DEMYSTIFYING GLASS SURFACE TREATMENTS

- OR -

EVERYTHING YOU ALWAYS WANTED TO KNOW ABOUT GLASS SURFACE TREATMENTS BUT WERE AFRAID TO ASK

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I. INTRODUCTION AND OBJECTIVES

Thanks very much to editors, publishers and other key figures in UK glass trade publications for this opportunity to review glass surface treatments and help to set the records straight by demystifying them.

Mystification surrounds glass surface treatments for several reasons:

- the **technologies** appear very complicated and many in number;
- there is much confusion about **terminologies,** technical and commercial;
- **marketing claims** are made that do not match reality, and in some cases are misleading.

This situation is increasingly detrimental to the markets for flat glass. Glass and glazing companies are more and more likely to lose business, unless steps are taken to avoid further damage in the marketplace.

If users of glass are confused and their expectations are not being met, there will be dissatisfaction and complaints. A mystified and confused market will not expand as it should, and may decline if nothing is done to rectify the situation.

There are many different brands of glass surface treatments on the market today, as well as many other brands that have come and gone over the years. However, as this presentation points out, there are only three general categories of technology - water-repellents, self cleaning glass and durable surface protection.

The main objective of this presentation is to provide information for you to reach your own conclusions about glass surface treatments. Assuming you agree to the importance of setting records straight, I will ask you as central communicators for the flat glass industry to help by:

- focusing on what is important to know about the technologies
- clearing up the confusion caused by many different terminologies
- highlighting the risks of unrealistic and sometimes misleading marketing claims.

To help in achieving these objectives, this presentation outlines a 6-step ‘demystification’ process as follows:

Step #1 - concentrate on knowledge that is really necessary
Step #2 - don’t let terminologies ‘blind you with science’
Step #3 - focus on basics of the technologies
Step #4 - avoid the dangers of ‘Labland’
Step #5 - make reality checks and carry out risk assessments based on exposure to the 12 enemies of glass.

II. BACKGROUND

Glass is a marvellous material of construction - promising visibility, clarity and cleanliness. Of these three features, cleanliness is most important because of its direct effects on the other two promises – visibility and clarity.

The main purpose of glass is to transmit light, natural and artificial. Therefore, anything that helps to maintain light transmittance should be considered as positive. Anything that interferes is negative.

Light transmittance depends on glass **cleanliness.**

Cleanliness of the glass depends on its **cleanability**.

Cleanabilty depends on **resistance to the 12 enemies of glass** described below.

Starting in 1981, Ritec introduced the first category of glass surface treatments as part of the 'ClearShield' System for glass renovation, protection and maintenance. At the core of ClearShield is a special grade of polymeric resin.

One of ClearShield's features is high water-repellency, but this is not the reason it has endured more than 25 years. The main purpose and benefit of ClearShield is durable glass surface protection.

Several years later, products with water-repellency as their main purpose and benefit started to enter the flat glass markets. First came **silicone fluid-based products**, well known as water-repellents since their introduction in the 1940's. Later on, during the mid- to late 1990's, two different types of water-repellent technology (**hybrid organic-inorganic composites** and **silanes**) were introduced in Germany as "nanotechnology".

These three types of water-repellents are marketed under a number of different brand names – a source of much confusion. Additional confusion is caused by the fact that visual appearances are very similar at the time of application. Initially it is difficult, if not impossible, to see differences between ClearShield and the water-repellents – or between the water-repellents themselves - when water is sprayed onto treated glass surfaces.

The water-repellents branded as "nanotechnology" cause confusion because different technologies and products use this description. Also, suppliers of these products indicate that "nanotechnology" is an advantage in performance and durability – when this is not relevant.

Suppliers of all three types of water-repellents make claims of performance and durability based on laboratory tests – even though lab tests alone cannot predict performance or durability under real life conditions of exposure and use.

There are now many brands of water-repellents on the market. Many more brands have come and gone over the years because **they have not stood the test of time - the only way to prove performance and durability.**

Starting in 2001, most of the major flat glass manufacturers introduced self cleaning glass. This description causes confusion, particularly when suppliers of self cleaning glass publish many pages of precautions and instructions for maintaining the self cleaning glass.

In spite of many suppliers and brands for glass surface treatments on the market today, it is useful to know that there are only three general categories and five types of technology:

- **water-repellents**
  - reactive silicone fluids
  - two-layer composites – branded "nanotechnology"
  - silanes – also branded "nanotechnology"

- **self cleaning glass – a titanium dioxide (TiO_2) coating**

- **durable glass surface protection** – a special grade of polymeric resin

Technologies within the three general categories above differ from each other not only in technology but also in purpose, functionality and most characteristics.

The three types of water-repellents also differ from each other in technology, but have certain characteristics in common such as high water-repellency. All are classified as hazardous because they are either Highly Flammable or Extremely Flammable.

Many technical and commercial terminologies have been introduced to describe the technologies, with various marketing concepts and technical descriptions. As examples, the marketing concepts include nanotechnology, photocatalytic and "non-stick". Corresponding technical descriptions include hydrophobic, hydrophilic and polymeric resin.

The confusion in terminologies is increased by suppliers claiming that hydrophobic performance is better than hydrophilic or vice versa. Or they may claim that one technology is better than another based on certain laboratory tests. This presentation shows why such factors may be important, but are not what really matters.

This presentation also highlights the risks of unrealistic, and sometimes misleading, marketing claims. Statements such as "self cleaning, lasts for the life of the glass" can raise expectations to unrealistic levels, causing customer confusion and dissatisfaction. Statements such as "lasts for up to ten years", when they are based on laboratory tests only, can be unrealistic and sometimes misleading.

Because of the differences in technologies and concerns about their terminologies and marketing claims, it is very important to determine if a technology is fit for a specific purpose in a particular application. Otherwise, expectations will not be met and there will be risks of complaints and lost business.

It is therefore important to determine what you need to know and what is not necessary to know in determining fitness for purpose of a glass surface treatment under particular conditions of exposure and use.

III. THE 5-STEP DEMYSTIFICATION PROCESS

In demystifying glass surface treatments, it is important to make simple and straightforward comparisons of the technologies. Attachment 'A' is shown with this objective in mind.

Other important factors are shown in the following 6-step process:

A. STEP #1 – Concentrate on Knowledge that is Really Necessary

The first step in demystifying the technologies is to consider knowledge that is necessary and that which is not. To give an idea of what this means, let's consider a metal surface treatment known as polytetrafluroethylene. Otherwise known as PTFE, this technology makes metals "non-stick" and is sold under brand names such as 'Teflon' or 'Tefal'.

Please ask yourself - how important is it to know:

1) details of the basic technology?

Polytetrafluoroethylene or PTFE has been on the market so long that the technology is not normally an issue because of its proven performance, durability and added value.

However, if a new brand or technology entered the market, or if you were considering PTFE for use outside its normal conditions, you should know more.

2) how the surface treatment is applied, under what conditions and the safety requirements?

The technical, production and health & safety departments of an applicator would need to know, but not everyone else.

3) how the surface is converted into "non-stick"?

You may be interested to know that PTFE creates a "non-stick" surface by making it much smoother and non-reactive with most other substances. These features are getting closer to things of importance, but normally you do not need to know how PTFE works from a purely technical point of view.

4) the advantages of a "non-stick" pan compared with a normal metal pan?

The answer is "very important", and in the majority of cases this is all you really need to know. Basically you need to know what a "non-stick" pan will do for you compared with an ordinary, untreated pan – such as easier to clean, lower in maintenance, resistant to staining/discolouration and higher in added value.

5) the recommended after-care or maintenance?

Again, "very important". Otherwise, there are risks of degradation to the surface treatment making warranties void.

6) if the surface treatment is 'fit for purpose'

The answer is "most important". For well-established brand names such as 'Teflon' and 'Tefal' this should already be known. However, if a new brand or technology entered the market or if you were considering a brand for use outside its normal conditions, you should know more. Otherwise, there are risks of customer complaints, higher costs and lost business.

Therefore, in most cases you do not need to know details of the technology, its application or how it works. These and other details do, of course, need to be known if you are evaluating a new brand or technology – and by technical, production and health & safety departments involved.

B. STEP #2 – Don't Let Terminologies 'Blind You With Science'

In considering terminologies as a source of confusion in glass surface treatments, we should again note that in the case of Teflon cookware there is the simple and well-known description of "non-stick" which everyone knows and understands.

For glass surface treatments, much of the mystification and confusion is caused by a multitude of terminologies including marketing concepts and technical terms.

1) Marketing concepts – including:

- self cleaning
- nanotechnology
- lotus effect
- durable surface protection
- "non-stick
- low-maintenance
- stain-resistant
- water-repellent

2) Technical terminologies - such as:

- titanium dioxide
- photocatalytic
- sol-gel process
- hybrid
- silane
- migratory or non-migratory
- polymer
- monomer
- chemical bonding
- physical bonding
- cross-linking
- moisture curing
- hydrophobic
- hydrophilic
- oleophobic
- organic
- inorganic

To review each of these concepts and terminologies in detail would be a huge job, and is not the purpose of this presentation. Also, like PTFE, you probably do not need to know. If you do need to know, such information is available from Ritec upon request.

Before going further, however, it is important to clear up some confusion by defining two words that appear throughout this presentation:

- Organic – substances from materials that are living or have lived, such as traffic film, body fats, tree sap and bird droppings.

- Inorganic – substances from non-living materials such as cement dust, metal oxides and run-off from concrete, bricks and stones.

C. STEP #3 - Focus on Basics of the Technologies

To demystify the technologies and clear up the confusion, it is important to consider the main purpose of each technology, its strengths and its weaknesses as shown below and summarised in Attachment 'A'. This type of evaluation will determine where the technology is fit for purpose and where it is not, helping to make sure that claims and expectations are met.

Even though there are many brands of glass surface treatments:

- there are only three general categories of glass surface treatments
- most products are simply re-brands of a technology
- there are many suppliers but few manufacturers, because most suppliers are distributors without ownership of the technology.

The three general categories of technologies are:

1) Water-Repellents – the "Battle of the Bubbles"

All products in this general category are, as the name indicates, high in water-repellency - their main feature. Repellency is easily demonstrated by spraying water onto treated glass and observing droplets or "bubbles" - instead of the water wetting or flattening out as it does on untreated glass or on self cleaning glass.

Since water-repellency is the main feature and is so easy to demonstrate, suppliers have focused on this to the point of starting the "Battle of the Bubbles" and giving misleading impressions and claims. For example, some suppliers indicate that high water-repellency alone means high performance or durability, which is not factual. There is no relationship between the size or shape of "bubbles" and performance under real life conditions of exposure and use.

Another part of the "Battle of the Bubbles" is making comparisons of water-repellency after rubbing tests are carried out in a laboratory. This means little, if anything, because test methods may vary from lab to lab. Above all, this type of testing bears no relationship to actual conditions of glass exposure and use.

Ritec will be pleased to provide, upon request, statements from at least 15 independent testing organisations confirming the fact that real life performance cannot be accurately predicted by any lab test or set of tests.

Since all products in this category have the feature of high water-repellency, they appear identical at the time of application.

There are many brands and re-brands of water-repellents currently on the market. Many more brands have come and gone over the years, mainly because field experience has shown such products to have limited performance, durability, track records and independent verifications.

Also, all of the water-repellents shown below are classified as hazardous because they are either Highly Flammable or Extremely Flammable. These hazard classifications require special precautions during handling, shipping, storage and application.

There are three sub-groups within this general category as follows:

a) Silicone fluid water-repellents – non-reactive and reactive.

Silicone fluids are polymers, were introduced during the 1940's and are well-known for high water-repellency. Initially these products were introduced as non-reactive silicone fluids that work like polishes or waxes, and attach to the surface physically instead of chemically. As a result, the non-reactive silicones have little, if any, durability and can easily be washed off.

Therefore, for purposes of this presentation, the non-reactive silicone fluids or polishes are classified as water-repellents - but not as glass surface treatments – because they have little, if any, durability.

After WWII, reactive silicone fluids (RSF's) entered the market. Applied as a liquid, this type of water-repellent forms a mono-molecular layer that attaches to glass and other surfaces through a weak chemical bond.

The RSF's are:

* limited in performance and durability, mainly because their single molecule has low resistance to chemical and physical attack;

* at risk of smearing for two reasons: a) due to their weak chemical bond, they can migrate across the glass surface and b) they attract and hold oily/greasy substances;

* at risk of causing adhesion failure because they attach to surfaces other than glass, such as window frames, causing adhesion failure whenever you refinish or repaint, or you want to bond surfaces to each other (because of these risks, RSF's should not be used in factories making insulating glass (IG) units or other products where wet seals are involved).

The RSF's are classified as Highly Flammable since they have a low flash point of about 14 degC. This classification requires special precautions during handling, shipping, storage and application. For application in a factory, a spark-proof environment is also required.

As a result, RSF's are used mainly where flammability is not an issue, durable surface protection is not required and frequent re-application to maintain water-repellency is both possible and acceptable, e.g., automotive glass (retail).

b) Water-repellents marketed as "nanotechnology" - two-layer composites

Much confusion is caused by suppliers describing glass surface treatments as "nanotechnology", a term that has become ubiquitous in industries developing smaller and smaller components such as biomedical equipment and computer microprocessors.

As the name implies, nanotechnology is based on "nano" which is short for nanometre (1 nanometre is $1/1000^{th}$ of a millimetre). The definition of nanotechnology is generally considered as "working with units or particles measuring less than 100 nanometres".

On this basis, nanotechnology is a physical measurement that does not determine either performance or durability of medical or computer components – or glass for that matter. In spite of this, during the late 1990's several companies in Germany jumped on the nanotechnology "bandwagon" by introducing water-repellents under this name and indicating that nanotechnology means something in terms of glass surface treatment – when this is not relevant.

Under the above physical definition, most substances can be considered as nanotechnology. All the glass surface treatments – water-repellents, self cleaning glass and durable glass surface protection - meet this definition, and therefore could also be marketed as nanotechnology.

Two-layer composites have limited performance and durability, mainly because the composite has a tendency to break down as the top layer becomes damaged or worn away. Degradation to the bottom layer occurs as moisture penetrates the degraded top layer. When this happens, there is a tendency towards smearing as particles of one or both layers migrate across the glass surface.

Currently there are two types of two-layer composites on the market:

i) **Hybrid organic-inorganic composites -** introduced in Germany as "nanotechnology" during the late 1990's.

There are several manufacturers and a number of distributors for this type of composite. Initially they were developed at the Institute of New Materials (INM), associated with the University of Saarbrucken, as treatments for surfaces other than glass - such as metals. They were the first glass surface treatments to join the nanotechnology "bandwagon".

This type of two-layer composite is high in water-repellency because the top layer is microscopically rough. However, this surface roughness is a disadvantage because it makes the attachment of contaminants easier when compared with a smooth surface.

When first introduced, this type of "nanotechnology" claimed to be adaptable to almost any type of surface from metals to plastics to glass. This raised expectations to very high levels, however experience has shown the

expectations to be impractical because of technical limitations and not taking into consideration certain fundamentals as shown below.

Commercially, these products have limited success because of several incorrect assumptions made at the beginning, such as:

* experience on one substrate means a technology will work on another;
* experience in a particular market sector means a product is fit for purpose under different conditions of exposure and use;
* laboratory tests can predict performance and durability in real life.

None of these assumptions is correct and any one of them could be detrimental, but all together they have caused serious misunderstandings and confusion in the marketplace for glass surface treatments.

This type of two-layer composite is based on a process called 'sol gel', which bonds organic and inorganic nanoparticles using a coupling or cross-linking agent to form a two-layer composite on the glass surface. Usually the inorganic material bonds to the substrate and the organic material, which varies depending on the desired properties, forms the top layers.

This type of two-layer composite requires rubbing onto the glass surface to allow the molecules to "align themselves". Therefore, these products:

* cannot be sprayed;
* are suitable for relatively small sizes and limited quantities of glass panels due to physical effort needed for application.

These products are classified as Highly Flammable since they have a low flash point of about 14 degC. This classification requires special precautions during handling, shipping, storage and application. For application in a factory, a spark-proof environment is also required.

As a result, RSF's are used mainly where flammability is not an issue, durable surface protection is not required and frequent re-application to maintain water-repellency is both possible and acceptable, e.g., shower and automotive glass (retail).

ii) Capped silicone film – introduced in the United States during the mid-1990's, later re-branded as "nanotechnology".

This product was re-branded to join the nanotechnology "bandwagon". As mentioned before, all of the water-repellents could be called nanotechnology.

This product consists of a base layer of silicone and a top layer or "cap" of chlorinated silane. Each of these layers is water-repellent.

The silicone and chlorinated silane are supplied as liquids, then separately atomised into a sealed chamber to treat glass panels that have been placed on racks or stillages. This process treats both sides of the glass panels.

The chlorinated silane is classified as very hazardous in terms of personal health and safety. Both the silicone and the chlorinated silane are classified as Highly Flammable since they have a low flash points of about 14 degC.

These health and safety classifications require special precautions during handling, shipping, storage and application. For these reasons, application is done in the sealed chamber mentioned above.

As a result, the capped silicone product is used mainly where flammability and other health and safety restrictions are not issues, durable surface protection is not necessary and re-application is not a requirement.

c) Other water-repellents – silanes - introduced in Germany as "nanotechnology" in the late 1990's.

Silanes (monomers) have been used for many years as sealers and water-repellents for mineral surfaces such as concrete, bricks and stonework. They were introduced in Germany as "nanotechnology" for use as glass surface treatments - mainly to compete with the two-layer composites in market sectors such as shower glass.

Calling the silanes "nanotechnology" added to confusion in the marketplace because the main feature of silanes is water-repellency. Initially their appearance is indistinguishable from other water-repellents, but suppliers do not always reveal the fact that their products are silane-based and monomeric.

It is risky to take a product working in a certain market sector into market sectors with different conditions of exposure and use – particularly if used on a different substrate. Unfortunately this is what happened and, as a result, the silanes have had relatively limited success as glass surface treatments.

All of this has added to confusion in the marketplace because, as mentioned above:
- all of the water-repellents can be called "nanotechnology";
- all are similar, if not identical, in appearance at the time of application.

It is therefore difficult, if not impossible, to tell the differences through visual appearance. The only simple way of telling the difference between the two-layer composites and the silanes is that the composites have to be rubbed onto the glass surface and the silanes do not have to be rubbed..

These types of silanes are limited in performance and durability, mainly because their mono-layer has relatively low resistance to chemical and physical attack;

These types of silanes are classified as Highly Flammable since they have a low flash point of about 14 degC. This classification requires special precautions during handling, shipping, storage and application. For application in a factory, a spark-proof environment is also required.

As a result, the monomeric silanes are used mainly where flammability is not an issue, durable surface protection is not required and frequent re-application to maintain water-repellency is both possible and acceptable, e.g., shower and automotive glass (retail).

2) Self cleaning glass – titanium dioxide (TiO_2 coating)

Starting in 2001, glass promoted as self cleaning has been introduced by most major float glass manufacturers. There are currently about five different brand names in this category, all based on the same technology – a coating made of titanium dioxide (TiO_2).

According to literature of the manufacturers, self cleaning glass reduces the maintenance of exterior glass exposed to *organic* dirt such as bird droppings and tree sap. Manufacturers advise protection of self cleaning glass against inorganic contaminants such as limescale, concrete run-off and metal oxides. It must also be protected against run-off from silicone sealants that are not approved by the manufacturer.

The TiO_2 coating is reactive, and to work it needs a combination of 1) sunlight and 2) rainfall or rinse water. The TiO_2 coating reacts with ultraviolet (UV) radiation in sunlight to oxidise or break down organic dirt to be washed away by rainfall or rinse water.

TiO_2 is commonly used as a white pigment in paints because of its efficiency in scattering visible light and imparting whiteness, brightness and high opacity. It is also widely used in other types of coatings and plastics, paper, inks, food, cosmetics and toothpastes.

For many years it has been known that titanium dioxide acts as a photocatalyst, using light to catalyse the oxidation of organic compounds. Work carried out at the University of Tokyo led in 1995 to a discovery that the photocatalytic reaction of TiO2 also makes the surface hydrophilic, meaning it makes water sheet or spread over the glass surface instead of repelling the water like all the other glass surface treatments.

This knowledge led to the development of self cleaning glass, which is made by applying the TiO_2 coating on-line to float glass using chemical vapour deposition (CVD) technology. Also known as a "hardcoat" or "pyrolitic" process, this method of application fuses the metal oxide coating onto the top or airside surface of the float glass. Therefore, attachment of the self cleaning coating is physical instead of chemical bonding.

The TiO2 coating can only be applied on the float line. It cannot be applied, repaired or re-applied on-site.

Unfortunately, since self cleaning glass was introduced this terminology has raised expectations to levels that cannot possibly be met. For example, many consumers interpret this name as 'zero cleaning regime'.

Instead of making a reality check, manufacturers sought to outdo claims of their competitors. As an example, one product was claimed to be one of the best inventions in many centuries. Some advertising and publicity indicated the glass actually cleaned itself under most circumstances, and headlines appeared such as "Cleaning Glass: A Thing of the Past".

Initially the claims for self cleaning glass were based on laboratory simulations and relatively limited field trials. Since then, the manufacturers have come to terms with the technical realities of glass surface treatments. As a consequence, they have steadily been modifying their sales brochures and websites to clarify the applications where self cleaning glass is fit for purpose and where it is not recommended.

Since self cleaning glass requires exposure to both sunlight and rainfall/rinse water to work, it is unsuitable for interior locations. It is also not recommended for external areas that are sheltered.

Self cleaning glass is not promoted or suitable for surface protection as indicated by various precautions published by the manufacturers regarding protection of the self-cleaning coating against physical and chemical attack during handling, installation and use.

3) Durable glass surface protection – polymeric resin

This technology is highly water-repellent, the only characteristic in common with the water-repellent products described above, and has totally different features when compared with self cleaning glass. For example, self cleaning glass is water-sheeting or hydrophilic and all the other glass surface treatments are water-repellent or hydrophobic.

As further examples of the differences compared with other glass surface treatments, the polymeric resin:

- makes the glass surface "non-stick" with easy-clean, low-maintenance performance;
- resists weathering and chemical attack;
- resists staining and discolouration
- is chemically inert or neutral to most substances
- resists adhesion of both organic and inorganic dirt, which is very important because inorganics (such as limescale, cement dust, run-off from concrete, metal oxides and silicone sealant run-off) are much more difficult to remove and cause much more damage than organics.

Since the "non-stick" surface of this technology is non-reactive, it does not depend on external factors to work.

Durable glass surface protection can be applied at any stage before, during or after construction. It is not classified as hazardous, and can be safely applied either in a factory or on-site. Applications include all types of exterior and interior glass in buildings, transportation vehicles and marine vessels.

D. STEP #4 – AVOID THE DANGERS OF 'LABLAND'

Claims made for glass surface treatments are frequently misleading and sometimes dishonest. Many times the claims are based on laboratory tests alone, which can be misleading because no lab test or combination of tests can accurately predict performance or durability under real life conditions of exposure and use.

This reliance on lab tests alone, living in 'Labland', can be dangerous. In the lab, an artificial, man-made environment can be created but only Mother Nature can make the 'cocktail' of conditions found in real life.

It is therefore important to challenge the following claims, because none of them can be substantiated through real life exposure and use:

- performance or durability can be based on laboratory tests alone;
- statements that are valid in laboratory conditions, but not in real life;
- comparisons of different glass surface treatments based on laboratory tests only;
- positive test results under a certain set of conditions mean that a technology is 'fit for purpose' in other conditions;
- surface preparation is not necessary before application of a glass surface treatment;
- the surface treatment will last for life of the glass or glazing.

Challenging these claims or statements is easy. All you have to do is ask the supplier to leave Labland for a few moments and provide independent verifications or proof of their claims.

E. STEP #5 – Make Reality Checks and Carry Out Risk Assessments

1) The Emperor's New Clothes – from Fantasy to Reality

The current market situation of mystification, confusion and unrealistic claims reminds me of "The Emperor's New Clothes", a fable by Hans Christian Andersen about a ruler obsessed by clothes and fashion. Two men convinced the emperor and his courtiers that it was possible to weave a special cloth. This cloth was exceptionally beautiful and had a special feature – it was invisible to any person who was unfit for office or totally stupid.

The emperor paid the two men to weave the cloth based on expectations of being able to find out which persons in the empire were unfit for their places and to distinguish the clever from the stupid. When the emperor sent his most trusted aides to inspect the cloth, they could of course see nothing but were afraid to admit this because it would mean they were unfit or stupid.

When the time came for the emperor himself to inspect the cloth he asked opinions of others who continued to ignore reality, so the emperor himself was afraid to admit the truth. He also pretended to admire the cloth and ordered a new suit to be worn in a procession.

During the procession, a little boy in the crowd shouted “but he has nothing on at all”. Then others in the crowd awoke to reality and said “he is as naked as the day he was born”, but the emperor’s procession ignored these remarks and carried on as if nothing had happened.

In this story, the two men sold a new concept that had no references, track records or other credentials. The concept did not match reality in any way, but became workable in the minds of the emperor and his aides because of a fantasy based on extremely high but totally unrealistic expectations.

The emperor and his courtiers were safe with their fantasies as long as they stayed in their own world. They left this world of fantasy and entered the real world where they were seen by a little boy who was innocent, not worried about being considered stupid and held no office. It was not until the boy spoke up that everyone moved from fantasy to reality.

The emperor had an opportunity to face reality, but hid his embarrassment and carried on as if nothing was wrong. The boy’s outburst was a relief to others because all along they knew the emperor was naked but were afraid to speak up. They had been made to look like fools, but no longer had to make-believe.

The little boy was a “reality check”.

2) The Importance of Reality Checks for Glass Surface Treatments

We need similar reality checks for glass surface treatments because of the marketing claims that are unrealistic and do not match reality. In many cases these claims are based on tests in the artificial environment of laboratories, which are necessary to give preliminary indications but which do not accurately predict real-life performance. Marketing messages are raising expectations of customers to unrealistic levels that cannot be met.

Organisations making these controversial claims and statements appear to be carrying on like the emperor, as if nothing is wrong. Hopefully they will make their own “reality checks” before their fantasies are exposed to others.

It is therefore important that glass and glazing companies, specifiers and consumers ask questions and challenge any claims or statements that do not appear to match reality. Basic questions should be asked about any technology for glass surface treatment, regardless of who makes it or what it is called. Too many controversial statements are going unquestioned, causing misunderstandings and confusion.

Making reality checks for a glass surface treatment is not difficult. All you have to do is ask the supplier for:

a) proof of performance and durability under actual conditions of exposure and use, i.e. success track records under real-life conditions;

b) independent verifications of marketing claims;

c) not only the advantages, but also any draw-backs for an intended glass installation or use;

d) performance guidelines or warranties for specific market sector(s), since some suppliers offer no warranty and others state warranty periods that are so long that they need reality checks of their own.

e) health & safety restrictions – during transport, storage, application and use.

3) The Importance of Risk Assessments

Risk assessments are a part of everyday life at construction sites and other places of work, with the objective of avoiding risks with the potential of causing real harm to workers and property. Health assessments are made for persons at risk of exposure to disease.

From the time glass is produced, it is at risk of real harm by one or more of the 12 enemies shown in Attachment 'B'. These enemies, both chemical and physical, can attack glass during handling, transport, storage, installation and use. The type and severity of exposure to these enemies determines the level of risk.

A simple risk assessment for exposure at three stages - before, during and after construction - can easily be done for each of the enemies of glass. The risk multiplies as exposure to the number and intensity of enemy attacks increase, so in cases of high risk it is important to apply surface protection as early as possible in the life of the glass.

4) Assessing Risks Based on Exposure to the 12 Enemies of Glass – Including the 'Hidden Menaces'

In many ways, the mineral composition of glass behaves like a metal and the destructive effects of glass surface corrosion are similar to "concrete cancer". For glass, metals and concrete, the main enemies are moisture and alkalinity. Both glass and metals are highly vulnerable to attack by these substances and in the case of concrete, if the cement content is too alkaline, small cracks appear during the ageing process allowing moisture to penetrate.

The main causes of glass surface corrosion or "glass skin cancer" are the ten enemies shown in Figures 1a and 1b. Either separately or together, these enemies attack glass chemically and/or physically. They can be acidic or alkaline, although alkalinity is more aggressive to glass. They can be organic or inorganic, although inorganic substances cause greater glass surface degradation.

Moisture, particularly in its vapour phase, and alkalinity are highly detrimental to glass because they attack both chemically and physically, "etching" the surface. The sources of moisture and alkalinity are inorganic. Together, moisture and alkalinity are especially aggressive.

Moisture attacks glass through dissolution of the soda content, which is alkaline, and then deposits the soda onto the surface through evaporation. Alkalinity from sources such as cement dust, concrete run-off and caustic cleaning products can etch the surface of glass as easily as hydrofluoric (HF) acid.

Based on these observations:

- most inorganic contaminants are high in alkalinity, one of the greatest enemies of glass;
- most of the organic contaminants are acidic;
- most of the 12 enemies of glass cause staining or discolouration, as well as "etching" or physical damage, and they bond chemically and are therefore difficult, if not impossible, to remove with conventional methods.

Physical abrasion can occur at any time during glass handling, transport, installation and use. Surface corrosion is increased when harsh or abrasive methods are used in attempts to remove contaminants. Surface pitting occurs when the wind bombards exterior glass with minute particles of dirt, salt or sand and creates microscopic craters that retain moisture.

The Hidden Menaces

Well known to metal coating specialists are the "Hidden Menaces". Initially these contaminants may be non-visible, but the damage they cause is very real. They are found on building surfaces everywhere and are harmful not only to metals but also to most other materials of construction, including glass.

Alkalis react with acids to form salts – primarily chlorides and sulphates – natural and man-made contaminants that are airborne and found everywhere around us. If salt contaminants chemically bond to a substrate such as glass and cannot be washed away with conventional methods, they are referred to as 'surface-reactive salts' (SRSs). An example is "limescale" on shower glass, which includes chlorides and sulphates of calcium and magnesium.

Chlorides are compounds of chlorine which come from numerous industries such as power plants, mining, pulp and paper manufacturing as well as the petroleum industry, from production through refining operations. Marine environments generate chlorides from seawater, salt spray and marine air with entrained salt. Chlorides are also in cleaning products and road de-icing salts.

Sulphates are salts of sulphuric acid and mainly come from sulphur dioxide (SO_2) generated by flue gas, coal burning and vehicle emissions. Combined with atmospheric moisture, sulphates cause acid formation and produce a corrosive reaction that forms various sulphates on the surface.

In addition to SRSs coming from airborne contaminants, they may be formed by chemical reactions on the glass surface. For example, alkaline residues of cleaning products can react with acid rain to form salts. Similarly, sodium hydroxide residues can react with sulphuric acid in atmospheric pollution to form sodium sulphate. Residues of calcium carbonate from seawater or hard tap water can react with sulphuric acid to yield calcium sulphate.

SRSs are especially damaging to glass because they are hygroscopic, meaning they draw moisture from the air. In fact, moisture is attracted so well that it will be drawn right through any physically-attached coating by a process known as osmosis - unless the protection is highly hydrophobic or water-repellent and resistant to chemical attack.

An example of the hygroscopic nature of salts is ordinary table salt or sodium chloride (NaCl). Frequently grains of rice are placed in a saltshaker to absorb moisture, otherwise the salt will draw moisture from the air and "cake". Chlorides and sulfates do a similar thing when left on a glass surface.

Because the contaminants that form SRSs are airborne and everywhere around us, they start to react on glass soon after it leaves the float line. Since the SRSs are, by definition, surface reactive they are difficult, if not impossible, to remove with conventional washing methods. The SRSs continue to build up on unprotected glass during its lifetime, forming a "cocktail" of salts on the surface that are difficult, if not impossible to remove.

The complexity of SRSs in the environment, which may be present as a mixture of contaminants including a variety of salts, cannot be duplicated in a laboratory. This is one of many reasons that the only way to determine performance or durability of glass surface protection is through actual field conditions.

IV. SUMMARY AND CONCLUSIONS – WHAT REALLY MATTERS

The market for glass surface treatments is expanding. Unfortunately, market growth may be hindered by confusion caused by marketing concepts, technical terms, product descriptions as well as controversial statements and claims.

Steps must therefore be taken to demystify the technologies, terminologies and marketing claims of glass surface treatments. Otherwise, the risks are high for damage to the flat glass industry in general and markets for glass surface treatments in particular.

What matters to specifiers and consumers is a clear understanding of the benefits, which are the things that motivate action to buy. Features are important, but not to the same extent.

As an example, relatively few people know the chemistry of "non-stick" cookware, how it is made or how it works. What matters is an understanding of product benefits and confidence that the cookware will keep its promises - ease of cleaning and resistance to staining/discolouration – and meet their expectations of cookware that is easier to clean and keep clean.

Likewise, what matters to users of glass surface treatments is having glass that is easier to clean and keep clean, and confidence that these expectations will be met. The type of technology and how it works do not really matter to most people.

What really matters to users of glass surface treatments:

1. **Easy to understand** – clear statement of benefits, not just features
2. **Track records under actual conditions of use**, not just lab tests
3. **Performance matches expectations – fitness for purpose**, such as –
    - proven suitability for the end user's environment
    - protects the glass substrate
    - resistant to staining/discolouration by organic and inorganic contaminants
    - user-friendly during handling, transportation, storage, installation and use
    - easily maintained and easy to re-apply when damaged or worn away.

Reality checks are necessary to make sure that glass surface treatments meet the criteria listed above. In making reality checks, it is important to recognise that verification of fitness for purpose (item 3 above) may involve other factors related to particular glass installations. Whatever the criteria, they should be considered under conditions for each type of use and not be so general that expectations for other individual uses are raised to levels so high that they are not achievable.

It is dangerous to make claims about glass surface protection without taking into consideration the many different types of glass, the variety of uses for glass and the wide range of exposure conditions.

I believe that recognition is growing for the dangers of unrealistic and sometimes misleading claims. For example, 'US Glass' magazine announced in their January 2004 edition that they decided to describe all new technologies for glass surface treatments as 'low-maintenance' because all require some effort to keep them clean.

It is in the interest of everyone involved with glass surface protection – including marketers of new technologies, glass and glazing companies and specifiers – to carry out reality checks to help clear up the market confusion and controversies. The emperor and his courtiers did not do this, so fantasy did not turn to reality until the little boy spoke up.

We should not wait until someone speaks up to face reality. Making reality checks will highlight the many ways for glass and glazing companies to profit from glass surface treatments, according to specific market requirements.

Therefore, I feel that what really matters for everyone involved in marketing glass surface treatments – including manufacturers, distributors and glass and glazing companies –
is to **tell it like it is, and sell it like it is**!

* * * * * * * *

ClearShield™

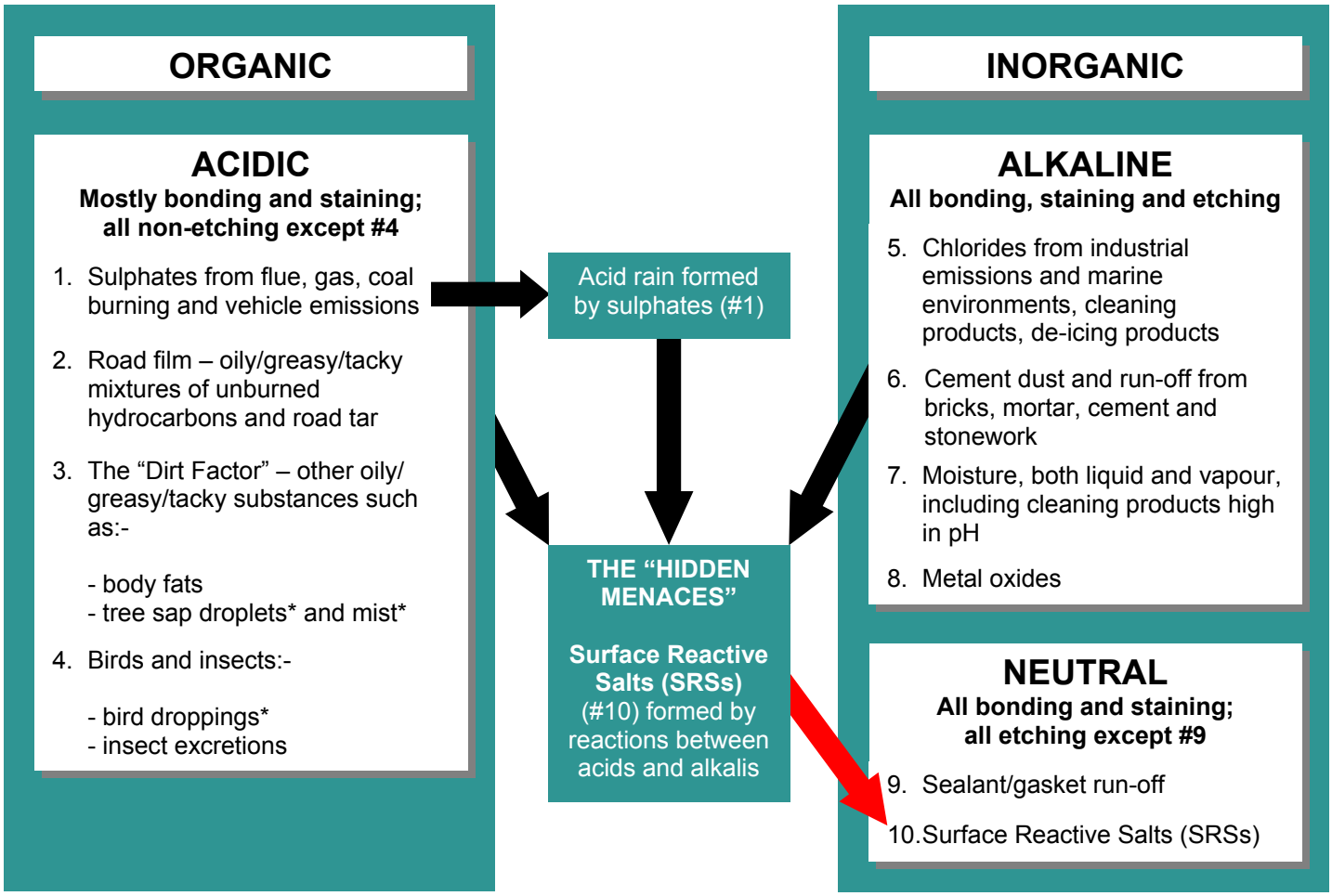
Attachment 'A'

GLASS SURFACE TREATMENTS - THE THREE MAIN CATEGORIES

	Water-Repellent	Self Cleaning Glass	Durable Glass Surface Protection
1. MAIN FUNCTION(S)	• Makes glass water-repellent (hydrophobic)	• Reduces maintenance of exterior glass exposed to organic dirt, such as bird droppings and tree sap -subject to availability of both a) sunlight and b) rainfall or rinse water • Makes the glass water-sheeting (hydrophilic)	• Makes exterior or interior glass 'non-stick' with easy-clean, low-maintenance performance • Resists adhesion of both organic and inorganic contaminants • Protects against glass surface corrosion • makes the glass water-repellent (hydrophobic)
2. USES	Mainly where - • flammability is not an issue • durable surface protection is not required or wanted • frequent re-application is both possible and acceptable to users • migration from one surface to another is not an issue (reactive silicone fluids)	Exterior glass exposed to both sunlight and rainfall or rinse water, but not exposed to inorganic contamination (see 10. below) Therefore, not suitable for - • interior use • exterior locations that are: – sheltered – exposed to inorganic contaminants such as cement dust and mortar during construction – exposed to run-off from silicone sealants not tested and approved by the glass manufacturer	All types of exterior and interior glass exposed to organic and/or inorganic contamination Glass surface protection - before, during and after installation
3. TECHNOLOGY	Reactive silicone fluid (polymer) or silane (monomer) or a mixture - monomeric or two-layer composite	Metal oxide coating (titanium dioxide or TiO2)	Polymeric resin – chemically cross-linking, multi-molecular
4. HOW IT WORKS	Some products, such as reactive silicone fluids, work by making the surface smoother with lower coefficient of friction, others such as organic/inorganic hybrids ("nanotechnology"), achieve water-repellency by making the surface rougher	The TiO2 coating reacts with ultraviolet radiation (UV) in sunlight to break down organic dirt to be washed away by rainfall or rinse water	Makes the surface chemically inert to most substances and smoother with lower coefficient of friction
5. MARKET SECTORS/ FIELD PERFORMANCE/ TRACK RECORDS	Market sectors where frequent re-application is both possible and acceptable to users, such as automotive glass, retail.	Exterior glass in residential windows and conservatories, some commercial glazing	Exterior and interior glass in all types of private and commercial buildings, marine vessels and transportation vehicles
6. WARRANTIES - PERFORMANCE AND DURABILITY	Not applicable in most cases due to limited performance and durability	Claims to last for life of the glass or the glazing, but this is not warranted and there is a disclaimer of responsibilities on the part of the manufacturer	Performance warranties or guidelines for each market sector
7. HEALTH & SAFETY	Most are Highly Flammable, flash point of about 14°C, or Extremely Flammable, flash point of -5°C	Not an issue for users since application is during glass manufacture	Not classified as hazardous, no flash point
8. INITIAL APPLICATION **a) Factory**	Due to health & safety restrictions, normally applied by cloth or pads in a well-ventilated area, but can be sprayed in a spark-proof environment The "nanotechnology" organic/inorganic hybrids (two-layer composites) cannot be sprayed, must be rubbed onto the surface	Only during glass manufacture, on the float line	Versatile, applied manually by cotton pads, or by spray using manual, semi-automatic or fully automatic equipment
b) on-site, in-situ	Same as 8.a) above	Cannot be applied on-site	Manually by cotton pads, or by spray
9. RE-APPLICATION - WHEN DAMAGED OR WORN AWAY	Manually by cloth or pads, due to health & safety restrictions	Cannot be repaired or re-applied if damaged or worn away	Manually by cotton pads, or by spray
10. OTHER CHARACTERISTICS	Some water-repellents, particularly reactive silicone fluids, a) migrate to other surfaces, so should not be used where adhesion may be an issue and b) hold oily/greasy substances that can cause smearing Special precautions required during handling, shipping, storage and application (7. above)	According to manufacturers, the surface of self cleaning glass must be protected against silicone sealants except those approved by the manufacturer as well as inorganic substances such as concrete run-off, metal oxides and cement Manufacturers publish precautions to be followed during transportation, installation and use	Part of a complete system of glass renovation, protection and maintenance Formulations to meet specific market requirements such as decorative glass, architectural, shower glass, hygiene and food contact

ENEMIES OF ARCHITECTURAL GLASS

A. CHEMICAL ATTACK



*Can be acidic or alkaline.

B. PHYSICAL ABRASION

11. Man-made:-

- incorrect handling during transport and installation
- abrasive cleaning

12. Natural:-

- wind erosion
- windblown particles of dust, grit and sand