



Winterization Instructions

Around the world most soiling occurs in the spring, summer, and early fall. However, some may still want to measure soiling or irradiance in the winter months. The Wash Extension utilizes distilled or filtered water to wash the “clean” reference cell on the ARES device, but that water can freeze in the right conditions. In locations that are constantly below freezing temperatures, the Wash Extension must be winterized. There are three options to winterize the Wash Extension:

The table below summarizes the three options. Details for each follow.

Option	What you do	Auto-wash in freezing weather	Key considerations
1. Isopropyl alcohol (IPA)	Fill the reservoir with a distilled water and IPA mix.	Yes. Mix strength sets the limit (45% protects to about -3°F).	Low cost and easy to source. Flammable and evaporates, so handle with care and keep the lid closed.
2. Propylene glycol (PG)	Fill the reservoir with a distilled water and DOWFROST PG mix.	Yes. Practical max of 33% protects to about 2°F .	Not flammable. The wash may freeze on the coldest days of the year, which is acceptable for data integrity.
3. Manual cleaning	Purge all water from the pump and lines, then wipe the clean reference cell by hand on a schedule.	No. ARES is cleaned only on your visits.	No chemicals needed. Requires site visits, at least weekly or every 2 weeks (daily is best).

Option 1: Add an Isopropyl Alcohol (IPA) mixture to the Wash Extension reservoir

To enable automatic cleaning of the ARES reference cell in freezing environments, an anti-freeze solution of isopropyl alcohol and distilled water can be added to the Wash Extension reservoir. IPA is inexpensive and easy to find locally. Fracsun applies a hydrophobic coating to ARES’ clean reference cell, so the solution will not stick to the surface if the array is properly tilted.

Fracsun recommends using a solution of distilled water and 99% isopropyl alcohol. A solution by volume chart can be viewed below. For example, if the lowest freezing temperature of the location is 11 degrees F, a 30% IPA solution (about 3:7 IPA:Water) is recommended.

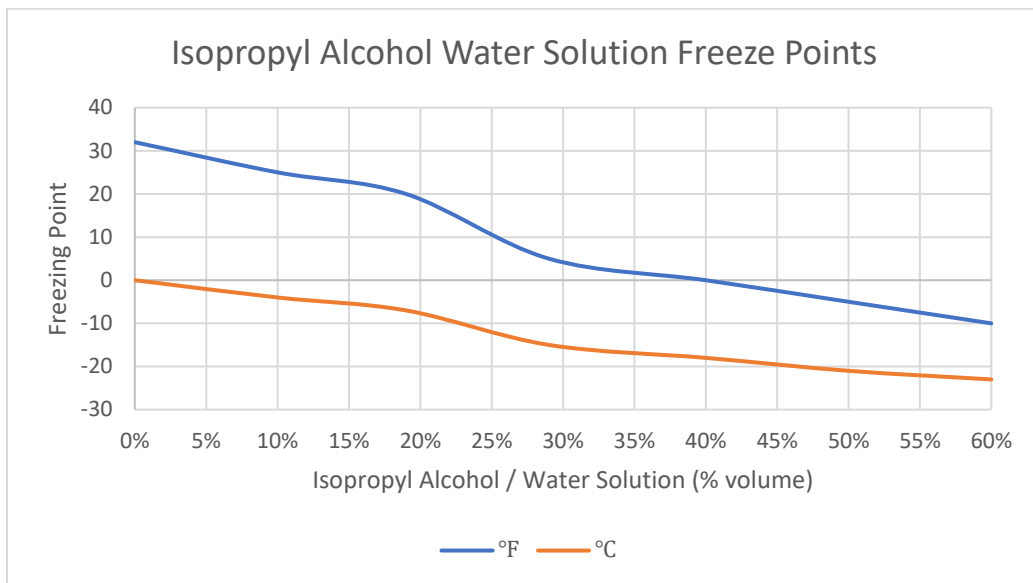
Mixture and volume

The entire reservoir does not have to be filled to get through the winter. Start with approximately 4 – 8 gallons of the solution, depending on the length of the winter. The default wash duration is 5 seconds, which uses approximately 5oz of solution per spray. An example table with gallons of IPA and water is shown below.

Mix the solution well and run the pump so that the IPA solution is in the pump head and flex tubing lines.

Safety and handling

IPA is flammable. Mix and store it away from heat, sparks, and open flames, and wear gloves and eye protection when handling it. IPA evaporates faster than water, so keep the reservoir lid closed. If the level needs topping off during the winter, add pre-mixed solution rather than plain water so the freeze protection is not diluted.



Example: gallons of isopropyl alcohol (IPA) and water

The examples below show how much isopropyl alcohol (IPA) and distilled water to mix for three common lowest winter temperatures. Because the whole reservoir does not need to be filled, they are based on a 4 gallon or 8 gallon starting volume. At 5oz per spray, that is roughly 100 sprays and 200 sprays respectively. Concentrations are rounded up to leave a margin of safety, and “Protects down to” is estimated from the chart above.

Winter severity	Lowest expected temp	Mix	Protects down to (approx.)	4 gal total (short winter)	8 gal total (long winter)
Mild	20°F	25% IPA	12°F	1.0 gal IPA + 3.0 gal water	2.0 gal IPA + 6.0 gal water
Moderate	10°F	30% IPA	5°F	1.2 gal IPA + 2.8 gal water	2.4 gal IPA + 5.6 gal water
Severe	0°F	45% IPA	-3°F	1.8 gal IPA + 2.2 gal water	3.6 gal IPA + 4.4 gal water

These amounts assume 99% isopropyl alcohol. If only 91% IPA is available, use about 10% more IPA and 10% less water (for example, 1.1 gal of 91% IPA in place of 1.0 gal of 99% IPA).

Upon completion of winter

When the freezing period is over, purge the IPA mixture from the reservoir. More details about purging the system can be found below in the section titled “Purge the Wash Extension”.

Option 2: Add a Propylene Glycol (PG) mixture to the Wash Extension reservoir

To enable automatic cleaning of the ARES reference cell in freezing environments, an anti-freeze solution can be added to the Wash Extension reservoir. Fracsun applies a hydrophobic coating to ARES' clean reference cell, so the solution will not stick to the surface if the array is properly tilted.

Fracsun recommends using a solution of distilled water and DOWFROST propylene glycol-based heat transfer fluid. A solution by volume chart can be viewed below. For example, if the lowest freezing temperature of the location is 11 degrees F, a 1:3 mixture of PG:Water is recommended (25%).

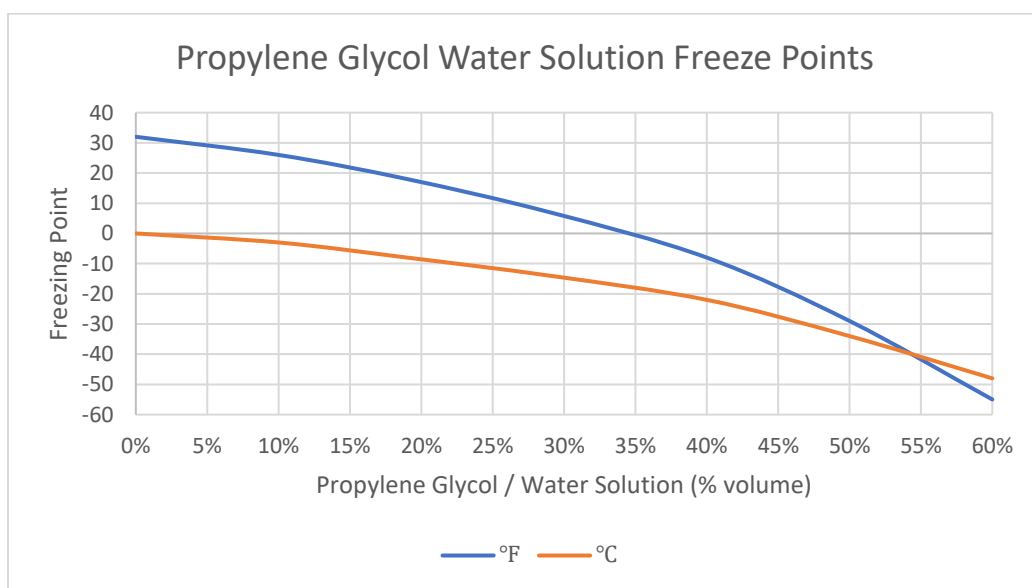
Mixture and volume

The entire reservoir does not have to be filled to get through the winter. Start with approximately 4 – 8 gallons of the solution, depending on the length of the winter. The default wash duration is 5 seconds, which uses approximately 5oz of solution per spray. An example table with gallons of PG and water is shown below.

Mix the solution well and run the pump so that the PG solution is in the pump head and flex tubing lines.

Maximum solution

A 33% solution serves as a practical maximum, considering the rarity of temperatures dropping below 10°F. Omitting an auto-wash on the coldest days of the year is deemed acceptable from a data integrity perspective.



Example: gallons of propylene glycol (PG) and water

The examples below show how much propylene glycol (PG) and distilled water to mix for three common lowest winter temperatures. Because the whole reservoir does not need to be filled, they are based on a 4 gallon or 8 gallon starting volume. At 5oz per spray, that is roughly 100 sprays and 200 sprays respectively. Concentrations are rounded up to leave a margin of safety, and “Protects down to” is estimated from the chart above.

Winter severity	Lowest expected temp	Mix	Protects down to (approx.)	4 gal total (short winter)	8 gal total (long winter)
Mild	20°F	20% PG	17°F	0.8 gal PG + 3.2 gal water	1.6 gal PG + 6.4 gal water
Moderate	10°F	30% PG	6°F	1.2 gal PG + 2.8 gal water	2.4 gal PG + 5.6 gal water
Severe	0°F	33% PG (max)	2°F	1.3 gal PG + 2.7 gal water	2.6 gal PG + 5.4 gal water

The 33% maximum protects down to only about 2°F, so on the very coldest days of the year the auto-wash may freeze. See “Maximum solution” above.

Upon completion of winter

When the freezing period is over, purge the PG mixture from the reservoir. More details about purging the system can be found below in the section titled “Purge the Wash Extension”.

Option 3: Manually clean the reference cell on a schedule and purge all water from system

Purge the Wash Extension

Any residual water left in the pump or lines can freeze. The most important component to purge is the pump head.

- Disconnect the *inlet* side of the water pump in the Wash Extension and press the “CLN NOW” button on the Wash Extension to purge all water from the lines and pump-head. Leave the inlet side disconnected until the last freeze.
- On newer Wash Extension units, the Fracsun team can *remotely* purge the Wash Extension by running the pump until the reservoir is empty. Please reach out to our team for this option.

Manually cleaning ARES

Use a clean damp microfiber towel to gently wipe away any soiling on the **clean reference cell only**. Do not forcefully scrub the glass, as this repeated practice will lead to scratches. When possible, dampen the microfiber towel with distilled or filtered water and dry with a second clean towel.

If a tougher cleaning agent is required, detergents intended for solar glass (plus filtered water) may be used to clean the cell.

Be careful when performing scheduled cleanings on tracking systems when the clean cell is above the soiled cell. Residual water can flow downward onto the soiled cell.



Do not clean or touch the “soiled” reference cell at any time unless instructed to do so.

Add a routine cleaning schedule to your winter O&M plan

Manually cleaning ARES takes less than 1 minute to perform and should be added to your winter O&M schedule. When manually wiping down the “clean” reference cell, data granularity is determined by the frequency of cleanings.

- **Once per week** or **once every 2 weeks** are acceptable manual cleaning frequencies
- **Once per day** in the morning (or evening) is the absolute best scenario, but is often impossible at unmanned plants.

Random cleanings not based on a schedule are not recommended but can be used to get a single datapoint.