SILO SEALING WITH ENVELON

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ABSTRACT

The paper describes the development of ENVELON Polymeric Vinyl Membrane specifically for gas sealing bulk storages used for wheat storage and describes in practical terms the qualities required for sealing coats and the way in which they should be applied. Envelon was introduced to Australia in 1940 and was used extensively for mothballing of naval and army equipment after the Second World War. It was later used for sealing fruit storage cold rooms and investigations into its use for sealing grain stores was begun in 1977. It is now used extensively, on both very large and relatively small farm stores.

When using sealants it is important to select the most appropriate sealant system for each particular application and to prepare precise specifications for both the use and application of the coating and membrane system. Flexibility, strength, ability to bridge gaps, ease of application, weather resistance and impermeability are considered to be essential features of successful sealants. Guidance is given on applying sealant coats, with particular reference to Envelon, in particular the importance is stressed of not applying sealants under ambient conditions when condensation on the substrate is likely to occur.

Technical details of Envelon are given in the appendices, as are duties of inspectors during the application of sealant coatings and a glossary of terms used in describing coatings and corrosion.

INTRODUCTION

Thirty years ago the principal reason for industrial painting was to improve aesthetic appearance. Long term protection was considered as incidental. Today there is a change in this approach with long term sealing and protection being equal in importance with appearance and environmental considerations.

This change has been brought about by the customer being more conscientious and critical of the quality of the coating and the price he pays. A few years ago the appearance of a coal tar epoxy coating on wharf piling was not really important provided the film thickness was to specification; the coating on a bridge was intended primarily to prevent corrosion, not to enhance its appearance. Today the appearance of the bridge and the wharf is almost as important as the performance of the coating system. A storage structure must not only be well sealed and be aesthetically acceptable, but must also remain so for a reasonable period of time.

During the last few years membrane coating systems for use in controlled atmosphere stores have advanced dramatically. However, in despite of the development of modern sealing systems, there still remain four basic areas requiring careful attention when considering the sealing and protection of bulk storage structures:

1. Selection of the appropriate coating or sealant system for the particular situation and conditions.
2. Preparation of precise specifications both for the use and application of the coating and membrane system, and a clear understanding by all parties of what the specification entails.
3. Inspection to ensure the specification is correctly adhered to.
4. Protection of the membrane and its associated paint systems maintained during its entire service life by periodic inspection and spot repair.

A further important consideration is the proper preparation of the substrate for protective coatings. If this important step is ignored the whole operation is likely to be a waste of time and money. The measure of a coating's adhesion to the substrate is an important criterium in assessing its ultimate durability and performance. A protective coating, unless sufficiently thick to form a self-supporting structure, must be uniformly bonded to the substrate for the following reasons:

1. Sufficient attachment is necessary to prevent dislodgement under the gravitational and mechanical forces to which it is exposed.

2. Under immersion or conditions where condensation will occur, water vapour will penetrate between a barrier coating and an unbonded surface and condense on the unbonded surface. Progressive disbonding is most likely to occur.

THE DEVELOPMENT OF VINYLS AND THEIR USE IN SEALED STORAGES

There is some ambiguity in the literature and elsewhere as to precisely what is meant by the term vinyl; for example, vinyl house paints have a completely different composition and function to the vinyl Envelon used in sealant coatings. To simplify the nomenclature it is common practice in both the plastics and coatings industries to restrict the expression vinyl to the polymers and copolymers of vinyl chloride and vinyl acetate.

Polyvinyl chloride was first reported in 1872 and polyvinyl acetate in 1913. However, no serious commercial developments occurred until the mid

1920's. Polyvinyl acetate attracted interest as an adhesive, but polyvinyl chloride proved difficult to dissolve and was unstable in UV light or when heated. It was obvious that modifications were needed to improve these properties. In 1928 it was noted that copolymers of vinyl chloride and vinyl acetate produced resins of improved solubility in the then available solvents. Early developments are credited to Germán scientists, however Doolittle of Union Carbide in about 1936 patented a variety of solution vinyl resins using different monamer ratios. These were vinylite resins and have been marketed ever since for use in the coatings industry.

A copolymer of about 85-86% vinyl chloride with vinyl acetate was found to be almost impermeable in thin films to metallic ions and water. This polymer is completely tasteless and non toxic and is still used today as the final coat in beer and beverage can liners. Most of the basic coating formulations and systems were later developed during World War II. Solution vinyl coatings have proven over the years since then to perform in the most aggressive conditions. Their use in maintenance coating systems combines the properties of chemical resistance, toughness, water resistance and good exterior durability.

EARLY HISTORY OF SEALED STORAGES AND THE USE OF ENVELON

In the mid 1940's the US Department of Agriculture engaged in considerable research and development to find a suitable surface coating which could be applied by spray application to tobacco stores, where an air tight situation was required. Envelon membrane coating was selected because of its inherent properties and reliability.

During the 1940's, Envelon was brought to Australia and marketed under the name of Liquid Envelope, which is still a registered name held by Dominion Plastic Industries. Liquid Envelope was used extensively for the moth-balling of naval and army equipment after the Second World War and has continued in current use with various defence departments. Early in the 1960's, the name Liquid Envelope was changed to ENVELON, although even to the present time this range is still widely known by its original label.

As a result of research during the 1960's, it was found that by making fruit storage cool rooms completely air tight and by introducing certain selected gases, fruit could maintain its freshness up to and, in certain cases, in excess of one year. This process became known as controlled atmosphere (CA) storage. Once again a spray applied film was sought which would remain permanently flexible to accommodate substrate movement, even down to freezing temperatures, remain inert and stable to many gases while maintaining a completely impervious air seal. The Envelon membrane was found to fulfil all these requirements.

Dominion Plastic Industries became involved with wheat storage through State Agricultural Departments and bulk handling authorities, the Australian Wheat Board and the CSIRO in Canberra. Experience had shown that a spray applied membrane was needed for the permanent sealing of grain stores for fumigation and atmosphere control against insect infestation. Envelon appeared to possess what was needed to meet these stringent requirements.

After research by the CSIRO into the insect infestation of stored wheat, in 1977 it made contact with Dominion Plastic Industries to enquire after Liquid Envelope, which had been used by the Department of Entomology for a small experimental bin in Canberra many years previously. A small amount of work was carried out leading to further research into the technical and economic feasibility of sealing large wheat stores on a commercial basis. Work was subsequently carried out in nearly all the States in Australia by Dominion Plastic Industries and various State authorities. Interest was widely shown by scientists, engineers and managerial staff in this application of Envelon being carried out by Agricultural Departments, CSIRO, the State bulk handling authorities and the Australian Wheat Board. Extensive testing programmes were instigated by the CSIRO and the "Silo Sealing Committee" was appointed, which elected to carry out field tests in conjunction with laboratory testing. Although at the present time there is still much development work to do on sealed wheat stores in Australia, and, in fact, throughout the world, Envelon has already been used successfully. Structures which have been treated and sealed to a precise code of practice established by a Government-appointed scientific committee include horizontal concrete/steel stores, vertical concrete cylindrical cells, vertical steel bins and small, on-farm stores. The more noteable installations which have been sealed with Envelon include:

(a) A 300,000 tonne horizontal store constructed of concrete walls and aluminium roof cladding at Kwinana.

(b) A 22,000 tonne horizontal store constructed of concrete walls and galvanised steel roof cladding at Cunderdin.

(c) A similar store to (b) at Ongerup.

THE REQUIREMENTS OF A SEALANT COATING, WITH PARTICULAR REFERENCE TO ENVELON

Envelon is now being widely used on farm stores, particularly in Western Australia where the Agricultural Protection Board and Co-operative

Bulk Handling have vigorously advocated the concept of sealed storages as being the most appropriate for the highest standards of insect control now being demonstrated. Envelon has been developed over many years to include those characteristics and qualities most suitable for the sealing of grain stores for fumigation and controlled atmosphere storage. The more important features include:

I. Permanent Flexibility. Flexibility is of particular importance when considering expansion and contraction, e.g. steel or concrete, due to high and low temperatures or where two different types of substrate material are joined or overlap, with different coefficients of expansion. It is more important that the coating employed should not rupture or crack under such circumstances and over a long working life. This is an extreme test even for the best of membranes.

II. Strength and Abrasion Resistance. One of the essential properties of a film is its strength, often referred to as its toughness. Films of approximately 0.6 - 0.8 mm are commonly applied. Thickness will assist the material to last a long time but it is important that, at the same time, the sealant remains flexible and elastic. Envelon cures with a tough leathery feel, although unlike leather it will stretch and remain flexible. Films with these characteristics are resistant to abrasion and suffer minimal damage to the coating in the event of scuffing and abrasion.

III. A Seam-Free Surface. Sealants when applied by brush, roller or, as is most common, spraying, should leave a smooth seam-free surface, eliminating insect habitats in joints and gaps. Cleaning also is greatly facilitated once a bin is either being emptied or has been finally emptied. Brooming and dusting of areas are made considerably easier. During the application process, unless an area is specifically masked, which is normally not necessary, a fine smooth feather edge results which greatly reduces the event of a curl edge developing.

IV. Ability to Bridge Gaps. An essential property of successful sealants is the ability to bridge gaps. This means that, even though two surfaces may not meet or match perfectly, the sealant will bridge the gap to provide a continuous, even and seam-free surface. Envelon will bridge gaps up to 40mm wide. This is done purely by an application procedure. This bridging ability is of particular importance and assistance on older structures where movement has taken place, leaving gaps and spaces, or on concrete where cracks have developed or form work has left a rough or pitted surface. Extra filling of such cracks should be avoided by using sealants which can bridge gaps.

V. Weather Resistance and Impermeability. Surface coatings should be fully stabilised against changes from extreme heat to cold and solar radiation including particularly ultra violet radiation. This is of great importance when considering the resistance of coatings to weather, including high and low temperatures and frost. Some water based materials tend to crack when exposed to low temperatures and frosts, which are known to be critical times for the development of cracks. Envelon has been recently selected for use in the Antarctic after extensive testing of various coatings by the Department of Housing and Construction after being satisfied it remained flexible at sub-zero temperatures. Along with extreme weather resistance, also important is high impermeability, meaning the ability to withstand ingress of water from the outside and stop the escape of gases or atmosphere from the inside of any given sealed structure. When applied properly and with proper equipment, coatings should not have pin holes or a centre "honeycomb" texture. They should have a consistent smooth membrane providing a barrier to some of the most penetrating chemical gases. Impermeability figures for Envelon are given in the Technical Data Annex 1.

VI. Ease of Repair to Damaged Surfaces. Unfortunately, seals may be damaged by mechanical or other means, rendering a previously sealed storage either very expensive to use due to leakage and thus high costs of recharging or, in some cases, completely unuseable because of the amount of damage caused. With coatings that are very fast drying (touch dry in 5 minutes) an area can be repaired, sprayed and the store put back into service within a minimum of time. It should also be possible for damaged areas of the coating to be reinstated without disturbing the sound membrane around the repair area. Envelon will continue to cure in a sealed area. The repaired area will be immediately absorbed into the original coating without leaving any weakness in the repaired film. There will be a total molecular compatibility between the old and new coatings, regardless of age.

THE PRACTICAL APPLICATION OF SEALANT COATINGS

(a) Primers are formulated to adhere to metals, concrete, wood and masonry rather than to surface contaminants. If the surfaces to which primers are applied contain dirt, dust, scale, rust, oil or moisture, the bond of the protective system to the structure will be as good as the bond of the contaminant to the intrinsic surface of the structural component. The need for scrupulous surface cleaning prior to priming has become increasingly important, particularly since spraying has replaced brushing as a common method of application.

Applying specialist coatings is a skill learned by practice. However, many painters or applicators could improve the quality of their work and avoid costly mistakes by following the precise instructions of the coatings and equipment manufacturers. Frequently these require different techniques and practices to those used for conventional paints and if the manufacturers' instructions are not carefully followed there is a serious risk of failure of the coating.

(b) The ideal time for painting is when the weather is warm and dry with little wind. Obviously, many coating projects cannot be delayed until these ideal conditions prevail, therefore extra care will be needed (see (c)-(h) below).

(c) The substrate should be dry. Application should be avoided in rain and under conditions of high humidity when condensation of moisture is likely to occur on surfaces. Rain or condensation on the substrate interferes with bonding of the coating. Condensation on the surface of a freshly applied coating may alter its curing process.

(d) Extremely dry weather and low humidities can be a problem with water-based products. Rapid evaporation ("flash off") of the water may result in film cracking. It can also cause poor curing rates for solvent based coatings and also the ammonium types of inorganic coatings.

(e) At low temperatures the film thickness of high build or thixotropic coatings becomes more difficult to achieve. Curing reactions slow down or stop for many materials. Water based products may freeze. Solvents evaporate more slowly. Furthermore, when the relative humidity is over 70%, condensation is likely to develop.

(f) High ambient temperatures have some beneficial effects but this often increases overspray (dry fallout), trapped air or solvent bubbles and also reduce the pot life of catalysed materials.

(g) Wind is a nuisance, particularly when spray painting. The material, as it leaves the spray gun, can be deflected from the target. Solvent tends to evaporate quickly causing excessive dry spray at edges of the spray pattern. Lap marks become more evident. Dirt and other debris may become embedded in the wet film.

(h) Condensation becomes a problem when relative humidities exceed 70%. The solution is to avoid coating surfaces which are at temperatures below the ambient (surrounding) air. Unfortunately on large scale projects, primers are often applied late in the working day and sometimes at night. Contractors should establish that there is no likelihood of the structures falling below dew point temperatures during the night. Table 1 shows the conditions of ambient air temperature, uninsulated metal temperature and ambient relative humidity that will lead to condensation.

Table 1 – Relative humidity (%) above which moisture will condense on uninsulated metal surfaces.

Metal Surface Temperature °C	Surrounding Air Temperature °C 4	7	10	13	16	18	21	24	27	29	32	35	38	41	43	46	49
2	60	33	11														
4		69	39	20	8												
7			69	45	27	14											
10				71	49	32	20	11									
13					73	53	38	26	19	9							
16						75	56	41	30	21	14	9					
18							78	59	45	34	25	18	13				
21								79	61	48	37	29	22	16	13		
24									80	64	50	40	32	25	20	15	
27										81	55	53	43	35	29	22	16
29											81	68	55	46	37	30	25
32												82	69	58	49	40	32
35													83	70	58	50	40
38														84	70	61	50
41															85	71	61
43																85	72
46																	86

(i) Many of the application and dry or curing problems created by weather conditions can be reduced by lowering the viscosity of the material by the addition of the proper thinner. Thinning will improve flow and uniformity in the application of the material. It will also reduce overspray, lap marks, bubble entrapments and film "mud cracking" caused by rapid solvent flash off. However, the degree of thinning given in the product's application instructions should not be exceeded without checking with the manufacturer.

(j) Since thinning reduces the volume solids of a coating, film build may become difficult to obtain. In some situations reducing the thickness per coat and increasing the number of coats will result in a better job. This is often true in both cold and extremely hot weather. Thinner films permit easier escape of solvent under both conditions. Bubbles and pinholes in hot weather and extremely slow hardening rates of thick films in cold weather are the result of the solvent's difficulty in escaping at its ideal rate.

(k) To obtain a satisfactory coating it is essential that periodic inspections be made before, during and following the application. Proper inspection procedure begins with an inspection of the prepared surface. Specifications for the work should detail the quality of the prepared surface but often this is a decision left to the inspector and it is important that he be familiar with the individual tolerances of coatings. (For duties of inspectors, see Annex 2). Once the surface has been satisfactorily prepared as required by the specification it should be thoroughly dusted. Only then is it ready for paint. Surfaces which do not meet the specification should be referred for further preparatory work.

Each coat should be carefully inspected before the succeeding coat is applied. Oversprayer dust should be removed by light sanding or dusting. All loose contaminations in the primary coat should be removed and, together with any bare patches, be reprimed. The inspector must also ensure that sufficient drying time, as stated in the manufacturer's application instructions, be allowed between successive coats. To ensure proper coverage it is sometimes recommended that succeeding coats be of alternating colours or shades.

Specifications for the finished membrane and coating system usually call for a minimum film thickness. A variety of instruments would be used to make such measurements.

HUMIDITY AND DEW POINT CONDITIONS

The atmospheric conditions which prevail during the application of an organic coating should be such that the surface being coated is completely free of moisture. To ensure that no condensation occurs on the surface, the temperature of the substrate being coated should be at least $3^{\circ}C$ above the dew point for the prevailing conditions. Additionally, it is normally recommended that this moisture-free condition be maintained from one hour prior to coating through to one hour after coating. In accordance with good painting practice, no organic coating should be applied if the temperature is below $5^{\circ}C$ or the relative humidity is above 85%.

To check the suitability of conditions for painting, the relative humidity can be indicated by an hygrometer and the ambient air and substrate temperatures measured with a surface thermometer. It is recommended that the same instrument or sensor be used for measuring air and substrate temperatures since any minor error between two instruments may lead to significant errors.

From Figure 1 the difference between ambient air temperature and steel temperature for the observed relative humidity indicates if conditions are suitable for painting*.

COATINGS FOR CONCRETE

The reasons for painting steel are obvious but it is not so obvious why concrete should be protected. In general, concrete is considered to be a material of high durability, but it is still correct to speak about the "corrosion" of concrete. This deterioration is mainly caused by water, existing in different phases. Concrete surfaces, which are alkaline, are attacked by acid gases in the atmosphere, such as carbon dioxide and sulphur dioxide. By painting concrete it is possible to fabricate surfaces of high resistance to both mechanical and corrosive damage and wear.

When concrete cures, a water rich layer forms at the surface which, on drying, results in the mechanically weak material known as "laitance". Apart

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*The evaporation of volatile solvents from paint can result in the condensation of moisture when the relative humidity is high because when solvents evaporate there is a reduction in surface temperature which can cause moisture to condense. Because of this an upper limit of relative humidity of 85% is usually set for the applicationof paint containing volatile solvents. However, this limit should be varied if the temperature of the steel being coated is different from ambient temperature. Provided that the temperature of the substrate is at least $3^{\circ}C$ above ambient temperature, painting can be carried out up to at least 95% relative humidity. On the other hand, condensation is much more likely at high humidities, and it may be desirable to allow the temperature to stabilise.

from the poor mechanical properties, the chemical composition of this layer is different from the rest of the concrete. From reactions with carbon dioxide and a variety of oxides of sulphur, a voluminous calcium-sulphur-aluminate material is formed. This is a poor surface for painting and most coating failures on concrete are connected with the inefficient removal of this laitance layer.

Normal new or fresh concrete contains over 80kg of water per cubic metre and this evaporates until an equilibrium is reached with the surrounding air. For example, a concrete composed of water/cement/aggregate in the ratio of 0.6:1:5 contains about 9% water with 3.5% bound chemically to the cement. This concrete would contain 1.5% moisture when in equilibrium with air at 50% RH and the remainder must evaporate. If this moisture cannot escape before painting, or through the paint film, it sometimes forces off the paint film causing blistering and flaking. The ususal procedure is to allow the concrete to "cure" for about a month before laitance removal and subsequent paint application.

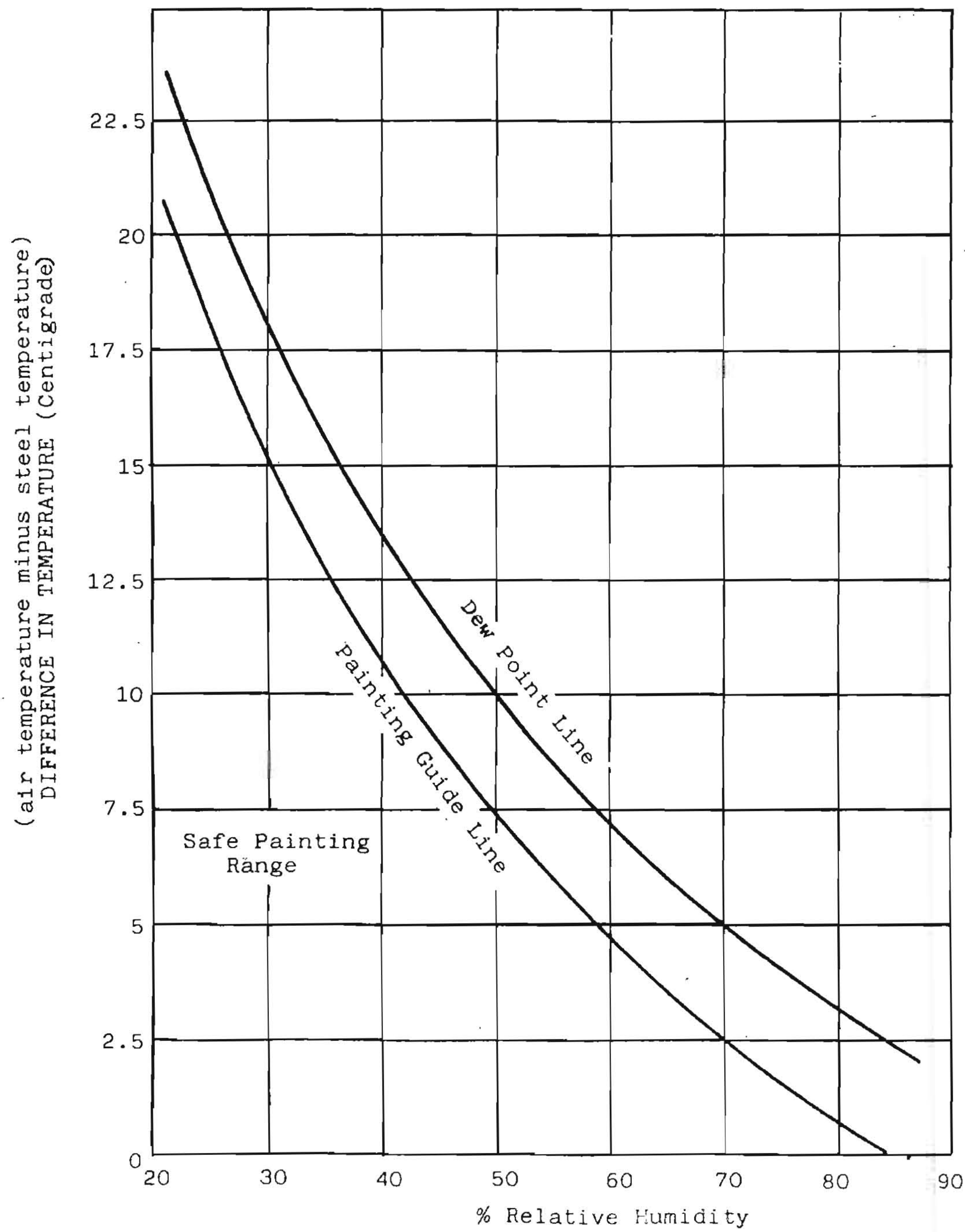

Fig. 1 Painting guide.

Annex 1

ENVELON TECHNICAL DATA

Colour: Aluminium Grey or White

Viscosity: 65 Krebs units at 25°C measured on a Stormer Viscosimeter using a 100g weight

Weight per litre: 0.758 Kg per litre

Solids Content: Non volatile - by weight 30-32%

Drying Time: Air dries to touch in 4 minutes, to handle in 20 minutes and cure in 12 to 24 hours

Spraying: Conventional air atomising or airless spray equipment is recommended. The following equipment has been used and found suitable. However, equivalents may be substituted:

	Gun	Air Cap, Fluid Tip/Needle
Binks-Bullows	Beta	68PB 2110
Arnold (C1G)	Beta	410553
Devilbis	J.G.A.	62AC

Moisture traps should be installed to avoid contamination of the coating. For airless spraying, use a machine of at least 16,000 kPa capacity and with adequate volume output for the specific application. A tip of 0.011" or 0.013" is normal; fan width should be chosen for particular work involved. For application to roof areas, a pole gun extension may be helpful. Continuous agitation is recommended during spraying operation.

Reduction Required Not normally required as ENVELON is supplied ready for use. Below 20°C viscosity increases considerably. Rapid agitation will bring material back to spraying consistency.

Shrinkage 40 µm film will not bridge over a concave surface after being subjected to accelerated weathering for six days.

Adhesion Measured on a Scott Tensilometer with jaws separating 7.5cm per minute. 30 µm film adhered to Alclad Aluminium (24-ST) with force of 5-10 kPa.

Chemical Resistance Excellent resistance to gasoline, oil, fat, grease, acids, alkalis, alcohol and salt spray.

Heat Resistant Shows no sign of plasticizer separation after being subjected to a constant temperature of 80°C.

Tensile Strength Measured on a Scott Tensilometer according to Federal Specification 22-R-601, produces a tensile strength higher than 3790 kPa.

Elongation Fresh films 280%. Aged film 270% when measured in a Scott Tensilometer according to Federal Specification 22-R-601.

Water Vapour Measured in modified Southwick cup in General Foods Cabinet at 100% RH and 38°C. Grams per 645cm^2 in 48 hours, 0.6 grams.

Incombustibility Dry film will not continue to burn or glow after source of ignition has been removed.

Storage Should be stored at 20°C for at least 24 hours before using. If body is still too heavy, rapid agitation will bring viscosity back to spraying consistency.

Cleaning Spray ENVELON thinner 5 is recommended for cleaning spray equipment after using ENVELON.

Annex 2

DUTIES OF INSPECTORS

General

The prime function of an inspector is to ensure that the agreed painting specification is being followed correctly without unnecessary delay or hindrance to the contract.

The inspector should not become the work supervisor accordingly, all communications should be made through the contractor's on-site foreman and should not be given directly to the painter.

The contractor should advise the inspector in sufficient time to enable the inspector to be present at the time he is required. The inspector should try to anticipate when he is to be required.

It is usual for the painting foreman to initially inspect all painting and carry out any necessary rectification before calling in the inspector.

Surface Preparation

The inspector should ensure that the following matters associated with surface preparation are observed:

1. That surface preparation complies with the specified Australian or other standard and that it is free from contamination.

2. That no area of prepared surface is primed before approval to proceed has been granted. Note: Inspectors should ensure that unnecessary delays are avoided.

3. That the first coat of primer or membrane is applied within the specified time period.

4. That coated surfaces are not contaminated by other cleaning processes.

In carrying out these duties, the inspector should note whether on-site ambient conditions are satisfactory for painting, as set out before.

Paint Application

The inspector should ensure that the following matters associated with the application of the coatings are carried out:

1. The membrane and associated products to be used comply with the relevant specifications.

2. The material containers are sound and not damaged in any way which may have caused, or will cause, the contents to deteriorate.

3. The condition of the membrane or paint in the container is satisfactory, i.e. the paint is free from undue settling, thick surface skin, gelling, foreign matter and the like.

4. No unauthorised thinning (which can affect the membrane or paint consistency, its hiding power, elasticity and application properties) has been allowed to occur.

5. No adulteration of the paint has taken place.

6. Multi-component paints are correctly mixed in the correct proportions and the paint is not used after the expiry of the pot life stated by the manufacturer.

7. The membrane or paint is applied by the correct method and that the specified drying times have elapsed between coats.

8. Any defective work is corrected immediately and any recoating follows precisely the coating system specified. Note: Irregularities or unsatisfactory areas should be clearly marked with chalk. Grease pencils or other such marking materials, which can affect paint adhesion, should not be used.

Final Inspection

Final inspection of the painted steelwork should include the following:

1. Measurement of the total dry film thickness of paint.

2. Checking for holidays in the paint film, if applicable.

Annex 3

GLOSSARY OF TERMS USED IN DESCRIBING CORROSION AND COATINGS

Acid	Compound producing hydrogen ions in water. See "pH".
Acrylic Resin	Synethetic resin that has excellent water resistance and hardness.
Activator	Component which, when added to a coating, speeds up a desired rection.
Aerobic	Micro-organism (bacteria) contributing to corrosion. Needs oxygen for growth.
Air Dried	Coatings that normally reach a desired hardness without external heat.
Airless Spray	Method of applying coatings using high fluid pressures - no air for atomisation. See "Hydraulic".
Alkali	Term applied to caustic and strong bases. See "pH".
Alkyd	Resin used in many types of industrial enamels. The reaction products of polyhydric alcohols and polybasic acids. Properties vary widely.
Alligatoring	Pronounced wide cracking over the entire surface of a coating. Resembles alligator skin,
Alloy	Mixtures of metals that are blended to provide various physical characteristics, e.g. brass, stainless steel, bronze.
Anaerobic	Micro-organism growth contributing to corrosion where no oxygen is present.
Anode	Positive terminal of an electrolytic cell; metal that corrodes.

Anodizing	Generally pertains to an oxide deposited on aluminium electrolytically.
Anti-Fouling	Coating applied to ship bottoms to prevent marine growth. May contain toxic ingredients.
Aromatic Hydrocarbon	Volatile solvent such as benzene, toluene, xylene. Usually extracted from coal tar, but can be made from petroleum. See "Solvent". Term refers to chemical structure - not smell.
Asphalt	Black resinous material of petroleum origin.
Binder	The resin portion of coatings whose function is to hold pigments together, and provide a cohesive film.
Bleeding	The diffusion of coloured matter through a coating from the substrate, also the discoloration arising from such diffusion.
Cathode	Negative terminal of an electrolytic cell; Hydroxyl ions usually produced here.
Cavitation	Force exerted by a high-velocity liquid forming a gas filled space. Usually a combination of corrosion and erosion.
Chalking	Form of paint degradation in weather resulting in loose pigment on surface.
Checking	Breaks or cracks in the film that may or may not penetrate to the underlying surface.
Coal Tar	Black resinous material derived from coal. A resin used in coatings.
Coat (of paint)	One application. Can include several passes if no drying time is allowed between.
Cold Flow	Characteristic of many plastics to take a permanent set after pressure is applied.

Cold Rolled Steel — Produced from hot rolled; has little, if any, mill scale. Typical use - auto industry.

Conductive Coating — Accomplished by the addition of pigment which will conduct (static) electricity.

Corrosion — Adverse reaction of any material with its immediate environment.

Cross Spraying — Pertains to making two passess with a spray gun over the same surface at right angles to each other.

Craters — Circular domes in dried film with a thin spot in centre. Can be minute up to 3 mm in diameter.

Curtains — Long horizontal runs in film; occurs on vertical surfaces.

Curing Agent — Activator or hardener added to a synethetic resin to increase chemical resistance and hardness.

Degrease — Removal of grease, petroleum products, fish oil, etc. Generally by the use of solvents, e.g. trichlorethylene, methyl ethyl ketone.

Deionized Water — See "Demineralised".

Delamination — Separation between coats and very poor adhesion.

Demineralised Water — Purified water from which metallic cations are removed by a hydrogen cation exchanger. Anions are removed by an anion exchange.

Diluent — Product introduced as a portion of the solvent to reduce cost.

Dispersion — Suspension of minute particules in a suitable medium.

Distilled Water — Water that has been vaporised and then condensed to remove impurities.

Dry Spray	Result of over-atomization. Produces dull powdery or pebbly finish. Some of the surface dust can be wiped off with the palm of the hand. Also called overspray or spray dust.
Drying Oil	A fatty oil capable of conversion from a liquid to solid by slow reaction with oxygen in the air. The "drying" thus refers to a change of physical state and not an evaporation of solvent. Paints can be made from drying oils due to this hardening ability.
Elastic	Springiness, rubbery quality - can be stretched.
Electrolyte	A solution of ions in water capable of conducting current.
Electro-chemical	Chemical changes produced by an electrical current or the production of electricity from a chemical reaction.
Enamel	Type of oil-base paint with high gloss.
Epoxy	Synthetic resin derived from petroleum products that can be cured by a catalyst or formulated to upgrade other synthetic resins to form protective coatings.
Epoxy-Baked	Epoxy formulation that requires higher than normal temperature to cure or react. Requires another resin or catalyst.
Epoxy-Catalyzed	Epoxy formulation that cures by the addition of a catalyst, generally at room temperature.
Epoxy-Modified	Predominantly epoxy but mixed with other resin or resins, e.g. epoxy-phenolic.
Ester	Compounds formed by the reaction of alcohols with organic acids, e.g. butyl acetate.
Etching	Generally pertains to the result of the treatment of a surface with acid.
External Atomization	When air is used to break up the coating material after it has left the spray gun nozzle.

Film	Coating or paint thickness. A wet film is one that has just been applied.
Flexible	Ability of a film to bend without breaking.
Flooding	Pigment that floats to the surface of a film, usually in streaks.
Force Dried	Application of heat above room temperature to hasten drying. May be up to 80°C but below that of baking temperature.
Foreign Thinner	A thinner that is not specifically recommended by the coating manufacturer.
Fouling	Marine growth, weeds, barnacles; growth of attachments to hulls of ships or marine structures.
Galvanized	Coated with molten metallic zinc by dipping.
Gelled	Coating which has coagulated and formed a jelly-like body.
Glossy	Mirror-like finish.
Grit	Angular abrasive particles made from by-product steel or iron slag. Frequently used instead of silica sand for blast cleaning.
Heavy Scale	Iron oxide rust formed in layers from 3 mm to 12 mm thick.
Holiday	Any discontinuity or bare spot in a painted area.
Hot Rolled Steel	Normally used in structures and tankage; has mill scale on surface. See "Cold Rolled".
Hydraspray	Trade name meaning hydraulic spray. See "Hydraulic Spray".
Hydraulic Spray	Material at 10,000 kPa or higher is forced through an aperture. No air is used for atomization.
Hydrocarbon	Extracts from petroleum, e.g. gasoline, lube oil.

Immersion Refers to an environment which is submerged continuously.

Inhibitors Compounds added in small concentrations to form protective films or which, combined with corrosion products, form less active compounds.

Inhibitive Pigment A pigment added to coatings capable of passivating or retarding the corrosion of the metal over which the coating is applied. Examples: red lead, chromate salts.

Inorganic Chemicals such as salts, acids, alkalis, etc. Based on all chemical elements except carbon.

Inorganic Zinc Coating containing a zinc powder pigment in an inorganic vehicle, e.g. zinc silicate.

Internal Mix Refers to a spray gun in which the material is mixed with air before being discharged through the tip.

Ion An electrically charged particle derived from soluble mineral chemicals on dissolving in water. Ions are both positively and negatively charged and equal amounts of each are formed by splitting of the original chemical when it dissolves.

Iron Oxide Ferric oxide - rust. Reddish in colour. Also used as paint pigment.

Ketones Class of organic compounds, e.g. acetone, MEK.

Lacquer Type of coating that dries from evaporation of solvent.

Lacquer Thinner Used to describe such solvent as ethyl alcohol, ethyl acetate and toluene.

Latex Milk-like fluid made up of particles of rubber or synthetic resin suspended in water.

MEK Ketone solvent, methyl ethyl ketone.

MIBK Ketone solvent, methyl isobutyl ketone.

Mastic	Term used to describe a heavy bodied paste-like coating.
Metalizing or Metal Spray	Method of applying atomized molten metal to a surface, e.g. zinc, aluminium.
Micron	Unit of film thickness = 0.001mm.
Mild Solvent	Solvent that has a limited range of dissolving ability.
Mill Scale	Layer of iron oxide formed on the surface of steel plates and sheet during manufacture. May be 50 - 125 micron thickness.
MILS	Unit used to designate film thickness. 1 mil = 0.001 (one thousandth) of an inch. Equivalent to 25 micron (μm).
Modified	Pertaining to a mixture of resins - one of which is predominant.
Monomer	Molecule of low molecular weight capable of conversion into polymers, plastics and synthetic resins.
Mottled	Descriptive of coatings of spotted appearance, blotches of a different colour or shades of a colour.
Mud Cracking	Phenomenon that occurs to films as they dry, appearing like mud drying in hot weather.
Natural Rubber	Sap or gum taken from the rubber tree.
Neutral	Term used to describe an environment which is neither acid nor alkaline.
Non-Ferrous	Term used to designate metals and alloys that do not contain iron or steel, e.g. brass, aluminium, magnesium.
Non-Immersion	Refers to an environment which is not continously submerged.
Oil Cleaner	Solvent and detergent often used to remove heavy deposits of asphalts and oils from ship hulls.

Orange Peel — Appearance of a coated surface resembling the skin of the orange.

Organic — Chemicals based on carbon, as contrasted to mineral chemical compounds. Carbohydrates, synthetic resins, solvents and an enormous variety of chemicals are organic.

Organic Zinc — Coating containing zinc powder pigment and an organic resin, e.g. zinc and epoxy.

Organosol — Colloidal dispersion of an insoluable material (synthetic resin) in a plasticizer with a solvent added. See "Plastisol".

Osmotic Blistering — Blistering of film due to salt deposits beneath the coating. Wet blisters, filled with salt solution, are formed.

Overspray — Sprayed coating that is dry when it hits the surface, resulting in dusty, granular adhering particules.

Oxidized Film — Coating that has lost its gloss and/or its surface has become powdery.

pH — Value indicating the acidity of a solution. Pure water has a pH value of 7 or neutral. Acidity ranges down to pH 0 and alkalinity up to pH 14.

Passive — Surface that has shown no active corrosion or an atmosphere that is not corrosive.

Pattern (Spray) — Shape of stream of material coming from the spray gun.

Pebbly — Rough, irregular surface having a coarse grainy texture.

Peeling — Poor adhesion but implies cohesion of film.

Phenolic — Synthetic thermosetting resin. The most important type historically is phenol-formaldehyde (Bakelite). These resins can be formulated to produce coatings, varnishes, moulding materials and adhesives.

<u>Phosphatizing</u> Use of phosphoric compounds as a surface treatment to combat corrosion, e.g. parkerizing, bonderizing.

<u>Pickling</u> Chemical treatment of iron or steel, usually with sulphuric acid to remove mill scale and/or rust.

<u>Pigment</u> Insoluble finely divided material whose function is to provide obscuring value, colour and protection.

<u>Pinholes</u> Formation of tiny circular holes in the film up to a few millimeters in diameter, usually having a residual solid in their centre.

<u>Pitted</u> Result of local corrosive attack forming holes in a metal surface. May be described as shallow or deep, small or large in diameter, and quantity or number per unit area.

<u>Plastic</u> Resinous material that may be moulded into desired shapes or dissolved to form a coating.

<u>Plasticizer</u> Materials added to improve flexibility and assist in compounding a coating.

<u>Plastisol</u> Similar to organosol but is packaged at 100% solids content.

<u>Polymer</u> Substance composed of giant molecules formed by the union of a group of simple molecules (monomers).

<u>Polymerization</u> Uniting of monomers to form polymers.

<u>Polyurethane Resins</u> Class of resins obtained by the reaction of diisocyanate with organic compounds, e.g. phenols, amines, to form polymers.

<u>Potable Water</u> Water fit for human consumption - drinking water.

<u>Primer</u> First coat applied to a surface. See "Coating System". Formulated to have good bonding and wetting characteristics and may or may not contain inhibitive pigments.

<u>Profile</u> Term used to describe anchor pattern on a surface, produced by sandblasting or acid treatment.

Reducer See "Thinner".

Relative Humidity Ratio of the quantity of vapour actually present in air to the greatest amount possible at the given temperature.

Resin Any of a group of amorphous organic materials; usually can be moulded or dissolved. Can be natural or synthetic.

Retarder Liquid added to a coating usually used to modify the drying rate.

Runs Synomous with sagging and curtaining caused by improper thinning or poor application.

Rust Formation of visible iron oxide, as a result of corrosion of iron or steel. May be described in order of severity: scattered pinpoints, blush or powdery, freckled or streaked, light scale, paper thin, flaked, medium scale (layers up to 3 mm thick), heavy scale (over 3 mm thick).

Sacked Treatment of concrete with grout to fill voids. A burlap sack may be used.

Salt Solution Commonly known as any combination of cation and acid radical as distinguished from acids and bases.

Satin Finish Descriptive term generally with reference to decorative paint, usually semi-gloss.

Silica Sand Clean sand made up of sharp silica particles. Does not contain dirt or clays. Usually recommended for blast cleaning.

Silicone Resin Resin formulated into coatings to withstand high temperatures.

Slush Coat Coating that is applied to the interior of a container by revolving the container and then draining out the excess coating.

Solvent Liquid whose function is to put the actual film composition in a physical condition so that it may be applied conveniently.

Surfacer	Pigmented composition for filling depressions to obtain a smooth uniform surface before applying finish coats; usually applied over a primer.
Synthetic	Manufactured, as opposed to 'made by nature'.
System Coating	See "Coating System".
Tensile Strength	Longitudinal resistance of a material to resist elongation. Expressed in pounds per square inch at the failure point.
Thermosetting Resin	Resin having the property of becoming insoluble upon the application of heat.
Thermoplastic Resin	Resin having the property of becoming soft upon the application of heat. Regains hardness on cooling.
Thinner	A liquid (solvent) added to a coating to adjust viscosity.
Thixotropy	A specific type of variable consistency behaviour. A thixotropic coating formulation shows a "false body" or apparent high viscosity, but on stirring or other agitation readily flows and shows low viscosity. Thixotropic paints are easily brushed or sprayed in thick films, but after application quickly "set" and do not run or wrinkle. Example: ketchup, mayonnaise, whipped cream.
Thousandths	Measurements of film thickness in decimal inches. See "MILS".
Tubercles	Round protuberances having the appearance of a plant-root segment, usually rust growth.
Varnish	A binder for enamels. The resins are chemically combined with the oil at high temperature to give a product of increased hardness and much faster drying time. Chemical resistance is also improved.
Vehicle	Liquid portion of a coating; a fluid or mixed solution made up of the binder and solvent.

Viscosity	Resistance to flow. The internal friction of a fluid.
Vinyl Resin	Synthetic resin having a wide range of chemical resistance. Can be formulated to produce adhesives, sheets, textile coatings, etc.
Volatile	Thinner component of the vehicle. The non-volatile components are known as the film formers.
Weld Spatter	Round particles of extraneous metal that adjoin a welded joint.
Wet Film	Designates the coating after application but before the thinner volatizes.
Wet Sand-Blasting	Use of wet sand in blast cleaning; has the effect of reducing dust particles in surrounding areas.