

Hydrogen Gassing: Symmetra, SmartUPS

By Stephen McCluer and Abigail Kasper

PROJECT AT A GLANCE

Project Type

This document identifies the worst case gassing rates for the various valve-regulated lead-acid (VRLA) modular battery units of SmartUPS VT, Symmetra LX, and Symmetra PX UPSs.

Applications

Small, medium, and large data centers

Equipment Installed

SmartUPS VT, Symmetra LX, Symmetra PX



Symmetra PX 250/500

CUSTOMER BENEFITS

- Quickly respond to requests for hydrogen gassing data for UPS batteries

Code Requirements

In the USA, requests for battery gassing information are driven by Fire Codes. Jurisdictions will adopt one of two model codes. The most common is the International Fire Code (IFC), published by the International Code Council. The other is the Fire Code, (NFPA 1) published by the National Fire Protection Association. Both have nearly identical requirements. The IFC requirements are shown here:

608.6 Ventilation. Ventilation of stationary storage battery systems shall comply with Sections 608.6.1 and 608.6.2.

608.6.1 Room ventilation. Ventilation shall be provided in accordance with the International Mechanical Code and the following:

1. For flooded lead-acid, flooded Ni-Cad and VRLA batteries, the ventilation system shall be designed to limit the maximum concentration of hydrogen to 1.0 percent of the total volume of the room; or
2. Continuous ventilation shall be provided at a rate of not less than 1 cubic foot per minute per square foot ($1 \text{ ft}^3 / \text{min/ft}^2$) [$0.0051 \text{ m}^3/\text{s} \times \text{m}^2$] of floor area of the room.

Exception: Lithium-ion and lithium metal polymer batteries shall not require ventilation.

608.6.2 Cabinet ventilation. When VRLA batteries are installed inside a cabinet, the cabinet shall be *approved* for use in occupied spaces and shall

be mechanically or naturally vented by one of the following methods:

1. The cabinet ventilation shall limit the maximum concentration of hydrogen to 1 percent of the total volume of the cabinet during the worst-case event of simultaneous “boost” charging of all the batteries in the cabinet; or
2. When calculations are not available to substantiate the ventilation rate, continuous ventilation shall be provided at a rate of not less than 1 cubic foot per minute per square foot [$1 \text{ ft}^3/\text{min}/\text{ft}^2$ or $0.0051 \text{ m}^3/(\text{s} \times \text{m}^2)$] of floor area covered by the cabinet. The room in which the cabinet is installed shall also be ventilated as required in Section 608.6.1.

608.6.3 Supervision. Mechanical ventilation systems where required by Sections 608.6.1 and 608.6.2 shall be supervised by an *approved* central, proprietary or remote station service or shall initiate an audible and visual signal at a constantly attended on-site location.

Notes:

- In the above methods, the preferred method is to calculate whether it is possible for battery gassing to achieve up to or greater than 1% of the total volume of air in the space (cabinet or room). The calculations must be performed by a professional engineer (PE) based on the characteristics of the room (which will be unique for every application).
- In the absence of such a calculation, the Code provides a “rule of thumb” [1 cubic foot per minute per square foot] which is very conservative and which will always result in a larger (and more expensive) ventilation system than would have been required if it had been based on calculations.
- The requirement for “supervision” is the owner’s responsibility. Failure of mechanical ventilation (i.e., fan failure) must sound and display an alarm to which a human being can respond 24/7.

Modular Batteries

APC by Schneider Electric manufactures plug-in Battery Units. Multiple Units are assembled to make a complete Battery Module (also known as a “string” or “shelf”). Because a UPS cannot have less than a complete Battery Module, the gassing data given in the tables in the following section are for “Battery Modules”. The individual “Battery Units” are described below. (See Appendix A at the end of this application note for an illustrated description of modular battery terminology.)

SYBTU1-PLP: All regions except Japan

The SYBTU1-PLP Battery Unit is used in both 208V and 400V Symmetra PX in all regions except Japan. It is also used in the SmartUPS VT UPS in North America. It contains eight 12-volt/6-cell Battery Units, each rated 7.2 AH. The following battery vendors are presently approved: BB Battery (BP7-12), CSB (GP1272F2), Panasonic (LC-R127R2P1), and Shenzhen Center Power Tech Co, LTD (CP1270).

SYBTJU1-PLP: Japan

The SYBTJU1-PLP Battery Unit is used in all Symmetra PX and SmartUPS VT units sold in Japan. It contains eight 12-volt/6-cell Battery Units, each rated 7.2 AH. The following battery vendors are presently approved: Panasonic (LC-P 127R2P1, UP-PW1236P1) and Japan Storage Battery (GS-PXL12072).

SYBTU2-PLP: Worldwide

The SYBTU2-PLP Battery Unit is used in 208V, 400V, and 480V Symmetra PX in all regions. It contains eight 12-volt/6-cell Battery Units, each rated 9 AH. The following battery vendors are presently approved: CSB (HRL 1234W F2FR), EnerSys (NPX-L35/250FRTW), Japan Storage Battery/GS Battery (PXL12090), and Panasonic (UP-PW1245P1).

SYBT5: Worldwide

The SYBT5 Battery Unit is used in 208/240V, 220/230/240V, and 380/400/415V Symmetra LX in all regions. It contains ten 12-volt/6-cell Battery Units, each rated 9 AH. The following battery vendors are presently approved: Panasonic (UP-RW1245P1), CSB (HR 1234W F2), B&B (HR1234W), and Kung Long (WP1234W).

Battery Enclosure Ventilation

No hydrogen can accumulate in APC Extended Runtime (XR) battery frames, which are designed to prevent the creation of hydrogen “pockets”. As shown on the battery frame installation drawings, the front and rear doors of the battery frame are fully perforated, thereby allowing almost unrestricted flow of air into and through the cabinet. The top plate of the cabinet also has two rows of square holes that run from front to rear.

Note: Sample illustrations are included in Appendix B.

Any hydrogen gas that is not recombined within the battery (due to excess charging or other fault condition) is fully released into the surrounding space within seconds. Greater details on the safety features built into the Symmetra and SmartUPS VT product line to prevent thermal runaway and off-gassing of batteries, as well as methods to calculate room hydrogen concentrations over time, can be found in Application Note #49, *InfraStruxure Battery Safety in the IT Environment: What happens When Ventilation Fails?*

Hydrogen Gassing Values

The following tables use data provided by the vendor with the highest battery gassing rate, to ensure that the worst-case scenario can be calculated.

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Table 1 – Single-Phase Symmetra Product Family

Gassing Rate Per Shelf/String (Cubic Feet per Hour)					
UPS Model	Battery Unit	Number of Battery Modules			
		1	2	3	4
Symmetra LX	SYBT5	0.00206364	0.00412728	0.00619092	0.00825456
	Notes:	Gassing Rate at 2.4 V/cell (ft ³ /hr) Assuming 98% Recombination Efficiency=0.000034394 ft ³ /hr Six cells per battery cartridge Ten battery cartridges per battery unit One battery unit per battery module			

Table 2 – Three-Phase Symmetra Product Family, 7.2AH Battery

Symmetra PX Battery Gassing Rate Per Shelf/String (Cubic Feet per Hour)									
UPS Model	Battery Unit	Number of Battery Modules							
		1	2	3	4	5	6	7	8
InfraStruxure 20kW All In One	SYBTU1-PLP*	0.00641	0.01282	n/a	n/a	n/a	n/a	n/a	n/a
Symmetra PX 10-40 kVA	SYBTU1-PLP*	0.00641	0.01282	0.01923	0.02565	n/a	n/a	n/a	n/a
Symmetra PX 20/40 Battery Frame (SYCFXR8)	SYBTU1-PLP*	0.00641	0.01282	0.01923	0.02565	0.03206	0.03847	0.04488	0.05129
Symmetra PX 10-80 kVA (Battery Frame SYCF8BF)	SYBTU1-PLP*	0.00641	0.01282	0.01923	0.02565	0.03206	0.03847	0.04488	0.05129
	Notes:								
	*	Gassing Rate at 2.4 V/cell (ft ³ /hr) Assuming 98% Recombination Efficiency= 0.000033392 Six cells per cartridge Eight cartridges per battery unit Four battery units (one battery module) per shelf Note: Calculation based on battery gassing data provided by qualified vendors.							

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Table 3 – Three-Phase Symmetra Product Family, 9AH Battery

Symmetra PX Battery Gassing Rate Per Shelf/String (Cubic Feet per Hour)										
UPS Model	Battery Unit	Number of Battery Modules								
		1	2	3	4	5	6	7	8	9
Symmetra PX 10-100kVA (Battery Frame SYCFXR9)	SYBTU2-PLP *	0.04032	0.08064	0.12096	0.16128	0.20160	0.24192	0.28224	0.32256	0.36288
Symmetra PX 250-500 kVA (Battery Frame SYBFXR8)	SYBTU2-PLP **	0.06048	0.12096	0.18144	0.24192	0.30240	0.36288	0.42336	0.48384	n/a
Notes:										
	*	Gassing Rate at 2.4 V/cell (ft ³ /hr) Assuming 98% Recombination Efficiency=0.00021 Six cells per cartridge Eight cartridges per battery unit Four battery units (one battery module) per shelf								
	**	Gassing Rate at 2.4 V/cell (ft ³ /hr) Assuming 98% Recombination Efficiency=0.00021 Six cells per cartridge Eight cartridges per unit Six units (one battery module) per shelf								

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Table 4 – SmartUPS Product Family

UPS Model	Battery Unit	Gassing Rate Per Shelf/String (Cubic Feet per Hour) Number of Modules				
		1	2	3	4	5
SmartUPS VT	SYBTU1-PLP	0.00641	0.01282	0.01923	0.02565	0.03206

Notes:

Gassing Rate at 2.4 V/cell (ft³/hr) Assuming 98% Recombination Efficiency= 0.000033392

Six cells per cartridge

Eight cartridges per battery unit

Four battery units (one battery module) per shelf

Note: Calculation based on battery gassing data provided by qualified vendors.

Conclusions

Find out the local regulations for battery installations. Provide gassing information from the above tables when requested by the site engineer. For multiple extended run time solutions, multiply the basic unit as appropriate. Because the Fire Codes and Mechanical Codes are concerned about the hazards posed by “big” batteries, gassing rates are rarely requested for battery systems containing less than 50 gallons of electrolyte (See App Note #143: *Electrolyte quantities in Symmetra UPS*).

Appendix A: Terminology Battery Modules

Shown: four “**battery units**”= one “string” = one “**battery module**”
One or more battery modules, in conjunction with the charging equipment, comprise a “battery system.”



This is a Battery Module (front view)

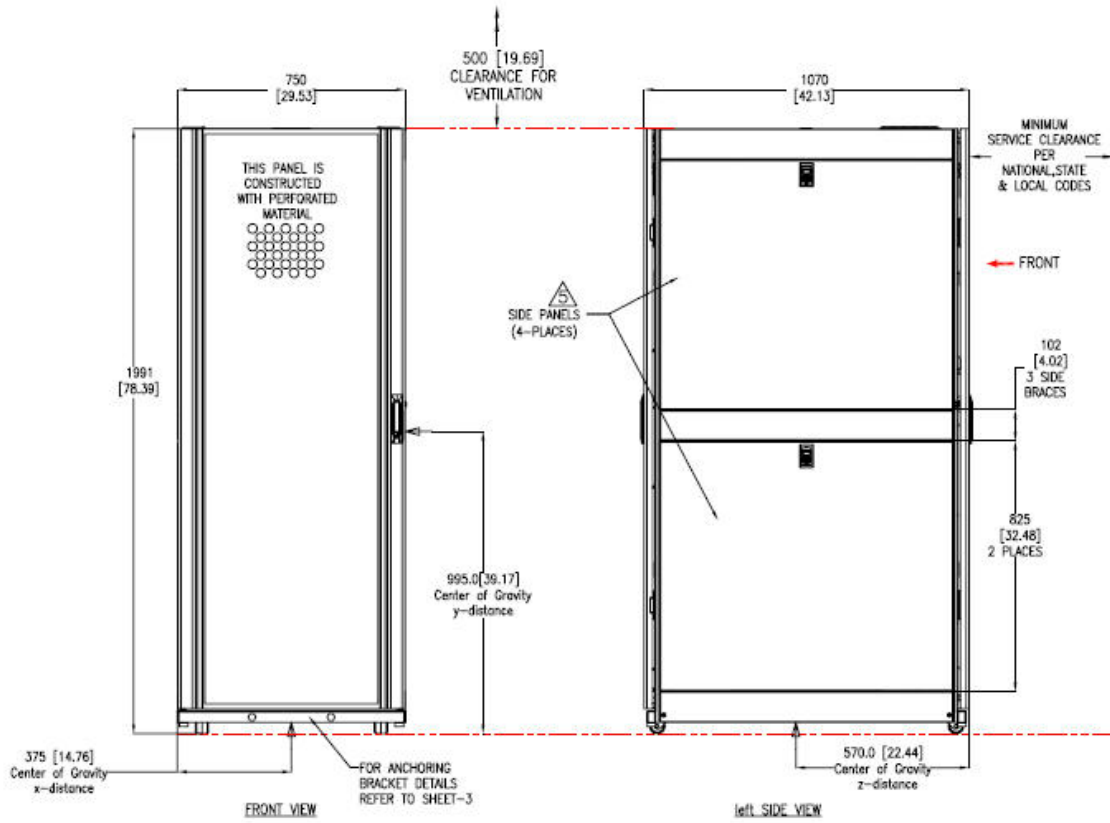


This is a Battery Unit (rear view)

Appendix B: Sample Battery Cabinet

Shown: Symmetra PX 250/500 Battery Cabinet (SYBFXR8)

Note: These installation drawings are used to illustrate the concept of battery enclosure ventilation. For solution accuracy, see the installation drawing for your cabinet. Installation drawings are available on the UPS product page at apc.com.



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