3M™ Wind Protection Tape 2.0 W8750 Technical Bulletin

Product Description

3M™ Wind Blade Protection Tape 2.0 (WPT) W8750 can be used to protect wind turbine blade surfaces from damage caused by minor impacts and erosion due to rain, sand, dirt, or other debris.

It is made from an exceptionally tough, transparent polyurethane elastomer that resists puncture, erosion and UV. WPT W8750 application is fast, easy and requires no special tools. WPT W8750 is solvent free, colorless and is constructed with a durable, pressure sensitive acrylic adhesive (PSA).

Product Features

Note: This technical information and data should be considered representative or typical only and should not be used for specification purposes.

- Highly resistant to rain and sand erosion
- Weather-resistant
- Excellent color retention (colorless)
- Easy to apply
- No embrittlement with time

Shelf life

Two years from date of manufacture.

Directions for Use

Consult local air quality regulations when using chemical products.

See **www.3M.com/wind** for 3M™ Wind Blade Protection Tape Application Instructions.

3M™ Wind Protection Tape 2.0 W8750 Basics

As with any other erosion film or coating, the final performance is dependent on the entire construction of the outermost layers of the wind blade, including composite materials, fillers, coatings, and primers. Any modification in one of these layers can influence properties like rain erosion resistance, weathering properties or the application process.

It is therefore recommended to test WPT W8750 on substrates of the same construction and using the same process as in the final manufacturing process.

WPT W8750 has a high performance pressure sensitive adhesive (PSA) which provides excellent adhesion to many surfaces. The best indicator for good adhesion is a destruction of the adhesive layer when the tape is removed (so-called cohesive failure in the PSA). For optimal performance, it is always recommended to achieve a cohesive failure.

WPT W8750 is highly UV stable and is not transparent to UV light below 385nm. Coatings beneath the tape will therefore also be protected from UV irradiation.

Surface Preparation

Surface preparation will always depend on the type and quality of the underlying coating or surface and the requirements of the manufacturing process.

In general the surface should be flat without paint marks, streaks, orange peel texture or other distortions which prevent full contact with the PSA.

It is recommended to use a grit 320 abrasive followed by thorough cleaning as the final step in the surface preparation process. It is best practice to strive for a smooth, non-porous surface, which is free of major abrasive tracks.

Simple grinding and cleaning cannot compensate for differences in the polarity or surface properties of coatings which may be due to batch-to-batch variations or curing conditions. It is therefore recommended to use an a primer in order to further reduce variability. The primer also allows to adjust the application process to the needs of the manufacturing process with respect to process time.

The use of 3M™ Wind Tape Adhesion Promoter W9910 (diluted to 20% of its original concentration by isopropyl alcohol) has shown the best results so far.

In general, the variation in surface roughness and primer concentration allows for fine-tuning the time available for repositioning the tape during the wet application process in the wet application process, as well as the time until a firm bond is developed.

Further details are available from our application engineers and in separate 3M documentation.

Tape Application

WPT W8750 has been developed for wet application. It is recommended to use 3M™ Tape Application Solution or a mixture of approximately 25 weight/% isopropyl alcohol and 75 weight/% demineralized water. Tap water or the additional use of soap is not recommended.

The tape should be stretched during the application only where there is a need (curvatures, etc.). In general, the tape should be conformed during the application.

To reduce the risk for stretching, the application is best done with the help of soft rubber squeegees. The use of hard tools is not recommended.

Further details are available from our application engineers and in separate 3M documentation.

Tapes and Coatings – A Comparison

Coatings

Coatings have the benefit of easy adaption even without thorough surface preparation. However, when a coating loses contact with the underlying surface due to harsh environmental or mechanical conditions, the resulting delamination is permanent and in most cases progressive.

The coating thickness is difficult to control during the application process and variations of ±50 µm are possible. In order to obtain the required minimum thickness, an excess of total average coating weight is needed.

The polymer forms after the application of coating. Since these chemical reactions are dependent on temperature, humidity, mixing quality and time, the resulting properties are highly dependent on the stability of the application process. In addition, the properties of the coating will vary throughout the depth of the coating layer.

The coating process also generates some by-products, mostly due to reactions with water which may lead to bubbles. Bubbles can be also introduced by the surrounding air during the mixing and application process.

Coatings are usually pigmented in order to eliminate or reduce the effect of ultraviolet irradiation.

3M™ Wind Protection Tape 2.0 (WPT) W8750

WPT W8750 bonds to surfaces by a permanently tacky PSA. Special surface preparation and a wet application process is required to obtain complete contact between the PSA layer and the surface. The final bond strength is usually achieved after a few hours depending on the surface preparation, application pressure and ambient conditions.

Since PSAs remain sticky even after delamination, they provide a self-healing effect. If small areas of separation occur due to the formation of micro-bubbles (e.g. under extreme weathering conditions) the PSA is able to re-connect to the surface without a permanent damage of the bond.

WPT W8750 consists of a polyurethane and a PSA layer of defined thickness which show only minor variations in the range of a few micrometers.

The polyurethane polymer has been prepared under optimum and reproducible conditions and does not contain any foreign material or bubbles. PSA and polyurethane are bonded permanently and cannot be separated.

Due to its transparent and clear appearance, WPT W8750 can adapt to a variety of surfaces. The tape is highly stabilized for maximum UV resistance.

Consult local air quality regulations when using chemical products.

History of Tape and Field Experience

The history of wind protection tapes originates many years ago when erosion on helicopter blades was observed during the Vietnam War. 3M led the development of tough, mostly polyurethane films, which were then transferred into the automotive market in the form of the so-called 3M™ Paint Protection Films (PPF).

With ever-growing requirements in the car and military industry, tapes were continuously improved upon and adapted to new products. One of the first fields of applications opened with the expanding wind industry. 3M tapes were the first products used on wind blades after erosion was observed at higher blade speeds.

In summary, field experience with erosion resistant tapes goes back to the 1960s in the military area. In wind applications, tapes have been used for over 20 years. This provides a vast knowledge base with respect to performance and application.

In contrast to tapes, erosion resistant coatings are a relatively new product family which have been promoted mainly by the manufacturers of paints. Products reached the market just a few years ago. Long-term performance measurements under real life conditions do not exist yet.

New 3M™ Wind Protection Tape 2.0 W8750 vs. Current 3M™ Wind Protection Tape W8607, Colorless

3M™ Wind Blade Protection Tape W8607 has been the workhorse for wind turbine blades during the last decade. It has been used on thousands of wind turbines and and has an average life time of 7 years. The increasing requirements and expectations as well as competition from coatings has triggered the development of a new tape in order to overcome some of the shortcomings of WPT W8607.

This concerns the following properties:

- Longer Overall Life-Time under real conditions
  - Better rain erosion performance
  - Better UV resistance
  - Better hydrolytic stability (less embrittlement with time)
- Gloss: Matte surface for less glare and lower friction in application process
- Easier application process: More conformable to adapt to curved surfaces
- Better removability: No embrittlement for easier removal

In order to achieve these goals a new polyurethane formulation was developed and optimized. The PSA was changed to a more stable version and the bond strength between polyurethane and PSA was increased by a proprietary process.

Aging and Possible Correlation to Life

Understanding the aging of polymers is a complex science and requires in-depth knowledge of all materials involved and their degradation mechanisms. It is a system property and does not depend on the performance of a single layer, component or ingredient.

It is therefore very hard to make predictions which exceed a time of more than 10 years for new systems, even by use of sophisticated lab tests.

3M has 50 years of experience with products based on the same or similar chemistry (polyurethanes and adhesives). This includes lab and field data on tapes which have been used in military, automotive and wind energy applications. A careful evaluation and judgement of these data allow more reliable predictions even for extended periods of time.

3M is known for its exceptional expertise in accelerated weathering and has contributed to many relevant ASTM standards. This mainly concerned test methods for more reliable predictions in several areas like traffic signs, automotive and aerospace applications. 3M is working with experts around the world to make tests more meaningful and reliable.

Selected Important Properties

Stress/Strain Behavior

WPT W8750 is based on a highly elastic polymer with spring-like properties. These properties are not dependent on the tape orientation.

Due to the chemistry and the manufacturing process of the tape, it will achieve its final properties about one week after application in a normal environment. For lab tests which are focusing on critical properties like tensile strength or rain erosion performance, it is recommended to store specimens at 50°C for 72 hours in a circulating air oven. This ensures that the final properties are achieved. Any process which involves high temperatures (like welding) will change tape properties temporarily. In this case it is suggested to store at 50°C for 72 hours in a circulating air oven before further testing is done.

Accelerated weathering under UV light

It is highly recommended that any accelerated weathering tests are done with the same construction as used on the actual blade. This concerns the composite and additional layers like gel coats, fillers, top coats, primers, etc. All these layers can have an influence on final film performance because degradation products may migrate throughout the specimens.

Standard test equipment for accelerated weathering is designed for the testing of flat plates. Introducing parts like rain erosion profiles heavily changes the conditions in the tester and may lead to large deviations in the temperature profile. It is recommended to record surface temperatures of parts and re-adjust settings as needed.

In addition, weathering of large parts introduces large amounts of polymers material into the test chamber. In frequently used test cycles (irradiation and condensation) there is only water replacement but no water exchange in the water reservoir. This may lead to the accumulation of degradation products within the tester. Interaction of degradation products with the specimens may lead to unpredictable and undesired results. A possible solution in fluorescent lamp testers is the addition of a spray cycle which takes care of water exchange in the reservoir.

Temperatures during accelerated weathering tests should not exceed realistic conditions. The higher the temperature, the higher the risk of deviating from the degradation mechanisms seen under real life conditions.

3M proposes the following Q-UVA cycle for accelerated weathering:

Standard	ISO 4892-3, cycle 2
Irradiation Phase (hours)	8
Temperature, Humidity (°C, % r.h.)	50/uncontrolled
Spectral Irradiance (W/m²nm@340nm)	0.76
Water Spray Phase (hours)	0.25
Temperature, Humidity (°C, % r.h.)	uncontrolled/uncontrolled
Condensation Phase (hours)	3.75
Temperature, Humidity (°C, % r.h.)	50, 95-100

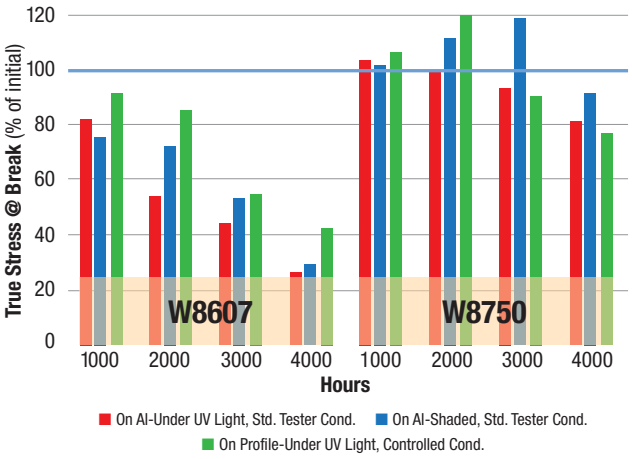
The diagram below shows the differences in property decay between WPT W8607 and WPT W8750 after accelerated weathering using these test conditions.

The red (under UV light) and blue (shaded= only influence of temperature and humidity) bars are describing the True Stress @ Break of WPT W8750 on aluminum sheets. The green bars show data from WPT W8750 which was aged on the complete erosion test profiles (under UV light).

The results show the excellent long term performance of WPT W8750.

True Stress @ Break of Conventional and New Wind Tape

after Q-UV @ 8 hours UV 0,76 W/m² nm (340 nm) @ 50°C, 15 min. spray, 3:45 hours condensation @ 50°C



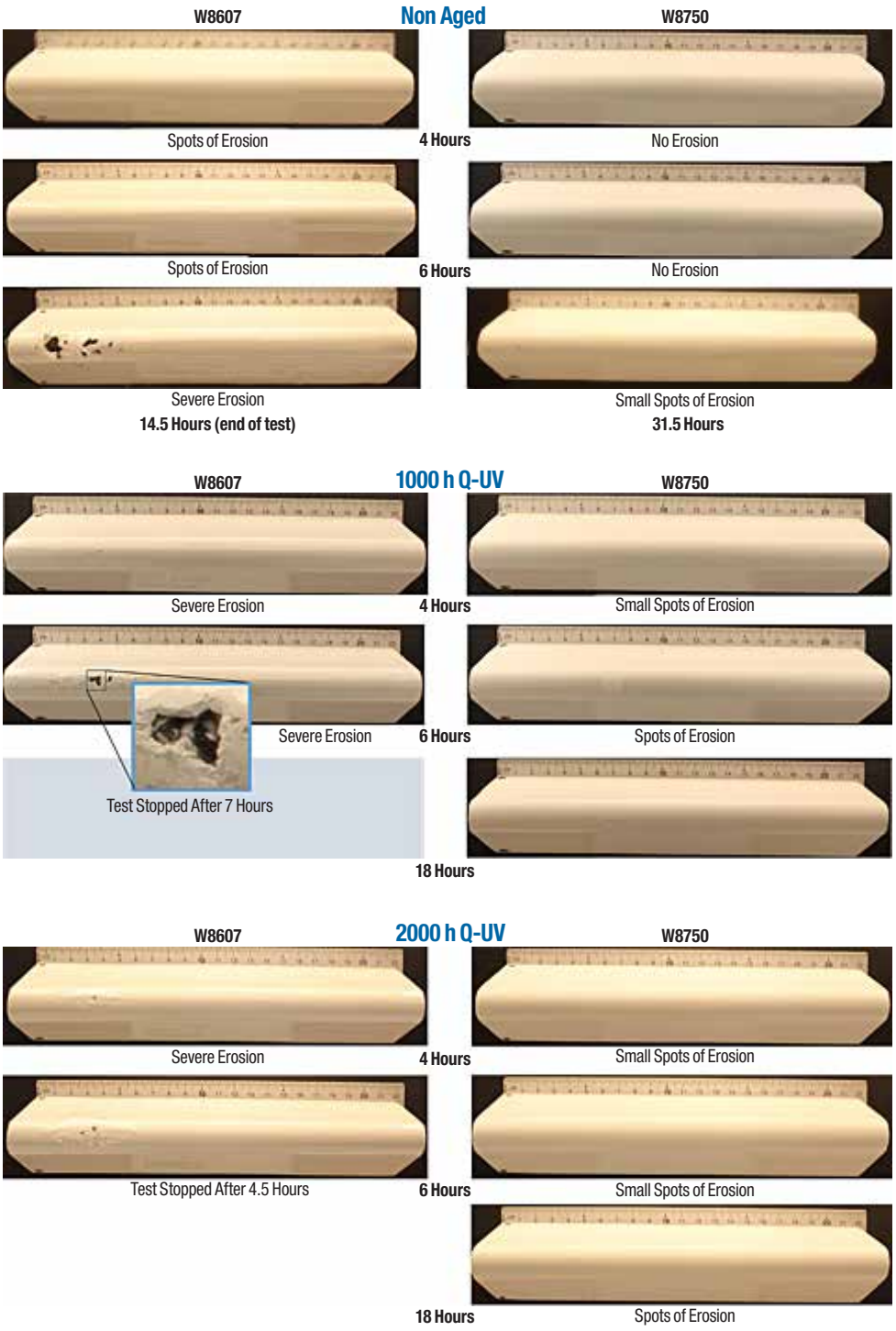
Further details are available from our application engineers and in separate 3M documentation.

Rain Erosion Performance

Test Specifications	
Duration(hours)	4.5
V_{root} (m/s)	125
V_{center}(m/s)	140
V_{tip} (m/s)	157
Rain (mm/h)	30-35
Droplet Size (mm)	1-2
Temperature (°C)	20-25

Rain erosion performance of 3M™ Wind Protection Tape 2.0 (WPT) W8750 was measured at PolyTech in Denmark. Maximum speed at the profile tip was 157 m/sec (351 miles/hour, 565 km/h).

The excellent performance of WPT W8750 especially after accelerated weathering is apparent by the images shown at the right.



For more information, including directions for use, contact 3M Renewable Energy at 800-755-2654 or visit us at 3M.com/wind.

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