# PRODUCT-SPECIFIC REQUIREMENTS

## High Voltage Circuit Breakers

PSR 2002:3

The Swedish Environmental Management Council
Version 1.0
2002-06-05

Information about the EPD system and registered EPD´s: www.environdec.com
Comments on the PSR document, please E-mail to: epd@miljostyrning.se

## Contents list:



## 1. General Information

This Product-Specific Requirement, PSR, is in compliance with MSR 1999:2 ("An application of ISO TR14025 Type III Environmental Declarations" by the Swedish Environmental Management Council"), the requirement for type III environmental declaration, published by the Swedish Environmental Management Council 2000-03-27.

The PSR refers in particular to annex D, paragraph D.1.4.1 Establishment of PSR by single enterprises of the a.m. document.

## 2. Definition of the product group “High Voltage Circuit Breakers”

This Product-Specific Requirements, PSR, defines the requirements on environmental parameters to be included in an Environmental Product Declaration EPD for High Voltage Circuit Breakers.

High Voltage Circuit Breakers includes:

- Live Tank (AIS) Circuit Breakers
- Dead Tank Circuit Breakers
- GIS Circuit Breakers
- Generator Circuit Breakers

Circuit breakers being part of assemblies shall be handled as the most appropriate of the above mentioned circuit breaker types. For such breakers the present PSR applies only to the breaker part pending the development of a PSR for assemblies.

### 2.1 Product parts

The product parts are separated in main parts and components. The main parts are those which are most essential for the function of the circuit breakers, whereas the components are supplementing the main parts. For the main parts it is mandatory to include the manufacturing processes in the Life Cycle Assessment, whilst for components it is voluntary to include the manufacturing processes. Both main parts and components may be manufactured in own factory or may be bought from suppliers.

The LCA study shall comprise at least the following parts where applicable:

| **Main Parts** (incl. constituent parts) | **Components** |
|---|---|
| Current paths: main contacts, conductors, terminals | Contact pieces |
| Interrupters (with insulating supporting structure) | Arcing contacts, nozzles |
| Insulators (interrupter & post insulators) | |
| Enclosure: tanks, flanges, covers<br>Insulators inside enclosure | |
| Bushings (excl. current transformers) | |
| Mechanism housings & mechanisms | Shafts, links, rods |
| Operating device (spring, hydraulic, pneumatic, electric motor drive) incl. mechanisms, gears and cubicles | Springs, cylinders, valves, pipes, motors, pumps, compressors, electronics & control, heaters, and equipment for storage of operating energy |
| Optional equipment such as pre-insert resistors and grading capacitors | Resistors discs, capacitors |
| Interrupting medium ($SF_6$, oil, air) and its supervising system | Gaskets, gauges, containers, desiccant adsorbers |
| Base frame (supporting frame between foundation and equipment) | |
| | Packing material for the transport to customer. |

| **Specially for Generator Circuit Breakers:** | |
|---|---|
| **Main Parts** (incl. constituent parts) | **Components** |
| Disconnector | Contact pieces |
| Earthing switch | Contact pieces |
| Starting switch | Contact pieces |
| | Transport equipment, lifting beam, rope sling, belt sling, shackles |

## 3. Functional unit

The functional unit shall be defined as a three-pole circuit breaker with the rated voltage and the rated short-circuit breaking current in question.

## 4. System boundaries

### 4.1 Performance

| | |
|---|---|
| **Product life time** | 40 years (350 400 hours) |
| **Running time per year** | 8760 hours (24 hours/day) |
| **Average load ($I_e$):** | 50% of rated current ($I_n$)[1)] |
| **Rated current ($I_n$)** | Specified acc. to IEC 60694[2)] |
| **Rated voltage ($U_n$)** | Specified acc. to IEC 60694[2)] |
| **Rated short-circuit breaking current ($I_{sc}$)** | Specified acc. to IEC 62271-100[2)] |

1) 100 % for Generator Circuit Breakers

2) IEEE C37.013 for Generator Circuit Breakers

*Specified lifetime and average load are base definitions for purpose of comparison only.*

### 4.2 Nature

For all life cycle phases as specified under section 5.

- Material and energy resources from nature into the system.
- Emissions (to air and water).

## 5. Life cycle

The Life Cycle Assessment, LCA study, shall consider all information given under sections 2 - 10 and enclosure #1 of this PSR and chapter 5 of Requirements for Environmental Product Declarations, EPD (MSR 1999:2) - an application of ISO TR 14025, published 2000-03-27 by the Swedish Environmental Management Council.

### 5.1 Manufacture phase

This concerns the product's environmental impact during manufacturing.

- Extraction and production of all raw materials
- Transport of raw materials to manufacture of main parts

- Manufacture of main parts
- Transport of main parts to assembly of product
- Assembly of product

Materials for recycling and waste for landfill or waste treatment are considered as outflows from the system and they are not influencing the numerical result of the analysis.

Data quality for the manufacture phase

- Data specific for a representative site should be used for manufacture of main parts and assembly of product.
- When there are alternative suppliers of a material, site-specific data can be chosen from one of the suppliers, with the exception for material with a high environmental impact, where data for a representative site should be used.
- The mix of electricity used during manufacturing may be approximated as the official one in the country of manufacture. The mix of electricity shall be documented.
- Hazardous waste is defined by EU Directive 91/689/EEC
- Transport of main parts and raw materials to manufacturer with actual transport and distance from supplier.
- Sources of generic data for materials and energy are the following:

| **Materials & energy** | **Sources **)** | **Published *)** |
|---|---|---|
| **Steel** | IISI (International Iron and Steel Institute) | 1998 |
| **Copper** | IME (Institut für Metallhüttenwesen und Elektrometallurgi, Aachen) | 1995 |
| **Aluminium** | EAA (European Aluminum Association) | 1996 |
| **Plastics** | APME (Association of Plastics Manufacturers in Europe) | 1993-1998 |
| **Chemicals** | APME (Association of Plastics Manufacturers in Europe) | 1993-1998 |
| **Electricity** | ETH (Eidgenössiche Technische Hochschule)<br>Data combined with "IEA (International Energy Agency) statistics 1998" | 1996 |

**) Or later edition.*
***) If other sources of generic data are used their origin must be documented.*

## 5.2 Usage phase

This concerns the product's environmental impact during the time it is in operational use. The LCA shall, as a minimum, contain the following:

- Transport of the product to customer
- Electricity consumption (calculated according to point 10).
- Ancillary material and chemicals for maintenance/service (according to the manufacturer's maintenance instructions).

Waste for landfill or waste treatment is considered as outflows from the system and they are not influencing the numerical result of the analysis.

Data quality for the usage phase

- Transport of the product to the customer is calculated as a 500-km distance transport and with lorry (as an average type of transport used for comparison reasons only).
- Electricity used during the usage phase (losses due to the resistance in primary and secondary circuits in accordance with section 10.1) shall be represented as OECD electricity mix (as a typical mix of electricity used for comparison reasons only).
- Hazardous waste is defined by EU Directive 91/689/EEC.
- Sources of generic data for materials and energy: see section 5.1

## 5.3 End-of life phase

This concerns the product's environmental impact during recycling. The LCA shall, as a minimum, contain the following:

- Recycling of material at end-of-life (according to section 10.3)

Waste for landfill or waste treatment is considered as outflows from the system and they are not influencing the numerical result of the analysis.

Data quality for the end-of life phase

- Energy used for recycling shall be calculated as though being supplied by an average European generation mix.
- Quantity of materials not recycled (to landfill) shall be documented as a total sum for all materials.
- Hazardous waste is defined by EU Directive 91/689/EEC.
- Sources of generic data for materials and energy: see section 5.1

## 6. Cut-off rules

- The total weight of parts not included in the LCA must not exceed 5% of the total weight of the circuit breaker.
- Parts and materials not included in the LCA shall be documented.

## 7. Allocation rules

The allocation of common environmental aspects during manufacturing of main parts and assembly of product will be made in proportion to the workshop area used for each different product.
The annual share of common environmental aspects for a certain product will then be distributed on the number of units per year of that product.

Other allocation rules may be used if they can be proven to be more relevant.

*Environmental aspect is defined in ISO 14001 as "Element of an organization's activities, products or services that can interact with the environment".*

## 8. Units

- SI measurement units
- Preferred power and energy units for comparison
  kW for power, kWh for energy

## 9. Summary of materials

- Gross weight of materials per functional unit (kg)

## 10. Calculation rules

### 10.1 Electricity losses

The losses of electricity during the use phase come from both primary and secondary circuits and are calculated as:

Primary circuits:

$E\ [kWh] = R\ [\Omega] \times I_e^2\ [A^2] \times H\ [h] / 1000$

| | |
|---|---|
| Resistance of current path, R: | stamped (as measured at type tests) |
| Average load, $I_e$: | 50 % of rated current |
| Life time of device, H: | 40 years (350 400 h) |

Secondary circuits:

Fixed connected anti condensation heaters:

E [kWh] = Rated power [W] x H [h] / 1000

Thermostat monitored heaters:

E [kWh] = Rated power [W] x 50 % x H [h] / 1000

Energy consumption for motors, pumps and compressors does not have to be accounted for as such devices are operating only for a fraction of the total lifetime.

### 10.2 $SF_6$ topping-up

The insulating medium $SF_6$ is usually kept in a sealed system. However, one must, during the entire life, consider a small amount of leakage, which must be topped-up during maintenance in accordance with the following calculation:

$SF_6$ topping-up [kg] = Z/100 [1/year] x Total initial $SF_6$ content [kg] x 40 [years]

Where Z [%] is the maximum leakage rate stipulated in the EPD by the manufacturer.

If the manufacturer's maintenance instructions call upon mid-life internal inspections 1% of the $SF_6$-gas is considered to be lost according to section 10.3.
$SF_6$-losses in connection with corrective maintenance are not accounted for due to very rare occasions.

### 10.3 Recycling of material

For the recycling of materials at the end-of-life the following rates shall be used: Copper 95 %, aluminium 80 % and steel 80 %. Higher recycling rates may be used if they can be documented.

At dismantling 1% of the $SF_6$-gas is considered to be lost. (The remaining 99 % are assumed to be recovered and essentially recycled or destroyed.)

## 11. Parameters to be declared in an EPD

For each phase of life cycle the following data shall be declared per functional unit:

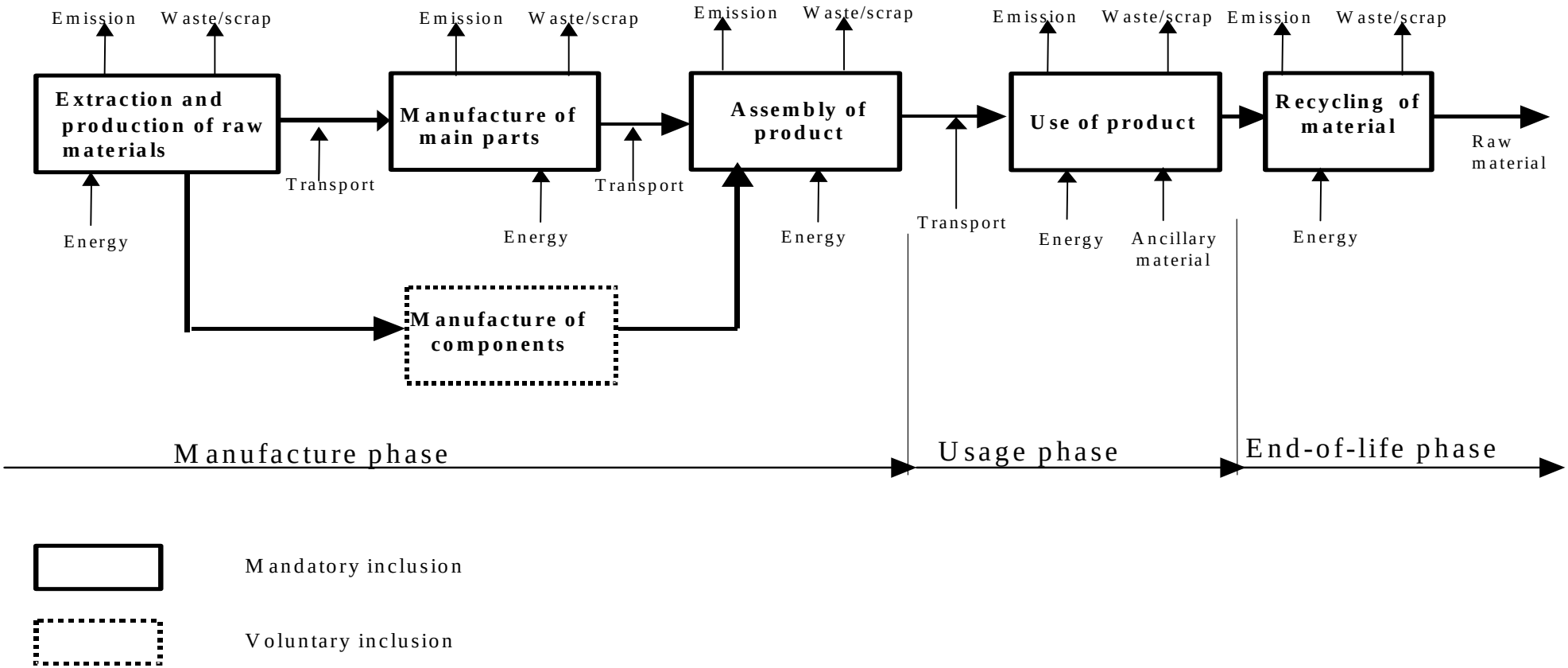
- Use of non-renewable resources
  - without energy content
  - with energy content
- Use of renewable resources
  - without energy content
  - with energy content

- Electricity consumption and losses
- Emission classifications
  - Global warming (GWP) kg $CO_2$ equiv. (100 years)
  - Acidification (AP) kmol $H^+$
  - Ozone depletion (ODP) kg CFC-11 equiv. (20 years)
  - Photochemical oxidant formation (POCP) kg ethene-equiv.
  - Eutrophication (NP) kg $O_2$

  The classifications are according to MSR 1999:2.
- Waste
  - Hazardous waste kg
  - Regular waste (as total sum) kg

## 12. References (to be included in EPD)

- The LCA report
- This PSR
- Reference to instructions for recycling of products and recovery of material
- Other documents that verify and complement the EPD
- Requirements for Environmental Product Declarations, EPD (MSR 1999:2) - an application of ISO TR 14025, published 2000-03-27 by the Swedish Environmental Management Council.


Emission
Waste/scrap
Extraction and production of raw materials
Energy
Transport
Manufacture of main parts
Manufacture of components
Assembly of product
Use of product
Ancillary material
Recycling of material
Raw material
Manufacture phase
Usage phase
End-of-life phase
Mandatory inclusion
Voluntary inclusion