



# Solvent Cleaning Replacement for Breathing Air Oxygen Systems/Components

7/31/2019

*Presented to:*  
OSCG

*Presented by:*  
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**Distribution A**

**NAV AIR**



01

**FRCSE**

One of six Fleet Readiness Centers commissioned by the Department of the Navy to perform maintenance, repair, and overhaul (MRO) on various Navy aircraft, patrol, anti-submarine, reconnaissance transportation, trainer, and rotary wing.

02

**OXYGEN SHOP**

Services flight-critical aircrew oxygen bottles and components for the P-3 Orion, F/A-18, F-5 and foreign military.

03

**MATERIALS ENGINEERING**

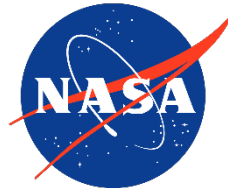
Tests the oxygen bottles for contamination and provide processing guidance to artisans.



# Background

**Phase out of Freon 113**  
As of 2015 requires CNO waiver

**Phase out of HCFC 225**  
No production after 2015



**NASA Solvent Investigation**



**Navy investigation of Solstice PF-HP**  
NESDI Funded



**Implementation**  
Updating MIL-STD-1330. Consulting NAVAIR tech warrant holders

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# Cleaning Efficiency



Contaminant	Solstice PF-HP		Freon 113	
	Average PPM	Pass/Fail	Average PPM	Pass/Fail
JP5	3.17	Pass	1.67	Pass
JP8	1.33	Pass	1.75	Pass
MIL-H-5606	0.05	Pass	2.00	Pass
MIL-PRF-17331	6.33	<b>Fail</b>	10.67	<b>Fail</b>
MIL-PRF-23699	1.33	Pass	1.17	Pass
MIL-PRF-27617 Type II	179.7	<b>Fail</b>	19.17	<b>Fail</b>
Skydrol LD-4	4.75	Pass	4.67	Pass
MIL-PRF-83282	0	Pass	0	Pass



# Compatibility Test Protocol

Prepare the test specimen

Submerge sample in test solvent for 24 hours at approximately 53°F

Remove specimen

Complete Compatibility Testing

Rubber

Tensile per ASTM D471

Volume per ASTM D471

Hardness per ASTM D2240

Plastic

Tensile per ASTM D 638

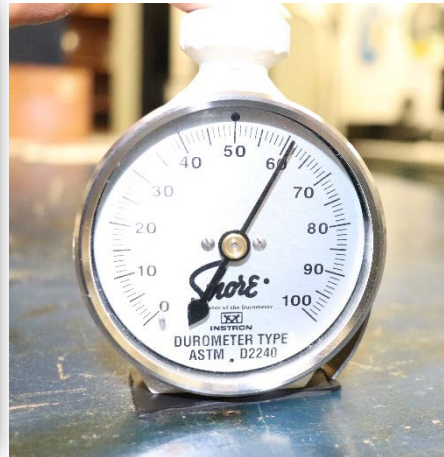
Weight per ASTM D543

Metal

Corrosion/ visual inspection per ASTM D1280



# Rubber Compatibility



Tensile and Elongation  
(% original)

Compatible  $\geq 85$

12Hr  $\geq 75$  and  $< 85$

1Hr  $\geq 60$  and  $< 75$

Incompatible  $< 60$

Hardness  
(change in units)

Compatible  $\leq \pm 5$

12Hr  $> \pm 5$  and  $\leq \pm 7$

1Hr  $> \pm 7$  and  $\leq \pm 9$

Incompatible  $> \pm 9$

Volume  
(% change)

Compatible  $\geq 0$  and  $\leq +10$

12Hr  $\geq -5$  and  $\leq 0$

1Hr  $\geq -10$  and  $\leq -5$   
 $> +10$  and  $\leq +15$

Incompatible  $< -10$   
 $> +15$

## MATERIALS



MATERIALS	Solstice	R-113
Adiprene	↗	⊥
Butadiene-nitrile MIL-P-5510	↘	↗
Butadiene-nitrile MIL-P-5516 Class A	↘	↗
Butadiene-nitrile MIL-P-5516 Class B	↘	↘
Butadiene-nitrile MIL-P-25732	↘	↘
Butadiene-nitrile MIL-P-83461	↘	↘
Butadiene-styrene, Commercial	↘	↘
Ethylene Propylene MIL-G-22050 Duro 65	↘	↘
Ethylene Propylene MIL-G-22050 Duro 80	↘	↘
Ethylene Propylene AIA NAS 1613 Duro 70	⊥	⊥
Ethylene Propylene AIA NAS 1613 Duro 80	↘	↘
Ethylene Propylene MIL-R-83285 Duro 60	↘	↘
Hypalon-40 MIL-R-81828	↘	↘
Kel-F- Polychlorotrifluoroethylene	↗	↗
Neoprene	↘	↗
Silicone, Commercial	↘	⊥
Polysulfide	⊥	⊥
Viton, MIL-R-83248 Duro 75	↘	↘
Viton, MIL-R-83248 Duro 90	↘	↗



Incompatible Not Tested 12 Hr Limit Compatible



# Plastic Compatibility



Tensile  
(% original)

Weight  
(% change)

Compatible  $\geq 95$

Compatible  $\leq 1$

12 Hr  $\geq 90$  and  $< 95$

























12 Hr  $> 1$  and  $\leq 2$

1 hr  $\geq 85$  and  $< 90$

1 Hr  $> 2$  and  $\leq 3$

Incompatible  $< 85$

Incompatible  $> 3$

MATERIALS		
<u>Derlin 150</u>		
PVC		
<u>Lexane</u>		
ABS		
Epoxy		
<u>Plexiglass</u>		
Torlon 4203		
Polyurethane		
<u>Surlyn 9650</u>		
Teflon FEP		
Nylon		
Teflon TFE		
Vespel-21		
<u>Ultem 1000</u>		
HDPE		
Polypropylene		
Flexible PVC**		

 Incompatible  
  Not Tested  
  12 Hr Limit  
  Compatible



# Metal Compatibility



Incompatible  
 Not Tested  
 12 Hr Limit  
 Compatible

MATERIALS	Solstice	R-113
Aluminum, Alloy 5052-0		
Aluminum, Alloy 5456		
Aluminum, Alloy 6061-T6		
Alloy Steel, Alloy HY-100		
Alloy Steel, MIL-F-22606		
Alloy Steel, Alloy 4130		
Brazing Material, BCuP-5		
Bronze; CDA922		
Carbon Steel, ABS Grade EH36		
Copper, Alloy C12200-H80		
Copper-Nickel Alloy C715-70/30		
Inconel, Alloy N6600 CW		
Inconel N06625		
Naval Brass, Alloy 464		
Nickel-Aluminum-Bronze Alloy C95800		
Nickel-Aluminum-Bronze Alloy C63000-HR50		
Nickel-Aluminum-Bronze Alloy C4200-HR50		
Nickel-Copper MIL-T-1368		
Nickel-Copper QQ-N-281		
Nickel-Copper QQ-N-286		
Stainless Steel, Alloy 304		
Stainless Steel, Alloy 316 QQ-S-763		
Titanium, Pure		
Titanium TI-6-AL-4V		





# Nonvolatile Residue

## Fourier Transform Spectrometry (FTIR)

- FTIR analysis was completed using 3 psi of gas in the testing cell at room temperature. FTIR was able to correctly identify target solstice peak. Peak wavelength is approximately 1150.

PASS

## Surface Quality Monitor (SQM)

- Solstice was compatible with the SQM method as outlined in MIL-STD-1330. The SQM was able to accurately read levels above and below the 5 ppm requirement.

PASS

## Gravimetric Analysis

- Gravimetric analysis using solstice was within 3% difference of the known solution. This method could accurately determine the amount of non volatile residue.

PASS



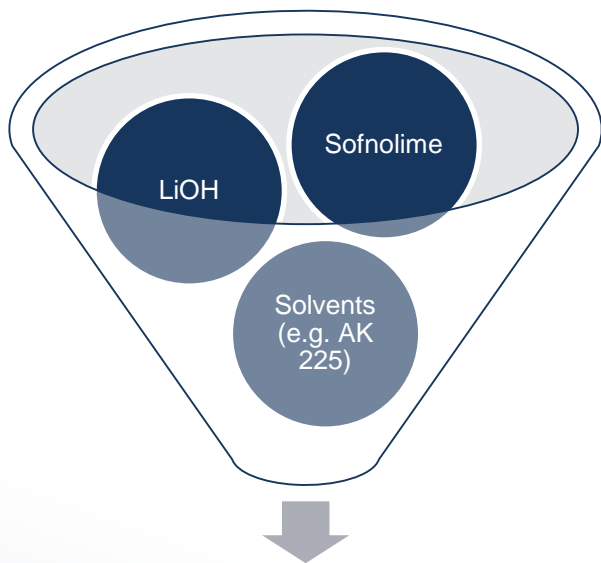
# Gauge Adsorbents

Preparation of Samples

Prepare supply cylinder of CO2 to 15 psig and 60 psig

Expose Solstice PF-HP at defined times

Evaluate using GC FID



Dichloro/ Monochloroacetylene  
Precursor Compounds

Exposures	Detection
LiOH 15 psi 30 min of CO2/ 30 min solvent exposure	None Detected
LiOH 15 psi 30 min of CO2/ 60 min solvent exposure	None Detected
LiOH 15 psi 60 min of CO2/ 30 min solvent exposure	None Detected
LiOH 60 psi 30 min of CO2/ 30 min solvent exposure	None Detected
LiOH 60 psi 30 min of CO2/ 60 min solvent exposure	None Detected
LiOH 60 psi 60 min of CO2/ 30 min solvent exposure	None Detected
LiOH 60 psi 60 min of CO2/ 60 min solvent exposure	None Detected
Sofnolime 15 psi 30 min of CO2/ 30 min solvent exposure	None Detected
Sofnolime 15 psi 30 min of CO2/ 60 min solvent exposure	None Detected
Sofnolime 15 psi 60 min of CO2/ 30 min solvent exposure	None Detected
Sofnolime 60 psi 30 min of CO2/ 30 min solvent exposure	None Detected
Sofnolime 60 psi 30 min of CO2/ 60 min solvent exposure	None Detected
Sofnolime 60 psi 60 min of CO2/ 30 min solvent exposure	None Detected
Sofnolime 60 psi 60 min of CO2/ 60 min solvent exposure	None Detected

# Honeywell

# PASS



# Navy Laboratory Recommendations



## NAMRU-Dayton

Awaiting final decision



## NMCPHC

Risk Assessment Code (RAC) is set to Medium.

Approved for use in well ventilated areas and with the use of gloves.

Recommended "RESTRICTED" use on submarines



## NEDU

Recommended "RESTRICTED" use

Off- gas analysis was completed by NASA White Sands Test Facility. They performed off gas analysis IAW TP-WSTF-629. The result were less than reporting limits.



# Summary

Multiple methods  
for cleaning oxygen  
components and  
systems.

6

Boiling Point is  
66° F

1

Can be used on all  
metals tested.

5

Can not be used on  
most rubbers and  
plastics.

2

Currently updating  
MIL-STD-1330

4

Ability to use  
multiple process  
verification  
methods.

3



# 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

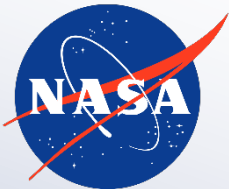
## Special Thanks to:

Alex Goloub and Sara Jane Neal

Verita Grannum

Graeme Nichols

Aliasger Ezzi



**Honeywell**

