

946 mL – 1 U.S. Quart



bp

TURBO OIL 2197

TURBINE ENGINE & ACCESSORY

**A State of the Art Turbo
Oil from a World Leading
Aviation Supplier**

BP TURBO OIL 2197



AN ADVANCED FLEETWIDE OIL FOR THE 21ST CENTURY

BPTO 2197 CAN PROVIDE:

- Unsurpassed cleanliness
- Extended on-wing life for engines and accessories
- Reduced operating costs due to lower maintenance
- Improved lubricating system reliability

BP Turbo Oil (BPTO) 2197 is our newest turbo oil, designed to be a 'fleet-wide' oil that provides superb performance in existing and new-generation commercial aircraft turbine engines and other components. BPTO 2197 offers exceptional high temperature cleanliness in vapor mist and liquid film areas, as well as outstanding oxidative, thermal and hydrolytic stability.

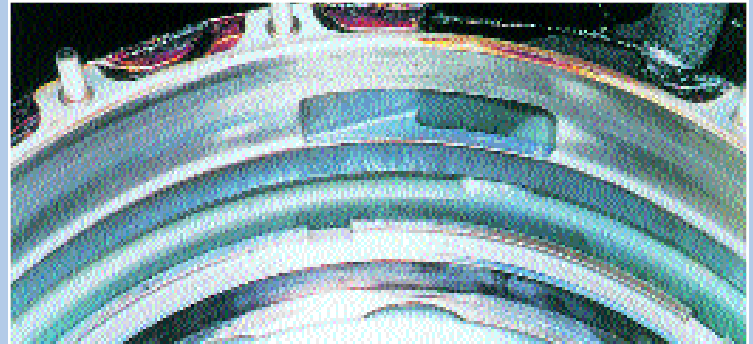
PROVEN PERFORMANCE

BPTO 2197 entered commercial airline service in mid-1995, and as of November 2000, has accumulated more than 7 million hours in engines and over 4 million hours in accessories. Specifically formulated to ensure that it could be used as a 'fleet-wide' oil for every commercial jet aircraft fleet, BPTO 2197 provides exceptional performance in the most demanding existing jet engines as well as new-generation engines just starting use in airline fleets. Besides demonstrating outstanding cleanliness and stability characteristics, BPTO 2197 is also proven to have good load-carrying capabilities and elastomer compatibility. Numerous tear-downs of high-time engines and other components such as Integrated Drive Generators (IDGs), Constant Speed Drives (CSDs) and Auxiliary Power Units (APUs) demonstrate these results.

SPECIFIC IMPROVEMENTS

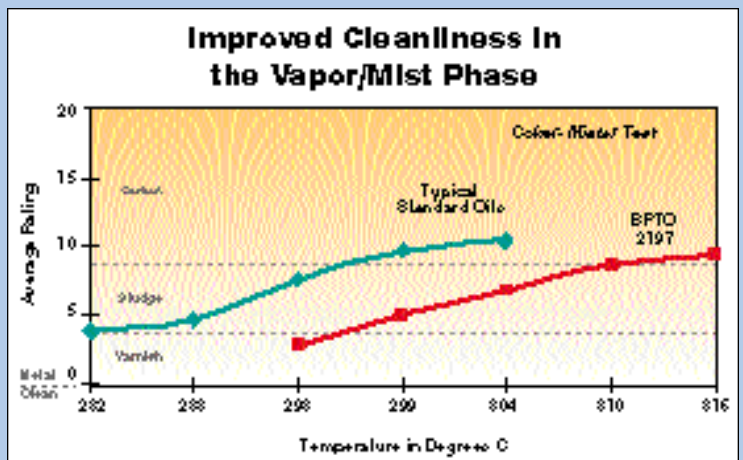
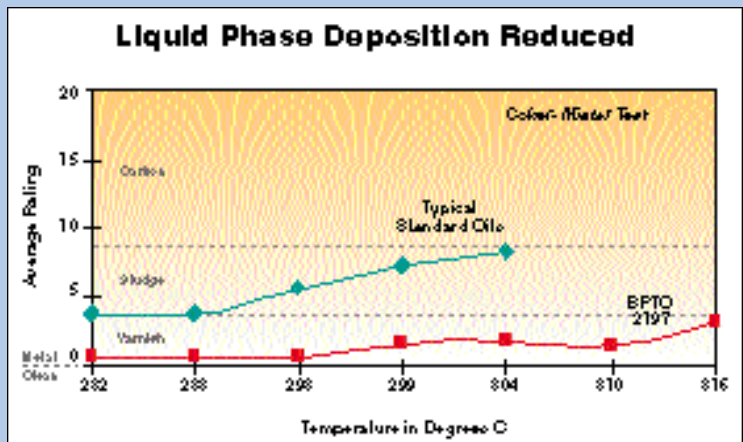
High Temperature Cleanliness - the key performance target in the development of BPTO 2197. With high thrust-to-weight ratios, today's turbine engines impose tremendous stresses on oils. BPTO 2197 maintains very low levels of deposition under severe thermal stress in the various categories that comprise total cleanliness:

Resistance to Formation of High-Temperature Insolubles - carbon deposition at high temperatures is a significant problem with turbine engine oils. BPTO 2197 achieves very low depositions, especially in critical high-temperature areas such as oil sumps and oil supply, breather and scavenge tubes.

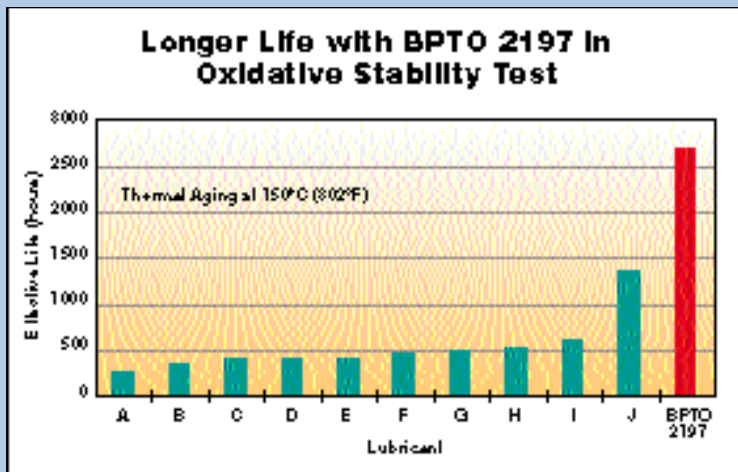


CF6-80C2 D Sump Oil Scavenge 8300+ hours on BPTO 2197

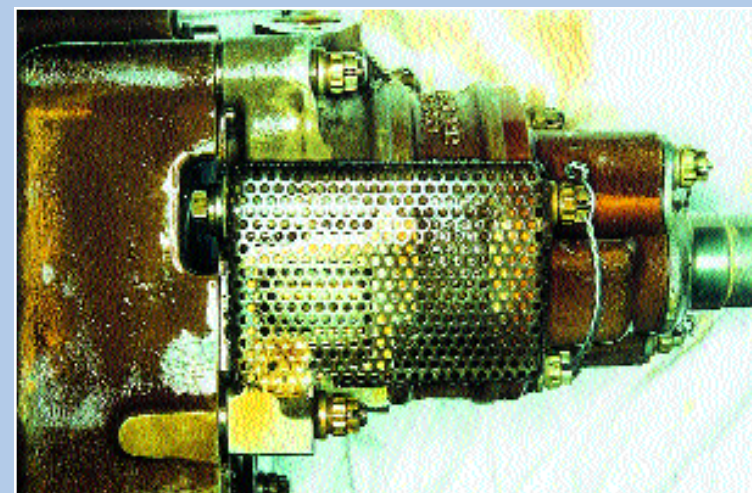
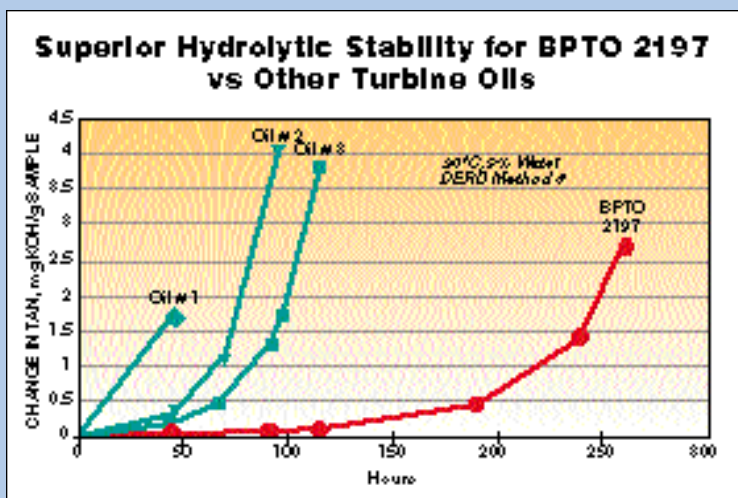
BPTO 2197's exceptional high temperature cleanliness is illustrated in our Coker-Mister test, in which deposits on test assembly areas wetted by a liquid film and vapor/mist are rated as a function of temperature.



Oxidation Stability - BPTO 2197 demonstrates outstanding resistance to changes in bulk properties, e.g. viscosity and total acid number, due to oxidative attack. The robustness of the BPTO 2197 antioxidant system is illustrated in the following chart:



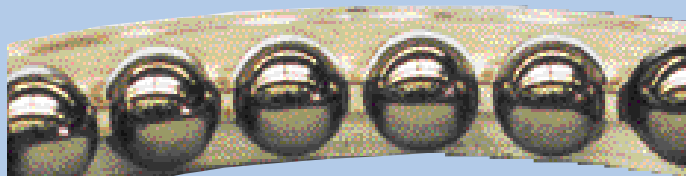
Hydrolytic Stability - BPTO 2197 resists formation of acids and alcohols due to hydrolysis.



JT8D-219 #4 - 4 1/2 - 5 - 6 Scavenge Pump
10,700+ hours on BPTO 2197

Corrosion - BPTO 2197 maintains low reactivity with the variety of metals used in turbine engines.

Load-Carrying - BPTO 2197 maintains good load-carrying capability, as indicated in lab tests and proven by field experience.



CF6-80C2 #4B Bearing
17,900+ hours on BPTO 2197

Elastomer Seal Compatibility - BPTO 2197 meets or exceeds applicable MIL and OEM specification requirements for compatibility with Viton, Silicone and Nitrile seals.

Low-Temperature Viscosity - BPTO 2197 has good low-temperature viscosity. This property is particularly important when starting certain accessory hardware such as APUs, which are typically started after cold soaking in temperatures of -40°F or lower.

Odor - while unrelated to performance, odor is nevertheless an important characteristic. BPTO 2197 is considered to be a low odor oil.

Color - BPTO 2197 has a bright, translucent color to enable maintenance personnel to quickly perform visual inspection of the oil.



BPTO 2380



BPTO 2197



Competitor's Oil

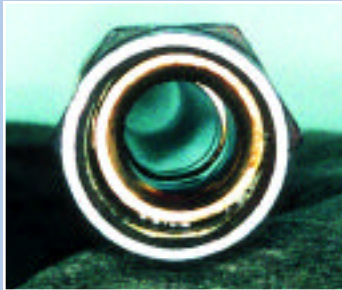
IMPRESSIVE FIELD TEST RESULTS

Oil Supply and Scavenge Tubes

After running with BPTO 2197 for approximately 10,750 hours, a JT8D-219 engine teardown showed clean No 4/5 oil supply tubes; these tubes normally show heavy coking when run with another High Thermal Stability (HTS) oil. Due to excessive coking, one major carrier typically replaced CF6-80 rear oil bearing tubes between 2,000 and 4,000 cycles while using a standard grade oil. After switching to BPTO 2197, a CF6-80 engine's oil tubes were inspected in excess of 5,600 cycles, and the tubes exhibited no signs of coking.



JT8D-219 #4 Oil Pressure/Scavenge Tube 10,700+ hours on BPTO 2197



JT8D-219 #4 Oil Breather Tube 8600+ hours on BPTO 2197
The #4 breather tube often builds up deposits that result in restrictions up to 100%. This tube, having run with BPTO 2197, is completely open with a small area of light varnishing.

Oil Compartments

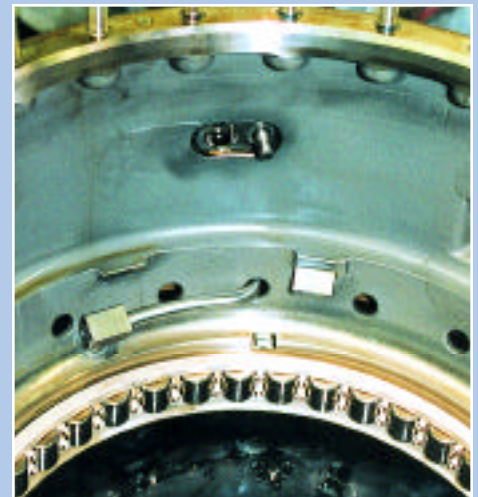
Some compartments typically suffer moderate to heavy coking. When run with BPTO 2197, oil compartments in the same types of engines normally show 'metal clean' to light varnish.



TSCP700 APU Turbine Bearing Compartment 1600+ hours on BPTO 2197



JT8D-219 #4 Squirrel Cage 10,700+ hours on BPTO 2197



CF6-80C2 #4R Bearing Compartment 17,900+ hours on BPTO 2197

Oil Filters

Several operators' experience with BPTO 2197 indicates that engine, APU and IDG oil filter replacements due to high differential pressure are reduced significantly.

Oil Consumption

Due to BPTO 2197's reduced coking around bearing compartments and gearbox seals, oil consumption may be reduced.

CONVERSION

BPTO 2197 has been formulated to resist washing of deposits left by other oils used in an engine prior to converting to BPTO 2197, and field experience has confirmed that switching to BPTO 2197 from another oil poses no concerns. Additionally, there have been no reported problems with seal incompatibility when changing to BPTO 2197.

SHELF LIFE

The shelf life of BPTO 2197 can extend beyond ten years when stored in original, unopened quart cans under acceptable conditions, such as away from extreme heat and moisture. Likewise, drummed product (includes 55 gallon drum and 5 gallon pails) has an expected shelf life of three years minimum. For all package styles, shelf life can be increased significantly beyond those stated above, depending upon storage conditions. Please contact your bp representative if you have any questions about product usability.



JT8D-219 Center Tube 8600+ hours on BPTO 2197

SPECIFICATIONS & QUALITY ASSURANCE

- BPTO 2197 meets or exceeds MIL-PRF-23699 and OEM requirements
- BPTO 2197 is a High Thermal Stability (HTS) class oil
- Each batch is subject to over 50 inspections - the Certificate of Analysis for each batch is reviewed by the plant Quality Control Coordinator
- Blending/storage tanks and lines are dedicated
- Plant's quality system is ISO 9002 certified for blending, packaging and shipping

Quality Assurance Test Results

Property	Requirement	BPTO 2197*	Method
Viscosity, cSt @ -40°C @ 40°C @ 100°C	13,000 max 23.0 min 4.9 to 5.4	12,539 26.98 5.28	ASTM D 2532 ASTM D 445 ASTM D 445
Flash Point, °C	246 min	262	ASTM D 92
Pour Point, °C	-54 max	-57	ASTM D 97
Total Acid Number, mg KOH/g	1.0 max	0.36	SAE ARP5088
Evaporation Loss, %, 6.5 hrs @ 204°C	10 max	2.30	ASTM D 972
Foaming Volume, ml/Vol @ 1 min settling Seq 1: 24°C Seq 2: 93°C Seq 3: 24°C	25/0 25/0 25/0	10/0 10/0 10/0	ASTM D 892
Thermal Stability & Corrosivity @ 274°C Viscosity, 40°C,% Total Acid Number, mg KOH/g Metal Weight, mg/cm2	±5.0 6.0 max 4.0 max	0.37 1.08 -0.154	FED-STD-791, 3411
Sediment Visual Undissolved Water Sediment, 1.2 µm filter, mg/L Total Ash, mg/L	None 10 1 max	None 0.85 0.12	FED-STD-791, 3010
Corrosion and Oxidative Stability, 72 hrs @ 204°C Viscosity, 40°C,% Total Acid Number, mg KOH/g Metal Weight Change, mg/cm2 Steel Silver Aluminum Magnesium Copper Sludge, mg/100mg oil	0 to +22.5 2.0 max ±0.2 ±0.2 ±0.2 ±0.2 ±0.4 50 max	14.75 0.96 0.011 -0.017 0.009 -0.012 -0.076 0.37	FED-STD-791, 5308

* Values shown here are representative of current production. Some are controlled by manufacturing specifications, while others are not. All of them may vary within modest ranges.

Other Specification Test Results

Property	Requirement	BPTO 2197*	Method
Viscosity @ 38°C, cSt % change after 72 hrs @ -40°C	25.0 min ±6	28.99 0.06	ASTM D 445 ASTM D 2532
Rubber Compatibility Swell, % AMS No. 3217/1, 72 hrs @ 70°C AMS no. 3217/4, 72 hrs @ 204°C Silicone, 96 hrs @ 121°C Tensile Strength Loss, Silicone, %	5 to 25 5 to 25 5 to 25 30 max	14.3 22.5 7.9 3.5	FED-STD-791, 3604 & 3433
Compatibility, Sediment mg/L	10 max	Pass	FED-STD-791, 3403
Storage Stability, low temp., 6 weeks @ -18°C	no crystallization, separation, gelling	Pass	Mil-23699, Part 4.4.2

*Tests run by outside lab during specification testing.

Other Specification Test Results (Continued)

Property	Requirement	BPTO 2197*	Method
Shear Stability, Viscosity Loss, % @ 37.8°C	4.0 max	0.00	ASTM D 2603 (ref MIL-PRF-23699F, note 13)
Corrosion and Oxidative Stability, 72 hrs @ 175°C			FED-STD-791, 5308
Viscosity, 38°C, %	-5 to +15	2.17	
Total Acid Number, mg KOH/g	2.0 max	0.25	
Metal Weight Change, mg/cm ²			
Steel	±0.2	0.00	
Silver	±0.2	-0.01	
Aluminum	±0.2	0.01	
Magnesium	±0.2	0.01	
Copper	±0.4	0.00	
Sludge, mg/100mg oil	25 max	0.25	
Corrosion and Oxidative Stability, 72 hrs @ 218°C			FED-STD-791, 5308
Viscosity, 38°C, %	Report	51.2	
Total Acid Number, mg KOH/g	Report	5.96	
Metal Weight Change, mg/cm ²			
Steel	±0.2	0.03	
Silver	±0.2	-0.04	
Aluminum	±0.2	0.00	
Titanium	±0.2	0.01	
Sludge, mg/100mg oil	25 max	1.16	
Ryder Gear Test - Average Result % of Hercolube A Reference # of Determinations	106 min 4 sides	123 4 sides	FED-STD-791, 6508

*Tests run by outside lab during specification testing.

HEALTH & SAFETY PRECAUTIONS

Health studies have shown that many synthetic and petroleum hydrocarbons pose potential human health risks that may vary from person to person. Under normal conditions of use, turbo oils have a low potential for human health risk. As a precaution, exposure to liquids and vapors of such products should be minimized. You can protect yourself from routine turbo oil-related hazards by using appropriate engineering controls and work practices, and by wearing proper eye protection, gloves and clothing. Additional important health and safety information for this product is provided in Material Safety Data Sheets, which are available from your BP representative. Exposure guidelines found in the Material Safety Data Sheet should always be followed.

Turbo oils should never be siphoned by mouth. However, if oil is ingested, DO NOT induce vomiting, but seek medical advice immediately to guard against the hazard of aspirating oil into the lungs. While the oil is not highly toxic by swallowing, aspiration may result in a chemical pneumonia that may not occur for some time.

Oils and greases in prolonged contact with skin can lead to skin irritation or dermatitis. Accordingly, turbo oils should

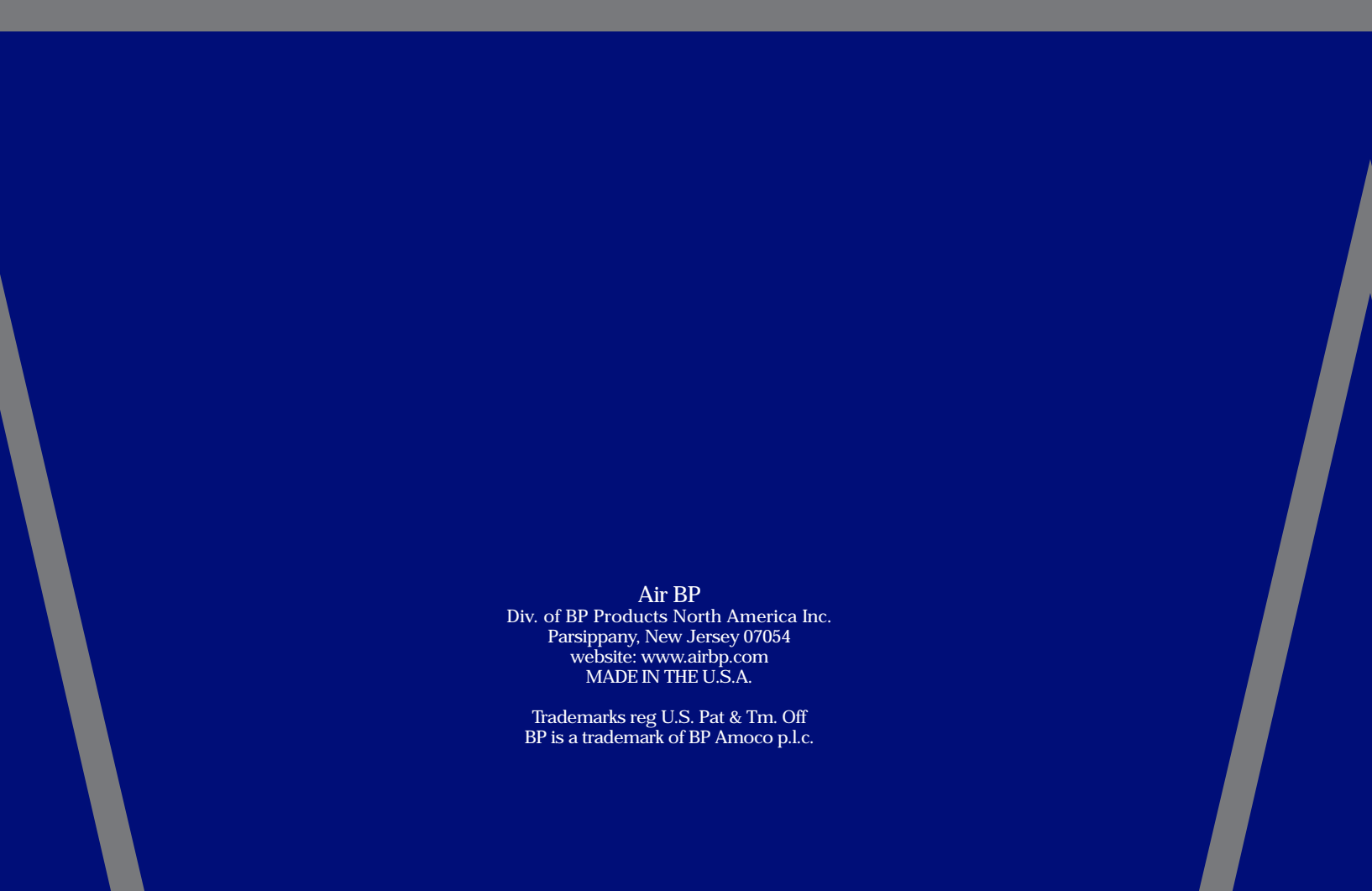
always be removed from the skin promptly, using a water-less hand cleaner, followed by washing with soap, water, and a soft skin brush. Soiled clothing should not be worn. If a turbo oil contacts the eyes, flush the eyes with fresh water until the irritation subsides and seek medical advice.

While the vapor pressures of turbo oils are very low, product could be misted in certain applications or form vapors in certain elevated temperature operations. Minimize or avoid prolonged breathing of mist or vapors of turbo oils. Inhalation exposure to turbo oil mists and vapors may result in light-headedness, dizziness, and/or headache, while excess exposures may cause respiratory irritation and unconsciousness. If a person is overcome by vapor, remove the individual and provide resuscitation and/or oxygen if available, and call a physician immediately.

In the event of fire or leakage of fluid onto a hot surface, turbo oils may emit fumes that are potentially irritating, noxious and possibly toxic. Be alert to such conditions and take all precautions to avoid and/or minimize exposure. Use supplied oxygen if necessary.

Air BP Lubricants

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