



Minimizing Toxicity Without Sacrificing Cleaning Performance

A New and Safe VOC-Exempt Solvent Addresses Toxicity Issues Related to TCE and nPB

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Solstice® Performance Fluid

Ever-changing regulations to protect worker safety and the environment continue to drive the need for safer, lower toxicity solvents in cleaning applications. Two solvents of growing concern include trichloroethylene (TCE) and n-propyl bromide (nPB), both of which have escalating toxicity and worker safety issues.

Users of TCE and nPB need long-term alternative solutions that offer a balance of:

- Favorable environmental, health and safety (EHS) properties
- Excellent and reliable cleaning performance
- Easy processing
- Non-flammability

Unlike other alternatives, Solstice® Performance Fluid (PF) meets all of those criteria, offering long-term safety and environmental benefits without sacrificing performance. These benefits include:

- High occupational exposure limit (OEL) of 800 ppm (WEEL*)
- Non-VOC* classification by the U.S. Environmental Protection Agency (EPA) and South Coast AQMD*
- Non-flammability designation as established by ASTM* E-681
- Ultra-low Global Warming Potential (GWP) of 1 (IPCC*, 2014)
- Equivalent, if not better, cleaning power
- High stability and compatibility
- Lower total cost of ownership

The TCE and nPB Dilemma

Component manufacturers use a degreasing process to completely remove manufacturing soils from parts, thereby ensuring part performance. Part failure is not an option, especially for high-reliability applications such as those in aerospace which must stay in service for up to 30 years, or for medical components which must operate reliably for patient safety.

While TCE and nPB can deliver excellent cleaning power in certain applications, both fall short on EHS performance.

- **TCE** is considered a low-cost workhorse solvent for heavy duty, bulk cleaning applications, but not for precision-cleaning where reliability is critical and not for softer materials like elastomers and plastics. It is also classified as a Hazardous Air Pollutant (HAP). This requires manufacturers to obtain a Title V permit to operate, and the degreasing process must comply with National Emission Standards for Hazardous Air Pollutants (NESHAP) – all of which increase operating expenses. As a VOC, it must also be included in facility air permits. The American Conference of Governmental Industrial Hygienists (ACGIH) has set the time-weighted average (TWA) threshold limit value for TCE to 10 ppm and has designated it as a suspected carcinogen.
- **nPB** is used in bulk cleaning applications and has performance limitations similar to TCE. It gained popularity as a replacement to TCE due to its lack of regulatory restraint at the time. Now, however, significant toxicity concerns have been raised, leading to ever-lower TWA threshold limits. Recently, the ACGIH changed its recommended TWA threshold limit value for nPB from 10 ppm to 0.1 ppm – which is lower than TCE. Even with

additional engineering controls such as containment, ventilation, more substantive respiratory personal protective equipment (PPE), and monitoring to limit exposure, it is extremely difficult and expensive to maintain employee exposure at levels lower than 0.1 ppm.

Regulatory pressure to reduce workplace exposure is expected to continue.

Relieving the Pressure

The Occupational Health and Safety Administration (OSHA) recommends reducing worker exposure in several ways, the two most effective being “eliminating the hazard of concern or substituting the hazardous substance with a less toxic/hazardous process.”

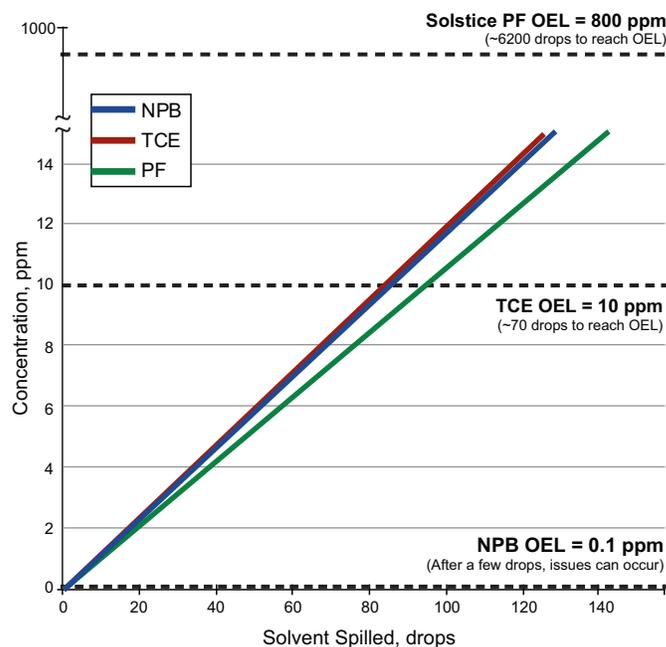
In other words, it is critical to manage risk by being proactive. This means making the switch from problematic products like TCE and nPB to a viable alternative before experiencing costly liability, litigation and fines, not to mention potential loss of sales.

Solstice PF is an excellent alternative with an exceptional combination of EHS properties. As shown in **Table 1**, when compared with TCE and nPB, Solstice PF provides a higher OEL, nonflammability per ASTM E681 testing, and a faint to no odor. In addition to its VOC- and HAP-exempt status, Solstice PF also has a very low atmospheric life of 26 days and an ultra-low GWP of 1.

The low toxicity of Solstice PF is reinforced in **Figure 1**, which shows how many drops of solvent need to be spilled before reaching the OEL limit in a worst-case scenario of no ventilation. As shown, just a few drops of

nPB and 70 drops of TCE can cause issues, compared to about 6,200 drops of Solstice PF. Solstice PF thus provides an important margin of safety for the work environment.

Figure 1: The High OEL of Solstice PF Improves Workplace Safety.*



*Calculations are based on a 400-square-foot room and how many drops of solvent could be dripped on the floor before reaching the OEL. Additional engineering controls such as ventilation further reduce the exposure rate.

Table 1: Solstice PF Has Excellent EHS Properties, Including Low Toxicity.

Properties	Solstice PF	TCE	nPB
Health & Safety			
OEL (ppm)	800	10	0.1
Vapor Flame Limits	None	12-29	4.6-9.1
Odor	Faint to None	Slight	Strong
Environment			
Atmospheric Life	26 days	6-8 days	16 days
GWP	1	140	n/a
VOC or HAP	VOC-exempt	Yes	Yes

Best of Both Worlds

Solstice PF, which is based on proprietary hydrofluoroolefin (HFO) technology from Honeywell, is specifically designed to deliver the best of both worlds: improved EHS performance in addition to outstanding cleaning performance.

On the performance side, Solstice PF offers:

- Excellent wetting, even in complex geometries.
- Fast drying for improved productivity.
- High solvency, dissolving a variety of oils and greases without damaging the substrate.
- High stability – no stabilizers or additives are required.
- Compatibility with a variety of polymers, elastomers and metals (no corrosion or cracking).

Solstice PF can also reduce the total cost of ownership due to:

- No need for additives, stabilizers or residue removal.
- No need for trans-1,2-dichloroethylene (TDCE) additives to improve performance.

- A lower boiling point, reducing energy needs for drying.
- Its VOC-free status, which avoids certain capital expenditures and permit costs.
- A small operational footprint versus, for example, aqueous systems which require significant space in addition to training and investment.

These and other properties make Solstice PF a versatile choice for cleaning precision metal and plastics parts in aerospace, military, medical device and other applications.

Performance Comparisons

The cleaning tests in Figures 2-3 demonstrate the outstanding performance of Solstice PF versus TCE and nPB, even in complex parts.

As shown in **Figure 2**, three oils were applied to a stainless steel bearing: Mobil 600W, silicone grease, and Nu-Calgon mineral oil. The bearings were then immersed in a boil sump for 3.5 minutes followed by a rinse in the clean sump for 40 seconds and a spinning of the bearing to ensure free rotation. Photos were taken

Figure 2: In General Applications, Solstice PF Provides Equivalent Performance to TCE and nPB.

	Mobil 600W	Silicone Grease	Nu-Calgon Mineral Oil
Dirty Parts			
(magnified view)			
Cleaned with Solstice PF			
Cleaned with TCE			
Cleaned with nPB			

**3.5-minute immersion in boil sump followed by a 40-second rinse in a clean sump.*

before and after to show the cleaning performance. As shown, Solstice PF shows no residue, demonstrating equivalent performance to TCE and nPB.

Figure 3 demonstrates the ability to clean two greases common to the aerospace industry that are more difficult to remove: AeroShell Grease #5 and Mobil 28 grease. The test involved a 5-minute immersion followed by 132 kHz ultrasonics. As shown, Solstice PF shows no residue, demonstrating outstanding cleaning performance.

Figure 3: In Demanding Aerospace Applications, Solstice PF Demonstrates Outstanding Cleaning Performance*.

	Aeroshell Grease #5	Mobil 28 Grease
Dirty Parts		
(magnified view)		
Cleaned with Solstice PF		

**5-minute immersion in Solstice PF with 132 kHz ultrasonics.*

The Business Case

Manufacturers seeking long-term alternatives to TCE and nPB can get everything they need from Solstice PF. This innovative degreasing solution minimizes toxicity without sacrificing cleaning performance. With Solstice PF, manufacturers can proactively manage risk and improve long-term business success.

Solstice PF is commercially available today, and approved under the EPA's Significant New Alternatives Policy (SNAP) program. It is also registered in Europe (REACH), Japan, Canada, Australia and South Korea. Contact your Honeywell representative for details.

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