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preinsulated panels systems

ENVIRONMENTAL PRODUCT DECLARATION FOR SANDWICH PANELS MADE OF RIGID EXPANDED POLYURETHANE AND ALUMINIUM INTENDED FOR USE IN THE CONSTRUCTION OF DUCTS FOR HVAC

Certified Environmental Product Declaration
Revision 1
Approval date 10/05/2010
Registration N. S-P-00146

Geographical area of application of this EPD: Europe
Year taken as a reference for the data: 2007

PRESENTATION OF THE COMPANY AND ITS PRODUCT

THE COMPANY AND ITS PRODUCTION

For more than three generations, P3 has operated in the field of ducts systems for air conditioning.

In the year 1989, what had originated as an adventure takes its definitive shape with the creation of P3. Today, P3 is part of an international group, whose mission is the promotion of the preinsulated aluminium duct P3ductal with the aim of turning it into a more and more prominent reality on the market of ducts for HVAC.

Following a trail of constant development from both the technical and commercial viewpoints, P3 has contributed its novel ideas to the construction systems of traditional sheet metal ducts made of galvanised steel. Indeed, the company created the P3ductal technology, which uses preinsulated aluminium panels and also produces the accessories, the machines and the equipment intended for the construction and installation of ductworks. In its plant situated in Ronchi di Villafranca Padovana, two production lines operate on a continuous basis, thus guaranteeing an output capacity of over 5 million square metres of panels per year. The panels are then stored in a covered warehouse of over 3,000 m^2. The plant extends over another covered area of 7,000 m^2 and over more than 20,000 m^2 of uncovered surface.

The P3ductal system is distributed in over 40 countries and counts on a sales network capable of providing support for both clients and designers in the choice and application of the product.
The strengths of P3 lie in the constant research for innovation and in the excellent quality standards of its products, which is attained by a continuous engagement in the studies conducted in its own laboratories which also operate in collaboration with University Research centres.

Since 1996, P3 has operated in compliance with a quality system based on the standards UNI EN ISO 9001-2000, and it has also obtained the environmental certification UNI EN ISO 14001-2004 as well as OHSAS 18001-99.

DESCRIPTION OF THE PRODUCT

- ### THE HYDROTEC TECHNOLOGY

Harmless for the ozone layer: this is the main feature of our Piral HD Hydrotec panels which constitute the foundation of the P3ductal system.
In compliance with both national and international standards for the safeguard of the ozone layer, P3 has eliminated the use of CFCs and HCFCs from its production cycle.
Applying its exclusive **international patent EP 1115771 B1**, the company set up an innovative production process where the expansion of the polyurethane foam is obtained only with water (GWP = 0 / ODP = 0), in substitution for fluorated gases with greenhouse effect (CFC, HFC, HCFC) and hydrocarbons (HC).

- **THE PIRAL HD HYDROTEC PANEL 15HP21**

The Piral HD Hydrotec panel 15HP21 is a *sandwich* panel, made up of an insulating core in rigid polyurethane foam covered on both sides with an 80 µm sheet of embossed aluminium. This panel is particularly suitable for the construction of ductworks intended for use in HVAC.
The thickness is 20.5 mm ± 0.5 mm. The rigid polyurethane foam is the result of a chemical reaction between specifically formulated polyols and isocyanates and the expansion of the foam is achieved by using only water as blowing agent.
The density of the PUR foam is 52 kg/m^3, with a tolerance of ± 2 kg/m^3.
Thanks to the high content of closed cells (more than 95%), the foam in the panel shows an initial thermal conductivity λ_i, as measured according to the standard ISO 8302, of 0,022 W/(mK) at a mean temperature of 10 °C, which is equivalent to a thermal resistance R of 0,93 (m^{2}K)/W. The special sandwich structure makes it possible to achieve high mechanical performance, represented by a flexural rigidity of 200,000 Nmm^2, declared according to the standards established by UNI EN 13403.
The use of aluminium for facings ensures a high level of hygiene and cleanliness, thus eliminating the problem related to the ageing of the insulating element and the release of particles. In addition, it guarantees the prevention of the proliferation of mould and bacteria. Indeed, as demonstrated by the testing conducted according to UNI EN 13403 (paragraph 7.4 “Microbial growth”), no significant growth of microorganisms takes place in the area surrounding the inoculation.
The panel may be used for the construction of ductworks within an air temperature range of -30 °C and +65 °C operating on a continuous basis. The panel underwent different national and international tests aimed at assessing its features of reaction to fire and obtained, amongst others, the Class 0-1 reaction to fire according to the “Decreto Ministeriale del 26/06/84” and a classification in class B-s3-d0 according to EN 13501-1 (SBI).

Table 1 –Technical specifications of the panel for 1 m^2 ready for sale. Details are limited due to the degree of confidentiality of the specific formula.

Material		Quantity (net)	Units
Overall mass of the panel[1]		**1.526**	**kg**
Embossed sheet aluminium 80 µm 100% primary		0.460	kg
Polyurethane foam Piral HD Hydrotech formula		1.066	kg
of which:	Isocyanate + Polyol	0.904	kg
	Flame retardants, catalysts, dyes, surfactants	0.149	kg
	Water	0.013	kg

[1] Excluding packaging and materials used for production processes only.

DECLARATION OF ENVIRONMENTAL PERFORMANCE

This section includes the main features as well as the results of the assessment of the environmental aspects carried out on the basis of a life cycle using the LCA methodology.

METHODOLOGY

As established by the "Requirements for the Environmental Product Declaration", the quantification of the environmental performance was worked out applying the methodology for Analysis of Life Cycle (LCA – Life Cycle Assessment) regulated by international standards ISO Series 14040 and in accordance with PCR 2008:06 *Air ducts - substantial materials*. The assessment methodology LCA makes it possible to establish the degree of environmental impact caused by a product or service in terms of the consumption of resources or in terms of the emissions in the environment, as well as the production of waste, as seen from a life cycle perspective ("from cradle to grave", as it were).

The data used, collected at P3, refer to the production of sandwich-type panels made of expanded polyurethane/aluminium used for HVAC and especially to the Piral HD Hydrotec 15HP21 panel. Besides, the study also relied on the support of the database of Boustead Model[2].

The unit to which the results refer to (**functional unit**) is the ***production of 1 m^2 of panel*****.**

SYSTEM BOUNDARIES AND MAIN HYPOTHESES

The analysis considered the whole production system and was based on each single operation starting from the raw materials production phase, including the production and transportation of energy vectors, to the intermediate and the final product transport.

A preliminary outline of the considered system is illustrated in Figure 1, which shows three different levels related to specific production activities:

1. the production of raw materials and their transformation, which took place in companies producing chemical or other materials (semi finished);
2. the preparation of the mixture and the specific formulation on the site of P3, situated in Ronchi di Villafranca;
3. the production (in P3) and distribution of the product.

[2] www.boustead-consulting.co.uk

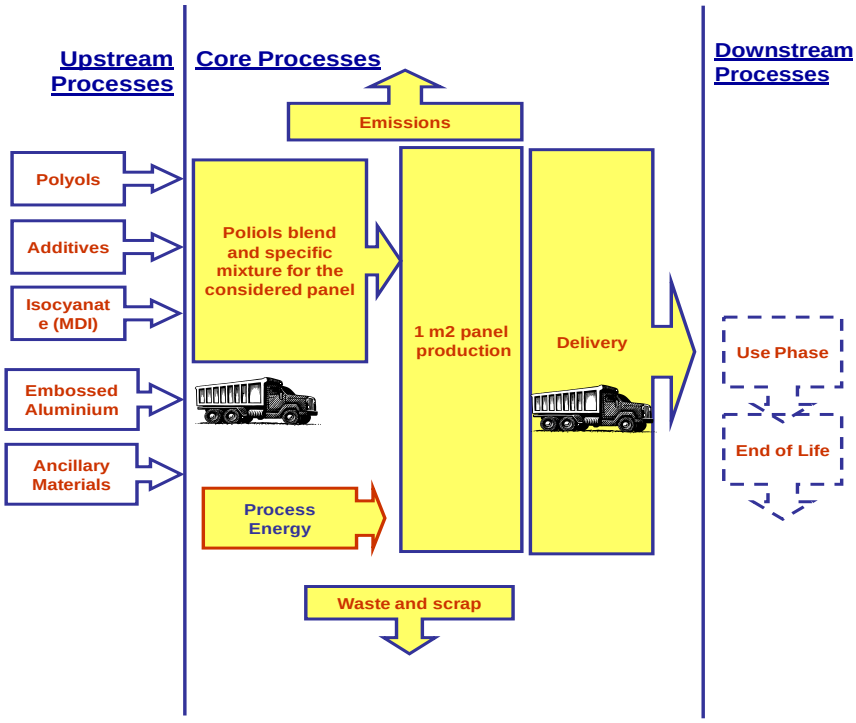

Figure 1 – Preliminary outline of the process considered. The yellow areas show the operations carried out in **P3**. The dotted lines mark phases as viewed in qualitative way.

As far as certain technical aspects are concerned, the following hypotheses may be underlined:

- the **production system of materials used** in the construction of the panel includes all the phases from obtaining the raw materials from the subsoil up to their production and use;
- the **quantities** of the above-mentioned materials are set in the product specifications while the **energies involved in the process** are quantified according to the overall volume produced;
- as for **transport**, the study considered the transport necessary for the stock-up of semi finished products and of consumption materials as well as the internal handling phases and final delivery;
- the **activities carried out on the production site** (heating, lighting, consumption materials, etc.) are included within the system boundaries considering its overall production;
- **delivery mode** regards the transport of the product both in Italy and abroad. The parameters considered for the distances covered are 1,000 km abroad, while in Italy they are based on average distances within the three areas in which the country was divided for this purpose: north, centre and south.

Considering the fact that the process takes place entirely in the Italian territory, the data concerning energy refer to the Italian energy mix, with the exclusion of the processes involved in the manufacture of some raw materials (isocyanate and polyols), in which case the European mix was taken as a point of reference.

ENVIRONMENTAL PERFORMANCE

In compliance with EPD® system regulations, below is a table illustrating the environmental performance of the Piral HD Hydrotec 15HP21 panel showing details of the natural resources consumption (with or without energy content) as well as the emission of pollutant substances and the production of waste.

Table 2 – Total consumption of resources related to the production of Piral HD Hydrotec 15HP21 panels. The data refer to a unit of 1 m^2 of panel.

Consumption of resources			Upstream Processes	Core Processes	TOTAL
With energy content [data in MJ]	Renewable Resources	Hydroelectric	10	0,4	10.4
		Wood and Biomass	1	<0.1	1
		Other renewable resources	1	<0.1	1
	Total of renewable resources		12	0.4	12.4
	Non renewable resources	Coal	21	0.5	21.5
		Oil	89	3	92
		Gas	95	3	98
		Nuclear resources	16	0.4	16.4
		Other	0	0.1	0.3
	Total of non renewable resources		221	7	228
	Total (Gross Energy Requirements)		233	8	241
	Of which electricity (P3)[3]		-	2.6	2.6
Without energy content [data in kg]	Total of renewable resources		<0.1	<0.1	<0.1
	Total of non renewable resources		3.5	<0.1	3.5
	Total		3.5	<0.1	3.5
	Water consumption		404	0.2[4]	404.15

The emissions released in water and in air are presented in an “aggregated” manner, providing the indicators established by the international system EPD.
The results of this classification are listed in Table 3 below.

[3] Inclusive of electric energy consumption and natural gas
[4] Of which 0.015 l/m^2 come from foaming processes

Table 3 – Potential contribution to the main environmental effects of the production process of Piral HD Hydrotec 15HP21 panels. The data refer to a unit of 1 m^2 of panel.

Indicator	Units	Upstream Processes	Core Processes	TOTAL
Global Warming Potential (GWP_{100})	kg CO_2 eq.	11	1	12
Acidification Potential (AP)	mol H^+ eq.	3	0,5	3,5
Eutrophication Potential (EP)	g O_2 eq.	303	16	319
Ozone Depletion Potential (ODP)	g CFC11 eq.	-	-	-
Photochemical Ozone Creation Potential (POCP)	g C_2H_4 eq.	24.7	0.7	25.4

Other significant data related to the description of the environmental impact of the system is the information connected with the production of waste. Table 4 shows the overall amount of waste generated by the production activities of Piral HD Hydrotec 15HP21 panels.

Table 4 – Total of waste produced by the system. Data expressed in kg.

Type of waste	Upstream Processes	Core Processes	TOTAL	Of which directly produced by **P3**
Non hazardous	3.6	0.3	3.9	0.3
Hazardous	<0.1	<0.1	<0.1	<0.1

USE PHASE AND END OF LIFE

As far as the use phase is concerned, the following considerations may be mentioned:

- Aluminium is not particularly degradable while polyurethane foam is non-putrescible, resistant to mould and stable from a dimensional point of view;
- The closed cells structure reduces remarkably the penetration of water, that within the space of a few years may, both in its liquid form and as steam, originate degradation processes by hydrolysis;
- Like all the foams having closed cells, also this one is subject to "ageing" effect, by which term we mean a decrease in its insulating properties due to the process which tends to equilibrate the gas contained in the cells with the gas in the atmosphere.

As for its disposal, it is possible to re-utilise the elements obtained from the ducts for insulation purposes in the building construction (floor or wall cavities). For other parts, as an alternative, it is possible to grind and separate (and possibly retrieve) the metal from the foam. Starting from the foam, once this has been separated from facings, a chemical process may be applied (glycolysis) which makes it possible to obtain a liquid reactive product to be mixed with a new polyol. Another hypothetical procedure is that of mixing the powder obtained by fine grinding of the foam with the polyol mixture intended for use in the production of insulating panels, at a proportional percentage of up to 10% by weight. As an alternative, on account of the high calorific power of the foam in spite of the flame retardants contained in it, the combustion process of the mixture with other waste, performed in special incinerators at very high temperatures makes it possible to “valorise” (waste-to-energy incineration) the "feedstock" energy available in the material.
Finally, sending the waste to the landfill after the grinding and compacting processes have been completed, should be seen as the last solution.
Since the performance in terms of thermal insulation ensured by Piral HD Hydrotec 15HP21 panels is strategic in evaluating the saving in energy related to the choice of preinsulated ducts, it was desired to go deeper into that aspect by examining the performances derived from the application of different types of technologies to a standard HVAC model.

For the sake of concreteness, below is an example of calculation used for a theoretical evaluation of the energy consumption associated with a standard HVAC model. Below are the data related to the project:

- HVAC system with a surface of 500 m^2 of ducts capable of supplying 8500 - 9000 m^3/h of treated air in a block of offices of about 600 – 650 m^2;
- Ductworks made of preinsulated panels Piral HD Hydrotec 15HP21, λ_u[5] = 0.024 W/(m K) (evaluated at a mean temperature of 10 °C) installed on a double ceiling or, as usual, not in the same room where the treated air is distributed;

5 The value for thermal conductivity mentioned refers to a value of λ_u used in the project, i.e. a value declared by the manufacturer which may be used by the designer for calculation purposes. This figure is also attributable to the same property during a period of time regarded as economically reasonable in normal conditions allowing for any possible ageing or statistical corrections.

- Operation of the system in summer: cooling of the workplace, estimated for an average time of 10 hours a day, for 5 days a week and for a total of 4 months (an overall total of 850 hours);
- The difference in temperature between internal air (about 17 °C) and external air (about 32 °C) is equivalent to 15°C.

Considering that the above value for thermal conductivity refers to a mean temperature of 10 °C, in order to calculate the actual performance of the ducts system in terms of energy it will be necessary to consider the value of λ_u at a mean working temperature of 25 °C. To calculate this conversion (Table 5) we must use the rules listed in EN ISO 10456 – 2007 (Building materials and products – Hygrothermal properties – Tabulated design values and procedures for determining declared and design thermal values):

$$\boldsymbol{\lambda_2 = \lambda_1 * F_t}$$

where **Ft** is the correctional factor for the working temperature, while the starting value for thermal conductivity is the figure declared by the manufacturer at 10 °C.

$$\boldsymbol{F_t} = \exp[\boldsymbol{f_T}*(T2-T1)]$$

with $\boldsymbol{f_T}$ being equivalent to the conversion coefficient for the fixed temperature established by the standard EN ISO 10456, which is 0.0055 for polyurethane foams with a thermal conductivity value of up to 0.025 W/(mK).

Table 5 – conversion of the values for thermal conductivity

Solution	λ_1 [W/(m K)]	f_T [1/K]	T2-T1 [K]	F_t	λ_2 [(W/(mK)]
Polyurethane	0.024	0.0055	15	1.086	0.0261

The energy consumption was worked out through an evaluation of the thermal power $\boldsymbol{Q_d}$ (kW) lost through the walls of the HVAC system by applying the following formula:

$$\boldsymbol{Q_d = U * \Delta T * S}$$

where **U** is the thermal transmittance of the ducts' walls, **ΔT** the difference in temperature between external and internal air and **S** the total surface of the ducts system. Table 6 shows the above-mentioned calculations:

Table 6 – physical/thermal evaluation of energy dispersion in the standard model

	Units	Piral HD Hydrotec 15HP21 panel
Thickness	m	0.0205 (insulating material 0.020)
Thermal conductivity λ_u	W/(m K)	0.0261
Resist. of insulating material	$(m^2 K)/W$	0.766
Internal liminar resist.	$(m^2 K)/W$	0.043
External liminar resist.	$(m^2 K)/W$	0.0122
Total resistance	$(m^2 K)/W$	0.93
Thermal transmittance U	$W/(m^2 K)$	1.07
ΔT	K	15
Lost thermal power Q_d	kW	8.05

Having hypothesised an operating time of 850 hours, the amount of thermal energy lost is about 6845 kWh which, expressed in a different unit of measure, is equivalent to 24642 MJ.

ADDITIONAL INFORMATION AND REFERENCES

This section of the declaration includes additional information connected with company management and with the validation procedure of the document.

TECHNICAL PERFORMANCE OF THE PRODUCT

To complete the description of the product being analysed, here is a brief illustration of other features offered by the Piral HD Hydrotec 15HP21 panel:

- **Low weight:** the extreme lightness of the panel makes it possible to reduce the weight of the load supported by the bearing structures, by the bracketing points and to reduce the labour force and the amount of materials needed for the final installation of the duct;
- **Low noise level:** the sandwich-type structure of the panel (aluminium-insulating material-aluminium) guarantees good acoustical behaviour;
- **Durability:** the external aluminium sheets coupled with the insulating material impart sturdiness, rigidity and good resistance to corrosion, to erosion and to deformation, even when the panel is used in particular applications;
- **Safety:** the Piral HD Hydrotec 15HP21 panel shows a limited degree of participation in case of fire accidents, it does not drip and the fumes produced have low degrees of opacity and toxicity, thus meeting the criteria established by the most stringent international standards.

ENVIRONMENTAL PHILOSOPHY OF THE COMPANY

Since the year 1996 P3 has operated according to the UNI EN ISO 9001-2000 standards, and later achieved the environmental certification UNI EN ISO 14001-2004 and OHSAS 18001-99. For broader diffusion of the outstanding environmental performance of its products, P3 has published this environmental product declaration with the format of an EPD.

Among the actions aimed at perfecting its efforts in environmental matters, P3 would like to mention the following:

- increase in the stock-up of raw materials in re-usable 1000 kgindicator small tanks, thus reducing the number of metal containers (drums) used and the scrap produced;
- introduction of a coefficient to express the waste/m^2 ratio of produced panels. This makes it possible to evaluate this parameter and to decide what actions should be taken in order to improve on it;
- constant monitoring of the panels' density in order to identify sensitive parameters and thus improve productivity while still using the same raw materials for production;
- sensitising the supplier of aluminium sheets to the possibility of using alloys, which may be obtained from recycled material and offer the same level of performance;
- reduction in energy consumption, by enacting a policy aimed at minimising waste (e.g. turning the PC off during the lunch break or while not in use, lowering the heating temperature by 2 °C during the winter season, etc.).

CONTRIBUTION OF GENERIC DATA

The employment in this study of generic data characterised only the production of the mixture for the construction of the panel. When verification took place, it was calculated that the influence of generic data is inferior to 10%.

CONTACTS

For further information about the activities undertaken by P3 or about this environmental declaration, please contact Mr Nicola Mela, Tel. 0499070301, e-mail n.mela @p3italy.it.
As an alternative, you may visit our site http://www.p3italy.it/.
Technical support was offered to P3 by the Study Life Cycle Engineering in Turin (www.studiolce.it - info@studiolce.it).

REFERENCES

- General Programme Instructions for EPD and Supporting Annexes
- PCR 2008:06
- Analysis of production operations for panels made of expanded polyurethane using the methodology known as Life Cycle Assessment (LCA), Final Report 8 October 2008 (Life Cycle Engineering, www.studiolce.it).
- Technical data sheets P3 (http://www.p3italy.it/)
- Boustead Model database and databases according to PCR

INFORMATION ABOUT THE CERTIFYING BODY AND ABOUT THE PCR

PCR 2008:06 review, was conducted by: *P3 - Life Cycle Engineering*
Independent verification of the declaration and data, according to ISO 14025: □ *Internal* *x external*
Third party verifier: *RINA Services S.p.A.* Certification Body (www.rina.org) accredited by SWEDAC (registration n° 1812) and ACCREDIA (registration n° 001H).
Valid until: 26/11/2011

Please note that EPDs obtained with different programs may not be comparable

GLOSSARY

Categories of environmental impact taken into consideration:

- Acidification Potential(AP): phenomenon by which atmospheric rainfall has a pH which is lower than average. This may cause damage in forests and cultivated fields, as well as in water ecosystems and objects in general. This phenomenon is due to the emissions of SO_2, of NO_x, and NH_3, which are included in the Acidification Potential (AP) index expressed in masses of H^+ produced.
- Ozone Depletion Potential (ODP): degradation and depletion of the ozone layer in the stratosphere, which has the property of blocking the ultraviolet components of sunlight thanks to its particularly reactive compounds, originated by chlorofluorocarbons (CFC) or by chlorofluoromethanes (CFM). The substance used as a point of reference for assessing the ODP (Ozone Depletion Potential) is trichlorofluoromethane, or CFC-11.
- Global Warming Potential (GWP): phenomenon by which the infrared rays emitted by the earth's surface are absorbed by the molecules in the atmosphere as a result of solar warming and then re-emitted in the form of heat, thus giving rise to a process of global warming of the atmosphere. The indicator used for this purpose is GWP

(Global Warming Potential). This mainly includes the emissions of carbon dioxide, the main greenhouse gas, as well as other gases with a lower degree of absorption of infrared rays, such as methane (CH_4), nitrogen protoxide (N_2O), chlorofluorocarbons (CFC), which are expressed according to the degree of absorption of CO_2 (g CO_2).

- Eutrophication Potential (EP): enrichment of the watercourses by the addition of nutrients. This causes imbalance in water ecosystems due to the overdevelopment encouraged by the excessive presence of nourishing substances. In particular, the Eutrophication Potential (EP) includes phosphorous and nitrogen salts and it is expressed in grams of oxygen (g O_2).
- Photochemical Ozone Creation Potential (POCP): production of compounds which by the action of light are capable of encouraging an oxidising reaction leading to the production of ozone in the troposphere. The indicator POCP (Photochemical Ozone Creation Potential) includes especially VOC (volatile organic compounds) and is expressed in grams of ethylene (g C_2H_4).
- Cumulated energy (Gross Energy Requirements - GER): is the overall amount of energy involved in a production system. This is made up of the addition of all the quantities of energy inherent in all the operations from the extraction of raw material. Gross energy may be subdivided at least in five categories: direct energy or energy content of fuel, feedstock energy, production & delivery energy, transport energy and biomass energy.