



PEP ecopassport® PROGRAM

PSR

SPECIFIC RULES FOR Wires, Cables and Accessories

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1. Introduction

This reference document complements and explains the Product Category Rules (PCR) for Product Environmental Profile (PEP) defined by the PEP ecopassport® program (PEP-PCR-ed3-EN-2015 04 02), available at www.pep-ecopassport.org.

It defines the additional requirements applicable to “Wires, Cables and Accessories”. 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 “Wires, Cables and Accessories” market.

	www.pep-ecopassport.org
PSR reference	PSR0001-ed3-EN-2015 10 16
Critical review	The third-party Critical review was carried out by Solinnen. The declaration of conformity published on 2015/08/05 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 for 5 years or until the PEP Drafting Rules, or the normative reference texts to which they refer, are modified.

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 in addition to the PCR, "Product Category Rules", (PEP-PCR-ed3-EN-2015 04 02) of the PEP ecopassport® eco-declaration program, this document sets out the specific rules for "Wires, Cables and Accessories" and defines the product specifications to be adopted by manufacturers in the development of their PRODUCT ENVIRONMENTAL PROFILES (PEP) particularly with regard to:

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

It covers the use, installation and end of life stages. In the "Wires, Cables and Accessories" category, there are four types of products:

- Power transmission wires and cables,
- Communication and data wires and cables, which may have metal or optical fiber conductors,
- Control and command wires and cables, which can have metal or fiber optical conductors,
- Power and telecom accessories.

To avoid any confusion with the PSR-005 ("Electrical switchgear and controlgear solutions), the accessories for energy networks and the accessories for telecom networks included in that Product Specific Rules document are

- Low voltage:
 - Junctions and shunts.
- Medium voltage:
 - Cable terminations,
 - Medium voltage separable connectors and plug-in bushings,
 - Medium voltage, taped, injected, heat shrinkable junctions and shunts for dry or paper insulated cables,
 - Medium voltage prefabricated junctions for insulated dry cables.
- High and very high voltage:
 - Cable terminations, junctions.
- Networks Telecom Accessories.
 - Optical network telecom accessories

The rules have been developed by the SYCABEL, professional organization of French cable, wire and connection equipment manufacturers, according to the procedures for openness and public access established by the PEP ecopassport® program. This specification document is primarily intended for:

- Environment and/or product managers,
- LCA experts in companies, in charge of PEP development,
- Verifiers in charge of PEP conformity assessment in accordance with the defined rules.

3. Energy wires and cables

3.1. Functional unit and reference flow description

This section specifies for energy wires and cables the section 2.1 “Functional unit and reference flow description” of the PCR (PEP-PCR-ed3-EN-2015 04 02), in order to provide a more precise definition of the functional unit for this product category.

In order to define the functional unit for energy wires and cables, the manufacturers shall use the following sentence:

« To transmit energy expressed for 1A over a distance of 1 km during X years and a Y% use rate, in accordance with the relevant standards (mention the relevant standards or refer the product technical data sheet).

Lifetime and use rate correspond to the application Z as defined in the table given in Appendix 1 of the specific rules for wire, cables and accessories. »

The determination of the numbers X of years depends on the application and is explained in the section 3.2.2 “Use stage”.

According to the functional unit definition, the different life cycle stages are not proportional to the same input parameters:

- The manufacturing, distribution and end of life stages are proportional to the studied cable length (1 km),
- The use stage is proportional to the cable length studied (1 km) as well as the intensity carried. As detailed in paragraph 3.2.2.2, on account of the wide possible range of these products use for a given application, and to ensure the PEP comparability, the impact of the use stage shall be calculated for 1A.

Therefore, in the table with the environmental impacts, the column “Total” represents the environmental impact of the reference flow fulfilling the functional unit. The total cable impact installed shall be calculated by the PEP user according to his own use scenario. Moreover, the insert below shall be completed and included in the PEP, to ensure clarity and transparency for the user.

This PEP has been drawn up considering the following parameters:

- 1 km for manufacturing, distribution and end of life stages,
- 1 km and 1A for the use stage.

The potential impact of use stage shall be calculated by the PEP user considering the real amperage through the product during the use by multiplying the impact by the square of the intensity. This PEP is valid in the intensity range taking into account the maximum allowable intensity.

If the intensity range is related to the installation conditions of the product, they shall be specified in the insert.

3.2. System boundaries

As described in the “Product Category Rules”, the following life cycle stages shall be included:

- The manufacturing stage as described in paragraph 2.2.3 of the “Product Category Rules”,
- The distribution stage as described in paragraph 2.2.4 of the “Product Category Rules”,
- The installation stage as described in paragraph 2.2.5 of the “Product Category Rules”,
- The use stage as described in paragraph 2.2.6 of the “Product Category Rules”,
- The end of life stage as described in paragraph 2.2.7 of the “Product Category Rules”.

The following sections complete, for installation, use and end life stages, the respective sections 2.2.5, 2.2.6 and 2.2.7 of the “Product Category Rules” (PEP-PCR-ed3-EN-2015 04 02) for energy wires and cables.

3.2.1. Installation stage

This section specifies the section 2.2.5 “Installation stage” of the “Product Category Rules” for the energy wire and cable category. Concerning energy wires and cables, and considering the wide range of possible installation of these products, installation processes are excluded from the system boundaries. This extended cut-off rule does not exclude the respect of the other requirements from the “Product Category Rules” (PEP-PCR-ed3-EN-2015 04 02), such as considering the packaging treatment, or waste from the installation stage (manufacturing, transportation and end of life of waste).

Below the environmental impact table, it shall be mentioned that the impact concerning the product installation processes should be completed by the PEP user.

3.2.2. Use stage

This section specifies the section 2.2.6 “Use stage” of the “Product Category Rules” for energy wire and cable category by setting the assumptions for the calculation of the use stage impact.

Concerning energy wires and cables, the product use stage impact is important even sometimes predominant over the product total life cycle. Therefore, the product life cycle impact depends strongly on the assumptions made at use stage.

The use stage impact depends on choices regarding:

- The product reference lifetime,
- The product use rate,
- The linear conductor resistivity,
- The current intensity through the conductor.

To ensure PEP comparability, different assumptions were set for these four parameters.

3.2.2.1. Reference lifetime and use rate

Reference lifetime and use rate of energy wires and cables were consensually determined by all the technical experts of the profession for the different possible application areas. This hypothetical reference lifetime is always assumed to be smaller than the average real lifetime of the product.

Any wire or cable, according to standards to which it corresponds to, belongs to a single application. The table given in Appendix 1 includes the different fields of application covered for wires and cables, and specifies the product reference lifetime and use rate leading to the use time to take into account in the calculations.

In the exceptional case an application is not described in the table in the appendix, and to ensure the PEP comparability, a 5-year lifetime with a 100% use rate shall be considered by default. Moreover, a request to update the Product Specific Rules for “Wires, Cables and Accessories” shall be made to the Technical Committee of the PEP Association for adding an application with a reference lifetime and use rate.

3.2.2.2. Linear resistivity and intensity

For energy transmission products, energy consumption results in losses by Joule effect, over the use time:

$$E = Z I^2 \times \Delta t$$

Where:

Z: linear resistivity of the cable in Ω/km

I: current in A

Δt : use time in s

Concerning energy wires and cables, because of the wide and various possible uses of these products for a given application, and to ensure the PEP comparability, the functional unit is expressed for a current of 1 A.

The determination of the exact use impact shall be carried out by the PEP users, depending on the product use context and using the impact calculated for 1A.

Concerning the linear resistivity of the conductor, it shall be, in order of preference, corresponding to an increasing resistivity:

- Either be measured according to the protocol of Appendix A of the standard IEC 60228 (“Conductors of insulated cables”),
- Either refer to the resistivity specified in the standard quoted in the functional unit,
- Either refer to the maximum value of the conductors at 20° C in IEC 60228 standard “Conductors of insulated cables”.

This rule allows expressing the losses by Joule effect in the cable during use stage regardless of the use scenario knowledge of end charge specific to each PEP user and thus ensures PEP comparability.

Energy consumption during use stage is then expressed in $\text{J.km}^{-1}.\text{A}^{-2}$ or equivalent unit, considering that the functional unit is given for 1A and for a length of 1 km of cable.

$$[1] E [\text{J.km}^{-1}.\text{A}^{-2}] = Z [\Omega.\text{km}^{-1}] \times I [\text{A}^2] \times \Delta t [\text{s}]$$

Thus, by multiplying by the square of the intensity and the actual length of the circuit, the PEP user gets the consumption by Joule effect over the considered use time.

Example: length= 10 km and average current I= 15A, the loss is then $225 \times R \times \Delta t$

Protection conductors are not taken into account in the calculation of the Joule effect losses.

For multi-conductors cables and assuming a balanced system, a current intensity of 1A shall be considered in every conductor except in the protection conductor.

The following assumptions shall be specified in the PEP and justified in the LCA report:

- Conductor resistivity determination method,
- Conductor resistivity value ($\Omega \cdot \text{km}^{-1}$),
- Reference lifetime and use rate.

3.2.3. End of life stage

This section supplements the section 2.2.7 “End of life stage” of the “Product Category Rules” for energy wire and cable category, by setting the processes to be considered in the study of the end of life stage.

To ensure PEP comparability, end of life steps to be taken into account are:

- Transportation, assuming a local transport as described in the “Product Category Rules”,
- A stage of grinding / separation of metals and plastics,
- Recycling of 100% of metals, linked to the economic value of these materials,
- Landfilling of other materials as described in the “Product Category Rules”.

As for the installation stage, considering the wide range of possible removal processes of these products, the removal processes and/or dismantling of cables are excluded from the PEP perimeter. The impact of removal shall be carried out by the PEP user, considering the product use features.

4. Communication and data wires and cables

4.1. Functional unit and reference flow description

This section specifies for communication and data wires and cables the section 2.1 “Functional unit and reference flow description” of the PCR (PEP-PCR-ed3-EN-2015 04 02), in order to provide a more precise definition of the functional unit for this product category.

In order to define the functional unit for the communication and data wires and cables, the manufacturers shall use the following sentence:

« To transmit a communication signal on 1 m, at a frequency of α Hz (or respectively a wavelength of β nm for a mono- or multi-mode optical fiber), during X years and a Y% use rate in accordance with the standards in force (mention the relevant standards or refer the product technical data sheet).

Lifetime and use rate correspond to the application Z as defined in the table given in Appendix 1 of the specific rules for wire, cables and accessories. »

If the protocol used and the cable (or respectively optical fiber) category are known, the manufacturer shall use the following sentence:

« To transmit a communication signal on 1 m according to XX protocol, YY category, during X years and a Y% use rate in accordance with the standards in force (mention the relevant standards or refer the product technical data sheet).

Lifetime and use rate correspond to the application Z as defined in the table given in Appendix 1 of the specific rules for wire, cables and accessories. »

The determination of the numbers X of years depends on the application and is explained in the section “4.2.2 Use stage”.

4.2. System boundaries

As described in the “Product Category Rules”, the following life cycle stages shall be included:

- The manufacturing stage as described in paragraph 2.2.3 of the “Product Category Rules”,
- The distribution stage as described in paragraph 2.2.4 of the “Product Category Rules”,
- The installation stage as described in paragraph 2.2.5 of the “Product Category Rules”,
- The use stage as described in paragraph 2.2.6 of the “Product Category Rules”,
- The end of life stage as described in paragraph 2.2.7 of the “Product Category Rules”.

The following sections complete, for installation, use and end life stages, the respective sections 2.2.5, 2.2.6 and 2.2.7 of the “Product Category Rules” (PEP-PCR-ed3-EN-2015 04 02) for communication and data wires and cables.

4.2.1. Installation stage

This section specifies the section 2.2.5 “Installation stage” of the “Product Category Rules” for communication and data wire and cable category. Concerning communication and data wires and cables, and considering the wide range of possible installation of these products, the installation processes are excluded from the system boundaries. This extended cut-off rule does not exclude the respect of the other requirements from the “Product Category Rules” (PEP-PCR-ed3-EN-2015 04 02), such as considering the packaging treatment, or waste from the installation stage (manufacturing, transportation and end of life of waste).

Below the environmental impacts table, it shall be mentioned that the impact concerning the product installation processes should be completed by the PEP user.

4.2.2. Use stage

This section specifies the section 2.2.6 “Use stage” of the “Product Category Rules” for communication and data wire and cable category by setting the assumptions for the calculation of the use stage impact.

There are three types of communication and data transmission cables:

- Twisted pair cables,
- Coaxial cables,
- Optical fiber cables.

In the case of communication wires and cables, the impact of the product use stage over the product total life cycle is low. The energy consumed during use stage by communication and data cables is related to the attenuation of the transmitted signals. This attenuation is due to the signal energy loss through the conductors.

Note:

- *On metal conductors, resistive losses and electromagnetic emission occurring at high frequency induce attenuation. Attenuation increases with conductors' length and frequency of emitted signal.*
- *On optical fiber cables, attenuation depends on the type of fibers, the used wavelength and on the optical fiber length. The attenuation measurement (in dB) expresses the ratio between the emitted energy and the received energy: the smaller the measured value is, the better the link is.*

The energy consumption during use stage shall correspond, in order of preference, to growing energy consumption:

- Either be measured. The paragraphs “Use stage losses determined by measurement” describe the loss measurement methods,
- Or shall refer to the loss maximum values as specified in the respective standards. The paragraphs “Use stage losses determined by standards” describe how to calculate the losses.

In all cases, the determination of loss method used shall be specified in the PEP and justified in the LCA report.

4.2.2.1. Twisted pair cables

Twisted pair cables are mainly used for computer networking and telephony. Networks are defined in the standards, such as being links of length up to 100 meters maximum, consisting in 90 meters of horizontal cables and 2 times 5 meters of patchcords. In business, installed horizontal cables may vary from 10 to 90 meters. The average length usually found in a set of connections is 40 meters.

This average length of 40 meters is used to calculate the energy loss at the frequency of considered protocol because attenuation is not proportional to the length but has an exponential behavior. Indeed, we know that more than 50% of the energy is consumed in the first 20 meters of cable.

The energy loss is calculated using a 40m cable length, and the consumed power is then reduced to the functional unit (1 meter of cable).

Use stage losses determined by measurement

For the use stage loss measurement, the following formula from Physics of transmission shall be used:

$$P \text{ lost} = (P_e - P_s) \times N_{\text{pair}} / L_{\text{average}}$$

Where:

P_{lost} = consumed power in Watt / meter of cable

P_e = power input in Watt and $P_e = U^2/Z = Z \cdot I^2 = U \cdot I$

Z = resistance of the cable in ohm

U = voltage in volt

I = intensity in ampere

P_s = output power in watt and $P_s = P_e \times 10^{(-ATT/10)}$

ATT = linear attenuation in dB of the cable at the frequency of the maximum amplitude of the spectrum used in the communication protocol for an average length (L_{average}) used in meters. The frequencies to be used are mentioned in the chart below. The measurement method of linear attenuation is described by the standard IEC 61156-1.

N_{pair} = the number of pairs used in the communication protocol.

L_{average} = average length in meters of an installed cable

In all cases, the obtained value in watt shall be multiplied by the reference lifetime and use rate of the corresponding application to obtain the energy consumed in Wh or Joule (see Appendix 1).

Generally, choices shall be identified in the PEP and justified in the LCA report.

Use stage losses determined by standards

Used network protocols set the frequency range of transmitted signals. For the loss calculation, the frequency value at the maximum spectral amplitude in the communication protocol is used. The frequencies to be used are mentioned in the table below.

To meet the requirements of these protocols, the cables are divided into categories. For each category is assigned an attenuation value according to the central frequency of the relevant protocol. This maximum attenuation by category is defined in the standard IEC 61156 corresponding to the cable category.

Table 1 below includes all the data to use for horizontal cables complying with the reference standards (performance standard cable IEC 61156 and Ethernet IEEE standard 802.3)

Table 1 : Data for Copper cables

<i>Twisted pair copper cables</i>			
Protocol	Frequency	Category	Power consumption
Ethernet 100M BP(*)=100MHz	31.25 MHz	Cat.5e According to IEC 61156-5	4.54 dB/40 m at 31.25 MHz Injected power = 14 mW leading to 0.454 mW/m of cable on 2 pairs
1 G Ethernet BP (*) = 250 MHz	83 MHz	Cat 6 According to IEC 61156-5	7.16 dB/40 m at 83 MHz Injected power = 14 mW leading to 0.565 mW/m of cable on 2 pairs
10G Ethernet BP (*) = 500 MHz	400 MHz	Cat. 6a According to IEC 61156-5	15.85 dB/40 m at 400 MHz Injected power = 14 mW leading to 1.364 mW/m of cable on 4 pairs
10G Ethernet BP(*)=600 MHz	400 MHz	Cat 7 According to IEC 61156-5	15.8 dB/40m at 400 MHz Injected power = 14 mW leading to 1.363 mW/m of cable on 4 pairs
10G Ethernet BP(*)=1000MHz	400 MHz	Cat 7a According to IEC 61156-5	15.04 dB/40m at 400 MHz Injected power = 14 mW leading to 1.356 mW/m of cable on 4 pairs
10G Ethernet BP(*)=1200MHz	400 MHz	Cat 7+ According to IEC 61156-5	14.56 dB/40 m at 400 MHz Injected power = 14 mW leading to 1.351 mW/m of cable on 4 pairs

(*) BP: cable bandwidth

4.2.2.2. Coaxial cables

For television modulated from 47 to 2500 MHz, the used power doesn't exceed 85 dB μ V, meaning 18 mV on 75 Ohms. Lost power is around 0.26 μ W. This lost power is considered negligible by comparison with the impacts of the manufacturing, distribution and end of life product stages.

For mobile telephony networks, the 50-Ohm coaxial cables inside transmitter equipping aerials are powered by a maximum electric power of 10 to 40W. The emission frequency varies from 1.8 MHz to 3 GHz.

With different diameters of coaxial cables and attenuations depending on the size of coaxial cables, it is difficult to establish a general rule. The determination of losses such as defined for twisted pair cables shall be used with the value 1 for the Nbpair parameter.

In all cases, the value obtained in Watt is multiplied by the reference lifetime and use rate of the corresponding application to get the energy consumed in Wh or Joule (see Appendix 1).

Moreover, the choices and assumptions used for loss calculation shall be identified in the PEP and justified in the LCA report.

4.2.2.3. Optical Fiber cables

Optical fiber cables are mainly used for computers networking from medium-sized to large distances. Used network protocols establish optical fiber type: either the multimode fiber, or the single-mode fiber. In optics, attenuation depends on the wavelength.

Distances of multimode fiber optical local networks are from 300 to maximum 2000 meters. A 150-meter length is used, consensually, to calculate the optical signal attenuation at the wavelength of the considered protocol as a conservative approach.

Distances in single-mode fiber optical local networks are less than 10 km. A 500-meter length is used, consensually, to calculate the optical signal attenuation in the wavelength of the considered protocol as a conservative approach.

Attenuation is not proportional to the length but is exponentially related. This value is then reduced to the functional unit (1 meter of cable).

For the optical signal loss calculation, the most impacting wavelength shall be used for attenuation for both types of optical fibers (as we don't know which one will be used by the final customer), that is to say $\lambda=850$ nm for multimode fibers (OM) and $\lambda = 1310$ nm for the single-mode fibers (OS).

Average lengths to estimate line losses are identified in Table 2 below.

Use stage losses determined by measurement

For the use stage losses determined by measurement, the formula issued from Physics of transmission will be used:

$$P \text{ lost} = (P_e - P_s) \times N_{bFO} / L \text{ average}$$

Conversion mW in dBm : $P[\text{mW}] = 10^{(P[\text{dBm}] / 10)}$

Where:

$P \text{ lost}$ = loss of optical signal in Watt / meter of cable

P_e : Input power in Watt

P_s : output power in Watt and $P_s = P_e \times 10^{(-ATT/10)}$

ATT: cable attenuation in dB at a used wavelength for an average length (L average) in meters. Wavelengths and installation average length are specified in the chart below. The measurement method of linear attenuation is described by IEC 60794 standard

N_{bFO} = number of optical fibers in the cable

L average = average length of installed cables in meters

In all cases, the value obtained in Watt shall be multiplied by the reference lifetime of the corresponding application to have the power in Wh or Joule (see Appendix 1).

Generally, choices and hypotheses used for loss calculation shall be identified in the PEP and justified in the LCA report.

Use stage losses determined by standards

The maximum attenuation values at the reference wavelength are 3.5 dB/km (IEC 60793-2-10) for multimode fibers and 0.4dB/km for single-mode fibers.

The table below includes all the data to use for the optical cables from reference standards (cable performance standard IEC 60793, IEC 60794 and Ethernet IEEE standard 802.3).

Table 2 : Data for optical fibers

<i>Optical Fiber Cables</i>					
Protocol	Optical fiber type	wavelength	Maximum distance	Average length	Power consumption
10GBASE-SR	Multimode	@850nm	< 300m	150 m	Attenuation at $\lambda=850\text{nm}$: 3.5dB/km Injected power=0 dBm leading to 1mW Leading to 0.76 mW/km or 0.76$\mu\text{W}/\text{m}$ of 1FO
1000BASE-SX			500m		
10BASE-FL			2 km		
100BASE-LX	Single mode	@1310nm	2 to 3 km	500 m	Attenuation at $\lambda=1310\text{nm}$: 0.4dB/km Injected power=0 dBm leading to 1mW Leading to 0.09mW/km or 0.09$\mu\text{W}/\text{m}$ of 1FO
1000BASE-LX			2 km		
10GBASE-LR			10km		

4.2.2.4. Reference lifetime and use rate

The reference lifetime and use rate of communication and data wires and cables were consensually determined by all the technical experts of the profession for the different possible application areas. This hypothetical reference lifetime is always smaller than the product real lifetime.

Any wire or cable, according to standards to which it corresponds to, belongs to a single application. The table given in Appendix 1 includes the different fields of application covered for wires and cables, and specifies the product reference lifetime and use rate leading to the use time to take into account in the calculations.

In the exceptional case an application is not described in the table in the appendix, and to ensure the PEP comparability, a 5-year lifetime with a 100% use rate shall be considered by default.

Moreover, a request to update the Product Specific Rules for “Wires, Cables and Accessories” shall be made to the Technical Committee of the PEP Association for adding an application with a reference lifetime and use rate.

4.2.3. End of life stage

This section supplements the section 2.2.7 “End of life stage” of the “Product Category Rules” for communication and data wire and cable category, by setting the processes to be considered in the study of the end of life stage.

To ensure PEP comparability, end of life steps to be taken into account are:

- Transportation, assuming a local transport as described in the “Product Category Rules”,
- A stage of grinding / separation of metals and plastics,
- Recycling of 100% of metals, linked to the economic value of these materials,
- Landfilling of other materials as described in the “Product Category Rules”.

As for the installation stage, considering the wide range of possible removal processes of these products, the removal processes and/or dismantling of cables are excluded from the PEP perimeter. The impact of removal shall be carried out by the PEP user, considering the product use features.

5. Control and command Wires and cables

5.1. Functional unit and reference flow description

This section specifies for control and command wires and cables the section 2.1 “Functional unit and reference flow description” of the PCR (PEP-PCR-ed3-EN-2015 04 02), in order to provide a more precise definition of the functional unit for this product category.

In order to define the functional unit for the control and command wires and cables, the manufacturers shall use the following sentence:

« To transmit data and signals on a distance of 1 meter during X years and a Y% use rate to control, measure and regulate equipments, in accordance with the standards in force. (mention the relevant standards or refer the product technical data sheet).

Lifetime and use rate correspond to the application Z as defined in the table given in Appendix 1 of the specific rules for wire, cables and accessories. »

The determination of the numbers X of years depends on the application and is explained in the section 5.2.2 “Use stage”.

5.2. System boundaries

As described in the “Product Category Rules”, the following life cycle stages shall be included:

- The manufacturing stage as described in paragraph 2.2.3 of the “Product Category Rules”,
- The distribution stage as described in paragraph 2.2.4 of the “Product Category Rules”,
- The installation stage as described in paragraph 2.2.5 of the “Product Category Rules”,
- The use stage as described in paragraph 2.2.6 of the “Product Category Rules”,
- The end of life stage as described in paragraph 2.2.7 of the “Product Category Rules”.

The following sections complete, for installation, use and end life stages, the respective sections 2.2.5, 2.2.6 and 2.2.7 of the “Product Category Rules” (PEP-PCR-ed3-EN-2015 04 02).

5.2.1. Installation stage

This section specifies the section 2.2.5 “Installation stage” of the “Product Category Rules” for the control and command wire and cable category. Concerning control and command wires and cables, and considering the wide range of possible installation of these products, the installation processes are excluded from the system boundaries. This extended cut-off rule does not exclude the respect of the other requirements from the “Product Category Rules” (PEP-PCR-ed3-EN-2015 04 02), such as considering the packaging treatment, or waste from the installation stage (manufacturing, transportation and end of life of waste).

Below the environmental impact table, it shall be mentioned that the impact concerning the product installation processes should be completed by the PEP user.

5.2.2. Use stage

This section specifies the section 2.2.6 “Use stage” of the “Product Category Rules” for control and command wire and cable category, justifying that the impact of the stage is negligible compared to the impact of the total product life cycle.

The environmental impacts of Joule effect losses for control and command wires and cables are negligible compared to other stages impacts (manufacturing, distribution and end of life). Indeed, these cables are using currents with an intensity around a few tens of mA, either because the transported currents are low in intensity (measure cables), or because the voltage and current are applied in a sporadic way (control cables).

Therefore, in the environmental impact table, the “Use” column shall include the reference “Negligible”, indicating that the impact assessment of this stage is negligible by comparison with the other life cycles stages of these products.

5.2.3. End of life stage

This section supplements the section 2.2.7 “End of life stage” of the “Product Category Rules” for control and command wire and cable category, by setting the processes to be considered in the study of the end of life stage.

To ensure PEP comparability, end of life steps to be taken into account are:

- Transportation, assuming a local transport as described in the “Product Category Rules”,
- A stage of grinding / separation of metals and plastics,
- Recycling of 100% of metals, linked to the economic value of these materials,
- Landfilling of other materials as described in the “Product Category Rules”.

As for the installation stage, considering the wide range of possible removal processes of these products, the removal processes and/or dismantling of cables are excluded from the PEP perimeter. The impact of removal shall be carried out by the PEP user, considering the product use features.

6. Accessories

6.1. Power connection accessories

6.1.1. Functional unit and descriptions of the reference flow

This section specifies the section 2.1 “Functional unit and reference flow description” of the PCR (PEP-PCR-ed3-EN-2015 04 02) for the power connection accessory category. It defines more precisely the functional unit for this product category.

In order to define the functional unit for the power connection accessories, the manufacturer shall use the standard formulation indicated below:

« To connect together the power transmission cables, or connect them to equipments, for one packaging unit, under operating conditions identical to those of the cable, namely: 1 A during X years, with a use rate of Y%, according to the standards in force. (mention the relevant standards or refer the product technical data sheet).

Lifetime and use rate correspond to the application Z as defined in the table given in Appendix 1 of the specific rules for Wire, Cables and Accessories. »

The determination of X number of years depends on the application, and is explained in Section 6.1.2.2 “Use stage”.

Because of the wide variety of possible uses of these products for a given application, and to ensure comparability of the PEPs, the impact of the use stage shall be calculated for 1A. In the table of environmental impacts, the “Total” column therefore represents the environmental impact of the functional unit, namely the connection of power transmission cables expressed for one packaging unit and for 1A. The total impact of the power connection accessories installed shall therefore be calculated by the user of the PEP based on his own scenario of use.

Moreover, the insert below shall be presented in the PEP to guarantee clarity and transparency for the user.

The PEP submitted was prepared taking into consideration the following parameters:

- 1 packaging unit for the production, distribution, installation and end of life stages
- 1 packaging unit and 1A for the use stage

The potential impact of the use stage, estimated as Joule losses, shall be calculated by the user of the PEP as a function of the actual amperage during the use of the product by multiplying the impact considered by the square of the intensity. The PEP is valid within an intensity range taking into account of the maximum permissible intensity.

6.1.2. System boundaries

As described in the “Product Category Rules”, the following life cycle stages have to be included:

- The manufacturing stage as described in paragraph 2.2.3 of the “Product Category Rules”,
- The distribution stage as described in paragraph 2.2.4 of the “Product Category Rules”,
- The installation stage as described in paragraph 2.2.5 of the “Product Category Rules”,
- The use stage as described in paragraph 2.2.6 of the “Product Category Rules”,
- The end of life stage as described in paragraph 2.2.7 of the “Product Category Rules”.

The following sections complete, for installation, use and end life stages, the respective sections 2.2.5, 2.2.6 and 2.2.7 of the “Product Category Rules” (PEP-PCR-ed3-EN-2015 04 02).

6.1.2.1. Installation stage

This section specifies the section 2.2.5 “Installation stage” of the “Product Category Rules” for the power connection accessory category. Considering the wide variety of possible methods of installation for these products, the determination of the installation impact shall be carried out on the basis of the hypotheses below to ensure comparability of the PEPs:

- The manual installation operations not requiring a power supply are not included within the scope of the study,
- The screwing or crimping processes are excluded, because of their low impact, as described in Section 2.2.8 of the “Product Category Rules” (PEP-PCR-ed3-EN-2015 04 02),
- For the installation processes requiring a thermal power supply (heat shrinkable accessories, for example), the impact of the installation shall be calculated as follow, taking into consideration the use of a gas torch:

- Gas consumption of the torch:

The consensual generic dataset to be taken into account is a consumption of 250 g of propane gas, taking into consideration the following hypotheses:

- A nozzle characteristic (NC), expressed in g/l, of 1000 g/h
- A length of use of the torch (Δt) expressed in hours, of 0.25h (15 minutes) per conductor, i.e.:

Gas consumption (C), expressed in grams, and calculated according to the following formula:

$$C = NC \times \Delta t$$

- Gas combustion emissions:

In agreement, the emissions associated with the complete combustion of the 250g of propane gas in the air to be considered are 749g of CO₂ and 408g of H₂O

The methods of installation described above correspond to the currently used technologies. In the case of future further developments, and to ensure the comparability of the PEPs, a request for updating the specific rules for “Wires, Cables and Accessories” shall then be made to the technical committee of the PEP Association.

Moreover, the treatment of waste from the packaging used to transport the product up to the installation place shall be considered in the installation stage, by applying the modularity principle mentioned in the “Product Category Rules”. Similarly, for products generating waste during installation, the manufacturing

of those waste, as well as their transportation to the installation place and their end of life shall be taken into account at installation stage.

6.1.2.2. Use stage

This section specifies the section 2.2.6 “Use stage” of the “Product Category Rules” for the power connection accessory category by establishing the assumptions to be made for calculating the impact of the use stage.

The impact of the use stage will depend on the selection regarding:

- The product reference lifetime;
- The product use rate;
- The linear resistance of the conducting part of the connection accessories;
- The intensity of the current going through it.

To ensure the comparability of the PEPs, different hypotheses have been established for these 4 parameters. These hypotheses shall be specified in the PEP and presented in the LCA report.

6.1.2.2.1. Reference lifetime and use rate

The reference lifetime and use rate of the power connection accessories were consensually determined by all the technical experts of the profession for the different possible application areas. This hypothetical reference lifetime is always assumed to be smaller than the average real lifetime of the product.

The table given in Appendix 1 indicates the different fields of application covered for the wires, cables and connection accessories and specifies the product lifetime, together with the use rate, resulting in the use time to be taken into account for the calculations.

In the exceptional case an application is not described in the table in the appendix, and to ensure the PEP comparability, a 5 years lifetime with a 100% use rate shall be considered by default.

Moreover, a request to update the Product Specific Rules for “Wires, Cables and Accessories” shall be made to the Technical Committee of the PEP Association for adding an application with a reference lifetime and use rate.

6.1.2.2.2. Linear resistance and intensity

For power connection accessories, the environmental impacts of the use stage are considered negligible, with the exception of the power consumption, which is expressed by the Joule losses over the use time.

The power consumption during use stage is then expressed according to the following formula:

$$E = R \times I^2 \times \Delta t \quad \text{or} \quad R = Z \times L \times 10^{-3}$$

Where:

E: power consumption, expressed in J;

R: resistance of the conducting part of the reference product for the power connection accessory, expressed in Ω ;

Z: resistance per unit of length of the conducting part of the reference product for the power connection accessories, taking the maximum value of the resistance per unit of length of the cable in the standard IEC 60228 relating to the class of the cable, the nature of the core and for the smallest cross-section supported by the accessory, in Ω/km ;

L: overall length of the conducting part in the axis of the cable in m;

I : intensity in A;

Δt : time of use in s.

For connection accessories, because of the wide variety of possible uses of these products for a given application and to ensure the comparability of the PEPs, the functional unit is expressed for an intensity of 1A per active conductor.

This rule enables the Joule losses to be expressed in the use stage regardless of the specific scenario to each user of the PEP.

With the same objective, resistance R of the conducting part is calculated for the most unfavorable case to take into account of all possible situations and enable the user to do the calculation.

The exact impact of the use stage shall be determined by the users of the PEP according to the context of use of the product, based on the impact calculated for 1A.

- Where the conducting part forms part of the connection accessory (accessory and conducting part in the packaging unit), R is then given by the manufacturer, considering that the functional unit is given for 1A. Thus, by multiplying by the square of the intensity, the user of the PEP obtains the power consumption over the use time considered.
- Where the conducting part is supplied by the installer (accessory without the conducting part in the packaging unit), the impact of the use stage is given for a resistance R of 1Ω

The actual resistance R shall be taken into account by the installer according to the rules set out above. Thus by multiplying by the square of the intensity and by the actual resistance of the conducting part, the user of the PEP obtains the power consumption over the use time considered.

For multi-conductor cables, and assuming a balanced system, a current of 1A in each conductor shall be considered, except for the protective conductor. The protective conductor is not taken into account when calculating the Joule losses.

6.1.2.3. End of Life stage

This section will supplement the section 2.2.7 “End of life stage” of the “Product Category Rules” for the power connection accessory category by establishing the steps to be considered at the end of life stage.

To ensure PEP comparability, end of life steps to be taken into account are:

- The separation between the accessory and the connected cable,
- Transportation, assuming a local transport as described in the “Product Category Rules”,
- Landfilling of materials as described in the “Product Category Rules”.

The processes of removal and/or dismantling of power accessories are excluded from the system PEP perimeter. The impact of removal shall be carried out by the PEP user, considering the product use features.

6.2. Optical Telecom accessories

This section concerns all equipments and accessories for passive telecom connections used in optical telecommunication networks, such as described below.

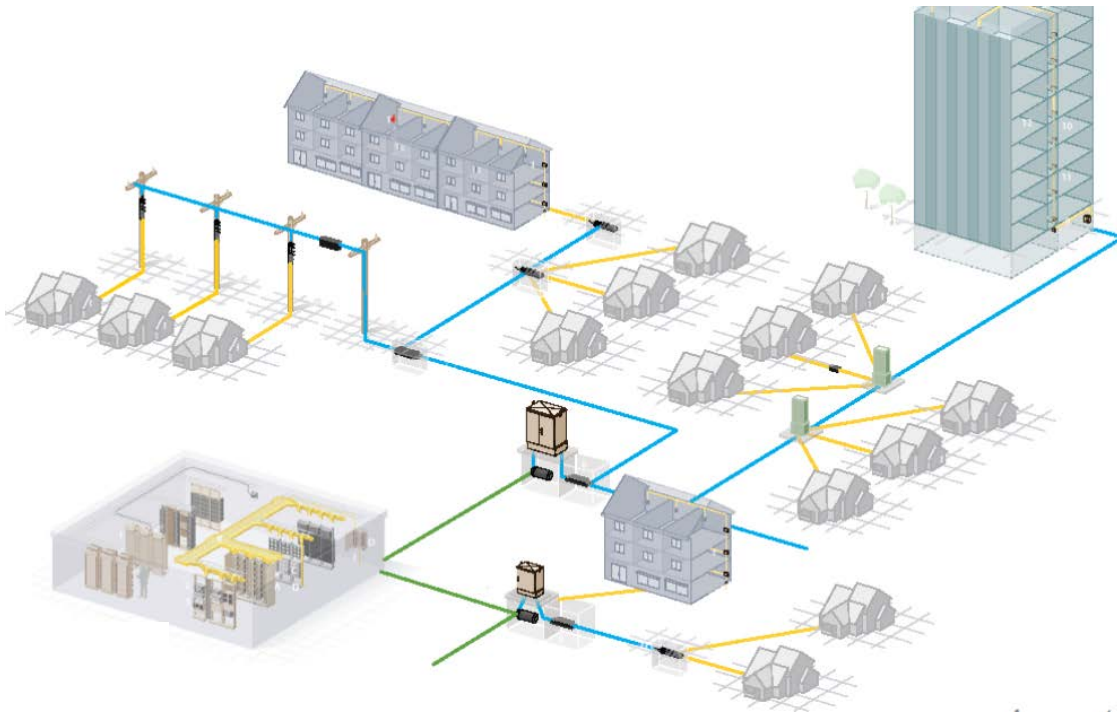


Figure 1 : Representation of an optical fiber network

Telecom accessory families considered are:

- Equipped bay and server farm
- Equipped cable heads and optical drawers
- Equipped cabinets
- Indoor optical boxes (OTO, ENTI, MDU, MMDB, OLT, FDU, ...)*
- Outdoor optical boxes (BP, OLT, ...)*
- Passive optical components (connectors, plugs, couplings, cords, pigtails, etc.)

The pre-terminated optical cables shall be handled by the integrator of solutions as a set of discrete components.

(*) Definitions :

OTO : Optical Terminal Outlet
MDU : Multi-Dwelling Unit
OLT: Optical Line Termination
BP : Branching Point

ENTI : External Network Testing Interface
MMDB : Multi-operator MDU Distribution Box
FDU : Fiber Distribution Unit

6.2.1. Functional unit and reference flow description

This section specifies the section 2.1 “Functional unit and reference flow description” of the PCR (PEP-PCR-ed3-EN-2015 04 02) for the optical telecom accessory category. It defines more precisely the functional unit for this product category.

In order to define the functional unit for optical telecom accessories, the manufacturer shall use the standard formulation indicated below:

« To protect and link, splice or connect

- *a connection point,*
- *during X years (reference lifetime)*
- *with a Y% use rate*

Lifetime and use rate correspond to the Z application as defined in the table given in Appendix 1 of the specific rules for wire, cables and accessories. »

According to the functional unit definition, production, distribution, installation and end of life stages depend on the maximum capacity of the reference flow fulfilling the functional unit.

The number N of connection points depends on the reference product used in the reference flow. The reference product belongs to a family of products listed in the introduction.

Consequently, the manufacturer shall realize the life cycle assessment for the maximal capacity of the reference product and shall present the results reduced to one connection point.

Note:

- A connection point is available in various ways: fusion splices, mechanical splicing, connectors. The nature of these connection points shall be specified in the PEP.
- Storing, Mixing and Deriving are secondary functions of equipments and accessories for Optical Telecom connections which are not included in the calculation of environmental impacts. Nevertheless, if necessary, these functions should be specified in the PEP.

Example of formulation of the functional unit:

« To protect and link a connection point for 30 years with a 70% use rate for optical telecommunication application in residential building ».

6.2.2. System boundaries

As described in the “Product Category Rules”, the following life cycle stages shall be included:

- The manufacturing stage as described in paragraph 2.2.3 of the “Product Category Rules”,
- The distribution stage as described in paragraph 2.2.4 of the “Product Category Rules”,
- The installation stage as described in paragraph 2.2.5 of the “Product Category Rules”,

- The use stage as described in paragraph 2.2.6 of the “Product Category Rules”,
- The end of life stage as described in paragraph 2.2.7 of the “Product Category Rules”.

The following sections complete, for the installation, use and end life stages, the respective sections 2.2.5, 2.2.6 and 2.2.7 of the “Product Category Rules” (PEP-PCR-ed3-EN-2015 04 02).

6.2.2.1. Installation stage

This section specifies section 2.2.5 “Installation stage” of the “Product Category Rules” for optical telecom accessory category. Concerning optical telecom accessories, and considering the wide range of possible installation of these products, the installation stage is excluded from the system boundaries..

This extended cut-off rule does not exclude the respect of the other requirements from the “Product Category Rules” (PEP-PCR-ed3-EN-2015 04 02), such as considering the packaging treatment, or waste from the installation stage (manufacturing, transportation and end of life of waste).

Below the environmental impacts table, it shall be mentioned that the impact concerning the product installation process should be completed by the PEP user, depending on its installation scenario.

6.2.2.2. Use stage

This section specifies the section 2.2.6 “Use stage” of the “Product Category Rules” for the optical telecom accessory category by establishing the assumptions to be made for calculating the impact of the use stage.

The environmental impacts of the use stage are calculated from joules effect losses of the optical connections.

Use stage losses determined by measurement

For the use stage losses determined by measurement, the following formula shall be used:

$$P_{lost} = P_{input} - P_{output}$$

Conversion mW in dBm : $P[mW] = 10^{(P[dBm]/10)}$

Where: P_{lost} = loss of optical signal in Watt
 P_{input} = input power in Watt
 P_{output} = output power in Watt

In all cases, the value obtained in Watt shall be multiplied by the reference lifetime and use rate of the corresponding application to obtain the energy consumed in Wh or Joule (see Appendix 1).

Use stage losses determined by calculation

Depending on the connection technology used, the maximum losses (Pcx) specified by the manufacturers are given in the table below.

As in the paragraph 4.2.2.3 of this document, it is considered that the power injected into the connection is 0 dBm or 1 mW and assumed a close connection with the laser (the most unfavorable case).

The calculation of the maximum value of the connection loss is made as follow:

$$P_{connection} = 1 - 10^{(-Pcx / 10)}$$

Table 3 : Data for optical connections

Technology used	Loss expressed in dB (Pcx)	Connection loss in mW
<i>Fusion splice</i>	<i>0.1 dB</i>	<i>0.023 mW</i>
<i>Mechanical splicing</i>	<i>0.25 dB</i>	<i>0.056 mW</i>
<i>Connector</i>	<i>0.5 dB</i>	<i>0.109 mW</i>

The energy consumed by **an optical connection** is then obtained by multiplying this value expressed in Watt by the reference lifetime, expressed in seconds, and the use rate.

In the case products in the reference flow support multiple types of connection technologies, the calculation shall be made by taking into account the most unfavorable technology.

For example, for a reference lifetime of 20 years and a 100% use rate, the total energy consumed in use is:

$$0.109 \times 10^{-3} \text{ [W]} \times 20 \text{ [years]} \times 365 \text{ [days]} \times 24 \text{ [hours]} \times 3600 \text{ [seconds]} = \mathbf{68\ 748\ Joules}$$

For illustration, 68,748 Joules is the energy consumption of a bulb of 70 watts during 16 minutes.

In general, the choices made and the underlying assumptions for the loss calculation shall be identified in the PEP and justified in the LCA report.

6.2.2.3. End of Life stage

This section supplements the section 2.2.7 “End of life stage” of the “Product Category Rules” for the optical telecom accessory category by setting the processes to be considered in the study of the end of life stage.

To ensure PEP comparability, end of life steps to be taken into account are:

- The separation between the accessory and the connected cable,
- Transportation, assuming local transport as described in the “Product Category Rules”
- Landfilling of materials as described in the “Product Category Rules”.

As for the installation stage, considering the wide range of possible removal processes of these products, the removal processes and/or dismantling of cables are excluded from the PEP perimeter. The impact of removal shall be carried out by the PEP user, considering the product use features.

7. Appendices

Appendix 1 : Hypothesis per application area

APPLICATION AREAS	Applications	Lifetime (years)	Use rate	Used time (years)
INFRASTRUCTURES	Energy distribution networks	40	100%	40
	Railway networks	30	100%	30
	Telecom networks (fixed and mobile phones)	20	100%	20
INDUSTRIAL APPLICATIONS	Oil, gas and petrochemicals	30	100%	30
	Handling	10	50%	5
	Automation	5	100%	5
	Nuclear	40	100%	40
	Wind turbines	20	30%	6
	Photovoltaic power plants	10	50%	5
	Airports	20	100%	20
ONBOARD SYSTEMS	Civil aeronautics	15	80%	12
	Shipbuilding and marine	30	80%	24
	Rolling stock	30	50%	15
	Automotives (Cars and trucks)	10	10%	1
BUILDING	Residential/tertiary/industrial	30	70%	21
	Data centers	10	100%	10
	LAN : residential	10	17%	1.7
	LAN: tertiary	10	25%	2.5
	LAN: industrial (factories, warehouses)	10	100%	10



PROGRAMME PEP Ecopassport®

Attestation de revue critique des RÈGLES SPÉCIFIQUES aux Fils, câbles et matériels de raccordement

Document revu : « RÈGLES SPÉCIFIQUES aux Fils, câbles et matériels de raccordement »

Version et date du document revu : Version du 24 juillet 2015

Établi par : le « Syndicat Professionnel des Fabricants de Fils et Câbles Électriques et de Communication »

Le Syndicat Professionnel des Fabricants de Fils et Câbles Électriques et de Communication (SYCABEL) a demandé à Solinnen, en tant que bureau d'études spécialisé en Analyse du Cycle de Vie (ACV), la revue critique du document « RÈGLES SPÉCIFIQUES aux fils, câbles et matériels de raccordement ».

Référentiels

L'objectif de la revue critique est de vérifier la conformité de ce document avec les référentiels suivants :

- le PROGRAMME PEP ecopassport®, il s'agit du document intitulé : « PCR - Règles de catégories de produits relatives aux équipements électriques, électroniques et du génie climatique » du PROGRAMME PEP ecopassport®, dont la référence est : « PEP-PCR-ed 3-EN-2015 04 02 » disponible à l'adresse : <http://www.pep-ecopassport.org>;
- la norme NF EN ISO 14025 – 2010 ;
- les normes NF EN ISO 14040 & 14044 – 2006.

Conclusion

Le document revu ne comporte pas de non-conformité par rapport aux référentiels. Par conséquent, ce document – RÈGLES SPÉCIFIQUES aux Fils, câbles et matériels de raccordement – est conforme aux exigences des référentiels.

Observation

Pour les fils et câbles destinés au transport de l'énergie, le document revu, comme la précédente version, recommande de présenter les résultats dans la colonne total pour 1 km de fils ou de câbles traversé par un courant de 1 A d'intensité. Rappelons que le bilan environnemental de la phase d'utilisation est essentiellement proportionnel à l'intensité électrique, et que, pour les autres phases, le bilan environnemental est essentiellement proportionnel à la longueur. De ce fait, bien que le document revu exige d'insérer un encart au sein de chaque déclaration avertissant le lecteur à ne pas multiplier la colonne total à la fois par l'intensité et la longueur, il est possible que des utilisateurs de déclarations fassent cette multiplication par erreur. Dans ce cas, le bilan environnemental des fils ou des câbles sera surévalué par rapport à ce qu'il devrait être si l'erreur n'était pas commise par l'utilisateur. Ainsi, Solinnen a recommandé au cours de sa revue de ne pas présenter de colonne « total » (comme par exemple dans NF EN 15804+A1). Cette recommandation n'a pas été retenue au sein du document revu.

Cette observation ne remet en cause la conclusion de la revue critique.


 Philippe Osset
 Président de Solinnen

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