Nolan Group

Marine & Auto Division

Head Above Water
Marine Fabrics and Fasteners

Technical Guide Number Four

Nolan Group

Your Textile Partner For Success

How to Tell a Good Yarn
Textile Manufacture and Testing

Technical Guide Number One

Nolan Group

Industrial Fabrics Division

Shady Characters
Polyfab Shadecloth for Human Protection

Technical Guide Number Two

Nolan Group

Blind & Awning Division

What Blind Freddy Knew:
Awning and Outdoor Blind Fabrics

Technical Guide Number Three

Nolan Group

Marine & Auto Division

Head above Water
Marine Fabrics and Fasteners

Technical Guide Number Four

Nolan Group

Industrial Fabrics Division

Got You Covered
Polycotton Canvas;
Coated or Laminated Industrial and
Architectural Fabrics

Technical Guide Number Five

Nolan Group

Commercial Division

Not Flawed
Commercial Carpet, Carpet Tiles and Acoustics

Technical Guide Number Six

Head Above Water

Marine Fabrics and Fasteners

Technical Guide Number Four

Second Edition, First Printing May 2020

Supplier Corporate Profiles

Glen Raven supplies the Nolan Group with Sunbrella, which is the leading brand worldwide of proofed, woven acrylic fabric. The company was founded in 1880 as an apparel company, but quickly morphed into an integrated textile business. By 1940, for example it was a leader in the supply of parachute fabrics; and very quickly embraced the opportunities provided by the development of synthetic yarns. It changed the fashion industry in 1958 with the invention of pantyhose, and with the launch of Sunbrella in 1961, quickly succeeded in supplanting the use polycotton canvas in the US awning and marine markets. The company is headquartered in North Carolina, and also has manufacturing facilities in India and China. It employs 3,500 people worldwide.

Established in 1947, Achilles is a Japanese listed public company with manufacturing facilities located worldwide, and has a sales turnover of 110 billion yen (A$ 2.2 billion). The company's activities are categorised into four divisions - Footwear, Plastics, Industrial Materials and Rubberised Cloth. The Nolan brands "Rollclear" and "Rollglass" are manufactured by the Plastics Division, at the modern Ashikaga factory near Tokyo. These and similar products are widely used for agricultural greenhouses, Industrial curtains and screens, roll-up blinds and boat enclosures. Specialty films incorporating flame retardants, tints and conductive prints for use as welding screens, insect repellent blinds, and anti-static curtains are also manufactured at the plant.

Headquartered in York Pennsylvania in the US, Herculite®, Inc. has been supplying the Nolan Group with innovative PVC laminates (such as Riviera) since the 1960's; and more recently Press polished PVC, including the Vybak and Strataglass brands. As one of the founders of the synthetic fabrics industry, Herculite® pioneered the use of PVC composite fabrics in the healthcare industry, and today also provides a vast array of brands, products, marketing, design, manufacturing, consulting and technical expertise for the Awning, Marine, Military and Industrial Fabric sectors. Its product development and testing facility contains one of the most extensive product testing databases in the industry and is fully equipped to support a wide range of testing regimes

For over 50 years, Spradling International Inc. has offered design and performance solutions for nearly every application to enhance any seating environment. With expanded PVC seating products specifically designed to meet the specific needs of the Automotive, Marine, Hospitality, Healthcare, Corporate Seating, Education, School Bus, Gaming and General Upholstery markets, Spradling is well established and flexible to support a diverse target market. The company is headquartered in Birmingham, Alabama and has five warehouse locations and freight forwarding operations in North America, plus two dedicated production facilities in South America that process coated fabrics incorporating state-of-the-art, closed-loop water and emission systems. It has 1,300 employees in seven countries.

About the Nolan Group

Nolan.UDA Pty Ltd, now trading as the Nolan Group, was officially incorporated in 2009. It originally comprised the merger of the trading operations of Nolan O'Rourke and Co. Pty Ltd (trading as Nolan Warehouses) and Upholstering Distributors Australia Pty Ltd as a 50-50 joint venture, and hence the company name. In 2016, the business of Radins Australia Pty Ltd was formally integrated into the company; and in 2017 Polyfab Australia was acquired.

Despite its hybrid nature and relatively short history, the Nolan Group has a proud legacy inherited from its constituent partners. Nolan O'Rourke was established in 1920 by William Bernard Nolan, and is still third generation family owned. The company had its beginnings importing Motor Body Parts and Accessories, but over the years, it diversified first into upholstery and furnishing supplies, then into the Industrial textiles and Commercial Flooring.

Upholstering Distributors Australia Pty Ltd (UDA) is itself a subsidiary of a fourth-generation family company, Thomas Peacock and Sons, established in 1881. The principal operations of that group were the manufacture of bedding, expanded foam and lofted polyester, although the former two divisions were sold in 2018.

Nolan Warehouses and UDA were well suited to merger. They were of similar size, operated in a like fashion, sold comparable (some identical) products to the same market segments in overlapping geographic areas. They complemented each other well, especially in terms of relative market penetration by both product type and geographic location. Importantly, the partnering businesses were well established, had an excellent reputation and a high level of mutual respect, mainly because of similarities in their cultures and business approach.

The success of the original merger led to the Radins' acquisition. Radins had its origins in the nineteenth century as a sailmaker, and the morphing into a wholesale distributor occurred gradually, with the fabrication arm sold off in the early nineties. The company's specialty was fabric supply to the awning and blind sector, complemented by a significant presence in Marine and Industrial Fabrics.

Polyfab Australia was acquired in late 2017. Established in 1995, the company had developed a number of innovative knitted shade and horticultural products in conjunction with its Indonesian manufacturing partner P.T. Carillon Sdn Bhd, which are sold worldwide, including the USA, New Zealand and the Middle East. The Nolan Group had been distributing these products in Australia for many years, so the acquisition was a logical fit.

The Nolan Group's philosophy is the building and strengthening of partnerships with our Customers and Suppliers. Our team of account managers and customer service staff undertake extensive product and sales training to ensure they provide the highest level of support and advice possible.

The mergers and acquisitions, coupled with rapid organic growth, have allowed the company to realise its ambition to become a complete wholesaler of outdoor textiles and related products to the automotive, marine, awning and blind, industrial fabrics and commercial market sectors. The business trades from six branches throughout Australia, located concentrically with the country's population and customer base.

The Nolan Group has a long history of supply to the Marine Trim Sector. Taken in 1972, the photo shows an eighteen-foot racing skiff sponsored by the company and its longstanding supplier Herculite Products.

TECHNICAL GUIDE NUMBER FOUR
Head above Water
Marine Fabrics and Fasteners

Disclaimer

This guide is designed to provide appropriate technical information to specifiers, fabricators, installers and consumers. The information contained herein or otherwise supplied is based on our own general knowledge, research, and advice obtained from consultants and experienced fabricators in the industry. The information is general in nature and provided in good faith, but no warranty is given or is to be implied with respect to its accuracy or applicability in specific circumstances.

This manual is dedicated to Marine Trim professionals. It is a highly skilled trade requiring intricate attention to detail in the fabrication of complex three dimensional fabric shapes.

INTRODUCTION

Under the Australian Consumer Law (which was enacted January 2011), a Marine Fabricator, being 'a supplier and manufacturer of goods', must guarantee that his goods are of 'acceptable quality'. The test for 'acceptable quality' is whether a reasonable consumer would find them fit for purpose, acceptable in appearance and finish, free from defects, and durable, that is, function for a reasonable period of time after purchase.

A boat owner, who commissions a fabricator to undertake work up to $40,000 in value, is considered a 'consumer' under the Act, and has considerable rights of remedy if the goods are found not to be of acceptable quality, including full replacement or refund.

To assist in managing this risk, the Nolan Group has developed a formal 'Fit for Purpose' statement which is designed to clarify the meaning of the frequently used terms of the Consumer Act, in the context of products used in a marine environment. This refers to the basic product technical specifications published in our "Fabricator Product Catalogue" and is incorporated into our formal warranties. This basic information is augmented by far more detail in the "Technical Guides".

The Nolan Group 'Fit for Purpose' Statement

The Nolan Group's products are specifically designed to be used for the recommended purpose and are guaranteed to be supplied free of defects.

'Free of Defects' means that the product meets its published description and technical specification and is homogeneous in appearance after allowance for minor variance, such as weaving faults, that are inherently the result of the manufacturing process, and accepted as industry standard.

The Nolan Group further warrants that the product will perform satisfactorily when used in its design context in the temperate climatic conditions experienced throughout Australia.

'Satisfactorily' means with continued but gradually diminished utility over its expected life, due to the unavoidable effects of Ultra-Violet Radiation and weathering, such as colour variation, strength loss, and dimensional change. Extreme climatic conditions, particularly high temperature and humidity may accelerate the inevitable product degradation.

'Expected Life' is at least the period covered by warranty, provided the product is installed properly, and cleaned and maintained as recommended.

Further, it is important that marine fabricators have an in depth understanding of the materials used in their trade. This is because essential features of products used in the marine trim industry are not easily discerned. The fabrics and fastening systems are mostly used outdoors and subject to extremes of environmental conditions, for which the products are especially formulated. For example, fabrics may have UV stabilisers and mildew inhibitors added, and are heat-set to minimise shrinkage. None of these features, however, can be determined simply by sight or feel. It is

therefore important to understand the specifications and test methods that are used to assess comparative performance. Only then can an informed choice be made of the right product to use in a circumstance, or between competing products.

Hence, the basic objective of this guide is to present technical information that is a more comprehensive than that provided in sales literature. It is part of a series for all the Nolan Group Products that outlines how products are made, the raw materials used and how their intrinsic properties impact on finished product characteristics and behaviour. Also included is advice on fabrication, based on industry experience gleaned from a wide range of end-use applications.

The products supplied by The Nolan Group are sourced from quality endorsed manufacturers, and their quality control procedures are fully documented and externally audited. This is designed to ensure that the products when manufactured do meet the published specifications. Further, the Nolan Group's limited warranties are supported by those offered in turn by our respective manufacturers, which should give confidence that the products supplied will indeed meet our "Fit for Purpose Statement".

TYPES OF MARINE CANOPIES AND COVERS

The **Bimini Top** is the simplest form of marine cockpit protection and comprises a fabric roof usually supported at both ends by a metal frame (refer **Figure One**). Its primary function is to provide shade and offers little other protection from the elements. It is very commonly used on small runabouts and trailer boats, and on the fly-bridge of larger vessels. It can be easily collapsed and folded when not needed, such as when the boat is trailered. If fabric or clear panels are attached, usually by zippers the structure becomes a **Bimini Enclosure.** Sometimes the panels are attached to a solid roof rather than a fabric cover, in which case they are simply referred to as an **Enclosure** (refer **Figure Two**).

Figure One – A simple 'Bimini Top', fabricated from Sunbrella

A **Structured Top (or Buggy or T-Top)** is essentially the same as a Bimini Top, but fixed in position, sometimes laced to the frame. These can be quite large, as sometimes seen protecting the upper deck of a small commercial passenger ferry.

An **Attached Bimini** is any canopy supported by framework and attached at one end to the cabin of a motor vessel, a radar arch or even another canopy. A **Convertible Top** is similar, but specifically attached to the windshield at the front edge. The fully enclosed cockpit area of a power boat is sometimes termed a **Camper Enclosure** (refer **Figure Three**).

Figure Two – A ‘Bimini Enclosure’, or simply an ‘Enclosure’, as in this example it is attached to a fibreglass top.
(Photo courtesy of Aussie Boat Covers)

Figure Three – A fully enclosed ‘Attached Bimini’, sometimes referred to as a ‘Çamper Enclosure’
(Photo courtesy of Aussie Boat Covers)

A **Dodger** (also known as a **Sprayhood**) is also a frame-supported cover, usually custom fitted over part of the cockpit and entrance (or “companionway”) into the interior of a sailing boat (refer **Figure Four**). It is designed to provide protection to the helmsman from wind, rain and sea spray, and is essentially a three-sided tent facing forward. It is open at the aft, with PVC clear windows enabling visibility forward, and to either side. Protection to the aft can be enhanced by cantilevering a roof to the rear, termed a **Connector** (refer **Figure Five**) or fully enclosing the remainder of the cockpit, which is sometimes termed a **Sailing Camper** (refer **Figure Six**)**.** The removable sides and rear of all these enclosures are referred to as **Curtains** or simply just **Clears**, if fabricated mainly from clear PVC. Generally, zippers are the most common form of attachment of these elements to the cover itself.

Removable covers are generally named after the areas of the boat that they are designed to protect, such as a Cockpit Cover, a Flybridge Cover, Windshield Covers, etc. An **All Over Cover** is self-explanatory and in Australia is mainly relevant to boats on trailers (refer **Figure Seven**).

Figure Four – A 'Dodger', or 'Spray Hood', with Sunbrella fabric covering the frame, and flexible glazing ('clears') fabricated from Strataglass. Note the removable zippered windscreen, and the Bimini at the stern.

Figure Five – The masthead view of a 'dodger' with a rear cantilevered 'connector'
(Photo courtesy of Aussie Boat Covers)

Figure Six – A 'dodger', with rear cantilevered 'connector' and fully enclosed aft deck. The combination is sometimes referred to as a 'Sailing Camper
(Photo courtesy of Aussie Boat Covers)

Figure Seven – A combined cockpit, windshield and bow cover for a trailered ski-boat. Note the folded Bimini.
(Photo courtesy of Aussie Boat Covers)

CANOPY FABRICS

Types of Canopy Fabrics

There are many brands of marine canopy fabrics available on the market, of varied composition, weather-proofing, weights and widths. But all of them can be classified into five basic groups, as illustrated in **Figure Eight** "The Physical Structure of Marine Fabrics". The canopy fabrics supplied by The Nolan Group are grouped into these categories and described as shown in **Table One.**

Based on manufacturers' specifications and testing undertaken by AWTA Textile Testing (detailed in **Appendix C**) the comparative performance characteristics of these fabrics if used in a marine environment are shown in **Table Two**. This is not meant to demonstrate that one fabric is better than another, simply that each performs differently in the marine environment, or in tests designed to simulate it. Choice of an appropriate fabric depends on the circumstances, or consumer preference.

Guide to the selection and use of canopy fabrics

In terms of selecting a fabric, the first point to be considered is the weight per square metre. This is particularly important for all over covers that are frequently taken on and off, as a large one can be heavy to handle, and awkwardly bulky to fold. Weight per se is not necessarily an appropriate indicator of strength, and the ratio of strength to weight is a better one for comparative assessment.

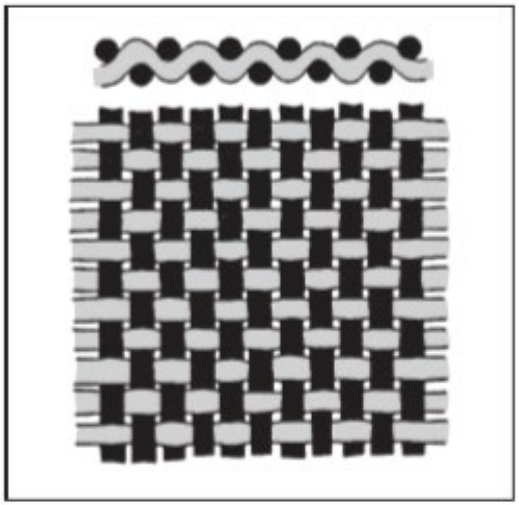
The whole point of a canopy or a cover is to provide protection, particularly from water penetration. However, there is a trade-off between this and breathability, that is the propensity of a fabric to allow moisture vapour, (as opposed to water droplets) to pass through it. Totally waterproof fabrics (Types B through E) have either a thin film laminated to the fibre matrix; or a coating (applied either to the top or the bottom) that infills the interstices within that matrix, either of which makes the fabric completely impervious. Consequently, these types of fabrics attain excellent results in water penetration tests.

Water resistant fabrics (Type A) rely on a hydrophobic surface treatment that significantly alters the fabrics propensity to leak, but still allows moisture vapour to pass through it. Although this treatment is not permanent, it does (if periodically rejuvenated) provide a high degree of water proofing (refer **Figure Nine**). However, the fact that it retains a high level of water vapour permeability allows spaces that are fully enclosed to match the external ambient atmospheric humidity, thus preventing internal condensation, an important factor in reducing mildew risk.

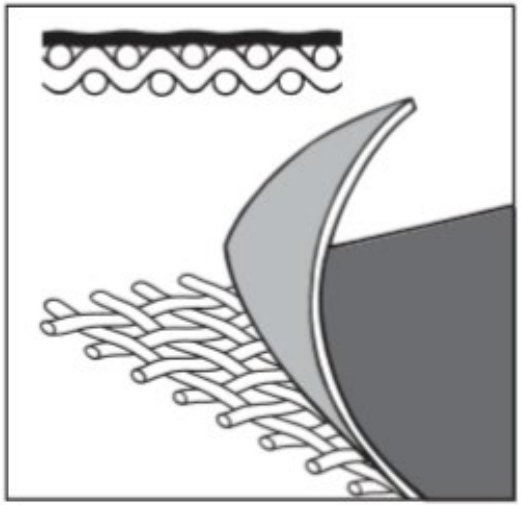
Nonetheless, the risk of mildew is always going to be a problem in tropical climates, or at times of the year when the temperature and atmospheric humidity are high. In these circumstances, canopies must be aired frequently, or be artificially de-humidified.

Figure Nine – The beading of water droplets on the surface of SunBrella Acrylic Fabric, caused by the polarising effect of the surface proofing, thus preventing leakage through the fabric.

Figure Eight – The Physical Structure of Fabrics

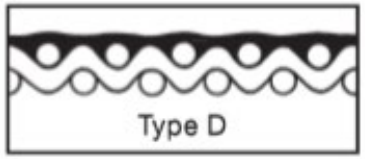


Type A: PLAIN WEAVE FABRICS
Water proofing and mildew treatment absorbed by fibres.

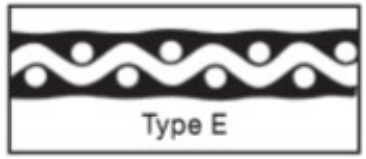


Type B: BI-LAMINATE
PVC sheet bonded to a single side of woven scrim. Exposed fibres are mildew treated.

Type C: TRI-LAMINATE
PVC sheet bonded to both sides of woven scrim.



Type D & E: SPREAD COATED FABRIC
Molten PVC or coating material is spread over the fabric surface. Exposed fabric is mildew proofed. Type E fabrics are coated both sides.



Notes: *(i) Type A fabrics (e.g. Sunbrella) are made water resistant by 'proofing', i.e. the application of a hydrophobic surface treatment. Refer Technical Guide Number One for a detailed outline of the process.*
(ii) Type B fabrics can be laminated on the topside (e.g. Mariner hooding) or the reverse side (e.g. Seamark)
(iii) Type D fabrics also be coated on the topside, or the reverse (e.g. Sunbrella plus).

Table One – Types of Marine and Related Industrial fabrics sold by The Nolan Group

Fabric	Nominal finished weight	Fabric type (refer Figure Eight)	Description	Features and recommended applications in a marine environment
"Mariner" Boat Hooding	640 gsm	B	Reinforced PVC bi-laminate, 100% polyester "dobby" weave backing. Width 183cm	Fully waterproof with attractive emboss, and fabric underside. Suited for Biminis, Canopies and covers.
Herculite "Riviera"	440 gsm or 509 gsm	C	Reinforced PVC tri-laminate; 100% polyester woven scrim. Width 200 cm (White and Snow White), 152 cm (Ivory).	Fully waterproof, mildew resistant, and easy to clean. A lightweight fabric, especially suited for large area canopies and covers.
Protex Polycotton Canvas	350 gsm or 520 gsm	A	8 oz or 12 oz loomstate weight poly/cotton (65/35) canvas, Warden proofed for mildew, rot and water penetration resistance. Width 200 cm	Suited for use on old wooden craft being restored "as original". Not as durable as acrylic, and now rarely used in this application. Requires periodic re-proofing to retain water penetration resistance.
Glen Raven "Sunbrella"	310 gsm	A	100% woven solution dyed acrylic with fluoro - carbon water repellent finish. Width 200 cm the colours commonly used in marine applications. 152 cm also available in other boutique colour selections.	Applications where "breathability" essential – e.g boom and sail covers. Suited also as a water repellent canopy cover. Requires periodic re-proofing to retain water penetration resistance.
Glen Raven "Sunbrella plus"	340 gsm	D	100% woven solution dyed acrylic with fluoro - carbon water repellent finish on top surface, and a polyurethane water proof coating on the underside. Widths and colour selection as for "Sunbrella" above.	Surface finish identical to "Sunbrella" but has higher degree and longevity of water penetration resistance. Does not "breathe" to the same extent. Ideally suited for roofing.
Glen Raven "Sunbrella Seamark"	440 gsm	B	100% woven solution dyed acrylic with fluoro - carbon water repellent finish on top surface, and a UV stabilised, fabric embossed vinyl film on the reverse side. Widths and colour selection as for "Sunbrella" above.	Surface finish identical to "Sunbrella". The fabric is reversible and can be used with either side facing upwards. Suited for applications where waterproofing is essential.
Herculite 2000	605 gsm	C	PVC tri-laminate, 100% polyester woven scrim. Width 200 cm. Acrylic lacquer both sides.	Waterproof, High tear strength, mildew resistant, and easy to clean. Suited as general purpose heavy duty cover, particularly in a tropical climate. Meets the Navy MilSpec.
Protex "PT Extra"	500 gsm	E	PVC coated, 100% polyester woven scrim. Width 250 cm. Acrylic lacquer both sides.	Waterproof, mildew resistant, and easy to clean. High Surface adhesion, and easily welded, Suited as general purpose lighter weight cover, particularly in a tropical climate.
Dickson "Spark"	290 gsm	A	100% woven solution dyed polyester with with fluoro - carbon water repellent finish. Width 120 cm	High Strength to weight ratio. Suited for use as an all-over cover. Limited life due to risk of strength loss after prolonged UV exposure.
Polyfab "Polyshield"	250 gsm	E	Woven HDPE tapes coated both sides with LDPE resin. Width 205cm	Budget priced, light weight. Suited for temporary applications, such as patterning, shade protection or emergency covers.

Table Two – Comparative Characteristics of Canopy Materials

Description	Acrylic Canvas			Woven Polyester	PVC Laminate				PVC Coated Polyester
Product name	Sunbrella	SunBrella Plus	Seamark	Spark	Mariner	Herculite 2000	Riviera		ProTEX PT Xtra
Width (cm)	203	203	152 or 203	120	183	200	200	155	250
Construction (refer Figure Eight)	Type A	Type D	Type B	Type A	Type B	Type C	Type C	Type C	Type E
Physical Properties:-									
Finished Weight (grams per square metre) *(note 1)*	310	340	530	290	625	605	508	440	500
Average Break Strength (Newtons/50 cm)	1078	1097	1037	2150	2076	1326	2460	2086	2039
Comparative Strength to Weight Ratio	3.5	3.2	2.0	7.4	3.3	2.2	4.8	4.7	4
Water penetration resistance (metres) (*notes 3 and 4*)	0.35	2.5	>25	0.35	>25	>25	>25	>25	>25
Vapour Permeability *(note 4)*	High	Very Low	Nil	High	Totally water and vapour impermeable				
Stability after extended UV exposure and accelerated weathering:-									
Average Break Strength loss	6%	0%	Not assessed	Not assessed	14%	11%	Not assessed	Not assessed	Not assessed
Colour Fastness *(note 2)*	Excellent	Excellent	Excellent	Good	Very Good	Very Good	Very Good	Very Good	Very Good
Propensity to mildew after abrasion and deliberate incubation:-			Not assessed	Not assessed			Not assessed	Not assessed	Not assessed
Extent of growth before cleaning	Severe	Severe			Severe	No Growth			
After cleaning with mild detergent	Slight	Moderate			Moderate	No Growth			
Re-growth after cleaning	No re-growth	No re-growth			Slight re-growth	No Growth			
Cleanability	Fabric can be damaged and proofing removed by rough rubbing				Relatively easy to clean, but progressively more difficult as aging occurs				
Relative Cost Factor (per sq m material only)	2.9	3.7	5.6	6.8	2.8	1.9	2.9	3.0	1.0
Other Issues	Surface Re-proofing required periodically. Type A fabrics fray when cut			Limited UV resistance	De-lamination a potential risk on towed boats if canopy or cover not secured properly. Less risk with coated (Type E)fabrics.				

Notes to table two:-

1)Finished weight per square metre is only useful to estimate the likely weight of a fabricated product and should not be used as a comparative indicator of ultimate strength, as this can be misleading. In this context, the ratio of break strength to weight is a better indicator.

2)Expected life is hard to predict because it depends largely on degree of UV exposure and amount of cleaning. All products are designed for use outdoors, and experience has shown that even with negligible maintenance, a minimum of five years can be expected with gradual deterioration of serviceability, manifested in lustre and colour change; strength loss; and greater difficulty in cleaning.

3)*The results of water penetration tests show that the fabrics are unlikely to leak, even under extreme conditions. If leakage does occur, it is almost certainly due to puncturing or seepage through joins or seams. However, changes due to aging can be an issue, and leakage may be a problem if for example, flex cracking of an impermeable surface occurs as a result of wind-whip, or if a water repellent finish wears off over time.*

4)Most mildew problems can be avoided if proper cleaning procedures are followed. This is because mildew tends to grow on detritus that has been allowed to sit on the surface, or to be deposited in the pores of the fabric, rather than on the fibres themselves

The most mildew resistant fabrics are tri-laminates (Type C) or those spread coated both sides (Type E), provided these have biocides in the PVC formulation. Proper seaming and sealing of the edges is required to eliminate the risk of 'wicking', which is propensity of water to migrate into the base scrim through capillary action, thus providing an amenable environment for mildew growth. Vinyls are also easier to clean than acrylic or polyester fabrics.

The Royal Australian Navy requires fabrics used on its vessels to be 'Milspec', that meet a particular specification developed by the US Department of Defence. If required, conformance certificates can be provided for the tri-laminate Herculite 2000.

It is vital that a fabricator explain to their 'consumer' two fundamental points. The first is that the marine environment is a particularly harsh one, and even the very best and expensive fabrics have a limited life. An analogy with the performance of Bar-B-Que covers is a good one if a fabricator needs to get this point across. These rarely last more than two or three years, and undergo embrittlement and colour fading, due to the degrading effects of UV radiation and transferred heat. Consumers are well aware of this and generally accept it as just one of those things. Marine fabrics are of better quality, and a longer life can be expected, but even so are not immune to the same detrimental environmental influences.

The second point is that marine fabrics last longer if properly and regularly cleaned. The contaminants generated from the air or birds that are deposited on the surface of the canopy (or its flexible glazing) can increase levels of the ambient alkalinity or acidity that can accelerate degradation; or promote mildew growth. It is important that these are removed. Even then, some fabrics require additional maintenance. For example, the water repellent finish on acrylic fabrics wears off over time, and canopies fabricated from this material require re-proofing every two years.

Guide to the fabrication of Canopy Fabrics

Setting Out, Cutting and sewing

Sunbrella should be cut with a hot-knife or ultrasonic cutting instrument or similar, in order to fuse the cut edge, and prevent fraying. If Sunbrella is cut with scissors, the edge will need to be overlocked. Use sensible precautions when cutting with a hot blade instrument, and always provide proper ventilation.

The polyurethane backing of Sunbrella 'Plus', and the Vinyl lamination on SunBrella "Seamark", Mariner Hooding or other PVC fabrics, give enough stability to these fabrics to eliminate the need for using a hot knife to seal the edges of the fabric. All that is needed is a sharp pair of shears.

In setting out, plan to run the warp direction (i.e. along the roll) in a bow to stern orientation. Under ordinary conditions, Sunbrella will not shrink, but tends to expand over time. Glen Raven recommend that the dimensions be undercut by approximately one half percent both in the length and the width directions. With other PVC laminated or coated fabrics, shrinkage of -0.5% in the warp direction should be allowed.

For joining panels, most fabricators use an overlap seam, which varies from 1/2" (12 mm) to 3/4" (20 mm) that is either double needled or double stitched. For this purpose, a double needle machine equipped with a puller is ideal. A lock stitch machine with a walking foot is ideal for hemming, which is necessary only if the Sunbrella fabric is cut with scissors.

A PTFE thread of a minimum size of 150 Tex is recommended for all sewing applications (Solarfix is the brand sold by the Nolan Group). Provided it is compatible with the sewing machine, a heavier 264 Tex minimum is available, and recommended for larger machines. Alternatively, a UVR stabilized polyester thread of 135 Tex can be used, but bear in mind this thread will lose strength over time. Quality Thread and Notions (QTN) B138 is recommended, because the thread colours specifically match those of the Sunbrella range. Avoid the use of polycotton, because of the risk of seam rotting and mildew. For a professional looking job, he use of acrylic braid or centerfold binding is also recommended in fabricating Sunbrella.

Use the same size thread for the bobbin as for the top stitch and maintain light to medium tension on both. We recommend 5 to 6.5 stitches per inch for marine applications. Maintain tension in front of and behind the needle during the sewing process to minimize puckering/gathering of fabric when seaming. Avoid too much back stitching because this technique can weaken the fabric and cause the fabric to tear more easily.

In our experience, most marine fabricators commonly use an R (regular round point), RG (round point rounded tip) or FFG (light ball point) needle. If when using an R point you notice that you are puncturing/cutting some of the warp or fill yarns in the fabric you may consider changing to an RG, FFG or other ball point needle. The ball point will tend to "push" between yarns instead of cutting them.

Refer to the machine manufacturers guide for the recommended needle size, but our experience suggests that Nm 120, (#18 Singer size) is appropriate for Solarfix 1500 D'Tex and QTN B138. Nonetheless, to maintain a tight seam, it is good practice to use the smallest size needle with which the machine will stitch properly. Constantly inspect and if necessary change needles for best results. Thread breakage is often related to a burr in the needle and not necessarily the size of the needle itself.

With Sunbrella Seamark, the use of a seam tape is strongly recommended when sewing panels together. This may also help to reduce seam leakage. When creating a "false fell" seam on a Bimini or Canopy Top, we recommend a minimum of 20mm seam allowance. Seamark is thicker than standard Sunbrella; so when folding and top stitching, there needs to be enough fabric for the stitch to "hold onto" on the bobbin side. When sewing through clear vinyl or polycarbonate, a Diamond Tri Point needle should be considered.

Fabrication and Installation

Make sure the fabric does not flap or rub against the supporting framework, the boat's structure, etc. in order to prevent abrasion or possible tearing of the fabric. Reinforcements should be used where the fabric contacts the framework, especially over squared or sharp angles.

Framework spacing should be no more than 900mm, and the pocket connections to framework should be reinforced. On large Biminis or covers, thought should given to the camber or crowning of the frame in order that drainage is facilitated. A minimum pitch of 30mm every 900mm bow to stern; and a crown pitch of 75mm from the centerline is recommended in the port to starboard directions.

For installations with less than optimal pitch, especially where a high degree of water repellency is required, Sunbrella Plus, which has a urethane back coating; or Sunbrella Seamark or Mariner Hooding, both of which are laminated to PVC, are the preferred option.

Use appropriately sized Stainless Steel or Aluminium tubing in the framework to insure to ensure a stable installation. If necessary, advice can be sought from the tubing manufacturer.

Completed marine tops should be handled with care. These tops are often collapsed/folded inside of a boot, should have spacers between the framework for transport. Abrasion between the top, the boot and components is increased exponentially when transported in the upright or "radar arch" position. The mounts should be dismantled and laid on the floor for transport.

FLEXIBLE GLAZING

Types of flexible marine glazing

For more than forty five years, the marine trim industry has used flexible clear PVC for marine enclosures (refer **Figure Ten**). Its main advantage has been its flexibility, which means it can be easily rolled up and down; bent around tight curves, and formed into complex shapes. Its main disadvantage has been lack of durability. It simply does not wear very well. It wrinkles during normal usage, and discolours and yellows with aging, both of which affect visual clarity and reduce effective life. Even with careful cleaning, a three to five year replacement cycle is not unusual.

There are many brands of flexible PVC on the market, each one of three generic types – calendared, extruded and press polished – the nomenclature basically a description of the way the product is manufactured. Despite its significantly higher price, press polished has been the generally preferred choice for top end boats, because of its relatively high initial clarity, and dimensional stability.

The scratch and Ultra-Violet light resistance (UV is the primary cause of degradation) of these products, and hence their effective life, can be improved with the application of surface coating, usually a polyurethane based lacquer. Because of cost, this has really only been used on press polished sheets. Even so, the film does not eliminate totally the risk of scratching. Furthermore, PVC absorbs moisture, and unless this propensity is carefully controlled during production, any residual will be trapped beneath the film, manifesting itself as a cloudy haze when the glazing is exposed to sunlight.

From a workability standpoint, trimmers prefer a 'soft' formulation. The stiffness of PVC is dependent on temperature, becoming markedly more malleable above 20° Celsius (refer **Appendix C**). At lower temperatures, particularly those experienced in winter in the southern climes, it can become relatively brittle, which is exacerbated if a PU coating has been applied.

Recently other materials have come to the fore, namely acrylic and coated polycarbonate, both of which can be classified as semi-rigid. They are far less flexible than clear PVC, and cannot be used in a roll-up context; but are compatible in terms of clarity, dimensional stability, and have better resistance to weathering.

Use of these products requires a different design mindset, to accommodate their relative rigidity. Solutions to this conundrum include creating windows that slide like patio doors, or flip up and fasten to the roof. Care must also be taken to ensure that curves are designed to be within tolerances. In this respect, acrylic can accommodate tighter radii than coated polycarbonate, the latter's recommendation being no less than a 250mm radius. Even so, this is generally well within the curvature required in practical applications.

Fabrication is also more complex. Because of its relatively low impact resistance, acrylic cannot be readily sewn, and needs to be bonded to the canopy fabrics and zippers. Coated polycarbonate can be sewn, but a diamond pointed needle is required for each job, as well some additional trimming or sanding of possible sharp edges.

The cost of both either acrylic or coated polycarbonate enclosure is about twice that flexible PVC, a factor which needs to be traded off against potentially longer life. As with any plastic, however, this is dependent on appropriate care and cleaning. Whilst not as sensitive as flexible clear PVC in this context, the rule of thumb is that the better the care, the better the outcome.

The great thing about these new generation products is that it provides a greater degree of end user choice, and increases fabricator options. There is no reason why, for example, flexible PVC could not be used in conjunction with semi-rigid materials in a context where the advantages of both are maximised.

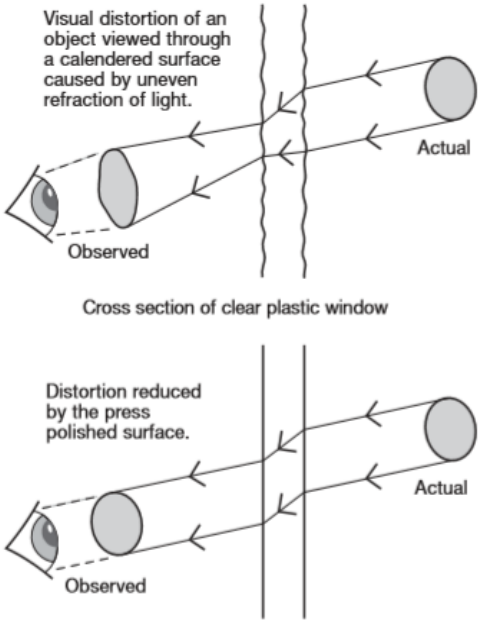
Figure Ten – An enclosure fabricated from Vybak Press Polished Clear PVC. This type of clear is preferred by high end boat owners because of its clarity.

Guide to the selection and use of flexible clear PVC

Product Selection

The Nolan Group's brands of flexible glazing products are listed in **Table Three.** The essential difference between calendered, extruded and press-polished PVC clear is clarity, which is very difficult to discern when viewed through a small piece, but obvious on the finished job. Light passing through a clear PVC material is refracted at each surface. Small imperfections in the surface cause the otherwise parallel rays to be refracted at different angles, as shown in **Figure Eleven** which distorts the image seen through the material. The smoother the surface, the less the visual distortion. The degree of distortion is subjective when assessed by the human eye, but can be measured by sophisticated electronic apparatus (i.e. a spectrophotometer, which measures light scattering and haze, as described in **Appendix C**). To some extent, the ultimate choice will depend on the customer's perception and budget, and a guide to the relative costs is given in **table three**.

Figure Eleven - Visual distortion caused by calendared surface imperfections



Some thought should also be given to the selection of the thickness of sheet. The 0.75mm is lighter, and will roll up more easily than the 1.00mm, but does not drape as well. Experience has shown that the heavier material is more suited for larger enclosures, particularly when subject to wind-load.

Unreinforced Clear PVC has a high ultimate strength, but exhibits a high level of deformation under load. Its tear strength is also relatively modest. Caution should therefore be exercised if the material is expected to be placed under stress, as it runs the risk of becoming "baggy".

Storage and handling

The packaging of all product is designed carefully to protect the contents. Rollclear is rolled about a core, which is suspended at each end. Rollglass is similarly packaged in a drum. A one metre allowance is provided in each roll to compensate for the indentation caused at the start and finish of the roll by the cut end. When removed from its packaging a roll should ideally be suspended on the core to prevent further indentation.

The packaging of CrystalClear, Vybak and StrataGlass is designed to protect the highly polished surface from damage. For this reason, each sheet is interleaved with tissue paper, before being rolled into drums. The drums should always be shipped and stored in the upright position and care should be taken when removing the sheets, or moving them on a worktable, which ideally should be covered with fabric.

Table Three – The Nolan Groups Flexible Clear Glazing Products

Nolan brand	Description of manufacturing process	Thickness (mm) or gauge (inches)	Dimensions	Tint Colour (if applicable)	Relative Cost per square metre	Features and applications
ACHILLES:-						
Rollclear SLS	Calendered	0.5mm (.020")	137cm x 40m roll		1.0	The SLS additive prevents sticking, enabling problem free rolling. Product noted with an asterisk is specially formulated to be dimensionally stable (DS). A budget priced product and suited for applications where visual clarity is not the prime motive for product selection.
		0.75mm (.030")*	137cm x 30m or 40m roll		1.5	
		1.00mm (.040")*	137cm x 25m roll		1.9	
Rollclear Tint	Calendered	0.75mm (.030")	137cm x 30m roll	Bronze	1.7	
		0.75mm (.030")*	137cm x 30m roll	Smoke	1.9	
		1.0mm (.040")	137cm x 25m roll	Smoke	2.3	
ACHILLES:-						
Rollglass	Extruded	0.75 mm (.030")	137cm x 30m roll		2.0	Excellent visual clarity. Ideally suited for large flybridge enclosures, which require a minimum of joins.
		0.75 mm (.030")	137cm x 20m roll	Black	1.9	
		1.00mm (.040")	137cm x 14m or 20m roll		3.1	
		1.00mm (.040")	137cm x 14m	Smoke	3.3	
		1.00mm (.040")	183cm x 14m		6.2	
Rollglass plus		1.00mm (.040")	137cm x 14m roll		4.4	The 'plus' option has higher levels of UV inhibitor and extended warranty.
		1.00mm (.040")	137cm x 20m roll		6.3	
		1.00mm (.040")	200cm x 14m roll		6.4	
HERCULITE:-						
Crystal Clear	Press Polished	0.5mm (.020")	137 cm x 280 cm sheet		2.6	Excellent visual clarity and dimensional stability. Suited for all marine flexible glazing applications.
		0.75 mm (.030")	137 cm x 280 cm sheet		3.9	
		1.00mm (.040")	137 cm x 280 cm sheet		5.1	
		1.00mm (.040")	137 cm x 280 cm sheet	Light Smoke	5.8	
NOLAN GROUP:-						
Vybak	Press Polished	1.00mm (.040")	137 cm x 280 cm sheet		4.7	Vybak has a 'soft' formulation and proven performance in Australia over many decades.
HERCULITE:-						
Strataglass	Press Polished and	0.75 mm (.030")	137 cm x 280 cm sheet		8.3	Incorporates scratch resistant surface coating on both sides, which also reduces plasticiser migration, and extends life.
	coated.	1.00mm (.040")	137 cm x 280 cm sheet		9.0	
		1.50mm (.060")	137 cm x 280 cm sheet		8.6	
		1.00mm (.040")	137 cm x 280 cm sheet	Light Smoke	9.6	
		1.00mm (.040")	137 cm x 280 cm sheet	Dark Smoke	9.6	

Loose sheets should be handled carefully to minimise the likelihood of scratching. It is inadvisable to stack sheets or finished enclosure curtains on top of each other without tissue interleaving, as the plastic may stick, and be scratched when pulled apart. Use the tissue paper included in the packaging to protect the sheets. Do not use "shrink-wrap" for this purpose, because if left for a prolonged period, it can alter the properties of the clear PVC through "plasticizer" migration.

Plasticiser migration or loss

PVC is made flexible by the use of plasticisers, of which there are a variety, all different in molecular composition. When two PVC's with different types of plasticisers are brought into contact, plasticiser tends to "migrate" from one to the other. The movement can be compared to water flowing between two connected tanks, with initially different surface levels, which continues until parity occurs. The "migration" of plasticiser is slow, and can take several months for it to become evident, either through changes in stiffness or dimension.

Caution should therefore be exercised when using a coloured PVC laminate for edging, as these may use different plasticiser to the clear. Herculite 2000 and Mariner Boat-hooding have been tested, and found to be compatible with all the clear PVC sold by the Nolan group.

Yellowing, stiffening or cracking is inevitably the result of plasticiser loss, and is irreversible. The process is normal, and gradual deterioration of all clear product will occur over the life of the product, which should be at least five years, particularly if the surface is cleaned regularly. More rapid deterioration can be an indication of plasticiser migration, UV degradation or chemical attack. The cause can usually be determined by laboratory analysis, and in the event of a complaint, samples should be submitted for testing.

Batch Variations

All clear PVC has a faint bluish tint, which is an integral part of its make-up, but can vary slightly between batches. Sheets proposed to be joined or adjoining, should therefore be carefully examined for such variation, which can sometimes be obvious on a finished job. When in doubt, use sheets from the same batch.

When calendaring or extruding PVC, it is extremely difficult to obtain uniform gauge or thickness across the roll. Although Achilles work to exacting tolerances, minute variations in thickness can occur, particularly at the edge, which can result in slightly wavy edges

Effect of temperature

The flexibility and dimensional stability of clear PVC varies with temperature (refer **Appendix C**), and it is important to do all marking and cutting out at room temperature, that is about 23°C, in order to minimise potential problems of expansion or contraction due to changes in temperature. Sheets installed tightly in cold weather will not necessarily remain so in warmer conditions. Shrinkage of up to 2% due to temperature should be allowed for.

Residual Stress relief

Due consideration must be made of the possibility of dimensional changes in "Rollclear" and "Rollglass", due to residual stresses resulting from the production process. Achilles recommend that before fabrication of these products, any cuts are allowed to lay flat or hang freely at room temperature for a number of days, which provides sufficient time for most of the residual stresses to be dissipated. Unless relieved, these stresses can cause shrinkage along the length of the roll of up to -3.2%, and expansion across it of up to +2.0%.

These precautions are not necessary if the "Dimensionally Stable" (DS) product is selected, which has been manufactured in a manner where all of the manufacturing processes that cause residual stress have been eliminated or carefully controlled. As a result, shrinkage along the length of the roll has been reduced to a maximum -1.2%, and expansion across it to a maximum of +0.6%.

Because of the different dimensional change in warp and weft directions, care should be taken in welding or joining sheets cut from a roll to ensure they are aligned compatibly, or else puckering may occur. Similarly, Zippers should only be used along the roll to minimise the potential strain on the chain teeth.

Tissue Marking and cloudiness

Press Polished Clear sheets should also be laid out flat overnight before use. Provided the ambient temperature is sufficiently high, any tissue marking that may have occurred in transit, which manifests itself as faint "snail trails" on the surface, should disappear. Should these still be there next morning, it is probably because the overnight temperature was too low. In this case, lay the sheets out in the sun on a black piece of carpet or apply hot air from a heat-gun, until the plastic softens.

The gun should be held 10 cm to15 cm away from the sheet while treating a thirty square centimetre area at a time. Care should be taken not to scorch the surface. If marks are still there after this treatment, it is possible contaminants in the plastic itself are causing the problem. If this is the case, contact your local branch of the Nolan Group for advice, before cutting out.

The same treatment can also be used for other light markings such as zip marks. PVC can absorb water, which shows up as a cloudy residue. This will disappear under the action of sunlight but may take some time to do so. The problem commonly occurs when a blind is rolled wet, which traps surface moisture.

Zippers and Framing

The finished job looks best when the product is held under slight tension, but care should be taken when zippers are employed as a fastening system. Over-tensioning can damage the teeth of the zipper, or make them very difficult to close.

In designing a canopy, avoid continued direct contact of the PVC with stainless steel or aluminium tubing, which can get hot in direct sunlight and scorch the clear PVC.

Care and Cleaning

Refer **Appendix A6** for detailed cleaning instructions, but generally the use of harsh chemicals for cleaning should be avoided as these can scratch the surface or leach plasticizer out of the material. Clear PVC should desirably only be cleaned with a dilute solution of mild soap and warm water or the recommended cleaners. Rinse with clean water and dry with a soft cloth or a sponge. The surface can be scratched by rubbing with a coarse cloth or even in general usage, and these are impossible to remove. Some success with slight scratching has been attained with careful use specific cleaners. The manufacturers recommend either Plexus (Achilles or Vybak) and IMAR 301 and 302 (Strataglass).

MARINE FLOORING

Types of marine carpet and hull lining

Marine carpets and hull-lining are similar in structure being non-woven, needle-punched products comprising blends of different deniers of UV stabilised polypropylene and /or polyester fibres. The first stage of manufacture is the selection of the appropriate fibre mix, by both colour and weight, which are batched by weight and blended. The blend is then needle-punched into a dense interlocking matrix. In this form, it is flexible and has a good deal of dimensional freedom. The lighter weights ($\simeq$ 500 gsm) in finer denier can be easily formed over convoluted surfaces and are ideal for use as hull lining.

Carpets tend to be heavier, both in fibre and overall weight, 650 gsm ("Reef" and "Raider") to 900 gsm ("Decord"). Surface profile is obtained by varying the pattern on the needle beds (or boards), and colour contrast within the patterns by needling a second or third time. Carpet is stabilised by applying a Latex, or synthetic rubber backing, which is applied in a liquid form, and solidified in an oven.

The polypropylene fibre used in Nolan Carpets is UV stabilised and is solution dyed, which means colour is an integral part of the fibre matrix, and not just impregnated into the surface. The UV stabiliser is a sacrificial component, acting similarly to zinc in galvanised iron and the life of the product in an outdoor environment depends on the amount of stabiliser in the fibre, and degree of exposure to ultra-violet light. The detail of the Nolan Group's carpet and hull-ling ranges are contained in **Table Four.**

Table Four – Details of the Nolan Group's Marine carpet and hull lining.

Range Name	Total weight (gsm)	UV warranty (years)	Product Features (all products latex backed unless stated otherwise)
Flex & Cabinliner	425	2 years	Unbacked. Suited for Hull lining and other internal applications.
Four Seasons & Reef and Raider	800	2 years	Available in a matching plain and/or ribbed pattern. No contrast in colour
Decord	1300	3 years	Heavy ribbed pattern with strong colour contrast as the 'valley' insert
Broad Rib Avondale	1020	3 years	Medium Ribbed pattern with no colour contrast.
Hobnail	1020	3 years	Cobbled diamond pattern

Fabrication and Installation Advice

Hull lining is designed to be adhered to the substrate with an outdoor adhesive that is non-water soluble, such as the Nolan "Fullatac" contact adhesive. Similarly, in a commercial context, carpet is also glued to the floor, and this practice is recommended for large scale marine applications, such as a ferry or other similarly sized commercial vessel. Formal laying instructions are available on request. Crucial points are: -

- To minimise the possibility of colour variation, each colour should be selected from the same batch. The rolls should be laid in sequential order, in the same direction every run.
- The correct amount of adhesive must be evenly applied and allowed to tack.
- The carpet should be overlaid and double cut, not butt joined.
- Rolling immediately after laying the carpet, especially along the joins, is essential to achieve adequate adhesive transfer.

Loose laying is not recommended, because of the risk of dimensional instability. Abrasion of the backing with the substrate can also cause fibre loss. However, the practice of loose laying with clip-down fasteners in the marine industry is common practice. If this is contemplated, pre-shrink an oversized piece of carpet before cutting to the finished shape, by saturating it with water and allowing it to dry for 24 hours. The backing should also be sealed with Ados Marine "Decktread" or similar product.

MARINE SEATING

Types of Marine Upholstery

The Nolan Group offers two types of upholstering materials that are suited for use in a marine environment, namely expanded vinyl and woven acrylic fabric.

For durability and ease of maintenance, expanded vinyl is unmatched by any other. It is water-proof, easily wiped clean, stain and mildew resistant, and has natural anti-bacterial characteristics. These properties can be further enhanced by addition of special formulations, or by additional surface treatment. The appearance can be changed by varying the texture or printing patterns on the surface. Even though the casual observer will find it difficult to notice, there can be significant differences in the formulation of and composition of expanded vinyls. Vinyl designed to be used in a marine application has a high level of UV inhibitor added, in order to prolong its life when exposed to sunlight. Without it, the vinyl will very quickly break down in service.

The Nolan Group markets a number of brands of expanded vinyl that are suited for both marine and heavy-duty commercial use (refer **Table Five**). “Capri” is a well-known and respected brand, and has been in service for four decades, and hence has proven performance in the Australian market. The brand was formerly owned by Nylex before it went into receivership in 2008, and the product, with improvements that reflect current technology, is still manufactured by the now independent Nylex Malaysia.

“Cordova” is also a brand that was formerly owned by Nylex, but the product has been substantially improved by the incorporation of silver ion technology, which enhances anti-bacterial and mould qualities, plus an anti-graffiti finish. These features are also incorporated in the “Silvertex” range, which features a fabric looking emboss. Both these latter ranges are manufactured by the Spradling Corporation, which is headquartered in the USA.

Table Five– Physical properties of the Nolan Group Expanded Vinyl ranges (all 137 cm width)

Brand	Overall Weight (gsm)	Backing Composition	Features
Capri	615	Knitted polyester	UV stabilised, abrasion resistant, colourfast. Plain and matching Pebble emboss.
Cordova “Ultra”	680	Hi-loft polyester	UV stabilised, SilverGuard anti-bacterial finish, Permashield anti–graffiti coating, Fire Retardant, three year warranty.
Slivertex	740	Hi-loft Polyester	As for Cordova Ultra. A Fabric pattern emboss.
Carbon Fibre	750	Knitted Polyester	UV stabilised, abrasion resistant, colourfast. Distinctive stripple emboss

Figure Twelve – ‘Capri’ Expanded Upholstery Vinyl and ‘Four Seasons’ carpet used in a ski-boat. Both products display a high level of durability in the marine environment.

Sunbrella acrylic upholstery fabrics are manufactured with the same type of UV stabilised yarn (but of lighter denier) that is used in their canopy materials. The fabrics are stain and mould resistant, and can be treated with bleach and other cleaning agents (refer **Appendix A2**). Cushion covers can be removed and successfully washed in a household

washing machine. There are number of ranges available, featuring mix-and match colours in plain, striped and Jacquard patterns. Refer http://www.3beaches.com.au/ for details of the fabric collections stoked by the Nolan Group.

Guide to product selection and fabrication

The choice between vinyl or acrylic fabric upholstery is dictated largely by the type of boat and its primary purpose. Vinyl is particularly suited to ski-boats or runabouts (refer **Figure Twelve**), where there is a greater likelihood of abrasion, contact with sunscreen, and salt water saturation, etc; than with larger vessels, where the recreational usage is not as extreme (refer **Figure Thirteen**). Nonetheless, there is no reason why Sunbrella fabric cannot be used in any marine application.

Figure Thirteen – SunBrella upholstery fabric on a cruiser. Note the matching of the colour with that of the canopy.

The comfort of the seat itself, no matter what the material chosen, depends markedly on the quality of the unseen filling material, namely the polyester/urethane foam, and polyester wadding. In a marine situation, if the seat is likely to get wet, then a reticulated polyurethane foam (such as the Joyce “Dricell” brand) is recommended.

The key determining factor is density, with the higher the density the greater the resilience (or “bounce”), durability and degree of support. In foam, comfort is also affected by hardness, measured by the force in Newtons to attain a 40% deflection. For upholstery seats, a high resilient foam of density 31kg/m^3 and hardness 190 Newtons (N31-190) is recommended. For seat backs, a lighter density and hardness is acceptable (N23- 130). Selection of lesser quality foam increases the possibly of "puddling" of the covering vinyl, due to cushion failure. The minimum density of polyester wadding used as padding should be 200 gsm.

Causes of occasionally observed problems in vinyl seating

Generally, it is the amount of coating mass and the quantity of UV stabiliser that will determine the life of the vinyl, although lacquers also have a significant effect.

The stiffening or cracking of PVC is due to plasticiser loss, and is usually caused by applied chemicals or UV exposure. It can sometimes be due to a reaction with the underlay or adhesive, or contact with wood surfaces with a urethane coating, which can cause discolouration of the vinyl surface.

The first sign of UV degradation is colour change, initially yellow then to a tan; and the appearance of dark spots. In later stages, the vinyl becomes brittle, and loses strength and elasticity. Yellowing of white vinyls can also sometimes be caused by high sulphide content in the atmosphere. This has occurred, for example, in boats moored near chemical plants.

Discolouration can be caused by dye transfer from denim jeans or by diffusion from the underside. For example, the ink from a ball point pen used for marking out may diffuse to the surface some time after fabrication.

Yellow, black, pink or purple staining can be the sign of a mildew problem, mostly experienced in marine situations, even in product treated with mildew inhibitors. It is usually caused by fungi growing in the seat cushion, whose digestive by-products are soluble in plasticizer, which tends to migrate to the surface. Offensive odour is a sure sign of mildew or fungal attack.

MISCELLANEOUS TRIM PRODUCTS

Metal Fasteners and Fittings

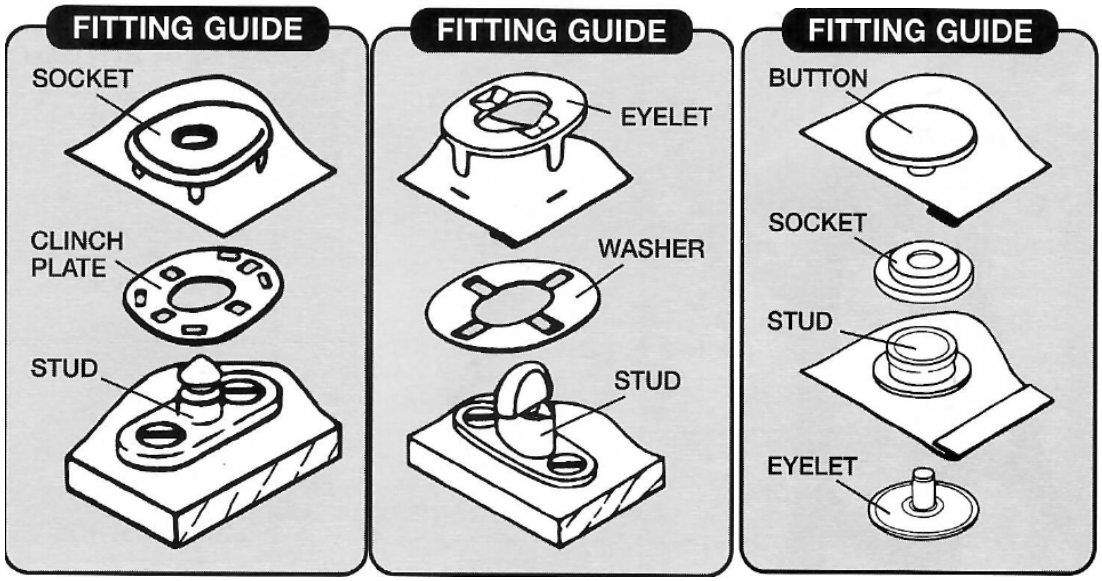
Metallic Composition of Fasteners

The commonly used fasteners in a marine environment are eyelets and durables (refer "Nolan Product catalogue"), manufactured from brass (which can then be either nickel plated or anodised) or stainless steel. Schematic diagrams showing how these products are used is shown in **Figure Fourteen (a), (b) and (c)**

Brass is an alloy of Copper and Zinc, in proportions 70% and 30% respectively. The Copper provides ductility and the Zinc adds strength. The nickel plating is quite thin, about five microns only, and whilst it adds some strength, the main reason for it is the aesthetics of the silvery finish. The black finish is the result of a copper / zinc oxide anodised to the brass surface, again for purely aesthetic reasons, although originally developed to dull brass buttons on military uniforms.

Stainless steel is an alloy of Iron and concentrations of Chromium in excess of 12%. There are many different types of stainless, categorised by quantity of alloy and crystal type, determined by the nature of the steel making process. The 316 marine grade Stainless Steel also contains Molybdenum.

Figure Fourteen – Fastener fitting guide
(a) "Lift-the-Dot fasteners **(b)** "Turn-Button" Fasteners **(c)** Durable fasteners



Q-snap Metal and Perfix Fasteners

The Q-Snap™ fastener is a similar to a typical press-stud fastener, but with modified stud and eyelet, which is designed to allow leverage to be applied to the canopy fabric as it is attached (refer **figure Fifteen (a)**). This ensures a tight fit, particularly in circumstances where the fabric may have shrunk slightly.

Figure Fifteen (a)
Fastening a Q-Snap Durable

Figure Fifteen (b)
The Perfix™ Fastening System

Made from UV stabilised, glass fibre reinforced Nylon, the Perfix™ Fastener **(Figure Eleven B)** is designed as an alternative to "Lift-the-DOT" fasteners, the post of which protrudes from the deck and can be unsightly, or cause injury or snagging. The base receiver of Perfix™ is rounded and has no protruding parts, and can be fastened either to the deck, with a screw or pop-rivet, or to another piece of fabric, with a specially designed receiver ring. The top button is spring loaded for easy release, and is force rated at 45kg (4.4 kN), at which load it releases without causing damage to the receiver

Figure Sixteen – A convertible top attached with 'Durable' fasteners. The use of the Perfix Q-snap at each corner of the windscreen greatly facilitates raising and lowering the top.

Metal fasteners and the risk of corrosion

Corrosion is spontaneous destructive oxidation, and occurs naturally in nearly all metals, the most obvious example being rusting of iron. Metal corrodes by releasing positively charged ions into water. To do so, it must first lose electrons, which travel to another part of the wetted surface and react with oxygen or hydrogen, forming an oxide on the surface. The essential involvement of water is the reason why rusting occurs much more rapidly in moist conditions as compared to a dry environment. Proximity to the ocean is also a contributing factor, since dissolved salt increases the conductivity of the aqueous solution.

Paradoxically, the formation of oxide on the surface of metal can protect it from further corrosion. With Aluminium, for example, the oxide formed at the surface is hard and tightly packed, ultimately building up a thin "passive film" forming a barrier to the virgin metal beneath it. This does not occur in iron because the iron atom is much smaller than its oxide, so the oxide layer is very loose and porous. This problem can be addressed by blending iron with other metals. The addition of chromium (in concentrations of more than 12%), which like aluminium has a compatible atomic size to its oxide, significantly improves the corrosion resistance of the combination, because the chromium oxide forms a surrogate "passive film". This is the principle behind stainless steel.

However, because of its reliance on the formation of an oxide layer, even marine grade stainless steel will have poor corrosion resistance in low-oxygen environments, such as below ground, or in crevices, or in tight places where hardware is attached. This is particularly true if the fitting is immersed in seawater, where the chlorides from the salt will attack and destroy the passive film faster than it can reform. Thus, the assumption that stainless steel is not subject to corrosion is not valid, particularly in a marine environment.

An alternative method of preventing corrosion of metals is to physically coat the surface, which is the principle behind galvanised iron. In this case, the iron is coated with zinc, which is more easily oxidised than the iron, and acts as a sacrificial component to the base metal. Thus the galvanised metal will not corrode until after the zinc coating does.

A similar principle applies to nickel plated brass, but the limited extent of the coating means its effect is limited. Brass is a durable alloy but is susceptible to attack by concentrated sodium chloride.

The relative difference in the oxidising propensity of metals leads to accelerated (termed "galvanic") corrosion when two of different types are placed together in an electrolyte, that is, any liquid that conducts electricity, such as salt water. The susceptibility is dependent on the "electrolytic decomposition potential (or nobility)" of the metal, with Aluminium being relatively more negative compared to stainless steel, and even more so than nickel and brass.

Galvanic corrosion is very damaging because it is concentrated at the metal/metal interface, where electrical resistance is low, and therefore current high (refer **figure Seventeen**). This can be exacerbated by earthing of batteries through the hull of the vessel. Care should be taken to avoid placing aluminium in direct contact with other metals, even stainless steel, such as for example, by inserting an insulating material such as neoprene between the metal/metal junction.

Adhesives, Cleaners and Lubricants

Adhesives and related solvents are widely and safely used in upholstery, trimming and carpet laying. However, these can be classified as 'hazardous' according to the criteria of the National Occupational Health and Commission of Australia. It is therefore essential that any risk associated with the use of these functional products is minimised by religiously following the instructions for use, storage and disposal that are printed on every container. In summary, key points to remember are: -

- Avoid inhalation of fumes, and direct contact of the substance with skin or eyes
- Use only in a well-ventilated space, having first eliminated any potential ignition source
- Store products in a cool, fire isolated space; and dispose of empty containers in accordance with the law and sensitivity to the environment.

Details of the adhesives, cleaners and lubricants sold by the Nolan Group and the HAZMAT references are shown in **Table Six**. The HAZMAT information can be downloaded from the website www.nolans.com.au

Figure Seventeen – *Corrosion of Aluminium in contact with a stainless steel eyelet after only 48 hours immersion in a salt spray. The circular imprint of the eyelet (left) is clearly visible. (magnification x 10)*

Table Six– Adhesives, Cleaners and Lubricants for trim and upholstery

Product	Manufacturer	Purpose or use	HAZMAT reference document number
General Adhesives:-			
Fullatak SC 29 (20 litre drum)	H.B. Fuller and Company	Sprayable contact adhesive	SC 29
Tensor Grip T65 (Aerosol can or 17.2k canister)	Quin Global	Solvent free, low VOC and flammability, sprayable contact adhesive	TG.T65.22
Lubricants:-			
Silicone based (aerosol can)	Faith Chemicals	Lubricant for Trim and upholstery. Should not be used in a workshop that has HF Welding equipment.	Faith 114 Silicone
Non-silicone based (aerosol can)	Faith Chemicals	Lubricant and mould release for trim and upholstery.	Faith 151
Cleaners:-			
Tensorgrip C101	Quin Global	Citrus solvent cleaner of substrates and overspray areas	TG C101
Vuplex	Vuplex Group.	Clear PVC cleaning, polishing, and Protection	MSDS dated 01/12/16
Imar 301	IMAR Products	Strataglass protective cleaner	MSDS dated 05/28/15
Imar 302		Strataglass protective Polish	MSDS dated 05/28/15

Thread

Details of the thread sold by the Nolan Group is listed in **Table Seven**. Thread size is generally distinguished by Tex, which is expressed as grams / kilometre. Obviously, the higher the Tex, the heavier the thread.

Caution should be exercised when using Tex to compare threads of different composition, because the base yarns may have very different densities. This means that threads of same Tex but different density will have different diameters. This is not a problem when comparing Polycotton to Polyester, because the density of each is similar. Hence, the diameters of Polycotton and Polyester threads of similar Tex will also be similar, as will be the appropriate needle sizing. However, PTFE has a higher density than polyester, and therefore PTFE threads will have a noticeably thinner diameters than polyester threads of the same Tex, and smaller needle sizes.

PTFE also has a lower tenacity than Polyester, and therefore PTFE threads will have less initial strength than Polyester threads of the same Tex. But, unlike polyester, PTFE does not suffer strength loss under the action of Ultra-violet light and will retain its initial strength over the whole of its effective life. The seams will also have smaller needle holes, an advantage for seam sealing.

The selection of an appropriate thread is a matter of judgement, but the main factor to consider is the required seam strength, with allowance for strength loss over time. Although widely used, a thread made from a polycotton blend is not recommended for a marine environment. Its primary advantage is that the cotton swells when wet, which seals the canopy seam, but experience has shown that it rots relatively quickly, and has a propensity to mildew.

Thread made from 100% polyester has greater longevity, and the seams can be sealed effectively with Silicon spray. However, polyester thread loses strength over time, and after five years will lose about half its initial strength. The Sunguard brand has the advantage of an exact colour match to commonly used Sunbrella colours.

Solarfix™ PTFE (polytetrafluoroethylene) thread has proven longevity in the field, because of its UV stability and chemical resistance. It simply lasts longer than the canopy materials. The downside is that it is much more expensive than equivalent strength polycotton or polyester threads, but perhaps that is the price paid for peace of mind. It is translucent, and therefore blends with any colour fabric.

Table Seven- Threads sold by the Nolan Group

Description	Tex	Tensile Strength		Recommended Needle Size		Construction and Features
	g/km	kg	lbs	US	Metric	
Terko 36	80	3.7	8.2	18-21	110-130	Polycotton. Cotton wrap absorbs water and swells to seal needle holes
Terko 25	105	5.3	11.7	19-22	120-140	
Terko 20	150	7.0	15.5	19-22	120-140	
Terko 12	210	10.6	23.3	21-23	130-160	
Dabond V138	135	9.0	21.0	22-25	140-200	100% Bonded Polyester. High UV resistance. Bleach, Mildew and rot resistant
Dabond V207	210	14.1	31	25-27	200-250	
Sunguard B138	135	9.5	21.0	22-25	140-200	As for Dabond, but with colours that excatly match Sunbrella Acrylic fabrics
Sunguard B207	210	13.6	30.0	25-27	200-250	
Solarfix PTFE	150	4.5	10.0	16-20	100-125	PTFE (Polytetrafluorethylene) Exceptional UV and chemical resistance. Retains initial strength for its working life
Solarfix PTFE	264	7.7	17.0	18-22	110-140	
Solarfix PTFE	300	9.1	20.0	19-22	120-140	

Shockcord and Loops

The marine grade shockcord supplied by The Nolan Group comprises a natural latex rubber core, encapsulated in a knitted matrix of high tenacity, UV stabilised polypropylene yarn. The rubber provides the elasticity, and polypropylene the strength and abrasion resistance.

A typical load extension curve for Saint branded loop is linear, that is, the rate of extension is proportional to applied load, until the loop has been extended to about 1.8 times its initial length, at which point the limit of elasticity is reached and it becomes almost impossible to stretch the loop further. A doubling of the applied load results in only an additional 10% extension. Failure begins to occur at 275 Newtons (equivalent to 28 kilos under gravity), due to progressive enlargement of the hole at the fixing point. To comply with the manufacturer's recommendation of a maximum 80% cord extension, the maximum recommended working load is 100 Newtons (i.e. ten kilograms of load).

Zippers

The Zippers supplied by The Nolan Group are manufactured by YKK, which is the leading zipper manufacturer in the world. The company specifies their products to Japanese Standard JIS – S3015. Zippers are classified and specified according to chain width, which is the width of the gear elements in millimetres. The YKK specification is reproduced in **Table Eight.**

Table Eight– Strength specification for YKK Zippers (JIS – S3015)

Chain Width(mm)	3	5	10
Lateral strength (kgf/2.5 cm)	20.0	25.0	12.0
Top Stop pull out force (kgf)	4.0	5.0	12.0
Horizontal break strength of retaining box (kgf)	5.0	7.0	15.0
Slider lock strength (kgf)	1.0	2.5	8.0
Slider tab failure load (kgf)	5.0	8.0	20.0

Patterning Material

Polyfab PolyShield is a versatile lightweight, coated woven polyethylene fabric, widely used for patterning in the marine trim industry. It is also suited for temporary covers or demountable shade structures. Product details are shown in **Table Nine**.

Table Nine – Specification for Polyfab Polyshield.

Properties	Test Method	Units of Measure	Values
Pick count / Yarn Density		per cm / denier	12 x 12 / 1500
Nominal Weight		gsm	250
Coating Thickness		microns	55
Tensile Strength Warp /Weft	AS 2001.2.3	N/ 50 mm	1500/1600
Wing Tear Warp/ Weft	AS 4878.7	Newtons	290/ 307
Flex Cracking	AS 4878.9	Cycles	100,000
Temperature Resistance		^{o}Celsius	-30^{o}/+70^{o}
Hydrostatic Pressure	AS 2001.2.17	kilopascals	215
Bursting Force	AS 2001.2.19	Newtons	1922
Bursting Pressure	AS 2001.2.4	kilopascals	3150

PRODUCT DIMENSIONS, PACKAGING AND LABELLING

With the exception of the Press Polished sheets, the Nolan Group's marine fabrics and clear PVC are produced in roll form. The products are wrapped around a cardboard core, and some are packaged in a box or tube. The press polished sheets are packaged in a drum. Regardless of the packaging, all products are labelled on at least one end at the factory and show, at a minimum, a description as well as the factory batch and part numbers; and where relevant, details of the range, such as colour, width, and roll length.

The Nolan Group has its own barcoding system. Upon delivery to the warehouse, each roll is bar-coded, which is the linkage to the original Nolan Group Order number, and all other records in the supply chain. The "date of last transaction" may be for example, when the container was received, or the roll itself receipted into a particular warehouse. When the roll or a cut length is sold to a fabricator, a label is attached to the parcel, which is also bar-coded, and referenced on the delivery docket and invoice; and linked to the customer order number. Thus, the origin of the material can be traced from any of these records, enabling for example, delivery of additional material from the same batch, should this be required.

Freight companies charge both by weight and cubic volume, but generally the products are too heavy for the "cubic" formula to apply. For convenience the relevant dimensions and roll weights are tabulated in **Table Ten (a) and (b).** These values can be used to calculate total pallet loads, and checked against the Safe Working Load of forklifts or the pallet racking in which they are stored.

PRODUCT SPECIFICATIONS

The basic physical specifications for the Nolan Marine products are the benchmarks determining "Fit for Purpose", and are the foundation of the product warranties (**Appendix B**). The products have also been further tested independently to assess durability, as described in **Appendix C**. If necessary, a basic description of the methods of tests used can be found in Technical Guide Number One – "How to tell a good yarn: Textile Manufacture and Testing".

Sunbrella is manufactured to US standards (i.e ASTM or The American Society of Testing Materials), and this specification is reproduced in **Table Eleven (a)**, and correlated with similar Australian Tests in **Table Eleven (b).** Mariner Hooding is also included for comparison.Achilles manufacture Flexible Clear PVC to the Japanese Standard JIS K 6732 "Polyvinyl Films for Agriculture", and the specification is reproduced in **Table Twelve (a)**, again corelated with Australian tests in **Table Twelve (b).** The physical properties (i.e. tear and tear tensile) of the Press Polished properties can be assumed to be similar.

Figure Seventeen – Capri Expanded Vinyl used in a Marine Environment

Table Ten (a) – Fabric and Carpet Roll dimensions, weights and packaging

Item	Roll Width (cm)	Roll Length (metres)	Unit Weight (gsm)	Roll Weight (kg)	Packaging Description
Protex Polycotton Canvas	220	35	500	39	Wrapped in heavy duty plastic
Protex PT Extra	250	30	500	38	
Marina Boat Hooding	205	30	625	38	Wrapped in heavy duty Paper
Herculite 2000	200	22.9	610	28	
Herculite Riviera	200	30	509	31	Boxed in 23 cm x 23 cm carton
Herculite Riviera	152	45.8	509	35	
Dickson Spark FR	320	60	290	56	Wrapped in heavy duty plastic
Glen Raven "SunBrella"	200	45	310	28	Wrapped with corrugated cardboard and heavy duty plastic
Glen Raven "SunBrella Plus"	200	42	340	29	
Glen Raven "SunBrella"	152	50	310	24	
Glen Raven "SunBrella Plus"	152	45	340	23	
Glen Raven "SunBrella Seamark"	152	30	440	20	
Polyfab Polyshield	205	50	250	26	Wrapped in heavy duty plastic
Capri	137	30	615	25	Wrapped in heavy duty Paper
Cordova “Ultra”	137	30	680	28	
Slivertex	137	30	740	30	
Carbon Fibre	137	30	750	31	
Flex	200	25	425	21	Wrapped in heavy duty plastic
Cabinliner	200	25	450	22.5	
Four Seasons, Reef and Raider	200	25	835	42	
Decord	200	25	1300	65	
Broad Rib Avondale, Hobnail	200	25	1020	51	

Table Ten (b) – Clear PVC product dimensions, weights and packaging

Item	Thickness mm (inches)	Dimensions	Unit weight (gsm)	Packaged weight (kg)	Packaging Details
Rollclear	0.5mm (.020")	137cm x 40m roll	635	35	
	0.75mm (.030")	137cm x 30m roll	950	39	Wound on a cardboard core suspended at each end in a box of dimensions 20cm x 20cm x 143 cm
	0.75mm (.030")	137cm x 40m roll	950	52	
	1.0mm (.040")	137cm x 25m roll	1270	43	
Rollglass	0.75mm (.030")	137cm x 20m roll	950	26	
	0.75mm (.030")	137cm x 30m roll	950	39	Wound on a cardboard core suspended at each end in a drum 20 cm in diameter x 143 cm in length.
	1.0 mm (.040")	137cm x 14m roll	1270	24	
	1.0 mm (.040")	137cm x 20m roll	1270	35	
	1.0mm (.040")	200 cm x 14m roll	1270	36	As above, but 210cm in length
Press Polished Clear	0.75mm (.030")	279 cm x 137 cm sheets	950	18	Five sheets interleaved with soft paper and packed in a drum, then boxed (25cm x 25cm x 140cm)
	1.0 mm (.040")		1270	24	
	1.5 mm (.060")		1905	36	

Table Eleven (a) – Sunbrella product Specification (US Standards)

Properties	Test Method	Unit	Sunbrella	SunBrella Plus
Fabric Construction: Ends	ASTM D3775-98	Each	76	76
Fabric Construction: Picks	ASTM D3775-98	Each	36	36
Fabric Weight	ASTM D3776-96	Oz/Square Yard	9.00	10.0
Finished Fabric Width	ASTM D3774-96	Inches	60.0	60.0
Hydrostatic Test	AATCC 127-1998	cm	40.0	150.0
Oil Repellency	AATCC 118-1997	Grade	5	5
Spray (Large)	AATCC 22-200	Rating	100 Front 100 Back	100 Front
Break Strength	ASTM D5034-95	Lbs. of Force	285 Warp 180 Weft	300 Warp 200 Weft
Tear Strength (wing rip)	ASTM D2261-96	Lbs. of Force	12 Warp 8 Weft	12 Warp 8 Weft
Tabor Stiffness	ASTM D1388-96	Tabor Unit	12.0	Not tested
Wyzenbeek Abrasion-Wire Screen	ASTM D4157-92	Cycle	40,000 Warp 40,000 Weft	40,000 Warp 40,000 Weft
California Technical Bulletin #117	TB 117-2013	Pass/Fail	Meets Class 1 Requirements	Meets Class 1 Requirements
Colorfastness to Light	AATCC 169-2003 Option 3	Grade	Grade 4 @ 2200 Kj	Grade 4 @ 2200 Kj
	SAE 1960J	Grade	Grade 4/5 @ 1500 Kj	Grade 4/5 @ 1500 Kj

Table Eleven (b) – Mariner and Sunbrella product Testing (Australian Standards)

Properties	Test Method	Unit	Sunbrella	SunBrella Plus	Mariner Hooding
Fabric Weight		gsm	314	340	625
Finished Fabric Width		cm	152; 203*	152;203*	205
Hydrostatic Test	AS 2001.2.17	kilopascal	3.4	24	>250
Break Strength	AS 2001.2.3	Newtons/50 mm	1358 Warp 797 Weft	1334 Warp 860 Weft	2100 warp 1500 weft
Elongation at Break	AS 2001.2.3	% change in length	36 Warp 33Weft	27 Warp 28 Weft	
Tear Strength (Tongue tear)	BS 3424 pt 5	Newtons	96 Warp 55 Weft	84 Warp 58 Weft	140 warp 100 weft

*Note: Limited colour choices in the 203 cm width option.

Table Ten (a): Flexible Clear Calendered PVC (Rollclear) Specification

Properties	Test Method	Unit of Measure	0.5 mm UV 3S	0.75 mm UV 3.5S	1.0 mm UV 4S
Gauge		inches	0.020	0.030	0.040
Thickness		mm	0.5	0.75	1.00
Finished Weight		gsm	635	950	1270
Breaking Force	JIS K 6732	N/cm	136 MD; 135 TD	167 MD; 158 TD	250 MD; 227 TD
Elongation at Break	JIS K 6732	%	349 MD; 370 TD	460 MD; 450 TD	402 MD; 400 TD
Elastic modulus at Break	JIS K 6732	N/cm	57 MD; 55 TD	54 MD; 51 TD	100 MD; 94 TD
Tear Strength (Wing Rip)	JIS K 6732	Newtons	42 MD; 42 TD	49 MD; 47 TD	81 MD; 78 TD
Cold Crack	JIS K 6772	^{o}Celsius	-45 MD; -35 TD	-50 MD; -45 TD	-50 MD; -45 TD
Light Transmission	JIS K 7105	%	87.2	86.2	84.4
Accelerated Weather test	JIS A - 1415	Condition after 500 hours	No observable change	No observable change	No observable change

Note: MD is the Machine Direction; TD is the Transverse Direction

Table Ten (b): Flexible Clear Extruded PVC (Rollglass) Specification

Properties	Test Method	Unit of Measure	0.75 mm UV 2.5S	1.0 mm UV 2S
Gauge		inches	0.030	0.040
Thickness		mm	0.75	1.00
Finished Weight		gsm	950	1270
Breaking Force	JIS K 6732	N/cm	201 MD; 182 TD	276 MD; 255 TD
Elongation at Break	JIS K 6732	%	338 MD; 347 TD	300 MD; 344 TD
Elastic modulus at Break	JIS K 6732	N/cm	97 MD; 92 TD	149 MD; 129 TD
Tear Strength (Wing Rip)	JIS K 6732	Newtons	51 MD; 48 TD	97 MD; 92 TD
Cold Crack	ASTM D-1593	^{o}Celsius	-41 MD; -36 TD	-32 MD; -25 TD
Accelerated Weather test	JIS A - 1415	Condition after 500 hours	No observable change	No observable change

Note: MD is the Machine Direction; TD is the Transverse Direction

APPENDIX A CARE AND MAINTENANCE INSTRUCTIONS

Appendix A1 Sunbrella Acrylic Fabrics

One of the best ways to keep Sunbrella® fabrics looking good and to delay the need for deep or vigorous cleaning is to hose fabrics off on a monthly basis with clear water. This practice will help prevent dirt from becoming deeply embedded in the fabric and eliminate the need for more frequent vigorous cleaning. In most environments, a thorough cleaning will be needed every two to three years.

When it's time for a thorough cleaning, Sunbrella fabrics can be cleaned while still on a boat or, size permitting, they can be removed for cleaning in a washing machine or dock side. When cleaning Sunbrella fabrics, it is important to observe the following:

- Always use a mild detergent such as Woolite or Dawn dishwashing liquid.
- Water should be cold to lukewarm.
- Rinse thoroughly to remove all detergent residue.
- Air dry only. Never apply heat to Sunbrella fabrics.

General or light cleaning

To clean Sunbrella while still on a boat, follow these simple steps:

- Brush off loose dirt.
- Hose down.
- Prepare a cleaning solution of water and mild detergent such as Woolite or Dawn.
- Use a soft bristle brush to clean.
- Allow cleaning solution to soak into the fabric.
- Rinse thoroughly until all detergent residue is removed.
- Air dry.
- May not require re-treatment depending on the age of the fabric.

If stubborn stains persist, you can use a diluted chlorine bleach/detergent mixture for spot cleaning of mildew, roof run-off or other similar stains (see Stain Cleaning Chart Chart below for specific recommendations).

Heavy cleaning for stubborn stains and mildew

Sunbrella fabric does not promote mildew growth, however, mildew may grow on dirt and other foreign substances that are not removed from the fabric. To clean mildew, or other stubborn stains:

- Prepare a solution of 1 cup bleach and 1/4 cup of mild detergent per gallon of clean water.
- Soak affected area in solution for 15 minutes.
- Remove stain with a sponge or clean towel.
- Rinse thoroughly to remove all detergent residue.
- Air dry.

Remember to protect the area around your Sunbrella fabric if using a bleach solution. Carpet or other fabrics that are not Sunbrella, or sewing thread may have an adverse reaction to the bleach. If a boat cover is suitable in size for a washing machine, these steps should be followed:

- Use mild detergent.
- For heavier stains add 1 cup of bleach to wash.
- Wash and rinse in cold water.
- Air dry. Never apply heat to Sunbrella.
- Re-treatment for water and stain resistance will be necessary after machine washing.

DO NOT dry clean Sunbrella fabrics.
DO NOT use a steamer or iron set to steam setting.

Re-treating the fabric

As part of the finishing process, Sunbrella fabrics are treated with a fluorocarbon finish, which enhances water repellency. This finish is designed to last for several years, but must be replenished after a thorough cleaning. Based on test results, Glen Raven recommends 303 High Tech Fabric Guard™ as the preferred re-treatment product for Sunbrella fabrics. Fabrics should be re-treated after thorough cleaning or after five years of use. For more information on re-treatment products, please visit www.303products.com.

Applying 303 High Tech Fabric Guard

303 should be applied to Sunbrella fabrics after each thorough cleaning, which typically removes the original finish and reduces the fabric's water repellency.

- Clean Sunbrella fabric, using one of the cleaning methods.
- Allow Sunbrella to completely air dry.
- Apply 303 Fabric Guard in a well ventilated area following instructions on the container.
- Apply 303 in a thin, even coat and allow fabric to dry completely.
- Apply a second thin, even coating of 303.
  (Two light coatings are more effective in restoring fabric water resistance than a single heavy coating. A 15-ounce bottle provides coverage of up to 50 square feet of fabric.)

Appendix A2 Sunbrella Upholstery Fabrics

Cleaning Removable Fabric

Hand Washing Soak fabric in a solution of ¼ cup mild soap per gallon of lukewarm water. Use a sponge or very soft bristle brush to lightly agitate the stain. Then rinse thoroughly to remove all soap residue, and allow fabric to air dry. *Machine washing* Some removable cushion covers can be washed in the washing machine. To wash, first close all zippers. Machine wash in cold water on the delicate cycle with normal amounts of mild laundry detergent. For severe mold or mildew, add 1 cup of bleach. Allow fabric to air dry.

Cleaning Non-Removable Fabric

Prepare a solution of ¼ cup mild soap per gallon of lukewarm water. Use a soft bristle brush to clean, allowing the cleaning solution to soak into the fabric. Rinse thoroughly to remove all residue and allow fabric to air dry.

Mold and mildew stains

Sunbrella fabrics do not promote mildew growth, however, mildew may grow on dirt and other foreign substances if not removed from the fabric. To remove mold or mildew:

- Prepare a solution of 1 cup of bleach and ¼ cup mild soap per gallon of water.
- Spray on entire area and allow to soak into the fabric for 15 minutes.
- Clean entire surface area with a sponge, clean towel or very soft bristle brush. • Rinse thoroughly to remove all soap residue.
- Air dry.

For severe mold/mildew growth, bleach quantities may be increased. It is best to clean the entire surface area of the fabric to avoid water rings and stains. For information on cleaning other common stains, see Acrylic Stain Cleaning Chart.

Appendix A3 Sunbrella Seamark

Sunbrella SeaMark does not promote mildew growth, however, mildew may grow on dirt and other foreign substances that are not removed from the fabric. This is especially true in warm, humid and dark environments. A program of keeping the fabric clean through regular washings, before mildew appears, will enhance the life and beauty of the acrylic and make successive cleaning easier. Full cleaning instructions are available on the Sunbrella website.

We recommend 303 Fabric Guard for re-treating the fabric surface of Seamark for water repellency and 303 Aerospace Vinyl Protectant for protecting the underside after cleaning.

Bird and tree droppings, as well as other loose particle soils, should be removed immediately. Vacuum with a brush attachment and rinse thoroughly with water to remove. This will prevent the soils from being redeposited during cleaning. Once the fabric has been rinsed, thoroughly spray a recommended cleaning solution over the entire surface and allow the cleaner to soak for 10 to 20 minutes. Then scrub lightly with a soft nylon brush, (one that you would feel safe in using on your car) or a terry cloth rag. Rinse thoroughly, until no remaining soap foam is observed. Additional cleanings may be required. It is best to determine the need for additional cleanings after the fabric has dried completely. Air dry only. Once it is completely dry the fabric can then be treated with 303 Fabric Guard.

Acrylic Stain Cleaning Chart

STAIN	RECOMMENDED CLEANING SOLUTIONS
BUTTER	Apply cornflour as an absorbent, remove excess , clean up with liquid detergent and water.
BEER	20 ml liquid detergent, 30 ml white vinegar per litre of water
BERRY	20 ml liquid detergent, 30ml to 60ml white vinegar per litre of water
BIRD DROPPINGS	20 ml liquid detergent per litre of water
BLOOD (DRIED)	Combine 20 ml liquid detergent and 40 ml ammonia per litre of water.
CHARCOAL, PENCIL MARKS	Vacuum, then clean with 20 ml liquid detergent per litre of water.
CHEWING GUM	Treat with isopropyl alcohol. Then clean with 20 ml liquid detergent per litre of water.
CHOCOLATE	Combine 20 ml liquid detergent and 40 ml hydrogen peroxide per litre of water.
COFFEE	Combine 20 ml liquid detergent per litre of water.
COLA	Combine 20 ml liquid detergent per litre of water.
CRAYON	Treat with isopropyl alcohol. Then clean with 20 ml liquid detergent per litre of water.
EGG (RAW)	Combine 20 ml liquid detergent per litre of water.
FOOD COLOURING	Combine 20 ml liquid detergent and 30 ml white vinegar per litre of water.
GRAPE JUICE	Combine 20 ml liquid detergent per litre of water.
GREASE (CAR)	Apply cornflour as an absorbent, remove excess , clean up with liquid detergent and water.
INK (PERMANENT, INDIA, BALLPOINT)	Treat with volatile solvent (acetone 100%). Then clean with soap and water and rinse thoroughly
IRON RUST	Treat with "Calcium Lime Rust" and rinse thoroughly.
MILDEW	Combine 20 ml liquid detergent and 80 ml bleach per litre of water
MILK	Combine 20 ml liquid detergent per litre of water.
MUSTARD	Combine 20 ml liquid detergent per litre of water.
NAIL POLISH	Treat with volatile solvent (acetone 100%). Then clean with soap and water and rinse thoroughly
OIL	Apply cornflour as an absorbent, remove excess , clean up with liquid detergent and water.

Acrylic Stain Cleaning Chart (Continued)

STAIN	RECOMMENDED CLEANING SOLUTIONS
PAINT WET / DRIED (LATEX, OIL, LACQUER)	Apply cornflour as an absorbent, remove excess , clean up with liquid detergent and water.
SHOE POLISH (LIQUID)	Apply cornflour as an absorbent, remove excess , clean up with liquid detergent and water.
SHOE POLISH (WAX)	Apply heated iron over towel. Apply cornflour as an absorbent, remove excess with a straight edge, clean up residual with liquid detergent and water.
SUNTAN LOTION	Apply cornflour as an absorbent, remove excess , clean up with liquid detergent and water.
TEA	Combine 20 ml liquid detergent per litre of water.
TOMATOE JUICE	Apply cornflour as an absorbent, remove excess , clean up with liquid detergent and water.
TREE SAP	Treat with solvent to soften (Turpentine) and remove as much of the tree sap as possible. Repeat as necessary. Then clean with soap and water and rinse thoroughly to remove solvent.
URINE	Combine 20 ml liquid detergent and 30 ml white vinegar per litre of water.
VOMIT	Combine 20 ml liquid detergent and 30 ml white vinegar per litre of water.
WATER COLOUR	Detergent, water, white vinegar
WAX (CANDLE)	Combine 20 ml liquid detergent and 30 ml white vinegar per litre of water.
WINE	Combine 20 ml liquid detergent, 30 ml white vinegar and 40 ml isopropyl alcohol or hydrogen peroxide per litre of water.

Appendix A4 PVC Marine Covers (Mariner and Riviera)

Wash regularly to avoid the accumulation of residue that could foster mildew growth and staining. To clean, first brush off loose dirt and rinse with lukewarm water. Wash with a sponge or soft brush, with lukewarm water and dishwashing detergent. Soak if necessary and let soap suds stand for a short while, but do not allow to dry. Rinse off soap residue with clean water. Allow to thoroughly dry before stowage.

In general, most soiling can be removed after repeated applications. If necessary, a 1:10 dilution of household bleach containing 5.25% Sodium Hypochlorite will not harm the fabric's PVC surface. Moderate scrubbing with a medium bristle will help loosen the soiling agent from the depressions of embossed surfaces.

Powdered abrasives, steel wool and industrial strength cleaners are not recommended, as they will dull the surface gloss. Dry cleaning fluids and lacquer solvents attack the surface, and should not be used.

Certain stains may become set if they are not removed immediately, so act quickly. Fresh stains such as lipstick, shoe polish, suntan cream and grease can be wiped with a cloth impregnated with methylated spirits, then washed with soapy water.

Dry stains should be coated with a paste made of equal parts of talcum powder and a dilute solution of bleach, allowed to dry and then cleaned off with methylated spirits.

DO NOT use industrial strength cleaners or vinyl conditioners, such as AMORALL, which tend to leach out the plasticisers, and reduce the life of the products

Appendix A5 Upholstery Vinyl

General Cleaning – Regularly clean fabrics with a solution of mild soap and water using a soft cloth or towel. Rinse thoroughly with fresh water and wipe dry.

Spot Cleaning – Spills and general marking is inevitable in a marine environment. Prompt attention to the affected area will minimise the chance of staining or fabric degradation. If a stain cannot be cleaned using the general cleaning instructions, clean the affected area with a solution of 30% methylated spirits and 70% water. Rinse thoroughly with fresh water and wipe dry.

Disinfection – If it is necessary to disinfect the upholstery surface, clean the fabric using the general cleaning instructions, then using a solution of 10% bleach and 90% water, wipe the surface for a second time. Rinse thoroughly with fresh water and wipe dry.

Appendix A6 Strataglass, (also applies to Vybak and Achilles products)

To properly clean and maintain your STRATAGLASS products Herculite only recommends using Strataglass Protective Cleaner and Strataglass Protective Polish. Both products are branded IMAR. Use of non-authorized cleaners or protectants may damage the Strataglass and void the warranty.

ALWAYS use Strataglass Protective Cleaner to immediately remove harmful liquids, creams, chemicals or sprays that come in contact with the Strataglass surface.

Rinsing the Strataglass Curtains: Each time you use the boat, flush the curtains thoroughly with clear water to rinse away any salt or environmental abrasives. Air dry or use a high quality chamois or a microfiber towel.

Cleaning the Strataglass Curtains: (every 1-2 weeks) Spray the Strataglass Protective Cleaner directly on the inside and outside surface of the STRATAGLASS or onto a soft cotton or micro fiber cloth. Gently wipe the STRATAGLASS surface to clean. If necessary, buff dry with another dry clean cloth. Strataglass Protective Cleaner should always be on hand for emergency spot cleaning of any harmful liquids, creams, chemicals or sprays that may come in contact with the STRATAGLASS surface.

Polishing the Strataglass Curtains: (every 1-2 months) this is the most important maintenance procedure to extend the life of the curtains and maintain the warranty. Make sure the STRATAGLASS product is clean and dry. Apply a light coat of Strataglass Protective Polish, inside and out, with small, light circular motions using a soft cotton cloth or applicator pad. Allow the polish to quickly dry. Lightly buff with a dry soft cotton or micro fiber cloth to a sparkling smooth shine. The Strataglass Protective Polish should be applied every 1-2 months, especially when the enclosure is new. Over time, with multiple applications, the polish will build up a protective barrier.

Note to the Fabricator: Upon project completion, we recommend using Strataglass Protective Cleaner to thoroughly clean the enclosure panels followed by a thorough application of Strataglass Protective Polish, both inside and out, as a final step in the fabrication process. This will establish the first basecoat of protection and promote watershed.

Note to the Owner: New clear vinyl products are soft and easily impressionable. We recommend that new STRATAGLASS enclosures panels should be in the installed position and fastened securely to the boat as much as possible. If the new curtains need to be removed and stacked, the enclosure panels should be carefully interleafed with a soft fabric such as a bed sheet. Clear vinyl will inherently strengthen over time and become less impressionable. When the boat is not in use, always close and fasten the STRATAGLASS enclosure panels in place to prolong the life of your curtains and maintain clarity.

NEVER use:-

1. other than IMAR products cleaner to clean STRATAGLASS products.
2. car wax or any kind of wash and wax to protect STRATAGLASS products.
3. cleaners, polishes, scratch removers, or any products intended for commercial grade vinyl or plastic.

This may damage the STRATAGLASS and void the warranty.

APPENDIX B NOLAN GROUP LIMITED PRODUCT WARRANTIES

Appendix B1 Marine Canopy and Acrylic Seating Fabrics

The Nolan Group warrants that its Marine Canopy Fabrics (SUNBRELLA, MARINER and RIVIERA) are specifically designed to be used in a marine and general outdoor context, and are guaranteed to be supplied free of defects.

'Free of Defects' means that the products meet their published descriptions and technical specifications, and are homogeneous in appearance after allowance for minor variance that is inherently the result of the manufacturing process.

The Nolan Group further warrants that the products will perform satisfactorily when used in its design context in the temperate climatic conditions experienced throughout Australia.

'Satisfactorily' means with continued but gradually diminished utility over its expected life, due to the unavoidable effects of Ultra-Violet Radiation and Weathering, such as colour fading, strength loss, and dimensional change. Extreme climatic conditions, particularly high temperature and humidity may accelerate this inevitable product degradation.

'Expected Life' is at least the period covered by warranty, provided the products are installed properly, and cleaned and maintained as recommended.

The warranty specifically excludes imperfections such as mottling, waffling, and folds caused by handling during fabrication of a canopy or its installation or its operation; mechanical fatigue due to wind load, and damage attributable to faulty design or installation, such as abrasion by componentry; or tear caused by undue concentration of stress at supports; to chemical attack due to atmospheric pollutants; to storm or cyclone events, including hail loading; and to vandalism.

The warranty period for SUNBRELLA Canopy and Upholstery fabrics (including SEAMARK) is TEN YEARS; for MARINER is TWO YEARS; and RIVIERA is FIVE YEARS

The liability of the Nolan Group is limited under this warranty to replacement of material only, or refund of the original invoice price, both options with a discount on value for the time the fabric has been in place, on a pro-rata basis as follows:-

The first half of the warranty period	Nil Discount
The third quarter of the warranty period	50% Discount
The final quarter of the warranty period	75% Discount

Liability for negligence (e.g careless operation, inappropriate cleaning procedures), or for any consequential loss, including labour and installation, is expressly excluded.

In the event of a claim, proof of purchase must be provided. In the event of a dispute, the determination of the manufacturer or recognised industry association is the sole basis on which replacement or refund is made.

This limited warranty shall under no circumstances override legal guarantees that may be required under the Consumer Act. The warranty is not transferrable and applies only to the original purchaser.

The Nolan Group Warranty is independently supported by those of our Suppliers:-
GLEN RAVEN Inc 1831 North Park Ave, Glen Raven NC 27217-1100 USA www.glenraven.com
Herculite Products Inc P.O. Box 435 Emigsville PA 17318 USA www.herculite.com

APPENDIX B (Continued) NOLAN GROUP LIMITED PRODUCT WARRANTIES

Appendix B2 Flexible Clear PVC

The Nolan Group warrants that the Flexible Clear PVC products, manufactured by Achilles (ROLLCLEAR and ROLLGLASS) and Herculite (STRATAGLASS, CRYSTAL CLEAR and VYBAK) are specifically designed to be used for Marine Clears, and are guaranteed to be supplied free of defects.

'Free of Defects' means that the products meet their published descriptions and technical specifications and are homogeneous in appearance after allowance for minor variance that is inherently the result of the manufacturing process.

The Nolan Group further warrants that the products will perform satisfactorily when used in its design context in the temperate climatic conditions experienced throughout Australia.

'Satisfactorily' means with continued but gradually diminished utility over its expected life, due to the unavoidable effects of Ultra-Violet Radiation and Weathering, such as gradual discolouration and embrittlement. Extreme climatic conditions, particularly high temperature and humidity may accelerate this inevitable product degradation.

'Expected Life' is at least the period covered by warranty, provided the products are installed properly, and cleaned and maintained as recommended.

The warranty specifically excludes imperfections such as creasing, folds, etc. caused by handling during fabrication, installation or operation; mechanical fatigue due to wind load, and damage attributable to faulty design or installation, such as abrasion by componentry; or tear caused by undue concentration of stress at supports; to chemical attack by pollutants; to storm or cyclone events, including hail loading; and to vandalism.

The warranty period is TWO YEARS for ROLLCLEAR and ROLLGLASS; STRATGLASS, CRYSTAL CLEAR and VYBAK; and THREE YEARS for ROLLGLASS PLUS.

The liability of the Nolan Group is limited under this warranty to replacement of material only, or refund of the original invoice price, both options with a discount on value for the time the fabric has been in place, on a pro-rata basis as follows:-

The first half of the warranty period	Nil Discount
The third quarter of the warranty period	50% Discount
The final quarter of the warranty period	75% Discount

Liability for negligence (e.g careless operation, inappropriate cleaning procedures), or for any consequential loss, including labour and installation, is expressly excluded.

In the event of a claim, proof of purchase must be provided. In the event of a dispute, the determination of the manufacturer or recognised industry association is the sole basis on which replacement or refund is made.

This limited warranty shall under no circumstances override legal guarantees that may be required under the Consumer Act. The warranty is not transferrable and applies only to the original purchaser.

The Nolan Group Warranty is independently supported by that of our Suppliers:-
Achilles Corporation Shinjuku Front Tower,2-21-1, Kita-Shinjuku, Shinjuku-ku, Tokyo 169-8885
www.achilles.jp/english
Herculite Products Inc P.O. Box 435 Emigsville PA 17318 USA www.herculite.com

APPENDIX B (Continued) NOLAN GROUP LIMITED PRODUCT WARRANTIES

Appendix B3 Expanded Vinyl Seating (Capri, Cordova, Silvertex, and Nortex Carbon Fibre)

The Nolan Group warrants that the Expanded PVC products, manufactured by Nylex Malaysia (CAPRI and CARBON FIBRE) and Spradling (CORDOVA and SILVERTEX) are specifically designed to be used for Marine Seating, and are guaranteed to be supplied free of defects.

'Free of Defects' means that the products meet their published descriptions and technical specifications and are homogeneous in appearance after allowance for minor variance that is inherently the result of the manufacturing process.

The Nolan Group further warrants that the products will perform satisfactorily when used in its design context in the temperate climatic conditions experienced throughout Australia.

'Satisfactorily' means with continued but gradually diminished utility over its expected life, due to the unavoidable effects of Ultra-Violet Radiation and Weathering, such as gradual discolouration and embrittlement. Extreme climatic conditions, particularly high temperature and humidity may accelerate this inevitable product degradation.

'Expected Life' is at least the period covered by warranty, provided the products are installed properly, and cleaned and maintained as recommended.

The warranty specifically excludes staining resulting from mildew growth on adjacent boat components, bleeding from adjacent boat components or denim clothing, or contact with suntan lotion, teak oil, or engine grease; degradation due to the presence of amines in adjacent urethane foam cushioning; damage caused by improper installation or failure of the seat and/or trim parts; deterioration due to the use of improper cleaning materials or procedures; and abuse or abnormal wear.

The warranty period is TWO YEARS for CAPRI, CORDOVA, SILVERTEX, and CARBON FIBRE ranges.

The liability of the Nolan Group is limited under this warranty to replacement of material only, or refund of the original invoice price, both options with a discount on value for the time the fabric has been in place, on a pro-rata basis as follows:-

The first half of the warranty period	Nil Discount
The third quarter of the warranty period	50% Discount
The final quarter of the warranty period	75% Discount

Liability for negligence (e.g careless operation, inappropriate cleaning procedures), or for any consequential loss, including labour and installation, is expressly excluded.

In the event of a claim, proof of purchase must be provided. In the event of a dispute, the determination of the manufacturer or recognised industry association is the sole basis on which replacement or refund is made.

This limited warranty shall under no circumstances override legal guarantees that may be required under the Consumer Act. The warranty is not transferrable and applies only to the original purchaser.

The Nolan Group Warranty for Cordova and Silvertex is independently supported by that of our Supplier:-
Spradling International Inc, 200 Cahaba Valley Parkway North; P.O. Box 1668, Pelham AL 35124
www.spradlingvinyl.com

APPENDIX C TESTING OF THE COMPARATIVE PERFORMANCE OF CANOPY FABRICS

Basis of Testing

Unfortunately, there are currently no recognised Australian or International Standards relating to the minimum specification or expected performance of Marine Canopy Fabrics.

For this reason, the Nolan Group requested Australian Wool Testing Authority (AWTA) to recommend a series of tests to simulate conditions likely to be experienced in a marine environment, with specific emphasis on the impact of Ultra-Violet light and mildew. The tests, which are described in detail below, were carried out simultaneously four products, namely *Sunbrella, Sunbrella plus, Mariner*, and *Herculite 2000*, in order to assess their comparative performance under identical test conditions.

Ultra - Violet exposure was simulated by a Xenon Arc light source, which replicates the spectral composition of sunlight. The arc was integrated into an Atlas Weatherometer, which allows modelling of extreme variations in temperature and humidity at the same time. However, while the results for different fabrics can be compared directly, caution should be exercised in extrapolating the results to measure field performance, as there is no scientifically accepted correlation between accelerated exposure to light and expected life.

Testing the effect of Ultra-Violet Light on Tear and Tensile Strength

Breaking Strength is a measure of the ultimate tensile strength of a parallel group of fibres within the woven matrix. In test method AS 2001.2.3, the ultimate load is expressed in Newtons per 50 mm, and extension at break as a percentage of the original length.

Tear strength is a measure of how readily the yarns in the fabric can be sheared. The British "Tongue Tear" test (BS 3424 pt 5) was adopted because it appeared to best simulate the action of an eyelet being pulled down the fabric.

This is different from the Australian "wing – rip" test (AS 2001.2.10) in which the sample has only a single cut. Although the results of both tests are expressed in Newtons, they cannot be directly compared. The British test effectively measures the force required to make two tears in parallel, against only one in the Australian test, and hence one would expect higher results. Comparative figures for "Mariner" are shown in **Table C1**.

Table C1 – Difference between "wing-rip" and "tongue" tear test results for "Mariner" Boat Hooding

Direction of Test	AS 2001.2.10 – "Wing –Rip" (Newtons)	BS 3424.5 – "Tongue Tear" (Newtons)
Length	140	267
Width	100	403

The comparative test results for break and tear strength before and after 1344 hours (two months) continuous testing in a weatherometer are shown in **Tables C2** through **C4**. Polyester is known to lose strength under such exposure, and because of its use in the base fabric and scrim in Mariner and Herculite 2000 respectively, some deterioration in both break and tear strength the strength of these products is to be expected. However, the acrylic products also showed strength loss in excess of what would normally be anticipated (i.e. <3% per year), and possibly indicates some testing anomalies.

Table C2 – Results of AS 2001.2.3 "Breaking force and extension of fabric"

	Breaking Force (N / 50 mm)		Extension at break (%)	
	Length	width	length	width
"Mariner"	2134	1542	20.2	24.2
Sunbrella	1358	797	35.8	33.2
Sunbrella plus	1334	860	26.5	27.9
Herculite 2000	1445	1207	24.3	23.6

The relative values of break and tear strength for "Mariner" and Herculite 2000 reflect the nature of their respective base fabrics. The open weave of the latter allows the yarns to bunch under the action of tearing, resulting in much higher resistance. The phenomenon is dependent on how rapidly the tearing force is applied – a more rapid rate of extension of the testing jaws would reduce the measured tear resistance.

Table C3 – Results of BS 3424 pt 5 "Tear strength - tongue method"

	Tearing Force (Newtons)	
	length	width
"Mariner"	267	403
Sunbrella	96.0	55.0
Sunbrella plus	84.0	58.0
Herculite 2000	458	549

Table C4 – Strength loss due to UV exposure

	Breaking Strength (AS 2001.2.3)		Tear strength (BS 3424.5)	
	Length	width	length	width
"Mariner"	-5.4%	-23.3%	-6.0%	-8.4%
Sunbrella	0.0%	-12.5%	-9.4%	-20.0%
Sunbrella plus	0.0%	0.0%	-15.5%	-6.9%
Herculite 2000	-9.3%	-12.5%	-20.5%	-3.3%

Assessment of Relative Water Penetration Resistance

All the fabrics were tested to AS 2001.2.17 "Resistance of fabrics to Water Penetration", and the results are shown in **Table C5**. The maximum pressure that can be applied in the apparatus is 250 kpa. The unit of pressure "kilopascal" is equivalent to a force per unit area of a 100 kilogram mass resting on a square metre. However, pressure is more generally expressed as a depth or column of water, which is also known as "hydraulic head". In this context, one kilopascal is equivalent to about ten centimetres of water.

As to be expected, the fabrics that are "water - proof" have higher penetration resistance than the "water – repellent" Sunbrella, which has the important compensating characteristic of being vapour permeable, that is, "breathable".

Table C5– Resistance to Hydrostatic Pressure (AS 2001.2.17)

	Pressure	Equivalent hydraulic head	
	(kpa)	(metres)	(feet)
"Mariner"	>250	> 25.5	>84
Sunbrella	3.4	0.35	1
Sunbrella plus	24	2.5	8
Herculite 2000	>250	> 25.5	>84

Assessing the "breathability" of Fabrics

The relative impermeability of a fabric can be tested by measuring the moisture vapour transmission through it. Moisture vapour transfer is the result of capillary action and diffusion, caused by different levels of humidity on either side of the membrane.

Sunbrella and Sunbrella 'plus' were tested to ASTM E96 – 2000, using both "Desiccant" and "Water" methods. In the first method, a circular piece of fabric is sealed over the open end of a test pot containing a moisture absorbing substance or "desiccant", which is oven dried before sealing of the pot. Air of specified humidity and temperature is

blown across the tests specimen at a set velocity, and the moisture transfer determined by the change in weight of the desiccant.

In the second method, a known quantity of water is sealed in the pot, and the moisture loss through the material again measured by relative weight of water before and after. The test conditions are the same in both cases, the relative humidity difference being 65% between the faces of the fabric at a temperature of 20°C.

The essential difference between the tests is the direction of vapour flow – into the pot in the "desiccant" method, and out of the pot in the "water" method. The first models the propensity of a dry enclosed space to absorb moisture from the outside air, and the second the propensity of water in an enclosed space to evaporate. In both cases the result are expressed in grams per square metre per hour, and the higher the value, the more efficient the fabric is at transferring moisture. The results are shown in **Table C6**.

To place these results in context, a "control" comprising an unsealed pot with equivalent desiccant or water content was tested at the same time and for the same duration. This measures the situation where no fabric at all impedes moisture flow, and is the maximum that can be expected under the test conditions. At the other end of the scale, the minimum is zero, that is a totally impermeable fabric.

Table C6 – Vapour permeability. Test Method ASTM E 96 -2000

Fabric	Vapour transmission (grams/hour/sq metre)			
	Desiccant Method		Water Method	
	gms/hr/m^2	Efficiency	gms/hr/m^2	Efficiency
Sunbrella	43.93	84.2%	23.51	48.8%
Sunbrella 'plus'	6.47	12.4%	5.34	11.1%
Control (max value possible)	52.16	100%	48.16	100%

The results show that "Sunbrella" is a highly efficient vapour permeable fabric, allowing up to 85% of air through; but at the same as having reasonable water penetration resistance. Note that SunBrella 'Plus' is the same woven and surface treated product, but with a polyurethane coating applied to the underside, which improves water penetration resistance, at the expense of vapour permeability.

Fungal Growth and Cleanability

Test method AS 1157.2 – 1998 "Fungal Resistance of Textiles" is designed to assess the amenity of the fabric as an environment for microbial growth. Samples are inoculated with Aspergillus Niger, and the growth or decline of this mildew culture assessed against a standard "control", which is essentially an environment which is known to be amenable. The results are assessed on a scale of one (no growth) to five (heavy growth). All of the fabrics when tested in their virgin state were rated as zero, that is, exhibited no mildew growth.

Samples of each of the fabrics were then abraded (test method EN 530 – 1994) for 30,000 cycles, and the culture growth test repeated, with any growth assessed as "severe", "moderate", "slight" or "no growth". The aim of this test was to determine the permanency of any surface applied mildew treatment. Three types of standard cleaning processes were then used on the abraded samples, and the extent of mould retained again assessed. The aim of this test was to determine how easy it was to remove the mildew. The washing / cleaning processes used were: -

1. A wipe of the affected area with a damp sponge
2. A wipe of the affected area with a damp sponge and detergent
3. A wipe of the affected area with a damp sponge and detergent, followed by a rinse under tap water.

Each of the samples cleaned by these procedures was allowed to air dry for 24 hours before evaluation. The cleaned samples were then resealed in plastic bags containing moistened paper towel and placed in an oven maintained at 40 degrees Celsius for a further 168 hours. This was designed to assess the propensity for mildew re-growth. The results for the four fabrics are shown in **Table C7**.

Table C7 – Propensity for mildew growth after abrasion, cleaning and re-incubation

	"Mariner"	Sunbrella	Sunbrella "Plus"	Herculite 2000
Extent of mildew growth after abrasion and deliberate incubation:-	Severe	Severe	Severe	None
Extent of mildew after cleaning:-				
(a) wipe only	Slight/moderate	Slight	Slight/moderate	None
(b) wipe with detergent	Slight/moderate	Slight	Slight/moderate	None
(c) wipe with detergent and rinsed	Slight	Slight	slight	None
Extent of mildew re-growth after cleaning and re-incubation:-				
(a) wipe only	Slight re-growth	No additional regrowth	No additional regrowth	None
(b) wipe with detergent	No additional regrowth	No additional regrowth	No additional regrowth	None
(c) wipe with detergent and rinsed	No additional regrowth	No additional regrowth	No additional regrowth	None

APPENDIX D TESTING FLEXIBLE PVC GLAZING

Summary of Relevant Test Results

Herculite (manufacturers of "CrystalClear", and "Strataglass") and Achilles (manufacturers of "Rollclear" and "Rollglass") have different specifications and test methods for measuring particular physical properties. However, many of the test methods are similar, and the results can be normalised (for example, by expressing tensile strength as a force per unit length). The main differences between the various products lie in degree of clarity and dimensional stability. Otherwise they are relatively homogeneous materials with similar physical properties.

Flexibility

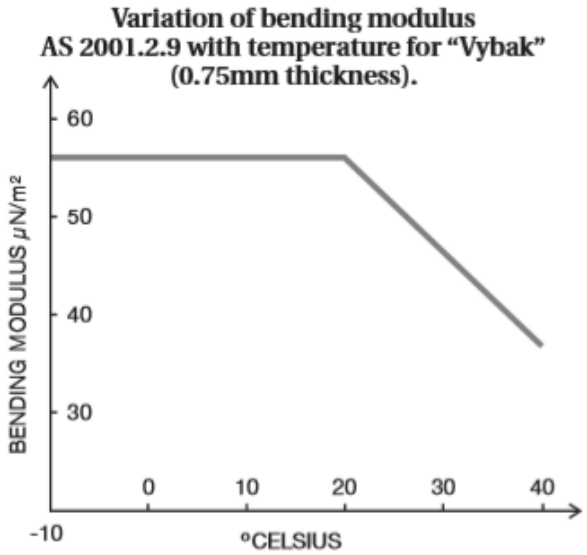
Experienced fabricators recognise that the workability of flexible clear PVC depends very much on ambient temperature. On cold days in winter for example, the material seems more difficult to fabricate, seemingly stiffer and more brittle, than on warm days in summer. The workability of the material is technically defined by two separate factors, namely its flexibility and Elastic Modulus.

The flexibility (sometimes referred to as "softness" or "hardness") of clear PVC is primarily a function of the amount of plasticiser added to the material, but also varies slightly with ambient temperature. Since plasticiser is the key determinant of field performance, the more added the longer the life of the product. The softer sheet is easier to work and roll up, but is more susceptible to scratching than a harder material, which also has better drape and therefore apparent clarity.

Physical properties vary with the amount of plasticiser added. Stiffness, which is technically the Elastic Modulus, is a measure of the relationship between applied stress (i.e. load) and the resultant strain (i.e the deformation under load) for the material.

The Stiffness or Bending Modulus for 0.75mm thickness Vybak has been determined by testing to Australian Standard AS 2001.2.9 "Determination of Stiffness of Cloth". The results vary with temperature, as shown in **Figure C1,** with the Bending Modulus relatively constant until room temperature (i.e 20°Celsius), and declining dramatically thereafter. The higher the temperature, the more flexible the material. Similar results could be expected with the Achilles and Herculite products.

Figure C1



Dimensional stability

Both the calendaring and extrusion processes exert considerable forces on the hot PVC "dough" as it is processed into sheeting. These applied forces result in residual stresses in the finished sheet, which are released when the material is allowed dimensional freedom. Whilst wound on a roll under tension, the sheet is constrained in both longitudinal and lateral directions, and residual stress is not relieved until it is cut off the roll.

Typically, the release of these residual stresses results in contraction in length in a direction along the roll, and expansion in width in a direction across the roll. The amount of contraction and expansion is dependent on both temperature and time. At room temperature these residual stresses are generally relieved over a period of a few days. At higher temperatures, the process is accelerated, and samples heated in an oven for ten minutes provide an indication of the extent of dimensional change that could be experienced. Typical results for a samples of "Rollclear" and "Rollclear DS" are shown in **Table C9.**

The difference between the two products is clearly demonstrated in the table. Rollclear DS has less dimensional change because the induced production stresses are less, because of careful management and control of the whole process, particularly tension of the calendered sheets.

Based on the figures in **Table C9**, up to -3.2% shrinkage along the roll, and up to 2.0% expansion across the roll can be expected due to stress relief for RollClear SLS Standard; and -1.1% and +0.7% respectively for Achilles DS. The actual amount will depend on the stresses induced, and varies considerably between batches. Experience has shown that in most cases, the actual dimensional change is considerably less than the figures shown.

Table C9 – Dimensional Stability of Calendered Rollclear

Temperature (°C)	Contraction (-) in length (%) along the roll		Expansion (+) in width (%) across the roll	
	Rollclear Standard SLS	Rollclear 'DS'	Rollclear Standard SLS	Rollclear 'DS'
0 °	0.0%	0.0%	0.0%	0.0%
40 °	-1.0%	-0.4%	+1.0%	+0.1%
50 °	-1.8%	-0.4%	+1.0%	+0.1%
60 °	-2.1%	-0.4%	+1.4%	+0.1%
70 °	-3.0%	-0.4%	+1.7%	+0.3%
80 °	-3.2%	-1.1%	+2.0%	+0.7%

Press Polished Clear is reheated during the press polishing production process, and thus is inherently stress relieved. Any dimensional change experienced is probably due to thermal effects. Vybak has been tested according to AWTA 56 - 1993 (modified) across the range of temperatures likely to be experienced in the field, and the results are listed in **Table C10**

Compared to a sheet conditioned at 20°Celsius, some shrinkage in both directions can be expected at lower temperatures, and expansion at higher temperatures. At 40°Celsius, the results show some contraction in both directions, which is probably evidence of stress relief.

Table C10 - Dimensional stability of Vybak sheet (0.75mm)

Mean linear change compared to a similar specimen at 20°Celsius, when exposed to:-	length (%)	width (%)
48 hours at -10°Celsius	-0.08	-0.03
48 hours at +30°Celsius	0.00	0.03
48 hours at +40°Celsius	-0.05	-0.03

Visual Light Transmission, Haze and UV stability

The relative clarity of a clear PVC sheet is assessed by measuring "Visual Light Transmission" and "Haze".
The visual light transmission is defined as the amount of light passing through the material, as opposed to that reflected, and haze is the amount of scattering of the transmitted light, outside of a 2.5^{o} bandwidth angle.

Achilles and Herculite use similar, but different apparatus for measuring these parameters, and the results cannot be directly compared. Achilles test to Japanese standard JIS K6714, and Herculite to US standard ASTM D 1003, which is also specified in the US Federal motor vehicle standard ANSI Z26. The tests measure the parameters, both before and after the test specimen has undergone a degree of simulated weathering or other conditioning.

The Achilles' test results for "Rollglass" are shown in **Table C11**. Since clear PVC absorbs moisture, the tests were repeated after soaking the sample in water for 24 hours at room temperature, designed to simulate the effect of changes in humidity; and also after rubbing the surface 1000 times with a cotton cloth under a one kg load, designed to simulate the abrasive effect of cleaning.

Table C11- Optical characteristics of "Rollglass"

Before conditioning:-	
Haze Value (%)	2.2%
Light Transmission (%)	85.6%
After Soaking:-	
Haze Value (%)	5.0%
Light Transmission (%)	83.1%
After Rubbing:-	
Haze Value (%)	2.6%
Light Transmission (%)	85.6%

The comparative transparency of "Rollclear" and "Rollglass" has been assessed in a "Visual light - Scattering Tester", (a more sophisticated apparatus than a haze meter used in JIS K6714), which measures haze over wavelengths of light discernable to the human eye. The results are shown in **Table C12**, and demonstrate the better optical transparency of "Rollglass", particularly on inclined angles.

Table C12 - Comparative Haze values for “Rollclear” and “Rollglass”

Inclined angle of the surface (from vertical)	“Rollclear”	“Rollglass”
90°	6.9%	6.1%
45°	8.1%	6.9%
60°	11.2%	7.9%

The results for Vybak, when The US standard ASTM D1003, are expressed in **Table C13** and compared with the requirements of the US Federal Motor Vehicle Standard, ANSI Standard Z26, with which it complies.

Table C13 - results of luminous transmittance test ASTM D1003

Transmittance (%)	Before weathering and UV exposure	After weathering and UV exposure	Decrease
Result for Vybak	79.3% to 80.4%	77.4% to 77.9%	2.4% to 3.5%
ANSI Standard Z26	70%(min)	70% (min)	5.0%(max)

Resistance to Ultraviolet Radiation

Ultra-violet light is the single most important determinant of the life of polished clear. Unless the UV inhibitors added are adequate, the material will very quickly yellow and ultimately breakdown under the action of sunlight. For this reason, a sample of Vybak was subjected to two years continuous 24hr exposure to UV-A radiation in a wet/dry cycle. Vybak showed no discolouring after this exhaustive test. The comparative luminous transmission tests, undertaken by the AWTA in Melbourne, are shown in **Table C14**

Table C14 - Results of luminous transmittance test for Vybak, before and after two years continuous exposure to a UV radiation source at 50°Celsius

Property	Before weathering and UV exposure	After weathering and UV exposure
Transmittance (%)	83.5%	82.9%
Haze Value	0.012	0.061

SYNOPSIS OF THE TECHNICAL GUIDE SERIES

How to Tell a Good Yarn – Textile Manufacture and Testing
Technical Guide Number One

The textile and flooring products mainly used in an outdoor environment are first classified by their basic construction and design function. Then the processes of production and finishing are described, including the implications on product performance of different types of yarn and yarn blends, the matrix of the weave, coating lamination and finishing. The products included are canvas, PVC coated or laminated polyesters, coated polyolefins, clear PVC, knitted shadecloth, expanded vinyl, leather, polyurethane fabrics, needle punched carpet and tufted carpet tiles.

A description of the test procedures used to assess quality attributes are described, and linked to the published specifications of the products; including the relevant Australian Fire tests and the outcomes required by the National Construction Code for Commercial Upholstery, Awnings and Outdoor Blinds, Shade and tension Structures, Flooring and Temporary Structures. A glossary of technical terms used in the textile industry is also included. Although specific to the brands sold by the Nolan Group, the information is sufficiently generic to be applicable to similar products generally used by fabricators in the Textile Conversion Industries.

Shady Characters – Polyfab Shadecloth for Human Protection
Technical Guide Number Two

Beginning with the basics, the two different types of knit construction which fundamentally affect the relative shading efficiency of the various Polyfab brands, or indeed any brand of shadecloth are described and illustrated. Then the concept of shade design, with the need to accommodate the daily and seasonal movement of the sun, is noted, with the consequent risk of lack of protection highlighted.

More technical information is provided on engineering design, including the behaviour of the fabric under two-dimensional loading, how to derive the Elastic Parameters from Biaxial Testing, and guidelines for fabrication and installation. Standard design details for a typical hypar and frame supported structure have been developed, and the procedure for gaining engineering certification for the use of these drawings anywhere in Australia is explained.

The specifications of the Polyfab products are compared with the requirements of AS 4174 – 2018 “Knitted and Woven Shade Fabrics”, including physical properties and the degree of UV protection. The ratings outlined in that standard and how they are integrated into the product warranties are explained. Additional technical information such as Solar heat transmission, flammability and chemical resistance of the products are also included.

What Blind Freddy Knew – Awning and Outdoor Blind Fabrics
Technical Guide Number Three

The primary aim of this guide is to detail the information supporting the Nolan Group’s “Fit for Purpose Statement”, which is in turn designed to clarify the specific meaning of the terms used in the Consumer Act of 2011, and the Nolan Group product warranties.

The terminology related to the different types of Awnings and Blinds is explained and illustrated, as is the basic construction and finish of the fabrics typically used, their specifications, as well as guidelines for fabrication and installation, and care and maintenance instructions. Fabrics included are Acrylic and Polycotton Awning Canvas, PVC coated polyester mesh, and Flexible Clear PVC.

The results of the testing for Solar Absorption, Reflection and Transmission for Vistaweave Mesh (to US standard ASHRAE 74-75 1988) and Dickson Acrylic (to European Standard EN 14500 and EN 14501), are provided and ranked by colour.

Head above Water - Marine Fabrics and Fasteners
Technical Guide number Four

In their dealings with the consumer, the Marine Trimmer has a difficult task in explaining the severity of the boating environment, particularly the effects of UV exposure on fabrics and flexible clear PVC. Starting with illustrations of the types of canopies and the terminology used to describe them, this guide progressively details information relevant to the materials commonly used. Based on protracted laboratory testing, the detail of which is contained as an appendix, it contains a simple table that outlines the comparative characteristics of different canopy materials, which is designed to facilitate appropriate product selection.

Included are product specifications, guidelines to fabrication of canopy materials and flexible clear PVC, Marine carpet and hull lining, upholstery; together with the appropriate use of foam underlay, fasteners, zippers, adhesives and thread. Detailed care and cleaning instructions, and copies of product warranties are provided. The warranties are formatted to the Nolan Group's "Fit For Purpose Statement", and relates the detail of the product's specification to the terms used in the Consumer Act of 2011.

Got you covered – Polycotton Canvas, Coated or Laminated Industrial and Architectural Fabrics
Technical Guide Number Five

Proofed cotton canvas was first developed for use by the British Army in the Crimean War and has been used ever since for temporary outdoor protection. The invention of polyester did not just improve the matrix of canvas, but coupled with PVC, allowed the development of synthetic tarpaulin and tenting fabrics that are widely used in transport, agricultural covers and structures. Similarly formulated polyolefin fabrics provide a lighter weight option.

This guide goes into the detail of the composition and structure of these types of fabrics, their technical specifications, and chemical resistance. It provides advice on product selection and fabrication, including allowance for dimensional change, welding and functional design, such as avoiding tear, flex cracking and potential mildewing. The reasons for the complexity of printing on plastics is explained, and also why the common practice of cutting 'wind holes' in banners is unnecessary.

The concept of anticlastic geometry, which is integral to the design of tension structures, is discussed; and European guidelines for fabric classification, fabrication tolerances and pre-stress are included; together with an explanation as to how biaxial tests results can be interpreted. References are provided to the calculation of Elastic Parameters for the Sattler "Atlas" range available with biaxial test results, which are available on the Nolan Group's website.

Similarly, the concept design of Grain Bunker Storages is provided, and a calculator that allows the sizing of covers and groundsheets for crops and stack heights has been developed and is also available on the company's Website.

Not Flawed – Commercial Carpet, Carpet Tiles and Acoustics
Technical Guide Number Six

Designed for Architects and Specifiers, this guide provides the technical data necessary to support the environmental guidelines of the Carpet Institute's Certification Scheme, which in turn underpins the Green Building Code rankings. It also contains the detailed product specifications and results of performance testing, including those of flammability required by the National Construction code. Similarly formulated materials are used as acoustic walling, and data regarding the effectiveness of these products is presented.

Nolan Group Locations

Nolan Group

Marine & Auto Division

SYDNEY
3 Bradford Street, Alexandria

NEWCASTLE
16 Ironbark Close, Warabrook

BRISBANE
14 Lions Park Drive, Yatala

MELBOURNE
7 Conifer Crescent, Dingley Village

ADELAIDE
489 Cross Keys Road, Cavan

PERTH
22 Hazelhurst Street, Kewdale

1300 35 75 85
Nolans.com.au
info@Nolans.com.au