 OPzV 250
6 OPzV 300	411	307	199	119	86,5	69,1	57,7	49,9	44,1	39,5	35,8	32,9	28,4	18,5	6 OPzV 300
5 OPzV 350	426	339	235	141	103	82,8	69,2	59,7	52,5	46,9	42,7	39,2	33,8	21,9	5 OPzV 350
6 OPzV 420	507	405	282	170	124	99,4	83,0	71,6	63,1	56,3	51,2	47,0	40,6	26,3	6 OPzV 420
7 OPzV 490	586	470	328	198	145	116	96,8	83,6	73,6	65,7	59,7	54,9	47,4	30,7	7 OPzV 490
6 OPzV 600	649	548	405	255	187	150	125	108	95,5	85,4	77,6	71,3	61,6	40,0	6 OPzV 600
8 OPzV 800	895	748	546	340	250	200	167	145	127	114	104	95,1	82,2	53,4	8 OPzV 800
10 OPzV 1000	1108	929	680	425	312	250	209	181	159	142	129	119	103	66,7	10 OPzV 1000
12 OPzV 1200	1317	1108	814	510	375	300	251	217	191	171	155	143	123	80,1	12 OPzV 1200
12 OPzV 1500	1308	1155	910	593	431	342	283	244	215	191	173	158	137	88,9	12 OPzV 1500
16 OPzV 2000	1780	1565	1225	790	574	456	378	326	286	255	231	211	183	118	16 OPzV 2000
20 OPzV 2500	2203	1941	1524	988	718	570	472	407	358	319	289	264	228	148	20 OPzV 2500
24 OPzV 3000	2617	2310	1820	1186	862	683	566	488	429	383	347	317	274	178	24 OPzV 3000

**Constant power in watts per cell**

**Voltage end of discharge : 1.65 V/cell**

Type	15'	30'	1h	2h	3h	4h	5h	6h	7h	8h	9h	10h	12h	20h	Type
4 OPzV 200	465	353	237	146	108	87	73	63	56	50	45	42	36	23	4 OPzV 200
5 OPzV 250	578	440	296	183	135	108	91	79	70	62	57	52	45	29	5 OPzV 250
6 OPzV 300	689	526	355	219	162	130	109	94	84	75	68	63	54	35	6 OPzV 300
5 OPzV 350	708	573	412	260	193	155	131	113	100	90	81	75	65	42	5 OPzV 350
6 OPzV 420	843	684	493	312	231	187	157	136	120	108	98	90	78	51	6 OPzV 420
7 OPzV 490	974	794	574	363	270	218	183	159	140	126	114	105	91	59	7 OPzV 490
6 OPzV 600	1076	918	697	461	345	280	236	205	181	163	148	136	118	77	6 OPzV 600
8 OPzV 800	1483	1256	942	617	462	374	315	273	242	217	197	181	157	103	8 OPzV 800
10 OPzV 1000	1836	1558	1173	771	577	468	394	342	303	271	246	227	196	129	10 OPzV 1000
12 OPzV 1200	2183	1857	1402	924	692	561	473	410	363	326	296	272	236	155	12 OPzV 1200
12 OPzV 1500	2164	1923	1544	1063	790	636	533	461	408	365	332	304	263	172	12 OPzV 1500
16 OPzV 2000	2945	2608	2080	1420	1055	849	712	616	544	488	442	406	351	230	16 OPzV 2000
20 OPzV 2500	3644	3233	2587	1773	1318	1061	889	770	680	610	553	507	438	288	20 OPzV 2500
24 OPzV 3000	4328	3847	3089	2126	1581	1272	1066	923	816	731	664	608	526	345	24 OPzV 3000

**Constant current discharge in amperes**

**Voltage end of discharge : 1.70 V/cell**

Type	15'	30'	1h	2h	3h	4h	5h	6h	7h	8h	9h	10h	12h	20h	Type
4 OPzV 200	250	192	129	78,8	57,7	46,1	38,4	33,3	29,4	26,3	23,9	21,9	18,9	12,3	4 OPzV 200
5 OPzV 250	311	240	161	98,4	72,1	57,6	48,0	41,6	36,7	32,9	29,9	27,4	23,7	15,4	5 OPzV 250
6 OPzV 300	370	286	193	118	86,5	69,1	57,7	49,9	44,1	39,5	35,8	32,9	28,4	18,5	6 OPzV 300
5 OPzV 350	381	313	225	141	103	82,8	69,2	59,7	52,5	46,9	42,7	39,2	33,8	21,9	5 OPzV 350
6 OPzV 420	453	374	269	170	124	99,4	83,0	71,6	63,1	56,3	51,2	47,0	40,6	26,3	6 OPzV 420
7 OPzV 490	523	434	313	198	145	116	96,8	83,6	73,6	65,7	59,7	54,9	47,4	30,7	7 OPzV 490
6 OPzV 600	576	494	379	251	187	150	125	108	95,5	85,4	77,6	71,3	61,6	40,0	6 OPzV 600
8 OPzV 800	795	677	512	336	250	200	167	145	127	114	104	95,1	82,2	53,4	8 OPzV 800
10 OPzV 1000	984	840	638	420	312	250	209	181	159	142	129	119	103	66,7	10 OPzV 1000
12 OPzV 1200	1169	1000	762	503	375	300	251	217	191	171	155	143	123	80,1	12 OPzV 1200
12 OPzV 1500	1154	1029	834	581	427	342	283	244	215	191	173	158	137	88,9	12 OPzV 1500
16 OPzV 2000	1572	1396	1125	778	570	456	378	326	286	255	231	211	183	118	16 OPzV 2000
20 OPzV 2500	1944	1730	1398	970	712	570	472	407	358	319	289	264	228	148	20 OPzV 2500
24 OPzV 3000	2309	2058	1668	1162	854	683	566	488	429	383	347	317	274	178	24 OPzV 3000

**Constant power in watts per cell**

**Voltage end of discharge : 1.70 V/cell**

Type	15'	30'	1h	2h	3h	4h	5h	6h	7h	8h	9h	10h	12h	20h	Type
4 OPzV 200	430	336	232	145	108	87	73	63	56	50	45	42	36	23	4 OPzV 200
5 OPzV 250	533	418	289	182	135	108	91	79	70	62	57	52	45	29	5 OPzV 250
6 OPzV 300	635	499	347	218	162	130	109	94	84	75	68	63	54	35	6 OPzV 300
5 OPzV 350	651	542	398	260	193	155	131	113	100	90	81	75	65	42	5 OPzV 350
6 OPzV 420	774	646	476	312	231	187	157	136	120	108	98	90	78	51	6 OPzV 420
7 OPzV 490	894	749	553	363	270	218	183	159	140	126	114	105	91	59	7 OPzV 490
6 OPzV 600	981	849	662	454	345	280	236	205	181	163	148	136	118	77	6 OPzV 600
8 OPzV 800	1356	1164	897	610	462	374	315	273	242	217	197	181	157	103	8 OPzV 800
10 OPzV 1000	1678	1444	1116	762	577	468	394	342	303	271	246	227	196	129	10 OPzV 1000
12 OPzV 1200	1993	1719	1334	912	692	561	473	410	363	326	296	272	236	155	12 OPzV 1200
12 OPzV 1500	1965	1761	1446	1035	785	636	533	461	408	365	332	304	263	172	12 OPzV 1500
16 OPzV 2000	2676	2390	1951	1389	1049	849	712	616	544	488	442	406	351	230	16 OPzV 2000
20 OPzV 2500	3311	2961	2424	1731	1311	1061	889	770	680	610	553	507	438	288	20 OPzV 2500
24 OPzV 3000	3931	3522	2892	2071	1571	1272	1066	923	816	731	664	608	526	345	24 OPzV 3000

**Constant current discharge in amperes**

**Voltage end of discharge : 1.75 V/cell**

Type	15'	30'	1h	2h	3h	4h	5h	6h	7h	8h	9h	10h	12h	20h	Type
4 OPzV 200	220	174	122	76,8	57,0	45,8	38,3	33,2	29,4	26,3	23,9	21,9	18,9	12,3	4 OPzV 200
5 OPzV 250	273	217	152	95,9	71,2	57,3	47,9	41,6	36,7	32,9	29,9	27,4	23,7	15,4	5 OPzV 250
6 OPzV 300	325	259	182	115	85,4	68,7	57,5	49,9	44,1	39,5	35,8	32,9	28,4	18,5	6 OPzV 300
5 OPzV 350	335	282	209	136	103	82,8	69,2	59,7	52,5	46,9	42,7	39,2	33,8	21,9	5 OPzV 350
6 OPzV 420	398	336	250	163	123	99,4	83,0	71,6	63,1	56,3	51,2	47,0	40,6	26,3	6 OPzV 420
7 OPzV 490	460	389	290	190	144	116	96,8	83,6	73,6	65,7	59,7	54,9	47,4	30,7	7 OPzV 490
6 OPzV 600	500	436	345	238	182	149	125	108	96	85,4	77,6	71,3	61,6	40,0	6 OPzV 600
8 OPzV 800	691	598	468	320	244	200	167	145	127	114	104	95,1	82,2	53,4	8 OPzV 800
10 OPzV 1000	855	742	582	400	305	249	209	181	159	142	129	119	103	66,7	10 OPzV 1000
12 OPzV 1200	1015	883	695	478	366	299	251	217	191	171	155	143	123	80,1	12 OPzV 1200
12 OPzV 1500	997	902	745	539	419	338	283	244	215	191	173	158	137	88,9	12 OPzV 1500
16 OPzV 2000	1358	1224	1006	724	560	451	378	326	286	255	231	211	183	118	16 OPzV 2000
20 OPzV 2500	1679	1517	1250	902	699	564	472	407	358	319	289	264	228	148	20 OPzV 2500
24 OPzV 3000	1994	1804	1491	1079	837	676	566	488	429	383	347	317	274	178	24 OPzV 3000

**Constant power in watts per cell**

**Voltage end of discharge : 1.75 V/cell**

Type	15'	30'	1h	2h	3h	4h	5h	6h	7h	8h	9h	10h	12h	20h	Type
4 OPzV 200	387	310	220	142	107	86	72	63	56	50	45	42	36	23	4 OPzV 200
5 OPzV 250	480	386	275	178	133	108	91	78	70	62	57	52	45	29	5 OPzV 250
6 OPzV 300	572	461	329	213	160	129	109	94	84	75	68	63	54	35	6 OPzV 300
5 OPzV 350	588	498	376	251	191	155	131	113	100	90	81	75	65	42	5 OPzV 350
6 OPzV 420	698	594	449	301	229	187	157	136	120	108	98	90	78	51	6 OPzV 420
7 OPzV 490	807	688	522	350	267	218	183	159	140	126	114	105	91	59	7 OPzV 490
6 OPzV 600	876	768	615	433	337	278	236	205	181	163	148	136	118	77	6 OPzV 600
8 OPzV 800	1212	1055	836	583	452	372	315	273	242	217	197	181	157	103	8 OPzV 800
10 OPzV 1000	1499	1308	1039	727	564	465	394	342	303	271	246	227	196	129	10 OPzV 1000
12 OPzV 1200	1780	1556	1241	870	676	557	473	410	363	326	296	272	236	155	12 OPzV 1200
12 OPzV 1500	1747	1585	1322	974	768	629	533	461	408	365	332	304	263	172	12 OPzV 1500
16 OPzV 2000	2378	2152	1786	1309	1029	841	712	616	544	488	442	406	351	230	16 OPzV 2000
20 OPzV 2500	2942	2666	2218	1630	1283	1050	889	770	680	610	553	507	438	288	20 OPzV 2500
24 OPzV 3000	3494	3171	2644	1948	1536	1259	1066	923	816	731	664	608	526	345	24 OPzV 3000

**Constant current discharge in amperes**

**Voltage end of discharge : 1.80 V/cell**

Type	15'	30'	1h	2h	3h	4h	5h	6h	7h	8h	9h	10h	12h	20h	Type
4 OPzV 200	189	153	111	72,2	54,5	44,2	37,1	32,4	28,7	25,7	23,4	21,5	18,7	12,2	4 OPzV 200
5 OPzV 250	234	191	138	90,2	68,1	55,2	46,4	40,4	35,8	32,2	29,3	26,9	23,3	15,3	5 OPzV 250
6 OPzV 300	279	228	165	108	81,6	66,3	55,7	48,5	43,0	38,6	35,1	32,3	28,0	18,4	6 OPzV 300
5 OPzV 350	286	246	188	127	97,0	79,1	66,9	58,5	51,9	46,5	42,5	39,1	33,8	21,9	5 OPzV 350
6 OPzV 420	340	293	224	152	116	94,8	80,2	70,1	62,2	55,8	51,0	46,9	40,6	26,3	6 OPzV 420
7 OPzV 490	392	340	260	177	135	111	93,5	81,7	72,6	65,1	59,5	54,8	47,4	30,7	7 OPzV 490
6 OPzV 600	422	375	302	218	171	141	120	105	92,9	83,5	76,4	70,5	61,3	40,0	6 OPzV 600
8 OPzV 800	584	515	412	294	230	189	160	140	124	112	102	94,1	81,8	53,4	8 OPzV 800
10 OPzV 1000	722	638	511	366	286	236	200	175	155	139	128	118	102	66,7	10 OPzV 1000
12 OPzV 1200	858	759	610	438	343	282	240	210	186	167	153	141	123	80,1	12 OPzV 1200
12 OPzV 1500	837	769	644	481	383	317	271	237	211	190	173	158	137	88,9	12 OPzV 1500
16 OPzV 2000	1146	1044	871	648	514	424	362	317	282	254	231	211	183	118	16 OPzV 2000
20 OPzV 2500	1412	1293	1081	806	641	529	452	396	352	317	289	264	228	148	20 OPzV 2500
24 OPzV 3000	1675	1538	1289	963	767	634	541	474	422	380	347	317	274	178	24 OPzV 3000

**Constant power in watts per cell**

**Voltage end of discharge : 1.80 V/cell**

Type	15'	30'	1h	2h	3h	4h	5h	6h	7h	8h	9h	10h	12h	20h	Type
4 OPzV 200	341	279	204	135	103	84	71	61	54	49	45	41	35	23	4 OPzV 200
5 OPzV 250	422	347	254	168	128	105	88	77	68	61	56	51	44	29	5 OPzV 250
6 OPzV 300	503	414	304	202	154	125	106	92	82	74	67	62	53	35	6 OPzV 300
5 OPzV 350	515	446	344	236	182	149	127	111	99	89	81	75	65	42	5 OPzV 350
6 OPzV 420	612	531	410	282	218	179	152	133	119	107	97	90	78	51	6 OPzV 420
7 OPzV 490	707	615	476	328	254	209	177	155	138	124	113	105	91	59	7 OPzV 490
6 OPzV 600	760	677	550	402	319	265	226	198	177	159	145	134	117	77	6 OPzV 600
8 OPzV 800	1053	931	751	543	429	355	303	266	236	213	194	180	156	103	8 OPzV 800
10 OPzV 1000	1302	1154	932	677	535	444	379	332	295	266	243	224	195	129	10 OPzV 1000
12 OPzV 1200	1545	1373	1112	810	640	531	454	398	354	319	291	269	234	155	12 OPzV 1200
12 OPzV 1500	1518	1387	1170	885	712	594	508	448	400	362	331	304	263	172	12 OPzV 1500
16 OPzV 2000	2068	1885	1583	1191	955	795	681	599	535	484	442	406	351	230	16 OPzV 2000
20 OPzV 2500	2557	2334	1965	1482	1191	992	849	748	668	604	552	507	438	288	20 OPzV 2500
24 OPzV 3000	3037	2775	2341	1771	1425	1188	1017	897	801	724	662	608	526	345	24 OPzV 3000

**Constant current discharge in amperes**

**Voltage end of discharge : 1.83 V/cell**

Type	15'	30'	1h	2h	3h	4h	5h	6h	7h	8h	9h	10h	12h	20h	Type
4 OPzV 200	169	140	102	68,2	52,0	42,2	35,8	31,1	27,6	24,8	22,6	20,9	18,2	12,0	4 OPzV 200
5 OPzV 250	209	174	127	85,1	64,9	52,8	44,7	38,9	34,5	31,0	28,3	26,1	22,7	14,9	5 OPzV 250
6 OPzV 300	249	207	152	102	77,8	63,2	53,6	46,7	41,3	37,2	33,9	31,3	27,2	17,9	6 OPzV 300
5 OPzV 350	255	223	172	118	91,7	75,2	63,9	55,9	49,7	44,8	41,0	37,9	32,9	21,7	5 OPzV 350
6 OPzV 420	302	265	205	142	110	90,1	76,6	67,1	59,5	53,7	49,2	45,4	39,5	26,0	6 OPzV 420
7 OPzV 490	349	307	238	165	128	105	89,3	78,2	69,4	62,6	57,3	52,9	46,1	30,4	7 OPzV 490
6 OPzV 600	376	336	274	203	161	134	114	99,9	88,7	80,0	73,3	67,7	58,9	38,9	6 OPzV 600
8 OPzV 800	520	462	374	274	217	179	153	134	119	107	98,0	90,5	78,7	51,9	8 OPzV 800
10 OPzV 1000	643	572	464	341	270	224	191	167	148	134	122	113	98,3	64,9	10 OPzV 1000
12 OPzV 1200	764	680	553	408	324	268	229	200	178	160	147	136	118	77,8	12 OPzV 1200
12 OPzV 1500	724	684	580	441	356	297	255	224	200	181	165	153	133	88,6	12 OPzV 1500
16 OPzV 2000	992	930	785	593	477	398	341	300	267	242	221	204	178	118	16 OPzV 2000
20 OPzV 2500	1224	1152	974	738	595	496	426	375	334	302	276	255	222	148	20 OPzV 2500
24 OPzV 3000	1448	1369	1160	881	711	594	510	449	400	361	330	305	267	177	24 OPzV 3000

**Constant power in watts per cell**

**Voltage end of discharge : 1.83 V/cell**

Type	15'	30'	1h	2h	3h	4h	5h	6h	7h	8h	9h	10h	12h	20h	Type
4 OPzV 200	310	258	191	128	98	80	68	59	53	47	43	40	35	23	4 OPzV 200
5 OPzV 250	384	321	237	160	123	100	85	74	66	59	54	50	43	29	5 OPzV 250
6 OPzV 300	457	382	284	192	147	120	102	89	79	71	65	60	52	34	6 OPzV 300
5 OPzV 350	466	410	319	222	173	143	122	107	95	86	78	72	63	42	5 OPzV 350
6 OPzV 420	554	488	381	266	207	171	146	128	114	103	94	87	76	50	6 OPzV 420
7 OPzV 490	639	564	442	309	241	199	170	149	133	120	110	102	89	59	7 OPzV 490
6 OPzV 600	689	616	506	378	303	253	217	190	170	153	140	130	113	75	6 OPzV 600
8 OPzV 800	952	848	690	512	408	340	291	255	227	205	188	173	151	100	8 OPzV 800
10 OPzV 1000	1178	1050	857	637	509	424	363	319	284	256	235	217	189	125	10 OPzV 1000
12 OPzV 1200	1399	1249	1022	762	609	508	436	382	340	307	281	260	227	151	12 OPzV 1200
12 OPzV 1500	1336	1255	1068	820	666	560	483	427	382	346	317	292	256	171	12 OPzV 1500
16 OPzV 2000	1825	1706	1446	1104	895	751	648	572	511	462	423	391	342	229	16 OPzV 2000
20 OPzV 2500	2254	2112	1794	1373	1115	937	808	713	638	577	529	488	427	286	20 OPzV 2500
24 OPzV 3000	2673	2510	2136	1640	1333	1121	967	855	764	692	634	585	512	343	24 OPzV 3000



**Constant current discharge in amperes****Voltage end of discharge : 1.85 V/cell**

Type	15'	30'	1h	2h	3h	4h	5h	6h	7h	8h	9h	10h	12h	20h	Type
4 OPzV 200	155	130	96,2	65,0	49,7	40,5	34,3	29,9	26,5	23,9	21,8	20,2	17,6	11,6	4 OPzV 200
5 OPzV 250	192	161	120	81,0	62,1	50,5	42,9	37,4	33,1	29,9	27,3	25,2	22,0	14,6	5 OPzV 250
6 OPzV 300	228	192	143	97,0	74,4	60,5	51,4	44,8	39,7	35,8	32,7	30,2	26,3	17,5	6 OPzV 300
5 OPzV 350	233	205	161	112	87,2	71,7	61,3	53,7	47,7	43,2	39,6	36,6	31,9	21,1	5 OPzV 350
6 OPzV 420	277	244	192	134	104	85,9	73,4	64,3	57,2	51,8	47,5	43,9	38,2	25,3	6 OPzV 420
7 OPzV 490	319	282	223	156	122	100	85,6	75,0	66,6	60,3	55,3	51,2	44,6	29,5	7 OPzV 490
6 OPzV 600	340	309	254	190	153	127	109	95,8	85,3	77,2	70,7	65,4	56,9	37,7	6 OPzV 600
8 OPzV 800	475	425	346	257	206	171	147	128	114	103	94,6	87,5	76,1	50,3	8 OPzV 800
10 OPzV 1000	586	526	430	320	257	214	183	160	143	129	118	109	95,1	62,8	10 OPzV 1000
12 OPzV 1200	694	626	512	383	308	256	219	192	171	155	142	131	114	75,4	12 OPzV 1200
12 OPzV 1500	647	627	535	411	335	281	243	214	191	173	158	147	128	85,9	12 OPzV 1500
16 OPzV 2000	888	853	724	554	449	377	326	287	256	232	212	196	171	115	16 OPzV 2000
20 OPzV 2500	1094	1056	898	689	560	470	406	358	319	289	264	245	214	143	20 OPzV 2500
24 OPzV 3000	1294	1255	1070	822	670	562	486	428	382	346	317	294	257	172	24 OPzV 3000

**Constant power in watts per cell****Voltage end of discharge : 1.85 V/cell**

Type	15'	30'	1h	2h	3h	4h	5h	6h	7h	8h	9h	10h	12h	20h	Type
4 OPzV 200	287	242	180	123	95	77	66	57	51	46	42	38	34	22	4 OPzV 200
5 OPzV 250	355	300	225	153	118	97	82	72	64	57	52	48	42	28	5 OPzV 250
6 OPzV 300	423	358	269	184	142	116	98	86	76	69	63	58	51	33	6 OPzV 300
5 OPzV 350	431	381	301	212	166	137	117	103	92	83	76	70	61	41	5 OPzV 350
6 OPzV 420	512	453	359	254	198	164	140	123	110	99	91	84	74	49	6 OPzV 420
7 OPzV 490	591	524	416	295	231	191	164	144	128	116	106	98	86	57	7 OPzV 490
6 OPzV 600	635	573	473	357	290	243	209	183	164	148	136	126	110	73	6 OPzV 600
8 OPzV 800	884	788	646	484	391	326	280	246	220	199	182	168	147	97	8 OPzV 800
10 OPzV 1000	1092	977	802	602	487	407	350	307	274	248	228	210	184	122	10 OPzV 1000
12 OPzV 1200	1294	1162	956	720	583	487	419	368	329	297	273	252	220	146	12 OPzV 1200
12 OPzV 1500	1209	1163	995	770	632	533	463	410	367	333	305	282	247	166	12 OPzV 1500
16 OPzV 2000	1649	1580	1348	1038	849	716	621	549	491	446	408	378	331	222	16 OPzV 2000
20 OPzV 2500	2038	1957	1672	1291	1058	892	774	685	613	556	509	472	413	277	20 OPzV 2500
24 OPzV 3000	2418	2326	1991	1541	1265	1067	927	820	734	666	610	565	495	333	24 OPzV 3000

**Constant current discharge in amperes**

**Voltage end of discharge : 1.87 V/cell**

Type	15'	30'	1h	2h	3h	4h	5h	6h	7h	8h	9h	10h	12h	20h	Type
4 OPzV 200	140	119	89,6	61,2	47,1	38,3	32,6	28,4	25,2	22,8	20,8	19,3	16,8	11,2	4 OPzV 200
5 OPzV 250	174	147	112	76,2	58,7	47,8	40,7	35,5	31,5	28,5	26,0	24,1	21,0	14,0	5 OPzV 250
6 OPzV 300	206	176	133	91,3	70,3	57,3	48,8	42,6	37,8	34,1	31,2	28,9	25,2	16,8	6 OPzV 300
5 OPzV 350	210	187	149	105	82,1	67,6	58,1	51,0	45,4	41,3	37,9	35,1	30,6	20,4	5 OPzV 350
6 OPzV 420	248	222	178	126	98,3	81,0	69,6	61,1	54,4	49,5	45,4	42,1	36,6	24,4	6 OPzV 420
7 OPzV 490	284	257	206	146	114	94,3	81,0	71,1	63,4	57,7	52,9	49,0	42,7	28,5	7 OPzV 490
6 OPzV 600	300	282	234	177	143	120	104	90,8	81,1	73,6	67,5	62,5	54,4	36,2	6 OPzV 600
8 OPzV 800	421	388	319	239	193	162	139	122	109	98,6	90,4	83,6	72,8	48,4	8 OPzV 800
10 OPzV 1000	518	481	396	298	241	202	173	152	136	123	113	104	90,9	60,4	10 OPzV 1000
12 OPzV 1200	613	572	472	356	288	242	208	182	163	148	135	125	109	72,5	12 OPzV 1200
12 OPzV 1500	570	570	489	380	312	264	229	202	181	164	151	140	122	82,6	12 OPzV 1500
16 OPzV 2000	781	776	662	512	420	354	307	271	242	220	202	187	164	110	16 OPzV 2000
20 OPzV 2500	963	960	822	637	523	441	383	338	303	274	252	234	204	138	20 OPzV 2500
24 OPzV 3000	1141	1140	978	760	625	528	458	405	362	328	302	280	245	165	24 OPzV 3000

**Constant power in watts per cell**

**Voltage end of discharge : 1.87 V/cell**

Type	15'	30'	1h	2h	3h	4h	5h	6h	7h	8h	9h	10h	12h	20h	Type
4 OPzV 200	262	223	169	116	90	74	63	55	49	44	40	37	32	21	4 OPzV 200
5 OPzV 250	325	277	211	145	112	92	78	68	61	55	50	46	40	27	5 OPzV 250
6 OPzV 300	386	330	252	174	135	110	94	82	73	66	60	56	49	32	6 OPzV 300
5 OPzV 350	389	350	281	200	157	130	112	98	88	80	73	68	59	39	5 OPzV 350
6 OPzV 420	460	417	335	240	188	155	134	118	105	95	88	81	71	47	6 OPzV 420
7 OPzV 490	529	482	389	278	219	181	156	137	122	111	102	95	83	55	7 OPzV 490
6 OPzV 600	566	528	440	334	273	230	199	175	156	142	130	121	105	70	6 OPzV 600
8 OPzV 800	790	728	601	453	369	310	267	235	210	191	175	162	141	94	8 OPzV 800
10 OPzV 1000	975	902	746	564	459	387	334	293	262	238	218	202	176	117	10 OPzV 1000
12 OPzV 1200	1155	1072	889	674	549	463	400	351	314	285	262	242	211	141	12 OPzV 1200
12 OPzV 1500	1074	1069	919	719	594	504	439	389	349	317	291	271	237	160	12 OPzV 1500
16 OPzV 2000	1466	1452	1245	969	799	677	589	522	468	425	390	362	317	214	16 OPzV 2000
20 OPzV 2500	1811	1798	1544	1205	994	844	734	651	584	530	487	452	396	268	20 OPzV 2500
24 OPzV 3000	2148	2138	1839	1438	1188	1009	879	779	699	635	583	542	475	321	24 OPzV 3000

**Constant current discharge in amperes****Voltage end of discharge : 1.90 V/cell**

Type	15'	30'	1h	2h	3h	4h	5h	6h	7h	8h	9h	10h	12h	20h	Type
4 OPzV 200	117	101	78,3	54,6	42,2	34,6	29,6	25,8	23,0	20,8	19,1	17,7	15,4	10,4	4 OPzV 200
5 OPzV 250	144	125	97,4	68,1	52,6	43,1	36,9	32,2	28,7	25,9	23,8	22,1	19,2	13,0	5 OPzV 250
6 OPzV 300	171	149	116	81,4	63,0	51,7	44,2	38,6	34,4	31,1	28,6	26,5	23,1	15,6	6 OPzV 300
5 OPzV 350	166	159	130	93,0	72,5	60,5	52,2	45,9	41,4	37,7	34,8	32,2	28,1	19,0	5 OPzV 350
6 OPzV 420	195	189	154	111	86,7	72,5	62,5	55,0	49,6	45,2	41,6	38,6	33,7	22,8	6 OPzV 420
7 OPzV 490	223	218	179	129	101	84,3	72,8	64,0	57,7	52,7	48,5	45,0	39,2	26,6	7 OPzV 490
6 OPzV 600	240	240	201	154	126	106	92,1	81,5	73,4	66,9	61,6	57,1	49,8	33,4	6 OPzV 600
8 OPzV 800	336	331	276	209	170	144	124	110	98,7	89,8	82,6	76,5	66,7	44,6	8 OPzV 800
10 OPzV 1000	414	410	342	260	212	179	155	137	123	112	103	95,5	83,2	55,7	10 OPzV 1000
12 OPzV 1200	490	487	407	310	254	214	185	164	147	134	123	114	99,7	66,8	12 OPzV 1200
12 OPzV 1500	455	452	418	329	273	235	205	182	164	149	138	128	112	76,3	12 OPzV 1500
16 OPzV 2000	622	623	566	444	367	315	275	244	219	200	184	171	149	102	16 OPzV 2000
20 OPzV 2500	764	766	702	552	457	393	343	304	273	250	230	213	187	127	20 OPzV 2500
24 OPzV 3000	910	905	836	659	546	470	411	364	327	299	276	256	224	153	24 OPzV 3000

**Constant power in watts per cell****Voltage end of discharge : 1.90 V/cell**

Type	15'	30'	1h	2h	3h	4h	5h	6h	7h	8h	9h	10h	12h	20h	Type
4 OPzV 200	223	192	150	105	81	67	57	50	44	40	37	34	30	20	4 OPzV 200
5 OPzV 250	275	238	186	131	102	83	72	63	56	50	46	43	37	25	5 OPzV 250
6 OPzV 300	325	284	222	157	122	100	86	75	67	60	55	51	45	30	6 OPzV 300
5 OPzV 350	305	302	247	179	140	117	101	89	80	73	68	63	55	37	5 OPzV 350
6 OPzV 420	362	359	294	214	167	140	121	107	96	88	81	75	66	44	6 OPzV 420
7 OPzV 490	417	415	341	248	195	163	141	124	112	102	94	88	77	52	7 OPzV 490
6 OPzV 600	459	457	384	295	243	206	178	158	143	130	120	111	97	65	6 OPzV 600
8 OPzV 800	640	629	526	401	329	278	241	213	192	175	161	149	130	87	8 OPzV 800
10 OPzV 1000	790	779	652	499	409	346	300	265	239	218	201	186	163	109	10 OPzV 1000
12 OPzV 1200	936	926	777	596	489	414	359	318	287	261	241	223	195	131	12 OPzV 1200
12 OPzV 1500	866	874	796	631	525	453	397	353	318	290	268	249	218	149	12 OPzV 1500
16 OPzV 2000	1186	1194	1080	851	707	609	533	474	426	389	359	334	292	199	16 OPzV 2000
20 OPzV 2500	1463	1476	1339	1058	879	758	665	591	532	485	448	416	365	249	20 OPzV 2500
24 OPzV 3000	1733	1748	1593	1262	1051	906	795	707	637	581	537	499	437	299	24 OPzV 3000

# IV/ Battery calculations

The following calculations will enable you to determine which unit in the PowerSafe® OPzV battery range you require in order to supply the power you need, and in the specified temperature conditions :

Where discharge includes current surges, please consult our commercial department.

## Constant discharge case

- Power required : 23.7 kW
- Minimum voltage : 376 volts
- Maximum voltage : 484 volts
- Back up time required : 4 hours

For a temperature of 20°C,

***the float charge voltage is 2.23 volts per cell.***

- Maximum number of 2V cells :  $484 \text{ V} / 2.23 \text{ V} = 217$
- Discharge current :  $23700 \text{ W} / 376 \text{ V} = 63 \text{ A}$
- Minimum voltage per 2 V cell :  $376 / 217 = 1.74 \text{ V}$

Refer to the table of electrical performance characteristics of the PowerSafe OPzV battery cells for an end voltage of 1.75 volts.

- For a discharge current of 63A or more and a discharge time of 4 hours, we find 68.4V A for the cell 6 OPzV300
- Type of battery : 217 cells 6 OPzV300 (320Ah in C<sub>10</sub> for 1.80 V)

For a temperature of 0°C :

***the float charge voltage is 2.35 volts per cell.***

- Maximum number of 2 V cells :  $484 \text{ V} / 2.35 \text{ V} = 206$ .
- Discharge current :  $23700 \text{ W} / 376 \text{ V} = 63 \text{ A}$
- Minimum voltage per 2 V cell :  $376 \text{ V} / 206 = 1.83 \text{ V}$
- Now refer to the section on the use of the PowerSafe OPzV battery accumulators, at the paragraph entitled "Effect of temperature on battery capacity, to find the capacity correction factor- in this case it proves to be 0.74.
- The equivalent discharge current will be :  $63 / 0.74 = 85 \text{ A}$
- Now go to the table of electrical performance characteristics of the PowerSafe OPzV battery range for an end voltage of 1.85 volts.
- For a discharge current of 85 amps or more, the cell in the PowerSafe OPzV battery range which corresponds to a 4 hour discharge time is the 6 OPzV420.
- The battery is thus made up of 206 cells of type 6 OPzV420 (560 Ah at C<sub>10</sub> for 1.80 V end voltage).

## Important note :

*In a case where the ambient temperature varies, the calculations should be performed on the basis of the lowest temperature*

*Example : For 11 months of use at 20°C and 1 month at 0°C, calculate the number of cells with a float voltage of 2.23 volts per cell, and find the corresponding accumulator with the loss of capacity transferred to the discharge current.*

# V/ Installation of the battery

---

## 1 - Warning

**The PowerSafe® OPzV battery cells are already charged when delivered, and are fitted with a protective cap on each terminal. They should be unpacked with care.**

Avoid short-circuiting terminals of opposite polarity, because these units are capable of discharging at a very high current, even if the lid or the container happens to be damaged.


## 2 - Unpacking the battery

Each shipment of PowerSafe OPzV batteries is accompanied by a packing list and installation instructions.

The packing list should be checked, and the Standby Batteries Sales Department - Standby Batteries should be told immediately of any missing items.

The markings on the lid should be read carefully :

- The type of cell
- The voltage in volts
- The capacity in ampere hours
- The storage limit date
- The float charge voltage at 20-25°C
- The arrow must always point upwards if the batteries are placed in the prone position.

**Note :** The  symbol indicates that the accumulator is of the recyclable type.

## 3 - Setting up the battery stands

**Construction :** These stands are in plastic-covered steels, and are notable for their :

- **mechanical strength**
- **adaptability**
- **ease of assembly.**

The standard stretchers of 600, 750, 900, 1200 and 1500 mm are designed to result in space-saving installations.

**Stand models :** There are two ranges of stands to suit the position in which the accumulators are to be placed :

### 3.1 - Standard stands for vertical cells

See also the appendix on page 20. The various assembly options are dependent on :

- The number of cells of which the battery is composed
- The floor area available

1 and 2 levels	3 levels
With	
<ul style="list-style-type: none"> <li>- 1 row</li> <li>- 2 rows flat</li> <li>- 3 rows flat</li> </ul>	<ul style="list-style-type: none"> <li>- 2 rows</li> <li>- Special design-consult our Sales Department</li> </ul>

**Important note :**

The floor must possess the necessary load-bearing characteristics.

**Assembly of battery stands :**

- The structure should be assembled in accordance with the exploded view and instructions supplied with the equipment.
- Check the correct fixing to the chassis after first checking the squareness.
- Take up any irregularity in floor surface using shims.
- The uprights of 2 or 3 level stands for vertical cells and the 4 and 6 level stands for horizontal cells are best mounted on a well.
- These plastic-covered metal stands are electrically insulated and require no connection to the building earth.
- For the installation of cells in the horizontal position, always ensure that the arrow on the lid of each unit is pointing upward.

### 3.2 - Stands for horizontal cells

(see appendix page 20)

Stand in a 4 and 6 levels are available  
 Connection in front of the stand for easier maintenance.

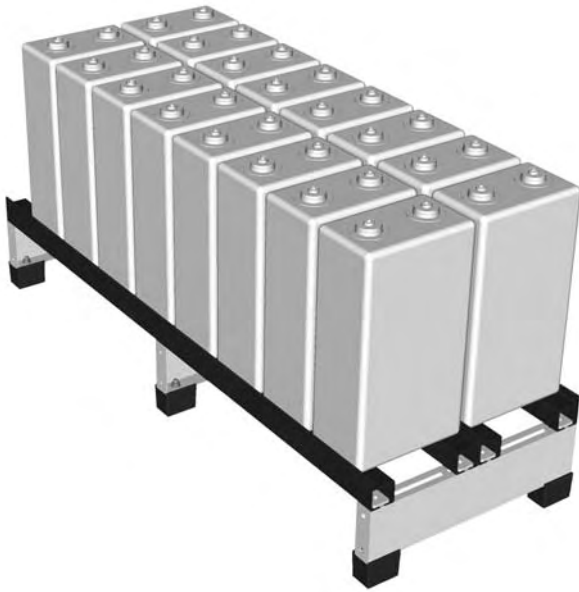
Metallic stands sizes		Vertical assembling							Horizontal assembling	
		V1	V2	V3	V4	V5	V6	H1	H2	
Type of cells	W H									
4 OPzV 200	W H	215 577	430 577	645 577	285 1582	500 1582		500 1430	500 1970*	
5 OPzV 250	W H	215 577	430 577	645 577	285 1582	500 1582		500 1430	500 1970*	
6 OPzV 300	W H	215 577	430 577	645 577	285 1582	500 1582	500 1908*	500 1430	500 1970*	
5 OPzV 350	W H	215 693	430 693	645 693	285 1698	500 1698	500 2024*	650 1430	650 1970*	
6 OPzV 420	W H	215 693	430 693	645 693	285 1698	500 1698	500 2024*	650 1430	650 1970*	
7 OPzV 490	W H	215 693	430 693	645 693	285 1698	500 1698	500 2024*	650 1430	650 1970*	
6 OPzV 600	W H	215 867	430 867	645 867	285 1872*	500 1872*		822 1430	822 1970*	
8 OPzV 800	W H	215 867	430 867	645 867	285 1872*	500 1872*		822 1430	822 1970*	
10 OPzV 1000	W H	290 867	580 867		285 1872*	650 1872*		822 1430	822 1970*	
12 OPzV 1200	W H	290 869	580 869		360 1874*	650 1874*		822 1430	822 1970*	
12 OPzV 1500	W H	290 1018	580 1018		360 2023*	650 2023*		930 1430	930 1970*	
16 OPzV 2000	W H	430 994			500 1999*					
20 OPzV 2500	W H	580 994								
24 OPzV 3000	W H									

Special studies, please see with our sales department.

\* Compulsory wall fixing

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## Standard stands for vertical cells :



Length of the stand is determined by the combination of 5 different longitudinal beams (Length 600 mm, 750, 900, 1200 and 1500 mm) in relation with the total length of cells.

## Standard stands for horizontal cells :



Length of the stand is determined by the combination of 5 different longitudinal beams (Length 600 mm, 750, 900, 1200 and 1500 mm) in relation with the total length of cells.

**Caution** : Take into account the in-between pillars.



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## 4 - Connecting of the cells

### in series :

The number of cells in series will determine the total float voltage :

$$U = V \times N$$

**U** = total float voltage   **V** = float voltage for one cell  
**N** = number of cells

## 5 - General recommendations

- Do not wear clothing in synthetic materials, to avoid the generation of static potentials.
- Discharge any possible static electricity from clothes by touching an earth connected part.
- Handle the battery cells with special implements provided (never lift the cells by their terminals).
- Use insulated tools.
- Place the cells beginning with the least accessible rows, spacing the cells as shown in the figure.
- Always ensure that the arrow on the cell lid is pointing upward if the cell is placed in the horizontal position.

### In parallel :

PowerSafe® OPzV battery cells of the same ampere hour rating may be connected in parallel to give higher current capability. This connection in parallel will be preferably carried out through an equipotential wiring for an equal current distribution in each string.

There is no technical reason for limiting the number of strings but for practical installation reasons, it is recommended not to exceed 4 strings in parallel especially if the battery is used in high discharge rates (standby time lower than 1 hour).

- Consult the drawing for the correct position of the cell poles (positive = red washer, negative = blue washer).
- Before attaching the inter-cell flexible cables, check that all terminals are in the correct position.
- The battery cells are connected in series, that is with a positive pole connected to a negative pole.
- Clean the cells with nothing other than a dampened cotton cloth.
- The tightening torque for connections is 23 Nm (2.3 Mkg) to a 25 Nm (2.5Mkg).

This maximum value must not be exceeded.

## 6 - Safety

All installation and ventilation must comply with the current regulations and norms

(In France : norm NFC15-100)

Batteries must be installed in accordance with EN 50272- 2 standard

Low ventilation requirement according to EN 50272-2 standard

## 7 - Standards

The PowerSafe OPzV battery range complies with the international standard : IEC 60896-21&22

Classified as "long life" according to the EUROBAT Guide 1999

EnerSys® production facilities worldwide are certified to ISO 9001 and ISO 14001

The PowerSafe OPzV batteries conform to DIN standard 40742

Proof against deep discharge according to DIN standard 43539 Part 5

# VI/ Battery storage

## 1 - Calculating the storage time

The storage time is indicated on the battery lid. This takes into account the shipping time of equipment, frequently quite lengthy (in the case of exports in particular).

## 2 - Storage conditions

The PowerSafe® OPzV battery should be stored away from any moisture or source of heat.

## 3 - Storage times

The self-discharge of PowerSafe OPzV batteries as a function of temperatures is as follows :

2% per month at 20°C
4% per month at 30°C
8% per month at 40°C

In order to ensure that the battery can be charged easily after a long period of storage, it is recommended that batteries should not be stored for more than the following periods without recharging :

6 months at 20°C
4 months at 30°C
2 months at 40°C

Failure to comply with these recommendations may compromise the life expectancy of the battery.

## 4 - Recharging stored batteries

PowerSafe OPzV batteries should be recharged at the float charge voltage to suit the temperature (2.25 volts at 20°C per cell for example) with a current limit of 0.4 C<sub>10</sub> and for a minimum period of 96 hours.

The battery will be charged when the charging current has remained constant for a period of 3 hours.

## 5 - State of charge

The PowerSafe OPzV battery state of charge can be determined approximately by measuring the open circuit voltage after the battery has been at rest for a minimum of 24 hours.

State of charge	Voltage
100%	2.13V/cell
70%	2.09V/cell
50%	2.06V/cell
20%	2.02 V/cell

The necessity of a refreshing charge can also be determined by measuring the open circuit voltage of a stored battery.

Refreshing charge is advised if the voltage drops below 2.07 V/cell.

# VII/ Commissioning charge

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When commissioning a new battery (first charge), follow procedure a) or b).

Procedure a) is recommended.

a) IU method (boost charge)

At a raised voltage of 2.33 - 2.40 Vpc. The charging time will be 12 to 24 hours depending on the initial charge condition. The current must be limited to  $0.4C_{10}$ .

Boost charging must be switched off or switched over to float charging as soon as the fully charged state is reached.

b) Float charge:

With a voltage of 2.25 Vpc. Full capacity will be obtained after a longer period of 4 to 6 weeks depending on state of charge.

# VIII/ Maintenance/checks

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- Every month, check the total floating voltage at the battery terminals. It should be  $N \times 2.25$  volts at a temperature of 20°C (tolerance 2.23 - 2.25 Vpc), where N is the number of cells in the battery.
- Once each year, effect a reading of the voltage of cells constituting the battery.
- A difference of plus or minus 3.5% between these individual floating voltages and the average voltage may be observed. This is due to the gas recombination process.
- A check on capacity (independent operation on load) can be performed once a year.

## Testing

Capacity tests are to be carried out in accordance with IEC 60896-21&22. Check that the battery is fully charged. Before testing new batteries it must be ensured that a sufficient commissioning charge has been applied.

## Safety

When carrying out any work on the battery, the applicable safety standards should be followed.

**Note :** Keep a logbook battery in which the measured values can be noted as well as power cuts, discharge tests( current, time, T°...) etc.

## The main factors causing reduction in the life expectancy of PowerSafe® OPzV battery cells

- Deep discharges
- Poor regulation of the float voltage
- Poor quality (smoothing) of the charging current
- High ambient temperatures

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