

USER MANUAL

PVSTOP FOR

FIRE & RESCUE SERVICES
FIRST RESPONDERS
ELECTRICAL TECHNICIANS
PV SYSTEM OWNERS
PV SYSTEM OPERATORS



CONTACT

P +44 (0)1902 357777

E sales@jactone.com

[in](#) Jactone Products Ltd

[f](#) Jactone Products

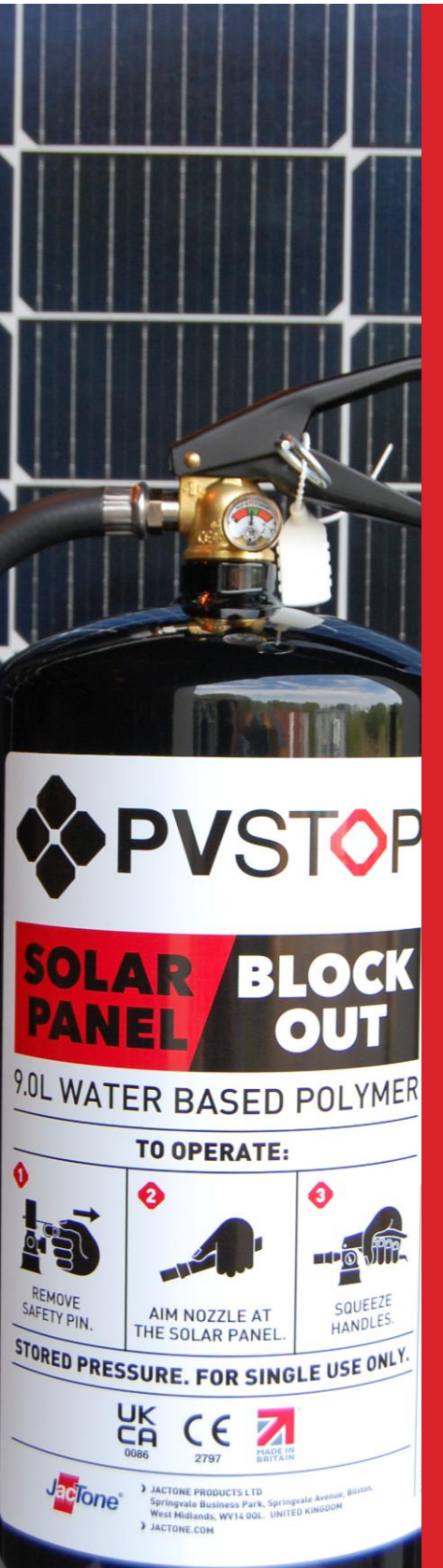
[v](#) Jactone1

[t](#) @Jactone_UK

MAKING SOLAR ENERGY SAFE.



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01 RENEWABLE ENERGY OVERVIEW AND RISK FACTORS

The world is in the midst of a clean energy revolution driven largely by rising grid electricity prices, government incentive schemes and a positive public sentiment towards protecting the future of our planet.

The increasing uptake of solar panels and the downward pressure on solar PV system pricing has led to an unprecedented level of growth in the global solar PV system market, growth that is forecast to increase exponentially in the decades ahead.

In line with the exponential growth of the solar industry, there has been a similar growth in the number of fire and emergency related incidents involving solar PV systems which has highlighted a number of unanticipated safety risks.

UNDERSTANDING THE PROBLEM

Solar panels cannot be easily “switched off”. As long as they are exposed to light, the solar panels and the wiring leading down from the panels are continually producing potentially lethal amounts of DC electricity, in professional terms this is known as the “DC Danger Zone” and up until now there has been no safe or practical way to “switch off” these solar PV systems at the source (the solar panel).

The ONLY way to de-energise or “switch off” solar panels at the source of production (the solar panel) is to block the light – light is the source of power

PVSTOP IS THE SOLUTION

PVSTOP is the only product that quickly and safely isolates the power produced by solar PV systems at the source, the solar panels themselves. PVSTOP coats solar panels like a “liquid tarpaulin”, blocking the light and “switching off” the solar panels in seconds, rendering the solar PV system electrically safe.

DO SOLAR PANELS PRODUCE ENOUGH POWER TO BE DANGEROUS?

Just a little current can kill.

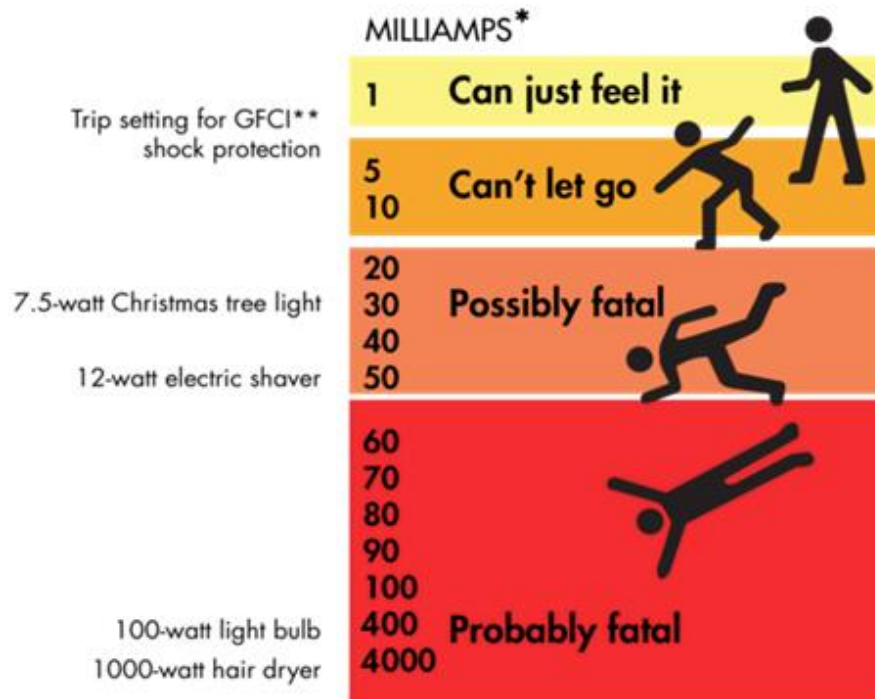
It is important to remember that as little as 0.5 amps (500 milliamps) is enough to kill a person.

A typical domestic solar PV array can produce 6 – 8 amps current (6000 – 8000 milliamps) at up to 600 volts. A commercial or industrial array can produce up to 1500 volts.

The level of current produced by solar PV systems is far in excess of that consumed by normal domestic electrical appliances, as illustrated in figure 1.

Figure 1

Just a Little Current Can Kill



* A milliamp is 1/1000th of an ampere, a measure of electrical current.

** A GFCI is a ground fault circuit interrupter, a device that protects against serious shock.

Appliance examples given for – 220v – 240v AC supply

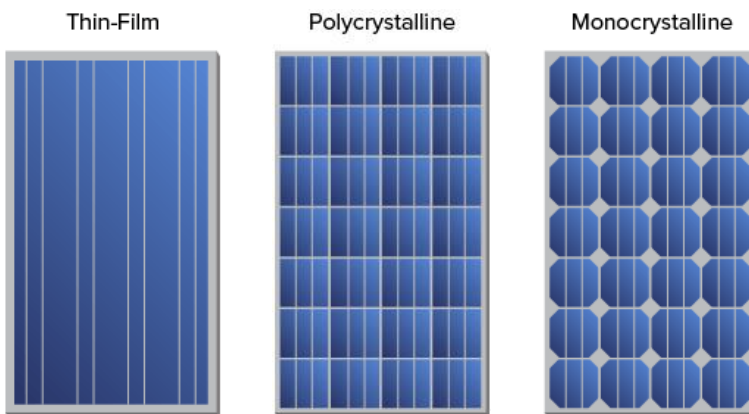
PVSTOP - HOW IT WORKS & WHY IT WORKS

PVSTOP is a simple solution to a complicated and technical problem. The coating is applied to solar panels, blocking the light and rendering the solar PV system electrically safe.

Later in this user manual we will outline the procedures on how to apply PVSTOP to solar panel arrays mounted in different configurations.

But firstly, we will briefly explain how solar panels generate electricity and why even just partial (40%) coverage of solar panels with PVSTOP will render any solar panel array electrically safe.

COMMON STYLES OF SOLAR PANELS



There are many types of solar panels available on the market and most panel manufacturers offer a range of models including mono and poly crystalline (also known as multicrystalline) varieties with various power ratings.



Regardless of the type of solar panel, the technology incorporated into the panel or the level of efficiency that the panel generates, all solar panels operate on the same principle, they generate power by converting light into (DC) electricity.

Photovoltaic (PV) simply means converting light into electricity.



PVSTOP is effective on all types of solar panel systems.

HOW SOLAR PANEL (PV) SYSTEMS WORK

In order to understand how PVSTOP works we will explain how the solar panel operates.



SOLAR PANEL

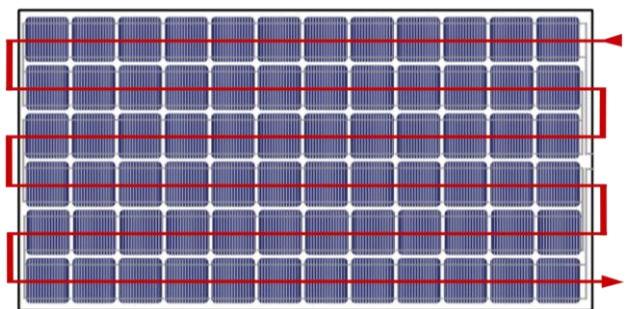
A solar panel is comprised of a number of solar cells wired together in series to create a solar panel. The most common are 60 cell and 72 cell panels. The diagram (right) demonstrates how power flows through a solar panel.

SOLAR CELL

A solar panel is comprised of many small units called solar cells.

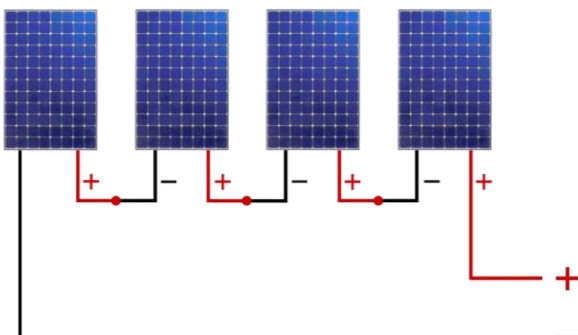
Solar cells produce power by allowing photons, or particles of light, to knock electrons free from atoms, generating a flow of DC electricity.

These solar cells are wired together in series to create a solar panel.



(Power flow through a solar panel)

SOLAR PANEL ARRAY



In turn, solar panels are connected together in series to create a string and the more panels connected together, the greater the power output of the solar PV system.

A residential solar PV system can have up to 600 volts of panels connected in series. A commercial or industrial array can have up to 1500 volts of panels connected in series.

DIFFERENCES BETWEEN AC & DC ELECTRICITY

Solar panels produce **DC** electricity (**D**irect **C**urrent), the other type of electricity (grid electricity) is AC electricity (**A**lternating **C**urrent).

AC electricity creates a “frequency” which can be remotely detected by a voltage detector commonly referred to as an “AC HotStick”. The AC HotStick allows first responders or electrical technicians to identify if an AC electrical source is “live” without coming into direct contact with the AC electrical source.

DC electricity (produced by solar panels, batteries and electric vehicles) does not have a frequency and cannot be detected remotely. This means that first responders and electrical technicians cannot easily or safely identify if a DC electrical source is “live”. As such they always need to assume a DC electrical source is “live” and dangerous.

HOW TO SWITCH OFF SOLAR PANELS










Even with the limitations on DC electricity detection, as long as solar panels are exposed to light, they continually produce potentially lethal amounts of DC electricity. In professional terms this is known as the *DC Danger Zone* and up until now there has been no way to easily and practically ‘switch off’ solar PV systems at source (the solar panel level)

The ONLY way to de-energise or “switch off” solar panels at the source of production (the solar panel) is to block the light – light is the source of power.

02 ABOUT PVSTOP

PVSTOP is an environmentally friendly, state of the art, water-based polymer coating that is sprayed onto solar panels like a “liquid tarpaulin”, blocking the light and “switching off” the solar panel system in seconds. Once applied, the PVSTOP coating dries into a protective, non-flammable film which can be peeled off the solar panels without damaging the system when it is time to re-activate the PV system.

Because PVSTOP is designed to be used in emergency incidents such as fire, flood or storms as well as during routine maintenance, PVSTOP has a number of additional product safety features;

 <p>Quick Drying</p> <p>Dries quickly into a waterproof, protective film</p>	 <p>Non-Flammable</p> <p>The coating is non-flammable in its dry state</p>	 <p>Non-Conductive</p> <p>Protecting operators from the risk of electrocution</p>
 <p>Anti-Arcing</p> <p>Isolates power at the source, eliminating electrical arcs</p>	 <p>Fire Retardant</p> <p>The coating is fire retardant in its wet state</p>	 <p>Insulating</p> <p>The coating protects against heat and encases any toxic nanoparticles from being released from burning or arcing solar panels</p>
 <p>Protection</p> <p>The coating does not damage the solar panels and once dry, can be easily peeled off the panels to re-activate the PV system</p>	 <p>Environmentally Friendly</p> <p>PVSTOP has been rigorously tested and verified by third party independent authorities around the world</p>	 <p>Global Accreditation</p> <p>ISO 14034:2016, Environmental Management - Environmental Technology Verification (ETV)</p>

PVSTOP

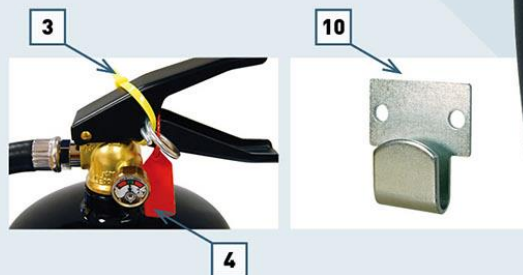


9.0L SOLAR PANEL BLOCK OUT

Product Specification

› PRODUCT CODE :	EPVS9
› CAPACITY :	9 Litres
› AGENT TYPE :	PVSTOP (water based polymer)
› TOTAL WEIGHT :	14.2kg
› OPERATING PRESSURE :	15 barg at 20 °C
› DISCHARGE TIME :	70 seconds
› EFFECTIVE RANGE :	Up to 10 metres
› TEST PRESSURE :	27 barg
› OPERATING TEMP RANGE :	+5°C to +40°C
› CYLINDER CONSTRUCTION :	Mild steel
› CYLINDER FINISH :	Polyester
› VALVE FINISH :	Brass

Product Details



- | | |
|--------------------------|---------------------|
| 1 Valve | 6 9.0L PVSTOP agent |
| 2 Safety pin | 7 Hose |
| 3 Transit tie* (yellow) | 8 Cylinder |
| 4 Anti-tamper seal (red) | 9 Hose clip |
| 5 Pressure gauge | 10 Wall bracket |

* Transit tie to be removed on commissioning

Specification subject to change without notice.



PVSTOP

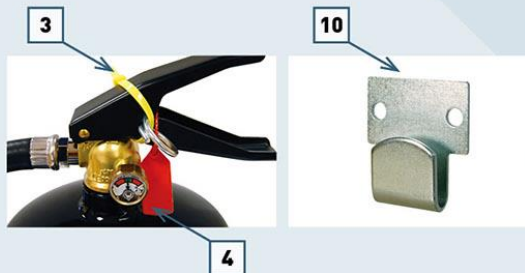


4.5L SOLAR PANEL BLOCK OUT

Product Specification

› PRODUCT CODE :	EPVS45
› CAPACITY :	4.5 Litres
› AGENT TYPE :	PVSTOP (water based polymer)
› TOTAL WEIGHT :	7.85kg
› OPERATING PRESSURE :	15 barg at 20 °C
› DISCHARGE TIME :	35 seconds
› EFFECTIVE RANGE :	Up to 10 metres
› TEST PRESSURE :	27 barg
› OPERATING TEMP RANGE :	+5°C to +40°C
› CYLINDER CONSTRUCTION :	Mild steel
› CYLINDER FINISH :	Polyester
› VALVE FINISH :	Brass

Product Details



- | | |
|--------------------------|---------------------|
| 1 Valve | 6 4.5L PVSTOP agent |
| 2 Safety pin | 7 Hose |
| 3 Transit tie* (yellow) | 8 Cylinder |
| 4 Anti-tamper seal (red) | 9 Hose clip |
| 5 Pressure gauge | 10 Wall bracket |

* Transit tie to be removed on commissioning

Specification subject to change without notice.



03 WARNINGS AND SAFETY INSTRUCTIONS

- **This PVSTOP unit is NOT a fire extinguisher and must not be used as such.**
- Do not put the unit close to heat sources, including radiators, electric heaters, open fires, or other appliances that generate heat.
- Under no circumstances should parts of the unit be tampered with or should an effort be made to remove parts.
- The information given on the unit label is important and may not be removed or changed.
- Under no circumstances should anyone try to loosen or remove a valve from a pressurised cylinder.
- Do not drop the unit or components of the unit from height, as this can cause damage to the unit.
- Do not change or convert any part of the unit.
- Do not spray the contents of the cylinder onto people or animals. When a cylinder has been used, it must be taken out of service and labelled as empty pending replacement.
- The PVSTOP unit is only supplied for the use for which it is designed and under no circumstances should it be used for other purposes.
- Do not use the unit if outside the warranty period.
- Do not drill, saw, weld, cut or in any other way tamper with the unit as doing so may cause the unit to become defective or dangerous.
- Do not pour contents of unit into sewer or water system.

04 SITUATIONAL AWARENESS

It is imperative that a high level of **situational awareness** is exercised before, during and after the application of PVSTOP.

A dynamic risk assessment process must be adopted to ensure safety and effectiveness of application. This should include as a minimum the constant assessment of:

- Access and egress routes
- Risk of falling debris
- Structural integrity of the roof or panel installation site
- Personnel life safety
- Fire and smoke related risks
- Power output
- Air quality
- Safety of bystanders and other personnel
- Impact of overspray on surrounding property

05 OPERATION



In the event of fire, call the relevant fire/emergency service agency immediately. Do not attempt to engage an active blaze without appropriate equipment. If heat, smoke, or structural integrity prevents access to PV panels, await the arrival of trained emergency personnel.

QUICK FACTS

- $P \text{ (watts)} = V \text{ (volts)} \times I \text{ (amps)}$
- 40% coverage of PVSTOP across the centre of the solar panel array will render the solar panels electrically safe
- There will still be volts (V) present in the PV system as light is still being received by the uncoated solar cells, however the 40% coverage breaks the circuit, reducing the amps (I) to zero
- As an example, a residential solar system with 40% PVSTOP coverage may still be producing significant voltage, but with 0 amps, the system is producing 0 power
- $(100 \text{ volts} \times 0 \text{ amps} = 0 \text{ watts})$
- Although 40% coverage of PVSTOP will render the solar panel array electrically safe, the objective should always be 100% coverage as a 'best practice' procedural measure.

BEFORE APPLYING PVSTOP



HEALTH & SAFETY

The PVSTOP polymer is non-toxic and non-conductive. When applied to the surface of solar panels, the coating is fire retardant in its wet state and non-flammable in its dry state. The dry coating waste may be disposed of as low hazard. Please see separate Material Safety Data Sheet (MSDS) for further Health and Safety Information.



PVSTOP OPERATOR

PVSTOP should only be applied by trained operators such as fire and emergency services personnel, first responders or electrical contractors. Under no circumstances should PVSTOP be handled or applied by untrained personnel who have not received risk assessment training.



RISK ASSESSMENT

Conduct an appropriate 360° risk assessment of the site and surrounding vicinity, including safety of the location, ventilation and escape routes. Safety of the operator is paramount at all times.



COVERAGE RATE

The theoretical coverage rate of the PVSTOP compound is approximately 4m² per litre at a WFT of 250 Microns. Practical coverage rates will fluctuate depending on variables such as:

- Distance from application target
- Environmental conditions (wind speed, wind direction, precipitation etc)
- Experience level of the operator
- Wet film thickness (WFT) applied to the solar PV array (thicker application decreases coverage and increases drying time)



DELIVERY RANGE

In ideal conditions, PVSTOP has a delivery range of up to 10 meters (30 feet). Always start application by applying PVSTOP to the furthest point of the PV array as delivery range will reduce as pressure is released from the unit.



WEATHER EFFECTS

Environmental factors such as wind speed, wind direction and precipitation (rainfall) will affect the delivery range and performance of the product.



VISIBILITY

The operator must ensure a clear line of sight to the PV array, if the operator cannot see the array, it will not be possible to apply the product accurately.



OVERSPRAY

Be aware of the impact of over-spray of the product on surrounding surfaces and property.

PVSTOP will peel off smooth, flat surfaces, but will stick to porous surfaces.



DISCHARGE TIME

A 9 litre PVSTOP unit has a continuous discharge time of approximately 70 seconds. A 4.5 litre PVSTOP unit has a continuous discharge time of approximately 35 seconds.

PVSTOP APPLICATION

GENERAL OPERATING INSTRUCTIONS

- 1

Wear protective glasses, masks, gloves and any other relevant, available PPE when using the device.
- 2

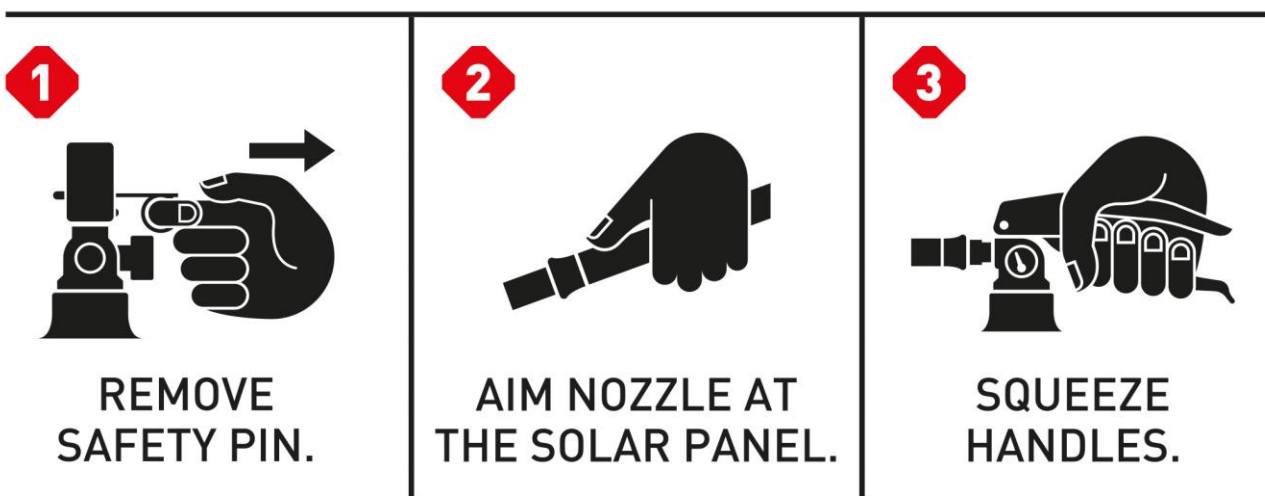
Ensure an appropriate risk assessment of the vicinity has been performed, including safety of the location, ventilation and escape routes. Safety of the operator is paramount at all times.
- 3

Hold the unit vertically prior to operation
- 4

PULL the safety pin
- 5

AIM the nozzle
- 6

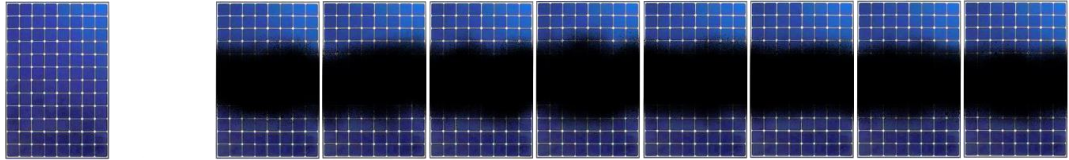
SQUEEZE the lever



PANELS IN PORTRAIT ORIENTATION

STEP Apply a strip of PVSTOP across the centre (40%) of the solar panel array.

1



For example, a domestic solar system with 40% PVSTOP coverage may still be producing significant voltage, but with 0 amps, the system is producing 0 power.

STEP Continue to apply PVSTOP until the solar panel array is completely coated or until the PVSTOP unit is empty (for additional safety, panel protection and allows the coating to be more easily peeled off post application).

2

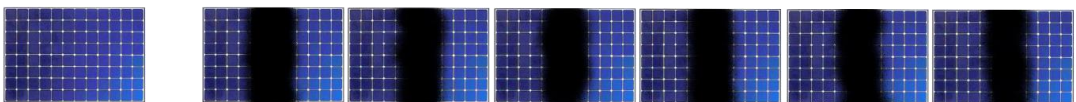


NOTE: - Although 40% coverage of PVSTOP will render the solar panel array electrically safe, the objective should always be 100% coverage as a 'best practice' measure. This applies to all panel array configurations as illustrated.

PANELS IN LANDSCAPE ORIENTATION

STEP Apply a strip of PVSTOP across the centre (40%) of the solar panel array.

1



STEP Continue to apply PVSTOP until the solar panel array is completely coated or until the PVSTOP unit is empty (for additional safety, panel protection and allows the coating to be more easily peeled off post application).

2

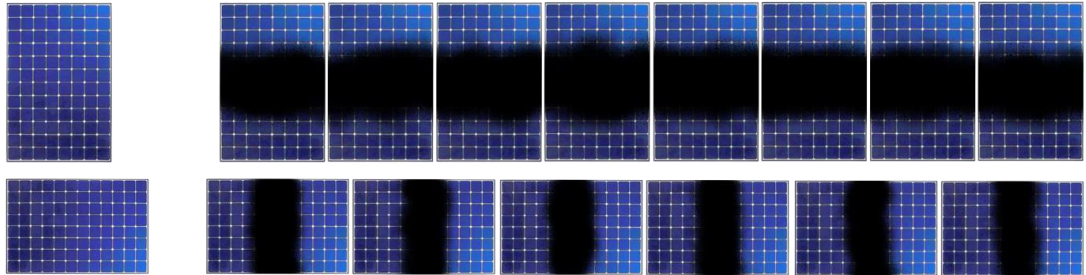


PANELS IN MIXED ORIENTATION

STEP

Apply a strip of PVSTOP across the centre (40%) of the solar panel array.

1



STEP

Continue to apply PVSTOP until the solar panel array is completely coated or until the PVSTOP unit is empty (for additional safety, panel protection and allows the coating to be more easily peeled off post application).

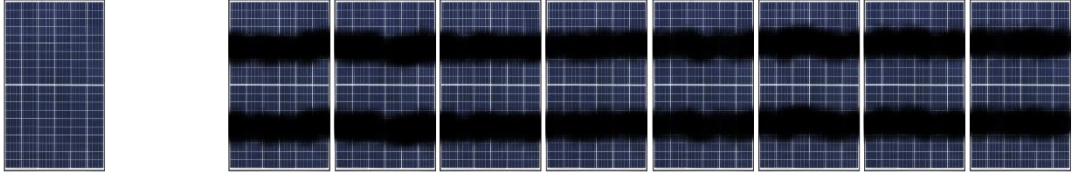
2



SPLIT PANEL DESIGN

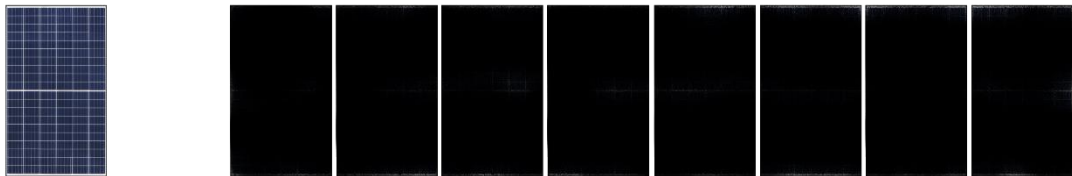
STEP Apply a strip of PVSTOP across the centre (40%) of the solar panel array.

1



STEP Continue to apply PVSTOP until the solar panel array is completely coated or until the PVSTOP unit is empty (for additional safety, panel protection and allows the coating to be more easily peeled off post application).

2



QUICK FACTS

- If in doubt about what type of solar panels you are coating, 100% coat all the solar panels for maximum safety.
- If possible and safe to do so, locate the solar PV system inverter LCD display to confirm that the PV system is no longer producing power before taking any further action.

PVSTOP POST-APPLICATION INSTRUCTIONS



ELECTRICAL ISOLATION

PVSTOP will de-energise the solar PV array as soon as the product is applied in its wet state.



DRYING TIME

Applied at an ambient temperature of 25°C (70°F) at a Wet Film Thickness (WFT) of 250 microns, the coating will be 'tack dry' in approximately 4-5 minutes. Higher panel surface temperatures and higher ambient temperatures reduce the drying time.

Conversely lower panel surface temperatures and lower ambient temperatures increases the drying time.



OPTIMAL COVERAGE

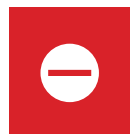
A minimum wet film thickness (WFT) of 250 Microns [100 Microns dry film thickness (DFT)] must be achieved, anything less may result in the product becoming difficult to remove.

- The coating is 'tack free' in approximately 120 minutes
- Once 'tack free' the coating forms a waterproof, protective film that protects the coated surface until the PV system is ready to be re-activated.



POROUS SURFACES

If PVSTOP is applied to porous surfaces, wash down affected area with water immediately. If PVSTOP is allowed to dry on porous surfaces it will be difficult to remove. A high-pressure water spray /pressure washer may be of assistance in removing PVSTOP from porous surfaces, but successful removal from porous surfaces is not guaranteed.



REMOVAL

The dry film can be easily removed by hand, or alternatively, with a high-pressure water spray/pressure washer from most non-porous surfaces. If removed in freezing conditions, the coating may be brittle.



DISPOSAL

The dry PVSTOP film is non-hazardous, environmentally friendly and can be disposed of as general solid waste.



EXTERNAL WEATHER RESISTANCE

Up to 12 months weather exposure.



CLEAN DOWN

Clean any equipment coated with PVSTOP with water immediately after use.

Coating cannot be removed from woven materials, clothing once the coating is tack free (such as personal protective equipment).

PV SYSTEM RE-ACTIVATION

Under no circumstances is the property owner to touch or engage with the solar panel system or attempt to remove the PVSTOP coating that has been applied to the solar PV system. The system must be inspected and serviced by an authorised electrical technician prior to the PV system being returned to service.

06 INSTALLATION & SERVICING

COMMISSIONING PROCEDURE

- Ensure the unit is suitable to cover the solar panel array area – see 5 for details
- Examine the exterior of the unit for signs of corrosion, dents, gouges, or damage that could impair the safe operation and integrity of the unit
- Check that the operating instructions are clear and legible
- Check the pressure gauge indicates correct pressure, if pressure is outside the specified limits refer to the manufacturer for guidance on appropriate action to be taken
- Weigh the unit, compare the mass with that given in the specification. Check that mass is no greater than $\pm 5\%$ of the nominal mass. Record the measured mass on the maintenance label
- Check that the hose is clear and unobstructed
- Check that the safety pin is in place and undamaged
- **IMPORTANT: Remove the transit tie – (YELLOW). Failure to remove this will prevent the safety pin being removed in an emergency situation**
- Ensure that the anti-tamper seal is fitted and unbroken
- Check the 'O' ring seals on the hose assembly and fit the hose to the valve, tighten fully by hand and then with a 17mm open spanner (do not over-tighten)
- Affix maintenance label to the unit, ensuring that none of the markings are obscured
- Check the service expiry date given on the front of the unit and make note in maintenance records
- Record next service due date on the maintenance label
- Site the unit in its correct location / protective cabinet as necessary

SIX MONTHLY BASIC SERVICE PROCEDURE AND MONTHLY INSPECTION

	6 Months	Monthly
▪ Examine the exterior of the unit for signs of corrosion, dents, gouges, or damage that could impair the safe operation and integrity of the unit.	✓	
▪ Check that the operating instructions are clear and legible.	✓	✓
▪ Check the pressure gauge indicates correct pressure, if pressure is outside the specified limits refer to the manufacturer for guidance on appropriate action to be taken.	✓	✓
▪ Weigh the unit, compare the mass with that given in the specification. Check that mass is no greater than $\pm 10\%$ of the nominal mass. Record the measured mass on the maintenance label.	✓	
▪ Remove hose. Check that the hose is clear and unobstructed and not subjected to splitting or cracks.	✓	
▪ Check that the safety pin is in place and undamaged.	✓	✓
▪ Ensure that the anti-tamper seal is fitted and unbroken.	✓	✓
▪ Check the 'O' ring seals on the hose assembly and refit the hose to the valve, tighten fully by hand and then with a 17mm open spanner (do not over-tighten).	✓	
▪ Update details on the maintenance label, including next service due date.	✓	
▪ Relocate the unit in its correct location / protective cabinet as necessary.	✓	✓

07 STORAGE AND PLACEMENT

- The unit should be available for immediate use at all times, located at an appropriate height and in a conspicuous position on brackets, on stands or within cabinets, where it can be seen easily by persons heading towards the location of the PV panels.
- The unit should not be hung in places where a fire could block the access to the unit or in small corridors where it could be knocked down or displaced from the wall. A minimum clearance of 1000mm is recommended.
- PVSTOP unit must be thermally protected if installed in locations where the temperature is outside the recommended storage range of 5°C to 40°C.
DO NOT ALLOW LIQUID TO FREEZE.
- Ensure the unit is protected from adverse environmental conditions, including extremes of temperature outside the recommended storage range, direct sunlight, corrosive environments or substances, moisture, dirt, dust, and debris.
- Signage should clearly indicate the location of the PVSTOP unit and other relevant firefighting equipment to avoid confusing the two.
- The instructions on the unit must be easy to read.

08 PRODUCT WARRANTY

- Product Warranty details available on request.

09 PVSTOP MATERIAL SAFETY DATA

- Refer to separate PVSTOP Material Safety Data sheet – latest revision

10 APPENDIX

PVSTOP POLYMER INFORMATION SHEET

Description

PVSTOP is a temporary peelable protective coating that when applied to the surface of solar panels is designed to isolate the power produced by the solar panel system. Applied in a liquid state, the coating dries to form a protective barrier that will last for up to 12 months. **DO NOT USE ON ACRYLIC SURFACES.**

Material Type

Water Based Polymer

Colour

Black

Surface Application

Solar PV Panels

Application

A minimum wet film thickness (WFT) of 250 Microns [100 Microns dry film thickness (DFT)] must be achieved, anything less may result in the product becoming difficult to remove.

Coverage

The theoretical coverage rate is approximately 4m² per l at a WFT of 250 Microns.

Removal

The dry film can be easily removed by hand, or alternatively, with a high-pressure water spray/pressure washer from most non-porous surfaces. If removed in freezing conditions, the coating may be brittle.

External Weather Resistance

Up to 12 months weather exposure.

Health & Safety

The polymer is non-toxic and non-conductive. When applied to the surface of solar panels, the coating is fire retardant in its wet state and non-flammable in its dry state. The dry coating waste may be disposed of as low hazard. Please see separate Material Safety Data Sheet (MSDS) for further Health and Safety Information.

Storage

Shelf life, from date of delivery from the manufacturer, is 36 months when stored in an approved pressure vessel. Store at temperatures between 5°C – 40°C.

DO NOT ALLOW LIQUID TO FREEZE.

Drying Time

A WFT of 250 Microns will be tack free in approximately 120 minutes at an ambient temperature of 25°C. Higher panel surface temperatures and higher ambient temperatures reduce the drying time. Conversely lower panel surface temperatures and lower ambient temperatures increases the drying time.

Clean Down

Clean any equipment coated with PVSTOP with water immediately after use. **COATING CANNOT BE REMOVED FROM WOVEN MATERIALS ONCE THE COATING IS TACK FREE** (such as personal protective equipment).

Technical Information

Tensile Strength

>5 MPa

Flashpoint

N/A

Viscosity

3000-9000 cP (s3, 10rpm, 20°C)

pH

7-8

Specific Gravity

1.02 (H₂O = 1 @ 20°C)

Adhesion

<1.0 MPa

Solids Content

42 ±2%

Maximum VOC

80gl⁻¹

Elongation

>1000%

DISCLAIMER

- Nothing in this document confers any rights or interests deriving from any patent relating to the method of using PVSTOP.
- The contents of this document are intended as a general guide only. The contents of it must be considered in context of all applicable health and safety laws. Where there is any doubt about any requirement or recommendation or any potential safety issue Jactone Products Limited should be consulted in relation to the taking of any actions referred to in this document before those actions are taken.
- In no circumstances will Jactone Products Ltd be liable for any negligent act or omission, or the infringement of any law, or inappropriate practice, in relation to the use, handling, storage and/or transport of PVSTOP Products.
- If any of the contents of this document is determined in any jurisdiction to be illegal, invalid, void or voidable, the contents of this document shall be adjusted to conform to the law of that jurisdiction and the remainder of the contents of this document will continue to have full force and effect