

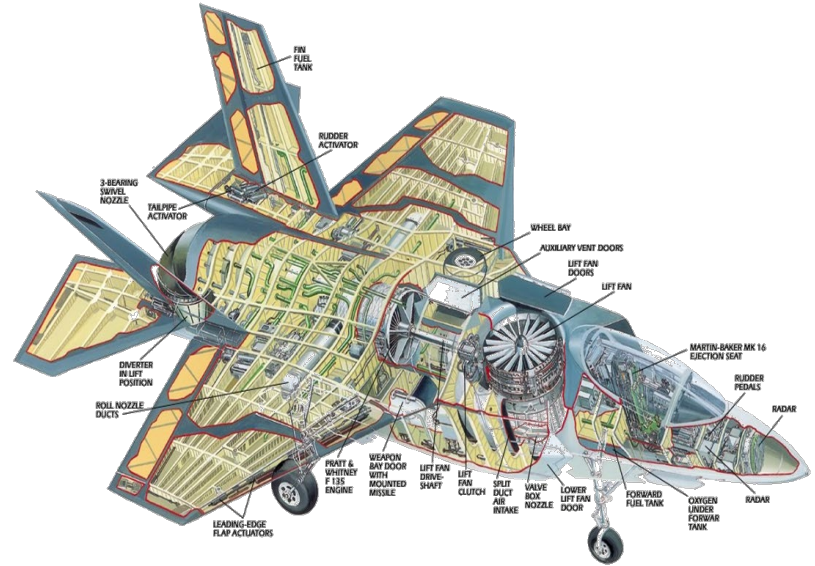


OSCG 2023

Next Generation Solvents 2.0

Why Solvent?

- ✓ Cleans Machining Fluids
- ✓ Low Surface Tension
- ✓ Dries Completely
- ✓ Low Residue
- ✓ Runs Neat
- ✓ Recyclable



What we need from a cleaning Process?

- Remove Soils from Parts
 - Leave <acceptable range
- Enter and Exit Complex Geometries of our Parts
- Dries Completely
- Compatible with Materials and Equipment
- Compliant with Govt Regulations and Corporate EH&S
 - Safe and nonpolluting

What we need from a Cleaning Process in GOX/LOX?

- Nonflammable/ Nonignitable
 - Autogenous Ignition Temperature Testing
 - Mechanical Impact Testing
- Virtually NO Residue
 - No residual cleaning agents/ soils

Solvent in GOX/LOX

- ✓ Cleans Machining Fluids
- ✓ Low Surface Tension
- ✓ Low Residue
- ✓ Dries Completely
- ⊗ Compatibility with materials
- × Nonflammable/ Nonignitable
- × Compliant

NASA MSFC-SPEC-3709 – Standard



National Aeronautics and
Space Administration

George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama 35812

MEASUREMENT
SYSTEM
INCH-POUND

MSFC-SPEC-3709
BASELINE DRAFT
EFFECTIVE DATE: 10-JAN-2017

EM22

MSFC TECHNICAL STANDARD

SPECIFICATION FOR SOLVENT, CLEANING, TRANS-1-CHLORO-3,3,3,- TRIFLUOROPROPENE, SOLSTICE® PF

Approved for Public Release; Distribution is Unlimited

CHECK THE MASTER LIST
VERIFY THAT THIS IS THE CORRECT VERSION BEFORE USE

MSFC TECHNICAL STANDARD

EM22

Title: Solvent, Cleaning, Trans-1-Chloro-3,3,3-Trifluoropropene, Solstice® PF	Baseline
Document No: MSFC-SPEC-3709	Page: 5 of 12
Effective Date: 10-JAN-2017	

1.0 SCOPE

1.1 Scope

This specification establishes the requirements for Honeywell Solstice® Performance Fluid (PF) solvent, trans-1-chloro-3,3,3-trifluoropropene. This material is intended for use for cleaning and cleanliness verification for spaceflight hardware and related ground support equipment and test systems.

1.2 Classification

The grade is specified based on the allowable level of nonvolatile residue (NVR) contamination in the solvent as follows:

Grade A – High Purity (HP), low NVR level for precision cleaning and NVR verification sampling.

Grade B – Standard Purity, commercial standard NVR level for general use. May be packaged and distributed by KYZEN under product name Metalnox® 6920.

2.0 APPLICABLE AND REFERENCE DOCUMENTS

2.1 Applicable Documents

The following documents of the revision listed (or latest revision if no revision is listed) form a part of this document to the extent specified herein.

ASTM D2109	Standard Test Methods for Nonvolatile Matter in Halogenated Organic Solvents and Their Admixtures
ASTM D2988	Standard Test Methods for Water-Soluble Halide Ion in Halogenated Organic Solvents and Their Admixtures
ASTM D2989	Standard Test Method for Acidity-Alkalinity of Halogenated Organic Solvents and Their Admixtures
ASTM D3401	Standard Test Method for Water in Halogenated Organic Solvents and Their Admixtures
ASTM D6806	Standard Practice for Analysis of Halogenated Organic Solvents and Their Admixtures by Gas Chromatography
ISO/IEC 17025:2005	General Requirements for the Competence of Testing and Calibration of Laboratories

CHECK THE MASTER LIST
VERIFY THAT THIS IS THE CORRECT VERSION BEFORE USE

US Navy

Cover Sheet



Solvent Cleaning Replacement for Breathing Air Oxygen Systems/Components

Presented to: 7/31/2019
OSCG

Presented by:
Kamil Carter
43420 Materials Engineering Lead

Distribution A

NAVY AIR

Final Sheet



Conclusion

**Solstice PF-HP will be the target solvent for
implementation into the MIL-STD-1330**

NSN for 10 lb cylinder is 6830-01-678-3176 (~\$600)

Establishing NSN for 200 lb cylinder

Special Thanks to:

Alex Goloub and Sara Jane Neal

Verita Grannum

Graeme Nichols

Aliasger Ezzi



Honeywell

KYZEN
Where Science and Care Converge.



Distribution A

NAVY AIR

DoD Cleaning Spec

MIL-STD-1330E(SH)

16 May 2022



DEPARTMENT OF DEFENSE STANDARD PRACTICE

- **PRECISION CLEANING AND TESTING OF SHIPBOARD OXYGEN, HELIUM, HELIUM-OXYGEN, NITROGEN, AND HYDROGEN SYSTEMS**

Timeline of Oxygen Device Cleaning Agents



Past

CFC-113

- Excellent Degreaser
- Suitable for use in GOX/ LOX
- Class 1 Ozone Depleting Material
- Montreal Protocol of 1987
 - Phase out Class 1 Chemicals by 2000

HCFC

- Excellent degreaser
- Suitable interim replacement for CFC-113 for use in LOX/GOX starting 1996
- Class II Ozone Depleting
- Clean Air Act VI bans production/ import of Class II ODS with exception of some refrigerants by 2015
 - Phase out existing Class II Chemicals by 2030

Current Next Generation Solvents 1.0

HFCs

- Medium Grade Cleaner without trans-DCE
- Trans flammable without additives
 - HFC Azeotrope with DCE and additives
- Not Class 1 or Class II
- **High Global Warming Potential**
- The *American Innovation & Manufacturing (AIM) Act* enacted in December 2020 mandates a phasedown schedule of **HFC** production and imports through 2036 from baseline years 2011-2013. **Beginning in 2024, 40% HFC's will be removed from the marketplace**, while by 2036 85% **HFC's** will be removed.
- U.S. DoD, GSA and NASA issue a Final Rule; **Use HFC Alternatives** Whenever Feasible

HFES

- Poor Cleaner without trans-DCE
- Trans flammable without additives
 - Forms Azeotrope with DCE and additives
- Not Class 1 or Class II
- Low Global Warming Potential
- No current Phase Out plans
- Major manufacturer 3M will exit manufacturing by **2025**
(if not before ?)

PFAS Considerations

- 3M issues letter **December 2022** they will discontinue all PFAS products by **2025**
- EPA evaluating PFAS for future restrictions
- Maine and Minnesota first states to enact PFAS restrictions
 - Broadening definition
- Future PFAS Restrictions?
 - Moving target
 - Local and State Regulations may apply

HFOs

HFO's are currently used to clean LOX Components and Breathable Oxygen Devices by NASA and the US Navy

- **Extensive flammability testing by Marshall Space Flight Center, Stennis Space Center and White Sands**
- **Certified non-flammable by NASA: RPT STD-8070-0001**
- **Certified safe for breathable oxygen systems: MIL SPEC 1330**
- **Cytotoxicity and extensive health studies performed by the US Navy**



What's Next?

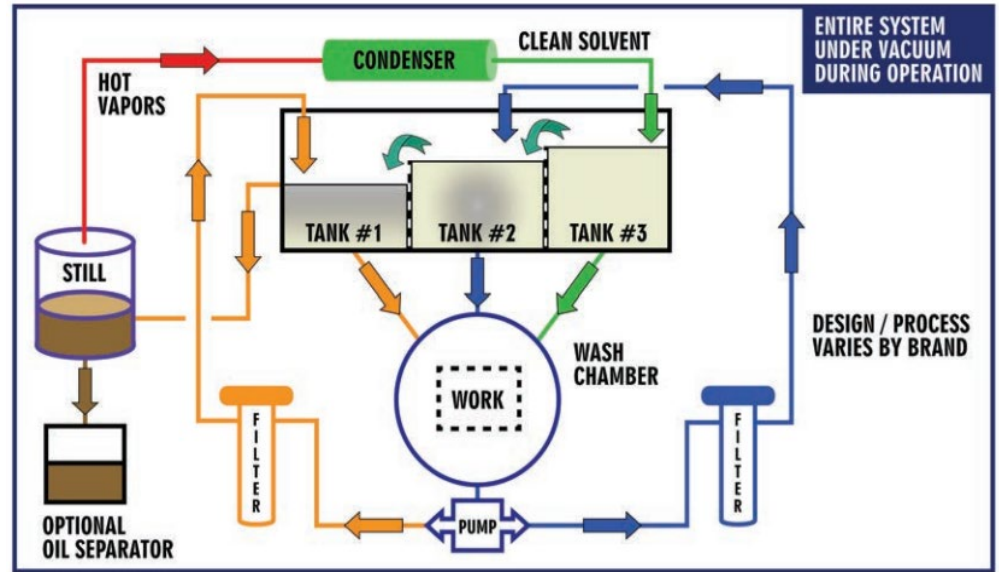
Next Generation Solvents 2.0

HFOs and HCFOs... We Believe

- Acceptable for GOX/ LOX
 - Nonflammable
 - Good solvency
 - Dries well
 - Low NVR
- Favorable Environmental qualities
 - Not Class I or Class II
 - Ultra Low GWP (<1)
 - Ultra Low ODP (1)
 - No HFEs, HFCs, or Bromides
 - Not a HAP (Hazardous Air Pollutant)

Vacuum Degreasing / Modified Alcohol

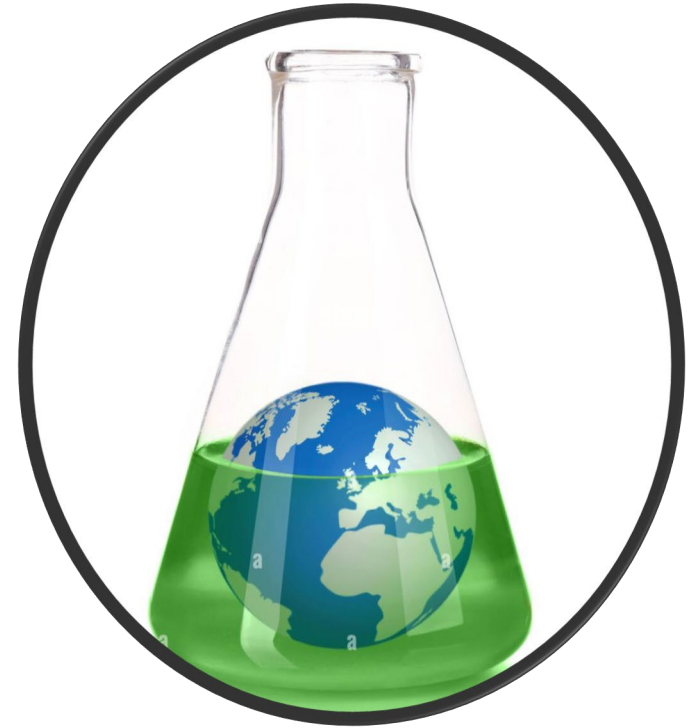
- Good Cleaning process for polar and non-polar soils.
- Cleans complex geometry
- Parts exit **clean & dry**.
- Low Cost of Operations)
- Favorable EH&S
 - No OZD, Not a HAP or PFAS
 - Low GWP, High PEL
 - No HFE, HFC, Nonhalogenated
- Likely need flushing



Aqueous Cleaning

- Relatively High NVR
 - ignition/ impact in OX system
 - Likely need flushing
- More Challenging to Dry
- Diluted
- Waste Streams

Change Happens



Identify → Validate

- Compliant
- Prove acceptable for GOX/ LOX
- Prove compatible with all components
- Effective removal of soils
- Business considerations
 - Current and future availability
 - Cost of material/ process
 - Future compliance

Future Compliance Considerations

- ~~Ozone Depleting~~
- ~~Global Warming~~
- HAP
- VOC
- PFAS
- PEL

SOLVENT
TECHNOLOGY

"SUSTAINABLE CLEANING TECHNOLOGY FOR THE FUTURE"
We Circle the Globe with Our Products

VACUUM
TECHNOLOGY

AQUEOUS
TECHNOLOGY

Questions and Contact Information

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