

## Effective and Environmentally Compliant Cleaner - Solstice® Performance Fluid

On January 1, 2015, the United States Environmental Protection Agency identified exemptions on the continued use of the hydrochlorofluorocarbon (HCFC)-225ca and -225cb. As these solvents are commonly used in cleaning and verification of aerospace propulsion systems using liquid and gaseous oxygen, the NESC supported the Agency initiative to identify and characterize acceptable alternate fluids. Honeywell's Solstice® Performance Fluid (PF), PF-high purity (HP), and PF-HP spray are an effective nonflammable cleaning solution system, with a favorable toxicity profile and low environmental impact. Solstice PF is suitable for electronics, metal, and precision cleaning. It can be used in vapor degreasing equipment and may be dispensed with a propellant to create an aerosol contact cleaner. Solstice PF has been shown to have negligible ozone depletion and a global warming potential of 1. With these characterized environmental and solvency properties, Solstice PF, PF-HP, or PF-HP spray may be an excellent choice for a variety of cleaning applications.

**Cleaning Capabilities:** The solubility characteristics allow for Solstice PF (NVR < 10 PPM) and PF-HP (NVR < 2 PPM) to be used to dissolve a number of typical soils that are encountered in military and aerospace cleaning operations.

**Non-Flammable:** Solstice PF does not exhibit flashpoint or vapor flame limits. It was determined not to have vapor flame limits at temperatures to 100°C (212°F) using an ASTM E 681 apparatus.

**Oxygen System Cleaning:** Solstice PF, PF-HP, and PF-HP spray are well suited for oxygen line cleaning as they effectively remove contamination and then can be completely dried. Solstice PF-HP and PF-HP spray passed the mechanical impact tests per ASTM D 2512- 82, has an oxygen-enriched autoignition temperature of 182°C (360°F) at 13.8 MPa (2,000 psig) per ASTM G 72, and Heat of Combustion of 2,448 kcal/kg (4,403 BTU/lb) per ASTM D240.

**Compatibility:** Solstice PF is compatible with metals commonly used in aerospace and military, and in all cases the metals tested per ASTM F483 indicated no solvent breakdown or acid formation.

**Implementation Consideration:** Solstice PF characteristics compared to other currently available cleaning solutions:


- Low solvent loss due to:
  - High heat of vaporization, and low surface tension - improved wetting characteristics and reduced drag-out loss
  - Recovery potential - distillation and carbon recovery
- Reduced energy requirements for processing
- High solvency, not a high-cost filler - reduces or eliminates blending
- High wetting index for removal of particulate matter from complex parts
- No post-process residue removal
- Potential drop-in alternative in aerosol cleaners

The unique solubility characteristics, high performance, nonflammability, stability, low toxicity, and environmental compliant properties of Solstice PF and PF-HP allow for use in a wide variety of applications from oxygen line cleaning

to degreasing. NASA Cleaning Facility Conversion: Cleaning facilities at SSC and MSFC have converted to Solstice PF with minimal issues. Points of contact at these facilities are Rick Ross ([harold.r.ross@nasa.gov](mailto:harold.r.ross@nasa.gov), 228-688-2353) and Mark Mitchell ([mark.a.mitchell@nasa.gov](mailto:mark.a.mitchell@nasa.gov), 256-544-5860).

### References

1. Replacement of Hydrochlorofluorocarbon-225 Solvent for Cleaning and Verification Sampling of NASA Propulsion Oxygen Systems Hardware, Ground Support Equipment, and Associated Test Systems, [NASA/TP-2015-218207](#)
2. Solvent Replacement for Hydrochlorofluorocarbon-225 for Cleaning Oxygen System Components, [NASA/TM-2017-219687](#)
3. ASTM STP 1596, "Flammability and Sensitivity of Materials in Oxygen-Enriched Atmospheres, 14th Volume." (West Conshohocken, PA: ASTM International, 2016)



**Solstice® Performance Fluid**

**Environmental and Safety Properties**

Flash Point	None
Lower/Upper Flame Limit (volume %)	None
Occupational Exposure Limit (PPM)	800
Global Warming Potential (100-year)	1
Volatile Organic Compound (U.S. and California South Coast Air Quality Management District)	Exempt

**Physical Properties**

Property	Solstice PF
Chemical Name	trans-1-chloro-3,3,3-trifluoropropene
Molecular Formula	CF <sub>3</sub> -CH=CClH
Molecular Weight	130
Boiling Point	19°C (66°F)
Latent Heat of Vaporization at Boiling Point	194 kJ/kg (83.4 BTU/lb)
Freezing Point	-107°C (-161°F)
Vapor Pressure at 20°C (68°F)	109 kPa (15.8 psia)
Liquid Density at 20°C (68°F)	1.27 gm/mL (10.6 lb/gal)
Surface Tension at 20°C (68°F)	12.7 dyne/cm
Liquid Viscosity at 20°C (68°F)	0.503 cP
Solubility of Water in Solvent at 25°C (77°F)	460 ppm
KB Value	25

