Case Study

July 2012

elios 2 European Liability Insurance Organisation Schemes

NHBC

10. Low-VOC Materials

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10.1 Introduction to the technology

This case study covers the use in the building industry of low volatile organic compound (low VOC) materials. Though other definitions exist in other EU nations, a definition of a VOC as stated in European Union directive 2004/42/EC is:

> *"any organic compound having an initial boiling point less than or equal to 250 °C measured at a standard atmospheric pressure of 101.3 kPa, and which can do damage to visual or audible senses."*

VOCs are used in a wide range of products. Products relevant to this case study include:

- Paints, paint thinner and solvents
- Wood preservatives
- Aerosol sprays (eg. expanding foam)
- Caulks and sealants
- Carpets
- Adhesives and fillers
- Finishes

Other (non-building) examples include air fresheners, stored fuels, dry-cleaned clothing, cleaners and disinfectants. The emission of VOCs from products may be at its highest at the point of application, but can continue for many years.

To use paint as an example, the product is made up of three major components:

- Pigment, which gives the paint its color
- Binders (also known as the vehicle or medium), which help the pigment stick to the applied surface
- Solvents (sometimes called carriers or thinners), which keep the paint in liquid form, making it easier to apply.

In this example the main source of VOCs is the solvent, and since the solvent is designed to evaporate to allow the product to 'fix', VOCs contribute directly to poor air quality. They may also be a health hazard; according to the US Environmental Protection Agency, VOC fumes can cause eye and throat irritation as well as headaches, nausea and dizziness. Some people with asthma find that paint fumes can trigger attacks, and long-term exposure to some VOCs has been linked to kidney disease, liver damage and cancer.

For a product to be classified as a 'low-VOC' product, most commonly its solvent content will have been be reduced.

Some specific sources of VOCs[1]:

VOC	Source materials
Formaldehyde	Urea formaldehyde foam insulation, particle board,

[1] from http://www.cranfield.ac.uk/health/researchareas/environmenthealth/ieh/ieh%20publications/vocslflt.pdf

	chipboard, plywood, water-based paints, fabrics, household cleaners, environmental tobacco smoke,
Styrene	Insulation, plastics, paints, textiles, disinfectants
Benzyl chloride	Vinyl tiles
Chloroform	Chlorinated water
1,1,1-Trichloroethane	Aerosol sprays, fabric protectors, dry-cleaned clothes
Carbon tetrachloride	Industrial strength cleaners
Aromatic hydrocarbons (toluene, xylenes, ethylbenzene, trimethylbenzenes), aliphatic hydrocarbons	Paints, adhesives, petrol, combustion products
Polycyclic aromatic hydrocarbons	Combustion products (smoking, woodburning, kerosene heaters)
Acrylic acid esters, epichlorohydrin, alcohols	Paints, paint thinning, adhesives, aerosols, window-cleaners, cosmetics
Ketones	Lacquers, varnishes, adhesives, polish removers,
Ethers	Resins, paints, varnishes, lacquers, dyes, soaps, cosmetics
Esters	Plastics, resins, plasticisers, lacquer solvents, flavours, perfumes

European Union directive 2004/42/EC states that from January 2010, all adhesives, fillers, paints, primers and decorative materials must contain no more than 30g per litre of VOCs. 30g per litre is approximately 30% by volume.

France and Germany have enacted regulations to limit VOC emissions from commercial products, and industry has developed numerous voluntary ecolabels and rating systems. A comparison of existing European labels can form a useful categorisation structure for low-VOC materials (see section 10.2).

Over the last few decades these regulations and standards have changed the marketplace, leading to an increasing number of low-emitting products. The leading voluntary labels report that licenses have been issued to several hundreds of appropriate products.

10.2 Available types of this technology

The word “low” varies by product type. For paints, which are the largest contributor to VOCs in the EU, manufacturers use a (voluntary) 5-tier scale:

- Minimal VOC content 0 - 0.29%
- Low-VOC content 0.30 - 7.99%
- Medium VOC content 8 - 24.99%
- High VOC content 25 - 50%
- Very high VOC content 50% or above

The tier is defined by the total of all VOCs in the product, as a product may contain more than one VOC.

VOC solvents may be replaced by a range of different materials. In paints these are often ‘natural’ materials, and can include:

- plant dyes and other plant products such as tungnut oil
- natural latex
- water
- milk protein or other food-grade ingredients
- clay, chalk and talcum
- bees wax
- linseed and citrus based oils
- lime plasters

The leading EU low-VOC emission rating schemes are as follows:

"Flower" ecolabel (pan-European)
A voluntary system across Europe designed to encourage businesses to market products and services that are ‘kinder’ to the environment.

EMICODE (Adhesives and more, Germany/Europe)
Any EMICODE labelled product must contain less than 0.5% m/m solvents, where solvent is defined as a VOC with boiling point of max. 200 °C.

GUT (Carpets, Germany/Europe)
The GUT label is an evaluation system for low-VOC emissions carpets within a wider label known as PRODIS.

Blue Angel (Germany)
The Blue Angel (Der Blaue Engel) is a German certification for products and services that have environmentally ‘friendly’ aspects.

Nordic Swan (Scandinavia)
An ecolabel with stringent environmental and climate criteria for 63 product groups

prEN 15052, ISO/DIS 10580
Resilient (flexible) floor coverings

AFSSET (France)
Construction products

M1 (Finland)
Construction products,

CertiPUR (information in English, French)
Polyurethane foam for furniture industry

DIM / DICL (Denmark)
Construction products

Byggvarudeklaration (Sweden)
Construction products

Natureplus (Germany/Europe)
Construction products

Indoor Air Comfort expanded scope (pan-European)
All EMICODE labelled products also can carry the Indoor Air Comfort 'Gold' label. Both auditing and certification are required for this label, so its use increases confidence in low-VOC emissions during use and production.

10.3 Strengths, weaknesses, opportunities and threats

This section outlines a discussion of the key drivers affecting the use of low-VOC materials.

Strengths
Low-VOC materials:

- improve indoor air quality for residents and building occupants, creating a more comfortable and productive environment
- improve safety and health for workers and building occupants, by reducing the incidence of eye and respiratory irritation, headaches and other symptoms of 'sick building syndrome'
- improve outdoor air quality by reducing the release of smog-forming chemicals
- reduce contaminants in landfill and groundwater
- reduce ozone depletion
- lead to reduced concentrations of greenhouse gases
- are more sustainable, as there is a lower reliance on oil-based products
- may, depending on the solvent, create faster drying paints which do not need solvents for cleaning brushes etc.

Weaknesses
Low-VOC materials:

- can be more expensive, as raw materials for the same performance are generally more expensive
- may not be easy to thin
- may, depending on the solvent (see comment above), take longer to dry and may have a less even finish.
- may need re-application more often – for example some low-VOC products do not last as long as higher VOC paints, and more layers are needed to cover marks
- may not have the same range of colours (for paints)
- may be labelled as low-VOC, but may not in fact be so - there is a such a wide range of VOCs that not all may be detected or identified in a supposed low-VOC product

Opportunities

- new homes and commercial buildings are said to have VOC concentrations that are two to ten times higher than comparable older structures in the long term
- regulations are driving down the acceptable limits of VOCs in household materials
- even at low levels it is not fully known what effects VOCs have in the long term, so there is likely to be increased demand for even lower or zero VOC materials

Threats

- the cost of raw materials for low-VOC products may increase more than those of higher VOC products
- recession likely to make purchases more price sensitive, so reducing uptake of low-VOC materials.
- low awareness of the benefits of low-VOC products could reduce 'pull through'

10.4 Building pathology, defects, and what can go wrong

10.4.1 Invitations to complete questionnaire

An invitation to complete the online version of the Elios II questionnaire was sent to 374 individuals in the following industry sectors:

TABLE 10.1 – Invitations to complete questionnaire

Sector	*Number sent*
Insurance	64
Certification Bodies	10
Accreditation Organisations	4
Builders/Installers	55
Manufacturers	74
Trade Associations	27
Professional Institutes	19
Architects	14
Quantity Surveyors	2
Other	4
Building Inspection Services	13
Government Organisation	22
Housing Associations/Commissioner	16
Consultancies	15
Merchant/retailer	5
Unknown	30
Total	374

In total 70 respondents completed some or all of the questionnaire. This is an 18% response rate.

10.4.2 Responses received

At the closing date of 1st October 2012, 8 responses had been received which related specifically to low-VOC materials. This is approximately 11% of the received questionnaires. The industry sectors of the respondents were as follows:

TABLE 10.2 – Responses

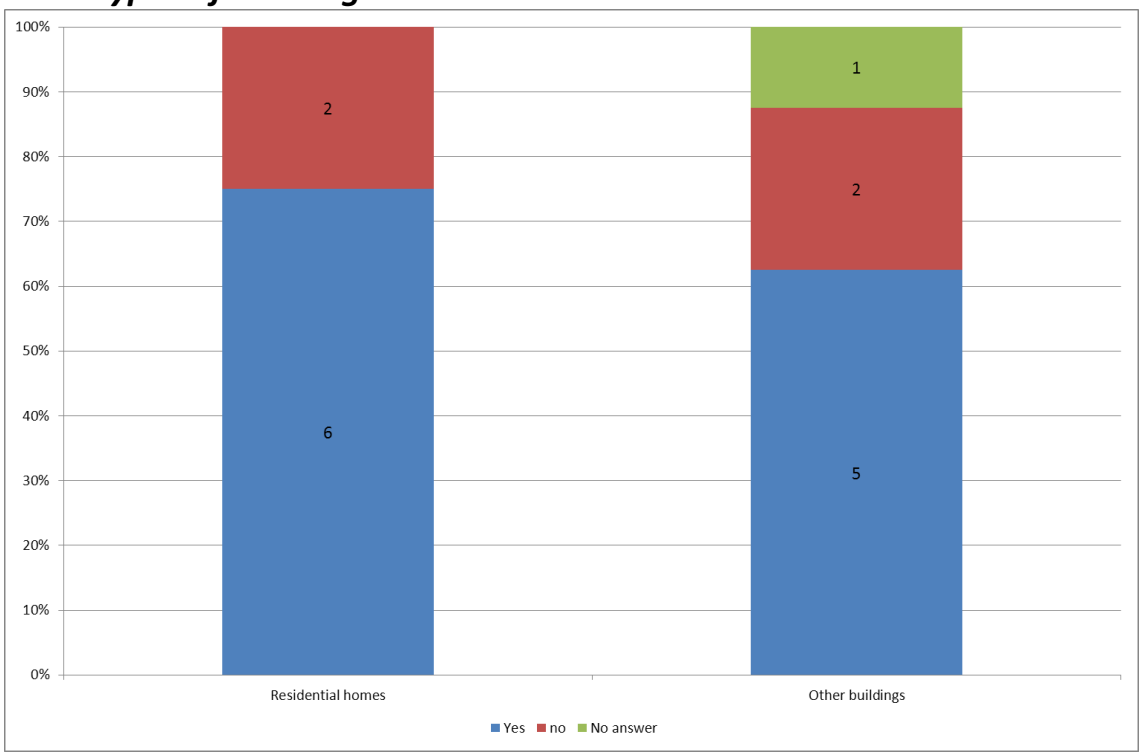
Sector	*Responses received*
Government organisation	2
Architectural practice	0
Housing organisation	1
Manufacturer	2
Retailer/merchant	0
Construction company	1
Installer	0
Building inspection service	2
Certification organisation	2
Insurance company	1
Trade association	0
Professional institution	2
Other (please specify)	2
More than one	4
Total	***8***

Note that some businesses are in more than one sector. Only three respondent gave any specific detail and counts, one claiming to have data relating to 402 installations of the technology, of which 200 (50%) were said to have experienced failures or defects. A second respondent gave no count of sites but said that 0.5% have defects. A third said that he had information on 2 sites, but no defects were recorded.

The following graphs and charts only relate to the people who responded about this technology.

CHART 10.3

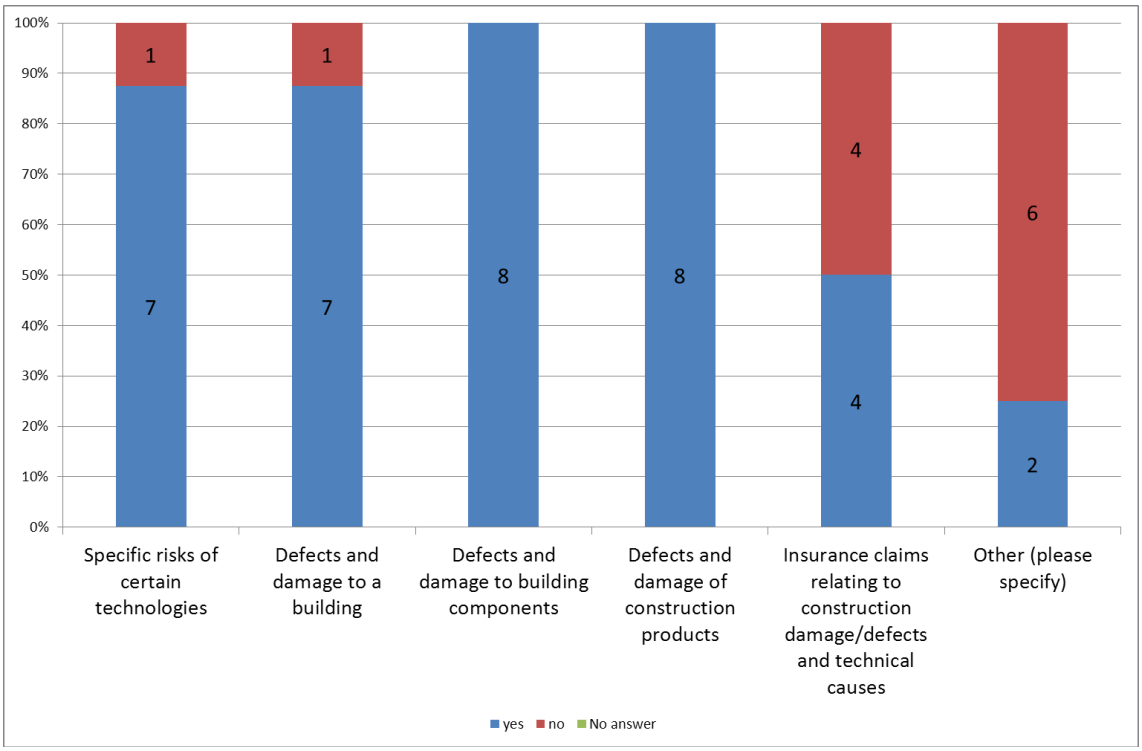
Question asked – *"Does your organisation collect or collate its own data on these types of buildings?"*



This chart shows the number of reporting organisations that collect data on each type of property. This is only for this eco-technology. Organisations may collect data on more than one type of property.

CHART 10.4

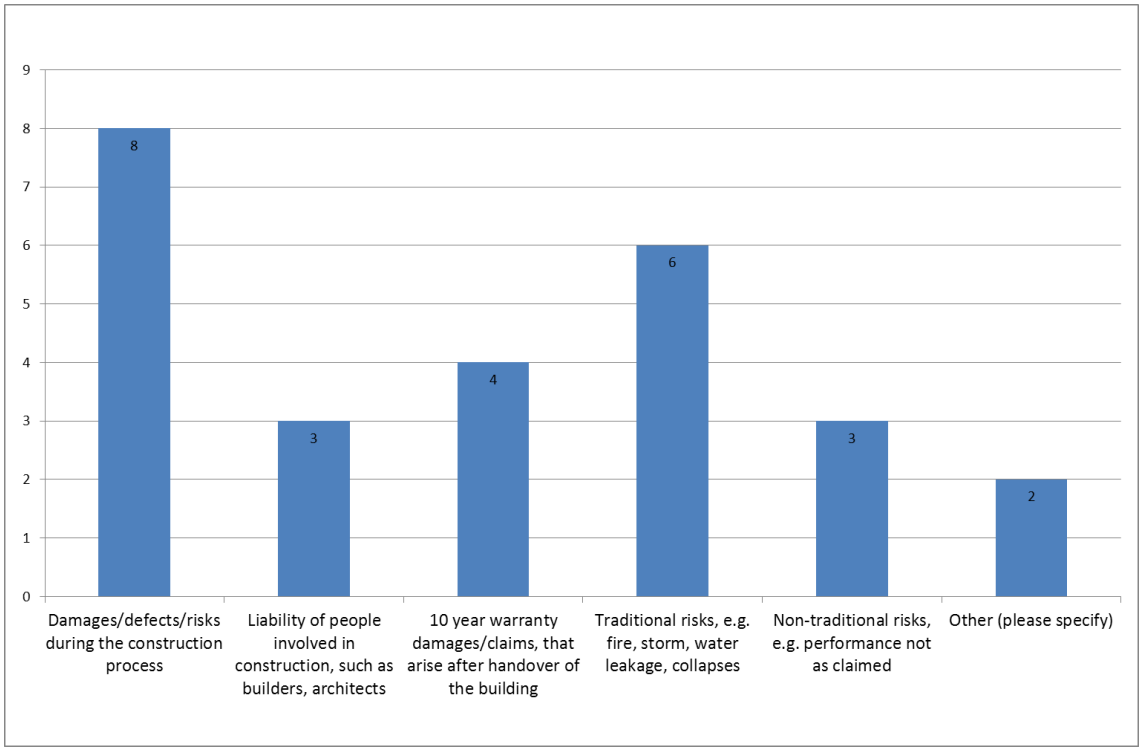
Question asked –*"Does your organisation collect its own data on these issues (please tick all that apply)?"*



This chart shows the various reasons that the reporting organisations collect data, and the number of organisations that gave each reason. This is only for this eco-technology, and not for all 10 technologies. Organisations may collect data for more than one reason.

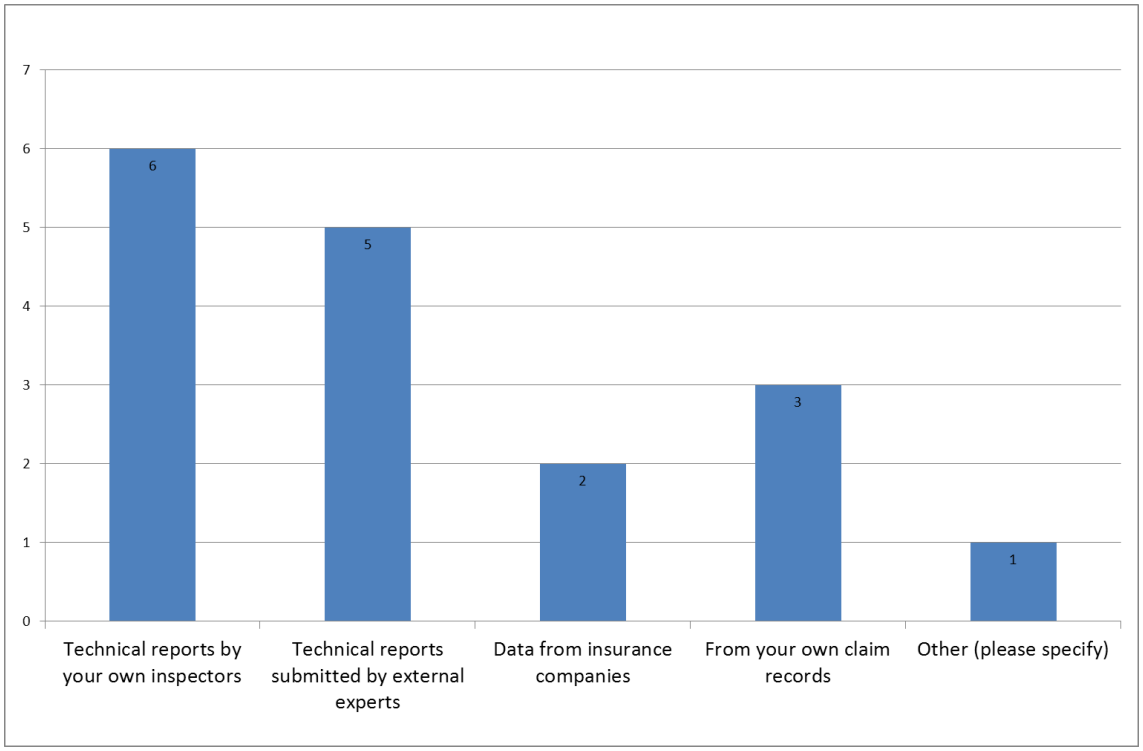
CHART 10.5

Question asked – *"What kind of damages/defects do the data refer to (please tick all that apply)?"*



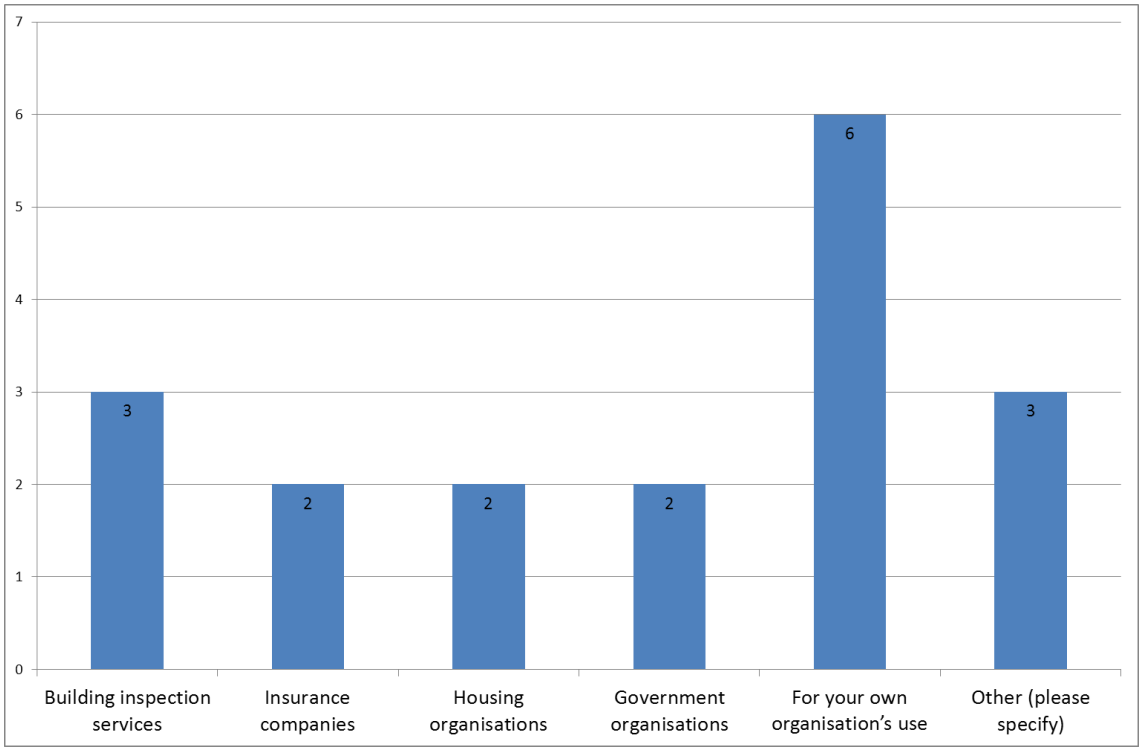
This chart shows the number of organisations that reported each kind of damage on which they collect data. Each column represents a different type of damage. This is only for this specific eco-technology, not overall. Organisations may collect data for more than one reason.

CHART 10.6
Question asked – *"How do you collect the data (please tick all that apply) ?"*



This chart shows the method by which each organisation collects data; each column represents a different method of data collection. This is only for this eco-technology, not overall. Organisations may collect data for more than one reason.

CHART 10.7
Question asked "*For whom do you collect the data (please tick all that apply)?*"



This chart shows the number and type of organisations that reported that they collect data about this eco-technology. Organisations may collect data for more than one type of organisation.

10.4.3 Summary of responses about databases

These statistics relate to people who responded about this technology.

About their database:

- 4 have a database, no one did not respond;
- 3 provided a date when data collection started – the earliest was in 2005 and 2 in 2007;
- 5 carry out statistical analysis of the data;

About data publication:

- 5 make data available on the web;
- 2 in newsletters;
- 2 in other publications;

Places where the data was published include:

- UK - www.structural-safety.org CROSS Newsletters
- CZ - www.tzus.cz; www.sbtools.cz; Obchod finance; Fasady; Mlada fromta

The publication may relate to other technologies and not explicitly relate to just this specific technology.

About the availability of data, of these 7 respondents:

- 3 publish summary data only;
- 3 publish raw data in any form;
- 2 publish raw data, even anonymously;

3 comments were passed, as follows:

- *"Where we have research projects funded by third parties, there is often a requirement to disseminate findings, under controlled know-how and IP, with commercially sensitive information removed."*
- *"Published results include expert comments on reports"*
- "Only the results of research work."

Finally, note that this question was answered in general about all 10 eco-technologies and may not apply to the specific technology.

10.4.4 Reasons for failures and defects

No counts for each cause of failure was offered in this section.

TABLE 10.8

Reason for failure/defect	Number	% of total
Requirement management		
Change in client's requirements	0	0.0%
Misunderstanding of the effectiveness of the technology	0	0.0%
Poor project management	0	0.0%
Inaccurate engineering or architectural data	0	0.0%
Delivery		
Late delivery	0	0.0%
Storage issues	0	0.0%
Awkward packaging	0	0.0%
Poor transport of product	0	0.0%
Installation		
Incorrect design for installation	0	0.0%
Incorrect installation documentation	0	0.0%
Failure in installation	0	0.0%
Commissioning failure	0	0.0%
Operational failure		
Product failure once installed	0	0.0%
Incorrect user documentation	0	0.0%
Misuse of product by end-user	0	0.0%
Performance not as claimed	0	0.0%
Other		
No other reasons were given for failure		
Total		

10.4.5 Failures/defects commentary

The respondents offered the following general comments and suggestions on the ways in which the failures and defects might be avoided in future:

TABLE 10.9

Reason for failure/defect	Commentary
Requirement management	
Change in client's requirements	The client or his advisors didn't consider carefully the desired properties and the requirements for these products..
Misunderstanding of the effectiveness of the technology	Lack of knowledge in the properties of these products.
Poor project management	
Inaccurate engineering or architectural data	Usually choices are (not) being made in the engineering phase.
Delivery	
Late delivery	
Storage issues	
Awkward packaging	
Poor transport of product	

Installation	
Incorrect design for installation	The chosen product is not fit for the intended application (that means: not fit for the subsurface upon which the product will be applied)
Incorrect installation documentation	
Failure in installation	New products often demand another application/processing or are more sensitive. Often products are applied on the traditional manner. This requires more education and support of the applicators.
Commissioning failure	
Operational failure	
Product failure once installed	Recent changes in VOC in paint formulation has led to early yellowing of gloss work in many homes
Incorrect user documentation	
Misuse of product by end-user	
Performance not as claimed	
Other (specified)	

General comments were:

- We have undertaken studies on internal air quality AIMC4 & Sigma home, looking at off gassing and VOCs but research findings to date has found little or no traces of any issues to raise concerns. Typically COSHH assessments are evaluated.

- We do not have information in any quantity but have received reported concerns about epoxy resin fixings.

One respondent said that half of his installations fail.

A second respondent stated that 0.5% had defects and 0.25% have had performance compromised.

10.4.6 Key findings

In summary:

- As no counts were provided, it is difficult to provide information on specific areas for action. However, some generalised comenmts can be made.
- There appears to be some change in color of some low–VOC paints over time
- There may be a need for increased knowledge of the designers/painters to make sure that preparation is better
- There may also be an issue with epoxy resin, but this would need verifying

Lessons:

- Perhaps there needs to be increased awareness of the limitations of these products, specifically amongst property owners.