Environmental Product Declaration

Power Transformers 40/50 MVA (ONAN/ONAF)

Registration nr. S-P- 00053

Issue	Rev	Description	Issue	Approved	Date
0	2	Revision “Additional qualifying factors”	S. Lo Rizzo	L. De Martin	10/09/2003
0	1	Revision “Environmental performance”	S. Lo Rizzo	L. De Martin	28/08/2003
0	0	Emission	S. Lo Rizzo	L. De Martin	16/06/2003

Presentation

Manufacturer

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ABB T&D S.p.A. Unità Operativa Trasformatori belongs to BA PTPT (Business Area Power Technologies Power Transformers).
BA PTPT is first in distribution transformer worldwide.
We have 23 factories located around the world in 20 countries.
We produce 1500 units per year.
The BAU (Business Area Unit) of Legnano is the focused factory for Large Power and Industrial Transformer.

Environmental management

The implementation process of Environmental System according to international standard UNI EN ISO 14001:96 started in 1998 and ABB T&D S.p.A. Unità Operativa Trasformatori received the certificate in July 1999.

Product description

For the design and manufacture of Power Transformers it is used the common ABB concept named TrafoStar and contained in Common Technology design system.
A TrafoStar transformer is built of standardized, service-proven components and modules, ensuring flexible, reliable and tailor-made transformer designs.
ABB has developed a completely new concept based on the best knowledge and experience of our facilities worldwide.
TrafoStar design is based on the core type technology. It has a circular shaped core limb surrounded by concentrically arranged, cylinder-shaped windings.
This transformer concept gives the most efficient use of the active material, while allowing short, competitive assembly times in the factory. Our core type technology with cylindrical windings has an excellent capability to withstand short- circuits even under the most demanding fault conditions.
The high voltage windings are normally manufactured in interleaved or shielded disc windings, while the low voltage windings are manufactured using the transposed cable conductor with layer or helical design.
The tapped portion of the winding is normally arranged as a separate physical winding shell.
This design allows a balanced ampere turn distribution, avoiding excessive short-circuit forces and additional losses.

EPD Transformer characteristics

The characteristics of transformer chosen for EPD are:

Power:	40/50 MVA
Voltage:	132+/-12*1.5 /15.6 (kV)
Frequency:	50 (Hz)
Vector group:	Yyn0
Type of cooling:	ONAN/ONAF

Scope of declaration

Data and calculations are according to PSR 2000:6 (Product Specific Requirements for "Liquid- or gas-filled and dry type transformers within the range of < 1000 MVA" version 1.1 dated 2001-02-21) and MSR 1999:2 (Environmental Product Declaration, EPD – an application of ISO TR14025, published 2000-03-27 by the Swedish Environmental Management Council) (www.environdec.com).
This EPD is also valid for similar transformers, provided that the range of variations within each impact category does not exceed + - 5%.

Functional unit

The functional unit, as specified in the PSR 2000:6, is defined as 1MVA of the system apparent power.

System boundaries

The Life Cycle Assessment covers all environmental aspects for extraction and production of raw materials, manufacturing of main parts, assembly of the transformer, transportation and use of the product and dismantling after end of life.
It includes consumption of material and energy resources as well as emissions and waste generation.
Calculations are based upon an estimated lifetime of 35 years and average load assumed as 50%.
In order to calculate potential impact, ETH LCI data source, for the manufacturing phase and ANPA-LCA version 2 database, for the use phase, were used.

Manufacturing phase

Total weight of excluded materials doesn't exceed 1% of total transformer weight.

Materials	*[kg/trafo]*	40 MVA [kg/MVA]	50 MVA [kg/MVA]	%
Aluminum	93	2.32	1.86	0.1
Copper profile	8788	219.7	175.76	13.9
Copper wire	243	6.07	4.86	0.4
Electrical steel	20050	501.25	401	31.8
Glass fiber	462	11.55	9.24	0.7
Kraft paper	421	10.52	8.42	0.7
Paint	38	0.95	0.76	0.1
Porcelain	158	3.95	3.16	0.3
Presspan	1120	28	22.4	1.8
Resin	6	0.15	0.12	0.0
Steel sheet	8258	206.45	165.16	13.1
Steel profile	7600	190	152	12.1
Transformer oil	15500	387.5	310	24.6
Red brass	41	1.02	0.82	0.1
Total	62778	1569	1256	99.6
Assembled transformer	63000	1575	1260	100
Cut-off				0.35

Packaging of product is not included in the system.

Use phase

Energy losses have been calculated according to PSR 2000:6 and are equal to 32.508.000 kWh for a transformer working as ONAN and 47.174.000 kWh if it works as ONAF.
No energy consumed by auxiliary equipment has been taken into account.
In case of air forced cooling, electrical energy consumed by auxiliary equipment stands for less than 1% of total energy losses.

End of life

End of life phase has been limited to a list of generated waste.
The transformer consists of large metals parts (copper, steel) relatively easy to dismantle and recycle. Remaining components (except for transformer oil) should be landfill. More information about transformer management at the end of life, are reported in the "Instruction and Operating Manual".

Waste	[kg/trafo]	40 MVA [kg/MVA]	50 MVA [kg/MVA]
Total waste (incl. hazardous)	63000	1575	1260
Hazardous waste	15500	388	310
Recycled waste	44938	1123	899
Landfill waste	2562	64	51

Allocation unit

The factor for allocation of common environmental aspects during manufacturing phase is calculated as the ratio of apparent power (functional unit) to the sum of apparent power (MVA) of all products produced annually in the relevant part of the production unit.

Environmental performance

ONAN

The environmental performance associated to the transformer working in ONAN conditions are in the following.

Resource use

Main resources associated to the various phases of the life cycle are the following:

Use of non renewable resources				
Resource	Manufacture		Use phase	
	[kg/trafo]	[kg/MVA]	[kg/trafo]	[kg/MVA]
Aluminium in ore	74	1.9	-	-
Bauxite	360	9	1700	42
Chromium in ore	2.1	0.053	280	7
Clay	4.9	0.12	-	-
Copper in ore	5700	140	380	9.5
Crude oil	30000	750	766000	19000
Gravel	2.5	0.062	-	-
Hard coal	44000	1100	465000	116000
Iron in ore	37000	920	45000	1130
Lead in ore	3.2	0.080	16	0.40
Lignite	700	17.3	3840000	96000
Limestone	1300	32.4	93700	2340
Manganese in ore	0.55	0.014	48	1.2
Natural gas	11300	280	872000	22000
Nickel in ore	0.61	0.015	200	5
Sand	5000	124	-	-
Uranium in ore	0.7	0.017	320	0.025

Use of renewable resources					
Resource	Unit	Manufacture		Use phase	
		[Unit/ trafo]	[Unit/ MVA]	[Unit/ trafo]	[Unit/ MVA]
Elec.Geother	MJ	930	23	-	-
Hydro energy	MJ	56700	1400	-	-
Water	kg	2390000	59700	665000000	16600000
Wood	kg	3040	76	383000	9600

Energy net consumption and losses

The net energy consumption and losses in the two phases are the following:

Energy	Manufacturing		Use phase	
Resource	[kWh/ trafo]	[kWh/ MVA]	[kWh/ trafo]	[kWh/ MVA]
Electrical energy	2790000	69700	32500000	813000
Heat energy	47400	1200	-	-

Waste

Waste produced in the different phases of the life cycle considered, are the following:

Waste	Manufacturing		Use phase	
	[kg/ trafo]	[kg/ MVA]	[kg/ trafo]	[kg/ MVA]
Hazardous waste	610	15	1540	38
Regular waste (incl. waste water)	1600000	40100	2270000	56700

Potential Environmental Impact

Potential environmental impacts tied to the various phases of the life cycle are the following:

Impact category	Equivalent unit per MVA	Manufacturing	Use phase	Manufacturing + Use phase
Global warming (GWP)	kg CO_2 (100 years)	4600	431000	436000
Acidification (AP)	mol H^+	3150	81600	84700
Ozone depletion (ODP)	kg CFC-11 (20 years)	0.00048	0.0029	0.0034
Photochemical oxidant formation (POCP)	kg C_2H_4	1.94	84	86
Eutrophication (NP)	kg O_2	110	4900	5000

The environmental performance associated to the transformer working in ONAF conditions are in the following.

Resource use

Main resources associated to the various phases of the life cycle are the following:

Use of non renewable resources				
Resource	Manufacture		Use phase	
	[kg/trafo]	[kg/MVA]	[kg/trafo]	[kg/MVA]
Aluminium in ore	74	1.5	-	-
Bauxite	360	7.2	2500	49
Chromium in ore	2.1	0.043	410	8.2
Clay	4.9	0.098	-	-
Copper in ore	5700	115	550	11
Crude oil	30000	600	1110000	22200
Gravel	2.5	0.05	-	-
Hard coal	44000	880	6740000	135000
Iron in ore	37000	740	65400	1300
Lead in ore	3.2	0.06	23	0.46
Lignite	700	14	5570000	111000
Limestone	1300	26	136000	2700
Manganese in ore	0.55	0.011	70	1.4
Natural gas	11300	226	1270000	25300
Nickel in ore	0.61	0.012	290	5.8
Sand	5000	99	-	-
Uranium in ore	0.7	0.014	470	1.9

Use of renewable resources					
Resource	Unit	Manufacture		Use phase	
		[Unit/ trafo]	[Unit/ MVA]	[Unit/ trafo]	[Unit/ MVA]
Elec.Geother	MJ	930	19	-	-
Hydro energy	MJ	56700	1100	-	-
Water	kg	2390000	47800	96500000	19300000
Wood	kg	3040	61	555000	11100

Energy net consumption and losses

The net energy consumption and losses in the two phases are the following:

Energy	Manufacturing		Use phase	
Resource	[kWh/ trafo]	[kWh/ MVA]	[kWh/ trafo]	[kWh/ MVA]
Electrical energy	2790000	56000	47200000	943000
Heat energy	59200	1200	-	-

Waste

Waste produced in the different phases of the life cycle considered, are the following:

Waste	Manufacturing		Use phase	
	[kg/ trafo]	[kg/ MVA]	[kg/ trafo]	[kg/ MVA]
Hazardous waste	700	14	2240	45
Regular waste (incl. waste water)	1605000	32100	3290000	65800

Potential Environmental Impact

Potential environmental impacts tied to the various phases of the life cycle are the following:

Impact category	Equivalent unit per MVA	Manufacturing	Use phase	Manufacturing + Use phase
Global warming (GWP)	kg CO_2 (100 years)	3700	501000	505000
Acidification (AP)	mol H^+	2520	94700	97200
Ozone depletion (ODP)	kg CFC-11 (20 years)	0.00038	0.0034	0.0038
Photochemical oxidant formation (POCP)	kg C_2H_4	1.6	97	98.6
Eutrophication (NP)	kg O_2	87	5700	5790

Additional qualifying factors

Sound power levels

The audible sound is originated mainly in the core because of the magnetostriction property of electrical steel.

Type	Measured value dB(A)
ONAN	50.1
ONAF	70.9

Surface coating

The tank is coated with two components solvent-based paint.

Life cycle results

It is observed that the environmental impact during the use phase is the most important one.

Impact category	Use phase in % of total 40 MVA	50MVA
GWP	98.94	99.27
AP	96.29	97.41
ODP	86.15	89.86
POCP	97.73	98.42
NP	97.83	98.50

In manufacturing phase copper production for windings is the most significant source of pollution. Transformer oil production can be noticed as a contributor to the POCP.

Third party certification

This EPD has been reviewed and found to comply with the Product Specific Requirement, PSR 2000:6 for "Liquid- or gas-filled and dry type transformers within the range of <1000 MVA", version 1.1 dated 2001-02-21, with the Swedish Environmental Council (requirements for environmental product declarations dated 27 March 2000).

Time of Validity

This EPD, reviewed by Det Norske Veritas according to MSR 1999:2 and PSR 2000:6, is valid up to September 2006 because no significant variations will aspect in this period.

Accredited Certification Body

Det Norske Veritas Certification AB
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References

- LCA report
- PSR for Transformers (PSR 2000:6)
- 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.

The above mentioned documents are available upon-request.

GLOSSARY

Life cycle assessment, LCA: It provides a framework, an approach and methods for identifying and evaluating environmental burdens associated with the life cycles of materials and services, from cradle to grave. The LCA method consists of four steps: goal and scope definition, inventory analysis, impact assessment and interpretation.

Acidification, AP. Chemical alternation of the environment, resulting in hydrogen ions being produced more rapidly than they are dispersed or neutralized. Occurs mainly through fall of sulfur and nitrogen compounds from combustion processes. Acidification affects crops, forests, water life and buildings.

Eutrophication, NP. Nitrification causes oxygen in lakes and waters to be consumed by growth and decomposition of plants and algae and, finally, to the death of organisms living close to the bottom of the sea.

Global warming potential, GWP. Estimated greenhouse effect in 100 years perspective. The greenhouse effect means that the average temperature in the atmosphere to such an extent that the average temperature on earth increases over time, affecting growth of crops and living conditions. GWP is based on the degree to which a mass unit of a specific substance can absorb infrared radiation relative to CO_2. In this way all emissions can be converted into an equivalent quantity of CO_2 that would cause an equal greenhouse effect.

Ozone depletion potential, ODP. Risk for depletion of the stratospheric ozone layer. Depletion of ozone layer allows more ultraviolet radiation to reach earth and cause damage to humans and crops. ODP is defined as the ratio between ozone (O_3) breakdown in the equilibrium state due to annual emissions of substance and ozone breakdown due to an equal quantity of CFC-11.

Photochemical ozone creation, POCP. Photochemical oxidant formation results from reactions between nitrogen oxides (NOx) and volatile organic compounds (VOC's) on exposure to UV light and it is mainly associated with summer smog. Photochemical oxidants are toxic to humans and affect growth of crops, trees and other green plants. Ethylene (C_2H_4) is used as a reference substance for POCP, i.e. POCP is measured in kg of C_2H_4 equivalent.

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