

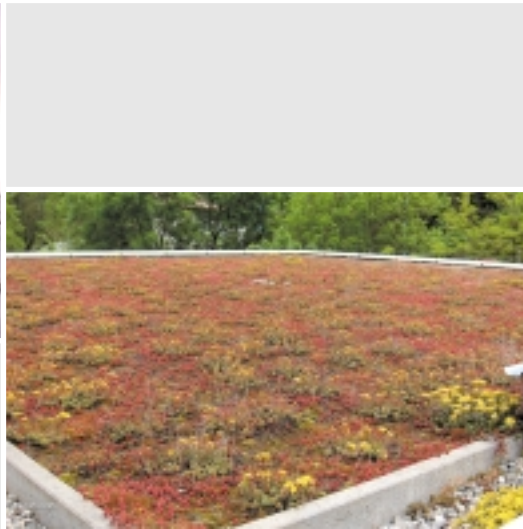
CSFE

Bituminous waterproofing systems

Contribution to the HQE® initiative

Environment and Health Statements

Produced by the Chambre Syndicale
Française de l'Étanchéité



INTRODUCTION

Sustainable development, reducing the greenhouse effect, waste recycling, life cycle analysis are all now terms in everyday use.

In the construction industry, the HQE® approach – Haute Qualité Environnementale (high environmental quality) – is a concrete response to these increasingly significant issues.

Wishing to take part in this initiative, the manufacturers of bituminous waterproofing products have contributed in the form of Environmental and Health Statements (**FDES fact sheets** – Fiches de Déclaration Environnementale et Sanitaire) for their proposed systems.

With the growing development of HQE® initiatives, the construction sector is more and more inclined to manage sites and construct buildings in accordance with this approach.

To facilitate evaluation of the environmental impact of building materials and systems that they specify and use, **the building products manufacturers** decided to use the FDES in the standard format described in the standard NF P 01-010.

This major and essential challenge led the five bituminous membrane manufacturers (Axter, Derbigum, Meple, Soprema and Siplast), members of the CSFE – Chambre Syndicale Française de l'Étanchéité (*French waterproofing employers' federation*) – to combine their efforts and resources to produce the FDES fact sheets for the principal bituminous waterproofing systems used in France.

Objectivity and neutrality has been ensured by requesting PricewaterhouseCoopers (PWC)-Ecobilan to draw up these statements.



BITUMINOUS WATERPROOFING



1. Effective protection

The principal task of bituminous waterproofing systems is to **protect the building from the elements** (water, snow, etc.). Beyond this main function, the waterproofing **conserves the value** of the property. In effect it protects the thermal insulation from rainwater ingress and ensures the durability of the thermal characteristics – a long-lasting, **viable option**. It also offers the possibility of making the building **accessible** to pedestrians and vehicles. It can allow the creation of a roof garden and thus contribute to keeping the building healthy.

2. Bitumen: a material with ideal qualities

Hydrophobic and flexible, bitumen provides ideal mechanical characteristics for creating a waterproof system. In addition to its excellent bonding qualities, bitumen does not absorb water and is resistant to structural movement. It retains its properties over a long period of time, thus making a contribution to the long life of buildings.

3. Exceptional longevity

As ancient texts show, notably the Bible (Genesis 11:3), **the use of bitumen dates back to ancient times** as the Tower of Babel and even Noah's Ark would have been built with the help of bitumen. The Hanging Gardens of Babylon were also waterproofed using bitumen. From the 4th millennium B.C. the Sumerians, the Babylonians and then the Assyrians used it as a hydraulic mortar (roofs, dams, etc) but also in craft and silversmith industries and even in medicine.

Today there are many ancient creations, such as the irrigation dykes of the Tigris at Assur (Mesopotamia), which prove the exceptional longevity of bitumen, following the example of other unreactive materials such as stone or wood.

4. A natural derivative of petroleum

Although bitumen exists naturally at the sites of old oil deposits, its current form, as used in the manufacture of waterproofing membranes, **comes from the industrial refining of crude oil**. However bitumen does not result from a specific transformation of the oil; **it is the**

heaviest part obtained during distillation.

The industrial production of bitumen is only a reproduction of a natural process (separation of different parts of oil), without any chemical transformation, which explains **the stability of this product over time**. The production process is a short one and is **less costly in terms of energy or waste** than is the case with other waterproofing materials.

5. A material that respects man and the environment

Essentially bitumen is composed of **carbon and hydrogen**. It is a hydrocarbon which is not used for combustion but which is developed as a construction material (roads and waterproofing). **It is a useful carbon store that generates no greenhouse gases**. The other constituents of bituminous membranes (fillers, polymers, slate, sand, etc) are inert or have a very low chemical reaction: **they pose no danger to man or nature**. Throughout their entire life on the structure, bituminous membranes represent no threat either to man or the environment: they do not release any organic, volatile compounds or give off any toxic or mutagenic gases which are harmful to health. Unlike tar, which is produced by distilling coal (coal tar), **bitumen is not classified as carcinogenic**. Insoluble in water and non-biodegradable, bitumen is the ideal material for all kinds of water storage (reservoirs, irrigation systems, polluted water, etc). Heating bitumen (to 160°C on average) with a welding torch results in a release of "bitumen fumes". Recent studies confirm that emissions are well below the recommended thresholds set by health organisations. (*INRS Vandoeuvre study 30/8 to 3/9/2004*).

A RESPONSIBLE AND EFFECTIVE METHOD

The CSFE chose to establish common industry fact sheets for the principal waterproofing systems, with the help of and following the methodology suggested by the specialists PWC-Ecobilan.

1. Joint FDES fact sheets – easy to use

As **the environmental impacts** of one type of waterproofing system are similar from one manufacturer and factory to another, the CSFE chose to establish common industry fact sheets stating the average impact generated by systems from the five manufacturers participating in this project.

2. FDES waterproofing system fact sheets – easily understood

Bituminous waterproofing systems comprise more than one product, i.e. bituminous primer, one or two reinforced bitumen membranes (RBMs), mechanical fixings, various types of protection (gravel, paving slabs, etc) and waterproofing details comprising one or perhaps two reinforcement angles, a capsheet and coping.

In order to simplify the complexity of such a wide range of possible combinations, the CSFE decided to produce **ten FDES fact sheets for complete systems** corresponding to the most common areas of use and including accessories, protection and details:

System 1: mechanically fastened, self-finished two layer waterproofing

System 2: torch-applied, self-finished two layer waterproofing

System 3: mechanically fastened, self-finished single layer waterproofing

System 4: torch-applied, self-finished single layer waterproofing

System 5: torch-applied, two layer waterproofing with extensive green roof

System 6: self-adhesive, self-finished, two layer waterproofing

System 7: loose-laid, two-layer waterproofing with added heavy protection – chippings

System 8: loose-laid, two-layer waterproofing with added heavy protection

System 9: loose-laid, single-layer waterproofing under paving slabs on supports

System 10: loose-laid, two-layer waterproofing under intensive vegetation (roof garden)

...and as waterproofing systems are frequently used over thermal insulation and a vapour control layer:

System 11: torch-applied bituminous vapour control layer.

Attention: in this situation it is necessary to include the environmental impacts of the bituminous vapour control layer and the thermal insulation chosen by the building owner with those of the waterproofing system.

System 12: WILOTEKT-Plus fully adhered structural waterproofing system (**note: not part of the original CSFE document**).

3. Trustworthy third party involvement

Given the complexity of the task, the CSFE joined forces with a reputable company – PWC-Ecobilan – in order to:

- **Train operatives** in the use of the specialist software (TEAM®);
- **Import external data** relating to the impact on the environment;
- **Guide the CSFE** during the process of producing the FDES fact sheets.



4. Life Cycle Analysis (LCA)

(See diagram below)

The FDES fact sheets were drawn up by **taking into account the environmental impact at every stage of the life of the products and systems**, from the extraction and/or the manufacture of the constituent materials until the end of their life, including demolition and the recovery or dumping of materials.

5. Measurement Unit (UF)

This was defined for each system considered by **“a 1m² flat roof covering with a polymer bitumen waterproofing system”**. This UF includes the waterproofing of ancillary works (waterproofing details, rainwater outlets, protection, etc) directly incorporated in the waterproofing system.

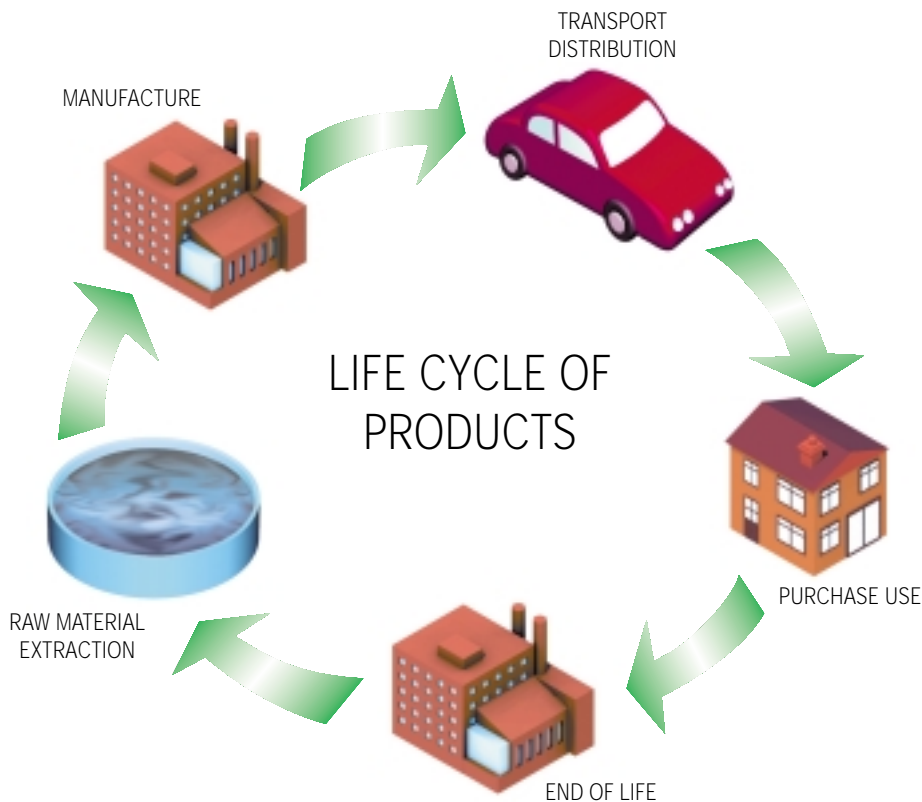
6. Typical life span (TLS)

The life of a waterproofing system varies according to exposure to sunlight and to added protection, if any. Also, the life expectancy of a system **does not correspond to that of the roof**: in fact the installation standards (DTU series 43) include the possibility of applying a second, even a third covering during the working life of a waterproofing system, without removing the previous layers.

The life of the system is usually called the **Typical Life Span (TLS)** of the system: in certain cases this can reach 90 years.

Each FDES fact sheet indicates the TLS to be taken into account for the waterproofing system in question.

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LEVEL OF ENVIRONMENTAL IMPACT

“The CSFE decided to draw up some FDES fact sheets corresponding to the average environmental impact generated by systems from the five manufacturers taking part in this scheme”



1 Focus: Bituminous waterproofing systems, a useful and sustainable store of petroleum constituents.

Although they contain a significant quantity of carbon matter derived from petroleum, **bituminous waterproofing systems globally emit only low levels of CO₂ or other greenhouse gases**. Bitumen is the greatest constituent by mass in a waterproofing system and is a heavy hydrocarbonated extract from petroleum – non-renewable fossil resource. It is extracted **by a simple distillation process** generating relatively little CO₂, requires no heavy chemical transformation, consumes low levels of energy resources and generates little greenhouse gas.

Furthermore, given the non-volatility of bitumen at ambient temperatures, bituminous membranes constitute **a sustainable way of storing carbon on the earth's surface**:

- In the form of waterproofing membranes installed on roofs;
- In the form of inert waste, whatever its use, after removal.

Bituminous waterproofing membranes, like road surfaces, therefore constitute a “useful” and sustainable store of petroleum constituents, emitting little CO₂.

2 Focus: Low impact on water resources

The use of water during the production of bituminous waterproofing systems is essentially for cooling purposes. **After use this water is restored to the environment with no notable change** other than a slight rise in temperature.

In addition, leaching behaviour studies carried out in line with regulations in the Dutch Building Materials Decree on bituminous membranes have shown that the **levels of HAP precursors are well below the statutory values** (“Branche calls for fairer tests on building materials” published in Land & Water); therefore the water can be returned to the environment or used as grey water (such as watering, flushing etc) without treatment.

However, in addition to being used on buildings, bituminous waterproofing is also used in civil engineering for storage and transmission of water, e.g. canals or reservoirs either used for temporary storage or for later treatment, etc. In certain other circumstances bituminous membranes are used for road bridges, storm water bunds and storage basins for contaminated liquids and therefore help to protect ground water from pollution.

3 Focus: Inert and recyclable waste

At the end of the system's useful life and depending on its composition, the waste from dismantling bituminous waterproofing systems is considered to be inert with no specific impact on the environment. It can be used as backfill.

It is also possible to recycle its energy potential in the form of combustible materials in certain industries. Similarly, it can be recycled into bulk or sheet bituminous products.



LEVEL OF ENVIRONMENTAL IMPACT

Notes on Units

- ① Fictitious volume of air or water, calculated in m³, by which it would be necessary to dilute each flux from the list to make it conform to the threshold given in the amended regulation of 2 February 1998.
- ② This indicator takes into account energy and non-energy resources (except water) consumed during total life span, by balancing each of them by a coefficient corresponding to a rarity index (fixed at 1 for antimony). It is expressed in kg antimony equivalent.
- ③ Aggregation of emissions into the air of mixtures likely to react with the ozone layer (in particular CFC, HCFCs). The reference molecule is CFC11, the indicator is given in kg. equivalent CFC11. Note: bituminous membranes do not generate any emissions of this type.
- ④ The ozone results from the chemical transformation of oxygen in contact with nitrogen and hydrocarbons under the effect of the sun's rays and at a high temperature (photochemical smog phenomenon or "ozone peaks"). The reference molecule is ethylene (C2H4) and the indicator is given in kg. equivalent ethylene.
- ⑤ Total primary energy comprises three major fractions: energy required for the production of raw materials (in particular bitumen and reinforcements) which is the biggest part, the energy process (approx. 1/3 of total) used in the factory and on site to produce waterproofing membranes and the energy used for transport.



No	Environmental impact	Unit	Notes	System 1	
				Annual	All TLS
1	Consumption of energy		⑤		
	Total primary energy	MJ/UF		11.2	674
	Renewable energy	MJ/UF		0.235	14.1
	Non renewable energy	MJ/UF		10.9	653
	(of which process energy)	(MJ/UF)		(4.3)	(258)
2	Depletion of natural resources	kg equiv. antimony/UF	②	0.00492	0.295
3	Water consumption	litre /UF		3.25	194
4	Solid waste				
	Recycled	kg/UF		0.014	0.840
	Discarded				
	Hazardous waste	kg/UF		0.000923	0.0554
	Non hazardous waste (DIB)	kg/UF		0.00828	0.497
	Inert waste	kg/UF		0.314	18.8
	Radioactive waste	kg/UF		0.000118	0.00705
5	Climate change	kg equiv. CO ₂ / UF		0.268	16.1
6	Acidification of the atmosphere	kg equiv. SO ₂ / UF		0.00109	0.0654
7	Air pollution	m ³ /UF	①	21.9	1310
8	Water pollution	m ³ /UF	①	296	17800
9	Depletion of the ozone layer	kg CFC equiv R11 / UF	③	0	0
10	Formation of photochemical ozone	kg equiv. ethylene / UF	④	0.547	32.8

No	Environmental impact	Unit	Notes	System 7	
				Annual	All TLS
1	Consumption of energy		⑤		
	Total primary energy	MJ/UF		11	990
	Renewable energy	MJ/UF		0.253	22.8
	Non renewable energy	MJ/UF		10.7	960
	(of which process energy)	(MJ/UF)		(4.19)	(377)
2	Depletion of natural resources	kg equiv. antimony/UF	②	0.00487	438
3	Water consumption	litre /UF		3.03	272
4	Solid waste				
	Recycled	kg/UF		0.0116	1.050
	Discarded				
	Hazardous waste	kg/UF		0.000904	0.0814
	Non hazardous waste (DIB)	kg/UF		0.00645	0.58
	Inert waste	kg/UF		1.01	90.8
	Radioactive waste	kg/UF		0.000118	0.0106
5	Climatic change	kg equiv. CO ₂ / UF		0.265	23.9
6	Acidification of the atmosphere	kg equiv. SO ₂ / UF		0.00116	0.104
7	Air pollution	m ³ /UF	①	32.3	2910
8	Water pollution	m ³ /UF	①	513	46200
9	Depletion of the ozone layer	kg CFC equiv R11 / UF	③	0	0
10	Formation of photochemical ozone	kg equiv. ethylene / UF	④	0.568	51.1

RESPONSE TO THE HQE[®] INITIATIVE

*Established in 1996
to integrate the
environmental approach
into the construction
industry, the HQE[®]
association defined 14
areas of action or “targets”
grouped into four main
categories:
eco-construction,
eco-management,
comfort and health.
Manufacturers from the
bituminous waterproofing
sector proposed concrete
responses to these
different targets.*

TARGET 1

Harmony between
buildings and their
immediate environment

- ◆ Bituminous waterproofing **systems** are designed to protect the building and its users from the most extreme weather conditions: rain, snow, ice, wind, hail, etc.
- ◆ The various **surface finishes** (granules in different colours, wood or mineral slabs, roof garden) allow optimum integration of the bituminous waterproofing system with its environment.
- ◆ The **addition** of a roof garden to protect flat roof waterproofing allows:
 - the creation of a permeable green space on the roof to replace the green space destroyed by the building.
 - a contribution to the preservation of biodiversity, as vegetation attracts insects which in turn attract birds;
 - a great variety of colour and shape depending on the types of plants chosen
 - an improvement of the local climate by absorbing dust and by lowering the temperature and humidifying the air.

TARGET 2

Integrated choice of
building products and
systems

- ◆ **The cost** of maintaining and refurbishing bituminous waterproofing systems are limited because of their long typical life span (estimated at more than 30 years). *In the UK BS8747 indicates a lifespan in excess of 50 years.*
- ◆ **The main constituent** of the membranes, bitumen, is a derivative of the distillation of crude oil destined essentially for the production of fuels. It does not result from a specific chemical transformation of oil, but from developing an end product.
- ◆ **The installation** of bituminous waterproofing membranes causes no harmful fumes in normal heating conditions (160° C). It presents no danger to man or the environment.
- ◆ **The possibility of being able to choose** loose-laid or mechanically fastened application methods facilitates the dismantling of the waterproofing, without damaging the insulation. If required extra insulation can be applied during renovation.

TARGET 3

Low pollution
building site

- ◆ **In the case of a two-layer system**, the bituminous waterproofing system helps the general management of the project: the first layer provisionally protects the building while works are in progress. The second layer can be installed once other trades have finished work, thus avoiding accidental damage.
- ◆ **The renovation** of a waterproofing system consists in most cases in adding a new RBM to the existing waterproofing, in order to prolong the function of both the system and the insulation.
- ◆ **Waterproofing membranes can be recycled**; this is due in particular to the thermoplastic properties of their principal constituents (bitumen, polyester reinforcement, polymers, fusible plastic films).
- ◆ **Very low emission levels.**
According to studies carried out to date, the bitumen fumes given off during installation of the waterproofing systems by torching are not harmful to human health.
- ◆ **If required, noise caused by using a torch can be eliminated** (in a built up area for example) by choosing cold adhesives, or by means of a hot air-applied system.



TARGET 4

Energy management

- ◆ **Bituminous waterproofing systems** protect the insulation and help reduce energy loss throughout the life cycle of the building.
- ◆ **The choice of a light coloured finish** on the waterproofing (e.g. white slate chippings) reflects 65% of the sun's rays when new and about 45% as it ages.
- ◆ **By increasing thermal mass**, the addition of a roof garden provides a more comfortable environment in winter and in summer and generates a saving of 20 - 30% of the use of air conditioning on the storey under the roof.

(source ENN: Environmental News Network, Suzanne Elston, 30.12.2000)



TARGET 5

Water management

- ◆ **A green roof** (intensive or extensive) allows a high level of water retention on the roof: 50 to 80% of annual rainfall in volume in a continental climate does not join the drainage network but is returned to the atmosphere by the process of evapo-transpiration (FLL rules for making green roofs, 2002 edition).
- ◆ **Waterproofing systems with protective chippings** and green roofs slow rainwater run-off, reducing the likelihood of the drainage system overflowing when there are violent storms.
- ◆ **Rainwater** recovered from a roof can be collected and used for sanitary purposes, such as watering plants and flushing toilets.



TARGET 6

Waste management

- ◆ **Bituminous waterproofing systems** do not generate waste during their life cycle.
- ◆ Extensive roof gardens, **made from entirely recyclable natural products**, form an ecosystem with low levels of green waste.



TARGET 7

Maintenance management

- ◆ **To ensure** the durability of the waterproofing, a simple preventative and diagnostic annual maintenance check will suffice.
- ◆ **For renovation projects** it is sufficient in many cases to add a new RBM to an existing system, without first removing any materials, to prolong the life of the system (see NF P 84-208/DTU 43.5). This procedure can be carried out up to twice during the life of the building (in other words a period of 90 years). This removes a significant source of waste.
- ◆ **Extensive green roofs** reduce maintenance costs to a minimum: annual visit for maintenance, little waste, limited watering (except in Mediterranean areas during particularly dry summers).



TARGET 8

Humidity control

- ◆ **Green roofs** absorb the sun's rays and refresh the atmosphere by evaporation of the water retained by the substrate: energy consumption of air conditioning units below is reduced.
- ◆ **In summer as in winter** the layer of vegetation contributes to the thermal mass of the roof.
- ◆ **A light coloured finish** on the waterproofing (e.g. white mineral chippings) will reflect 65% of the sun's rays when the system is new and 45% as it ages.



TARGET 9

Acoustic comfort

- ◆ **Due to their mass** and elastoplastic properties, bituminous waterproofing systems deaden impact noise (rain, hail).
- ◆ **Waterproofing systems** under heavy protection (chippings, membranes, garden, vegetation) also enhance phonic comfort by filtering airborne as well as impact noises.



TARGET 10

Aesthetics

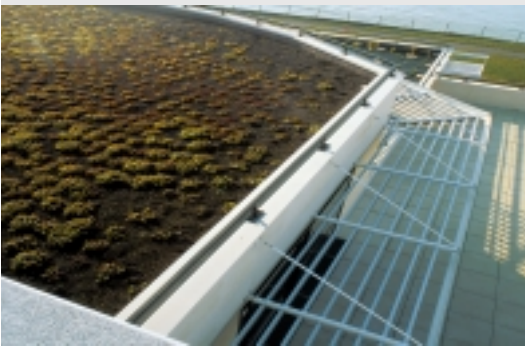
- ◆ The **many choices of surface finish** (granules, chippings, metal foil, vegetation, wooden or concrete slabs) allow the building to blend in with its environment.
- ◆ A green roof promotes harmony between the building and its surrounding environment and improves the urban landscape.



TARGET 11

Low odour levels

- ◆ **Bituminous membranes** do not generate any particular smell during their use.
- ◆ Waterproofing membranes can be mechanically **maintained** without using offensive smelling products.
- ◆ **Green roofs** can include fragrant plants (such as thyme, chives, lavender, etc).



TARGET 12

Health conditions

- ◆ The **installation of bituminous membranes** does not present any danger to man or the environment: they do not release any volatile organic compounds or toxins harmful to health.
- ◆ **Bitumen** is not classified as carcinogenic.
- ◆ **Bitumen** is insoluble in water.



TARGET 13

Air quality

- ◆ **Bituminous waterproofing systems** are chemically stable and do not release any noxious fumes while being installed.
- ◆ **The addition of a green roof** improves air quality by reducing atmospheric dust and transforming carbon dioxide into oxygen.



TARGET 14

Water quality

- ◆ **Insoluble in water** and non-biodegradable, bitumen is the ideal material to use for all types of water storage (reservoirs, irrigation water, polluted water, etc).
- ◆ **Green roofs** allow the collection of good quality rainwater (rainwater harvesting) separately for domestic, non-drinking use (grey water).



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