PEP ecopassport® PROGRAM

PSR

SPECIFIC RULES FOR Uninterruptible Power Supply (UPS)

PSR-0010-ed1.1-EN-2015 10 16

According to PSR-model-ed1-EN-20150320

Contents

1. Introduction

This reference document complements and explains the Product Environmental Profile (PEP) Drafting Rules defined by the PEP ecopassport® program (PEP-PCR ed.3-EN-2015 04 02), available at www.pep-ecopassport.org).

It defines the additional requirements applicable to UPSs. Compliance with these requirements is necessary to:

- Qualify the environmental performance of these products on an objective and consistent basis,
- Publish PEPs compliant with the PEP ecopassport® program and international reference standards.[1]

This reference document was drawn up in compliance with the open, transparent rules of the PEP ecopassport® program with the support of stakeholders and professionals in the electrical market.

	www.pep-ecopassport.org
PSR reference	PSR-UPS-ed1-EN-2015 10 16
Critical review	The third-party Critical review was carried out by SGS. The declaration of conformity published on 2013/12/18 can be found in the Appendices.
Availability	The Critical review report is available on request from the P.E.P. Association contact@pep-ecopassport.org
Scope of validity	The critical review report and the declaration of conformity remain valid within 5 years or until the PEP Drafting Rules, or the normative reference texts to which they refer, are modified.

With the publication of the PCR edition 3, this PSR was the object of an impact study which led to an editorial revision."

[1] ISO 14025, ISO 14040 and ISO 14044 standards

2. Scope

In accordance with the general instructions of the PEP ecopassport® program (PEP-General instructions-ed4-EN-2015 04 02) and additional to the PCR, "PRODUCT CATEGORY RULES", (PEP-PCR ed.3-EN-2015 04 02) of the PEP ecopassport® eco-declaration program, this document sets out the specific rules for UPS and defines the product specifications to be adopted by manufacturers in the development of their PRODUCT ENVIRONMENTAL PROFILES (PEPs) particularly with regard to:

- the technology and its type of application,
- the reference lifetime taken into account for the Life Cycle Assessment (LCA),
- the use scenarios to be adopted during the product use phase.

A UPS is a power system whose main function is to maintain the continuity of an a.c. power source to a load in the event of an input power failure.
Maintaining the power continuity has a much broader meaning than just an electrical protection against power outages. It also means protecting load from poor quality energy phenomena (e.g. overvoltage, voltage sags) by keeping the power source within specified characteristics.
In consistency with IEC 62040-3, this PSR applies to movable, stationary and fixed uninterruptible power systems that deliver single or three-phase fixed frequency a.c. output voltage not exceeding 1 000 V a.c.
The annex B of the IEC 62040-3 standard gives an overview of popular UPS topologies in use (VFI, VD, VFD). UPS types which are not explicitly defined by the IEC 62040-3 standard (e.g. UPS for specific applications) are not covered by the document and will be further the subject of additional sector-specific rules that will complement this document.
The vast majority of the application areas of UPS are covered by the scope :

- Data centers,
- Industry,
- Services,
- Telecom,
- Emergency lighting
- Fire protection systems,
- Medical…

Remark about the energy storage system
To protect load against outages, an energy storage system is necessary to provide the power to the UPS inverter for the required stored energy time. Among all possible energy storage system (flywheel, compressed air, etc...) the most commonly used technology is batteries.
If the energy storage system is incorporated inside the UPS, it is considered as a constitutive element of the UPS like other components (active components, passive components, circuit boards…) and is thus inside the scope of the PSR. Link with functional unit: see definition below.
If the energy storage system is not incorporated inside the UPS, the energy storage system is considered as an independent ad-hoc product which is not part of the constitutive element of the UPS and which is considered out of the scope of the PSR. Link with functional unit: see definition below.

3. Functional unit and reference flow description

These specific rules are additional to section 2.1 "Functional unit and reference flow description" of the PCR (PEP-PCR ed.3-EN-2015 04 02). The life cycle assessment analysis carried out and the resulting PEP applies to the devices whose functions and composition are as defined below.

3.1. Functional unit

Definition 1

In case the energy storage system is incorporated in the UPS:

"To protect the load of [P] Watts against input power failure during [X] years and provide a backup time of [Y] minutes in case of a power outage"

Definition 2

In case the energy storage system is not incorporated in the UPS:

"To protect the load of [P] Watts against input power failure during [X] years and switch to the energy storage system to avoid power outage."

Remarks :

- The functional unit shall mention the redundancy level of the UPS
- The determination of the numbers X of years is explained in table 1
- The determination of Y backup time is explained in section 6.5
- [X] : typical lifetime of the UPS in years
- [Y] : backup time in minutes
- [P] : output power of the UPS in Watts

3.2. Reference flow

To the functional unit corresponds a reference flow, which includes:

- The reference product representative of the product range,
- The energy storage system if incorporated inside the UPS,
- The reference product packaging,
- Products or items necessary for the maintenance of the UPS during its use phase which are integrated in the field of the study.

The general cut-off criteria defined in the generic PCR are to be observed. Some additional rules specific to UPSs are to be observed:

- Energy storage system: The energy storage system (e.g. batteries) is only to be taken into account if incorporated inside the UPS,
- Equipment which are not part of the UPS or not necessary for the UPS installation are not to be taken into account: for instance external cables, cooling of the room, …

3.3. Reference lifetime

In consistency with product categories defined in the second stakeholder questionnaire for ERP directive Preparatory Study, the Reference Lifetime is:

Output power [P] Units: Watts	**Reference lifetime [X]** Units: years
P ≤ 1500 W	5
1500 W< P ≤5000 W	8
5000 W< P ≤10000 W	10
P > 10000W	15

Table 1: reference lifetime

4. System Boundaries

These specific rules are additional to section 2.2 "System boundaries" of the PCR (PEP-PCR ed.3-EN-2015 04 02), which describes all boundaries per stage of life cycle.

The inputs and outputs related to the production of the materials and components making up the reference product and assembly are to be taken into account:

- Transformers (if incorporated inside the UPS)
- Electrolytic capacitors (if incorporated inside the UPS)
- Semi-conductors: IGBT / THYRISTOR, etc…
- Circuit boards
- Housing
- Fans and / or cooling systems
- Switch
- Relay
- Breaker
- Lead-acid battery (if included inside the UPS)
- Wires

5. Development of scenarios (default scenarios)

These specific rules are additional to section 2.5 "Development of scenarios (default scenarios)" of the PCR (PEP-PCR ed.3-EN-2015 04 02).

5.1. Use phase scenario

5.1.1. Typical load profile

The input parameters to determine the use phase scenario are the output power and input dependency characteristics of the UPS:

Output power P [P] Units: Watts	**Input Dependency Characteristics**	**Proportion of Time spent at specified Proportion of Reference Test Load [t]**			
		25%	50%	75%	100%
P ≤ 1500 W	VFD	0,2	0,2	0,3	0,3
P ≤ 1500 W	VI or VFI	0	0,3	0,4	0,3
1500 W< P ≤10000 W	VFD, VI or VFI	0	0,3	0,4	0,3
P > 10000W	VFD, VI or VFI	0,25	0,5	0,25	0

Table 2: from Energy STAR® Program Requirements Product Specification for Uninterruptible Power Supplies (UPSs), Eligibility Criteria Version 1.0

Example of use table 2: The VI or VFI UPS below 1500W is working 30% of the time at 50% load, 40% of time at 75% load and 30% time at 100% load.

5.1.2. Energy efficiency calculation

Energy Efficiency (Eff) is determined as specified in Annex J of IEC 62040-3.

In case of a single mode UPS

Use the energy efficiency of the available mode to calculate the average energy efficiency of the UPS. The average efficiency of the UPS has to be calculated according to equation 1

Equation 1 :

$$\text{Average efficiency} = [t]_{25\%} \times Eff_{25\%} + [t]_{50\%} \times Eff_{50\%} + [t]_{75\%} \times Eff_{75\%} + [t]_{100\%} \times Eff_{100\%}$$

Where :

Eff is the efficiency in % at specified Proportion of Reference Test Load [t], see table 2

In case of a multimode UPS

Calculate average efficiency according to equation 2

Equation 2 :

Average efficiency = 0,75x Eff1 + 0,25 x Eff2

Where :

- Eff1 is the average loading-adjusted efficiency in the lowest input dependency mode (i.e., VFI or VI), as calculated per Equation 1, and
- Eff2 is the average loading-adjusted efficiency in the highest input dependency mode (i.e., VFD), as calculated per Equation 1.

5.1.3. Energy consumption calculation

To calculate the UPS average energy consumption in use phase during its reference lifetime, the required input parameters are:

- Average energy efficiency of the UPS
- Product reference lifetime [X] as defined in table 1
- Average output power according to load rate

Equation 3:

Average energy consumption = (1 - average energy efficiency) x average output power x product

5.1.4. Maintenance

Some UPS may require to be maintained to reach the expected lifetime. A non exhaustive list of typical UPS components to be maintained is:

- Electrolytic capacitors,
- Fans,
- Batteries if incorporated in the UPS,
- PCB.

The amount of each component needed during the lifetime of the UPS has to be taken into account in the life cycle assessment, as defined in table 3 below

	Maintenance frequency					
Output power [P] Units: Watts	**Reference lifetime** Units: year	**DC capacitor of filtering**	**AC capacitor of filtering**	**Fans**	**Power supply PCB**	**Batteries**
P≤ 1500 W	5	No maintenance				
1500 W< P ≤5000 W	8	1	1	1	1	1
5000 W< P ≤10000 W	10	1	1	2	1	1
P> 10000W	15	2	2	3	2	2

Table 3: Maintenance frequency table

Example of use of table 3: for a UPS with output power > 10 000W, the DC capacitor of filtering has to be changed twice in the whole lifespan

5.2. End of life scenario

The general rules detailed in the PEP-PCR ed.3-EN-2015 04 02 shall be observed.
Examples of recyclability rates of raw materials and components can be found in IEC/TR 62635.

Note 1: spare parts necessary for the maintenance (see table 3) shall also be included in end of life treatment scenario.

Note 2: in case of UPSs with incorporated batteries in the European market, the 2006/66/EC batteries and accumulators directive applies and following minimum recycling rates for batteries should be respected:

- Lead-acid: Recycling of 65% by average weight,
- Nickel-cadmium: recycling of 75% by average.

In case of higher recycling efficiency, the manufacturer shall document it.

6. Drawing up the Product Environmental Profile

These rules are additional to section 4 “Drawing up the Product Environmental Profile” of the PCR (PEP-PCR ed.3-EN-2015 04 02).

6.1. General parameters

Following parameters shall be mentioned in the PEP:

- Location of the manufacturing plant,
- Environmental management system.

6.2. Description of the reference product and the product range covered

The reference product is characterized by:

- Model
- Commercial reference of the reference product and all the product covered
- Power (rated and apparent) in VA and W
- UPS configuration (see Annex A of IEC 62040-3:2011),
- UPS performance classification (see 5.3.4. of IEC 62040-3:2011),
- Product dimensions (height × width × depth),
- Mass without energy storage system e.g. batteries,
- Mass of energy storage system if incorporated,
- Input Dependency Characteristics according to IEC 62040-3 (VFI, VFD, VD): monomode or multimode,
- If the energy storage system is incorporated in the UPS the backup time,
- The power factor,
- Expected life time of the UPS,
- Redundancy.

Remark: a reference product is called a representative product in IEC 62040-4

6.3. Material disclosure

The constitutive materials have to be disclosed. Packaging materials shall also be declared.
It is recommended to use format specified the annex D of the IEC 62474 standard.

The material disclosure shall not be detailed for each component but give an overview of the material composition of the whole UPS.

6.4. Use phase

The average energy efficiency has to be declared according to clauses 5.2.2 of the present document.
If the UPS requires maintenance to reach its expected lifetime, the types and quantity of replaced components have to be declared in consistency with clause 6.2.4 of the present document.

6.5. Back-up time

The aim of this section is to list the parameters to be declared in the PEP to characterise the backup time declared in the functional unit:

- Technology of energy storage system
- Nominal load in W

The backup time is determined with the nominal active power of the UPS as specified in IEC 62040-3, clause 6.4.4.1

7. Appendices

7.1. Glossary

For the purpose of this document, the following terms and definitions apply.

Uninterruptible Power Supply or UPS: combination of convertors, switches, and energy storage devices (such as batteries) constituting a power system for maintaining continuity of load power in case of input power failure.
[*Source: IEC 62040-3:2011.3.1.1*]

Energy storage system: system consisting of single or multiple devices and designed to provide power to the UPS inverter for the required stored energy time.
NOTE : Notwithstanding challenges with respect to recharge, examples of energy storage systems include but are not limited to battery, double-layer capacitor ("super" or "ultra" capacitor), flywheel and fuel-cell systems.
[*Source: IEC 62040-3:2011.3.1.1*]

Battery: set of electrochemical cells of the same type so connected as to act together.
[*Source: IEC 62040-3:2011.3.1.1*]

Flywheel storage system: mechanical energy storage system wherein stored kinetic energy can be converted to d.c. power during stored energy mode of operation.
[*Source: IEC 62040-3:2011.3.1.1*]

Voltage and Frequency Dependent or VFD UPS: UPS classified VFD shall protect the load from power outage.
[*Source: IEC 62040-3:2011.3.1.1*]

Voltage Independent or VI UPS: UPS classified VI shall protect the load as requested for VFD and in addition from :

- Under-voltage applied continuously to the input;
- Over-voltage applied continuously to the input.

[*Source: IEC 62040-3:2011.3.1.1*]

Voltage and Frequency Independent or VFI UPS: UPS classified VFI is independent of supply (mains) voltage and frequency variations and shall protect the load against adverse effects from such variations without depleting the stored energy source.
[*Source: IEC 62040-3:2011.3.1.1*]

Redundancy: Addition of UPS units in a parallel UPS to enhance the continuity of load power, and classified as follows.

1) N + 0: UPS that cannot tolerate any failures while maintaining Normal Mode operation. No redundancy.
2) N + 1: Parallel UPS that can tolerate the failure of one UPS unit or one group of UPS units while maintaining Normal Mode operation.
3) 2N: Parallel UPS that can tolerate the failure of one half of its UPS units while maintaining Normal Mode operation.

[*Source: ENERGY STAR® Program Requirements Product Specification for Uninterruptible Power Supplies (UPSs), Eligibility Criteria Version 1.0*]

7.2. References

The following documents, in whole or in part, are referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

- Generic Ecopassport PCR: PCR Product Category rule of the PEP ecopassport ® Program number PEP-PCR ed.3-EN-2015 04 02,
- IEC 62040-3 Edition 2.0 2011-03: UPS - Method of specifying the requirements and test requirements,
- ENERGY STAR® Program Requirements Product Specification for Uninterruptible Power Supplies (UPSs), Eligibility Criteria Version 1.0,
- IEC 62474 : Material declaration for Products of and for the Electro technical Industry,
- ERP pre-study questionnaires.

7.3. Declaration of conformity

SGS	CRITICAL REVIEW - COMPLIANCE PEP PSR UPS	Page 1 / 1
		Author : Jean-Baptiste Molet

Period of review: 24th Oct. 2013 – 18th Dec. 2013
Date of report: 18th Dec. 2013
Version of the reviewed document: drafts v10 and v12.
Reviewer : Jean-Baptiste MOLET

CONTEXT

PEP Association developed a Product Specific Rule to provide more accurate recommendation in the LCA calculation for Uninterruptible Power Supplies. SGS work consists in a critical review of the document.

CONCLUSION OF THE CRITICAL REVIEW

After an initial review of the document, a few remarks have been done by the reviewer and taken into consideration by the PSR project team. Several non conformities have been solved during the review, and recorded separately.

We do not have more remarks about the compliance of "PSR-0010-ed1-EN-2014 02 11" to the ISO 14025, ISO 14044, and PEP–PCR–ed 2.1-FR-20121211 standards requirements.

Arcueil, February 18th 2014,

SGS CTS - 29, av. Aristide Briand – 94111 Arcueil Cedex – France t 01 41 24 88 88 f 01 41 24 89 99
Siège social : 20/22, rue Charles Parodinas – 92 583 CLICHY Cedex- France t 01 41 06 95 85 f 01 47 30 40 96 SAS au capital de 100 000 Euros
- Identification 420 660 629 RCS Nanterre NAF 743 B

7.4.

7.4. Example of average energy efficiency and average energy consumption calculation

Example of a 160kVA UPS, in VFI mode

Reference lifetime according to table 1: 15 years

Load profile : table 2

		Proportion of Time Spent at Specified Proposition of Reference Test Load $t_{n\%}$			
Rated Output Power, P, in watts (W)	**Input Dependency Characteristic**	**25%**	**50%**	**75%**	**100%**
P ≤ 1500 W	VFD	0.2	0.2	0.3	0.3
	VI or VFI	0	0.3	0.4	0.3
1500 W < P ≤ 10,000 W	VFD, VI OR VFI	0	0.3	0.4	0.3
P > 10,000 W	VFD, VI OR VFI	0.25	0.5	0.25	0

Time proportion	0,25	0,5	0,25	0,00	
Specified Proposition of Reference Test Load	25%	50%	75%	100%	
Power of Load in W	40000	80000	120000	160000	← Load proportion x rated power in W
Time spent in years	3,75	7,5	3,75	0	← Time proportion x expected lifetime in years
Time spent in hours	32850	65700	32850	0	← Time spent in Years x 365x24
UPS Efficiency	94,0%	95,0%	96,0%	96,0%	← UPS efficiency measured according to 62040-3
Power loss in W	2400	4000	4800	6400	← Power loss x rated power of UPS x(1-UPS efficiency)

Average energy consumption in kWh **499 320** ← (Time spent in hours$_{25\%}$ x Power loss in Watt$_{25\%}$ + Time spent in hours$_{50\%}$ x Power loss in Watt$_{50\%}$ + Time spent in hours$_{75\ \%}$ x Power loss in Watt$_{75\ \%}$ + Time spent in hours $_{100\%}$ x Power loss in Watt$_{100\ \%}$)/1000

Average energy efficiency **95%** ← Time proportion$_{25\%}$ x UPS Efficiency$_{25\%}$ + Time proportion$_{50\%}$ x UPS Efficiency$_{50\%}$ + Time proportion$_{75\%}$ x UPS Efficiency$_{75\%}$ + Time proportion$_{100\ \%}$ x UPS Efficiency$_{100\%}$