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ENVIRONMENTALLY SAFE AVIATION FUELS

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ABSTRACT

In response to the Air Force directive to remove Ozone Depleting Chemicals (ODCs) from military specifications and Defense Logistics Agency's Hazardous Waste Minimization Program, we are faced with how to ensure a quality aviation fuel without using such chemicals. Many of these chemicals are found throughout the fuel and fuel related military specifications and are part of test methods that help qualify the properties and quality of the fuels before they are procured. Many years ago there was a directive for military specifications to use commercially standard test methods in order to provide standard testing in private industry and government. As a result the test methods used in military specifications are governed by the American Society of Testing and Materials (ASTM). The Air Force has been very proactive in the removal or replacement of the ODCs and hazardous materials in these test methods. For example, ASTM D3703 (Standard Test Method for Peroxide Number of Aviation Turbine Fuels), requires the use of Freon 113, a known ODC. A new rapid, portable hydroperoxide test for jet fuels similar to ASTM D3703 that does not require the use of ODCs has been developed. This test has proved, in limited testing, to be a viable substitute method for ASTM D3703. The Air Force is currently conducting a round robin to allow the method to be accepted by ASTM and therefor replace the current method. This paper will describe the Air Force's initiatives to remove ODCs and hazardous materials from the fuel and fuel related military specifications that the Air Force Wright Laboratory.

INTRODUCTION

The 1990 Clean Air Act Amendments requires phasing out the domestic use of Ozone Depleting Chemicals (ODCs) by 1995. Section 326 of the National Defense Authorization Act of Fiscal Year 1993 mandates the Department of Defense (DoD) to stop requiring the use of ODCs within specifications and standards in contracts awarded after 1 June 1993. Air Force personnel were also directed by the Secretary of the Air Force and Chief of Staff to review all standards, specifications, and engineering handbooks for required use of materials identified by the EPA as Hazardous/Toxic (HAZTOX) and ODCs. The HAZTOX materials are better known as the 17 chemicals of the EPA's 33/50 source reduction program as listed in Table 1 [1].

As the preparing activity and technical focal point of the Air Force fuel and fuel related material specifications (listed on Table 2), the Fuels Branch of Wright Laboratory's Aero Propulsion and Power Directorate has been looking at alternatives to the ODCs and HAZTOX materials. There have been several programs initiated in order to allow the procurement of quality and environmentally safe fuels.

Table 1: EPA's 17 Chemical Groups

Benzene	Cadmium and Compounds
Carbon Tetrachloride	Chloroform
Chromium and Compounds	Cyanides
Lead and Compounds	Mercury and Compounds
Methylene Chloride	Methyl Ethyl Ketone
Methyl Isobutyl Ketone	Nickel and Compounds
Trichloroethane	Toluene
Tetrachloroethane	Trichloroethylene
Xylenes	

Table 2: WL/POSF Specifications

Number	Title	Latest Revision
MIL-T-5624P	Aviation Turbine Fuel, Grades JP-4, JP-5, and JP-5/JP-8 ST	29 Sep 92
MIL-I-25017E	Fuel Soluble Corrosion Inhibitor/Lubricity Improver	15 Jun 89
QPL-25017-17 Amendment 1	Qualified Products List for Fuel Soluble Corrosion Inhibitor/Lubricity Improver	24 Mar 94
MIL-T-25524D	Thermally Stable Aviation Turbine Fuel	8 Apr 94
MIL-P-25576C Amendment 2	Kerosene Propellant, RP-1	1 Mar 82
MIL-I-27686F	Fuel System Icing Inhibitor	10 Jun 91
MIL-T-38219B	Low Volatility Turbine Fuel, JP-7	1 Mar 85
MIL-T-83133D	Kerosene Types Aviation Turbine Fuels NATO F-34 (JP-8) and NATO F-35	29 Jan 92
MIL-P-87107C	High Density Synthetic Hydrocarbon Type Propellant, Grade JP-10	21 Feb 89
MIL-P-87173A	ALCM Engine Priming Fluid Propellant, Grade PF-1	23 Jun 89

BODY

The aviation fuels required by the military services are procured by the Defense Fuel Supply Center (DFSC) of the Defense Logistic Agency (DLA) using military specifications that require the fuel to meet certain property standards. The Fuels Branch of Wright Laboratory (WL/POSF) is the preparing activity of these specifications. The fuel quality results from it's properties and through proper handling of the fuel. The properties are monitored through many standardized test methods listed on the military specification. In the past, Federal Test Methods were developed to evaluate fuels. In order to obtain cost reduction and create standardization between military and commercial jet fuels, there has been a transition away from Federal Test Methods to commercial test methods, in particular, test methods standardized by the American Society for Testing and Materials (ASTM). Additives required in military aviation fuels are also monitored by commercial test methods governed by ASTM.

Some of the test methods used in the military specifications require the use of ODCs. With the enactment of the 1990 Clean Air Act Amendments and Section 326 of the National Defense Authorization Act of Fiscal Year 1993 the Air Force was faced with the immediate removal of ODCs from the fuel specifications. Unfortunately the Air

Force has only one vote in ASTM and removal of the ODCs would not occur before June 1993. DLA received an ODC waiver until 1 December 1993. Private industry has until 1995 to phase out Class I ODCs. In order to comply with the regulations, DLA will not require the use of ODCs when buying military items from the manufacturer. If the manufacturer decides to use ODCs during production then it is their responsibility to phase the ODCs out of their manufacturing process by 1995 in order to comply with the law. DLA is using the same interpretation to the American Society of Testing and Materials (ASTM) test methods that are listed in the fuel specifications. They regard the commercial test methods as a commercially packaged test method. The government can not unilaterally change these commercial methods. If ASTM requires the use of an ODC, they must phase the ODC out by 1995 in order to comply with the law. This alleviates the immediate ODC problems for DLA using the ASTM test methods [2]. The Air Force has taken a different position concerning this matter. The Air Force will not allow the use of any Class I ODC as of 1 December 1993. So, even though DLA will buy items from industry that use ODCs during their manufacturing, the Air Force will not be allowed to test their quality using any Class I ODCs. In summary, the Air Force policy on ODCs, regardless that they were part of commercial test methods, is to remove them as soon as possible.

As preparing activity, WL/POSF reviewed all of their fuel and fuel related specifications, the test methods, and the fuel additives to determine which required the use of ODCs. Five test methods which were included in nine military specifications were found to contain ODCs. All of the test methods were governed by ASTM and are listed in Table 3. The Fuels Branch wrote a letter to ASTM detailing the Air Force position and suggesting the removal of ODCs from their test methods. In the subsequent meetings of the committees governing the test method WL/POSF personnel have been representing the Air Force and working with ASTM to remove the ODCs.

Table 3: Test Methods Containing ODCs

TEST METHOD	METHOD TITLE
ASTM D2276	Standard Test Method for Particulate Contamination in Aviation Fuel by Line Sampling
ASTM D3703	Standard Test Method for Peroxide Number of Aviation Turbine Fuels
ASTM D4306	Standard Practice for Aviation Fuel Sample Containers for Tests Affected by Trace Contamination
ASTM D4308	Standard Test Method for Electrical Conductivity of Liquid Hydrocarbons by Precision Meter
ASTM D5452	Standard Test Method for Particulate Contamination of Aviation Fuels by Laboratory Filtration

The Air Force and ASTM efforts have been very successful. Currently the ODC, freon, which was used as a flushing fluid has been removed from ASTM D2276 [3] and D5452 [4] and petroleum ether is the current approved replacement. A task force is currently looking for a replacement to freon, which is used as a cleaning solvent, in ASTM D4306 [5]. Freon, also used as a cleaning solvent, has been removed from ASTM D4308 [5] and substituted with either a toluene/isopropyl alcohol mixture or n-heptane.

The final ODC that needed to be removed from the military specifications was in the peroxide test. The determination of peroxide number is very important for aviation fuel, especially fuel that has been in storage for more than six months. Peroxides can lead

to gums and deposits that clog fuel nozzles and degrade engine components. A new, rapid, portable hydroperoxide test for jet fuels, similar to ASTM D3703 [5], that does not require the use of ODCs has been developed by the University of Dayton Research Institute (UDRI), sponsored by WL/POSF. The Peroxide in Fuel Estimation and Concentration Test, called PERFECT, is a rapid, portable method suitable for laboratory use or in remote areas. It was developed to determine the hydroperoxide content of stored and transported fuels. It uses a voltammetric based detection system with a solid probe. The PERFECT also reduces sample size by 90%, reduces laboratory waste by 95%, and can analyze samples twelve times faster than the old method [6]. As preparing activity of the aviation jet fuel specifications, WL/POSF has established a team of Air Force, Army, Navy, Defense Fuel Supply Center, and industry personnel to expedite development of the new environmentally safe peroxide test into an industry accepted test method to be used in both military and commercial aviation jet fuel specifications. To prove this technology, a preliminary round robin was completed in April 1994 and resulting data presented to the Coordinating Research Council Aviation Fuel Committee meeting in April. The test results were well received and has resulted in many inquiries about standardizing this test method for commercial diesel fuels as well as aviation turbine fuels. In June 1994, WL/POSF managed a larger round robin test program that included ten different military and commercial laboratories testing both diesel and aviation fuel samples. The purpose of this test was to prove the technology of the test method and provide ASTM with the data needed for ASTM approval. The test data was well received by the ASTM committees and the new method is currently being balloted to become an ASTM standard test method. WL/POSF is currently revising the military specification for aviation fuel, JP-5, to require the use of the PERFECT test method thus eliminating the use of ODCs.

Although the timely removal of ODCs from military specifications have been first priority, there are other environmental concerns, like the EPA 33/50 program. Currently this has been a voluntary program for industry to reduce national pollution releases and off site transfer of 33% in 1992 and 50% in 1995 of the chemical groups listed in Table 1 [1]. DLA has adopted the EPA's 33/50 source reduction program under the Defense Logistics Agency's Hazardous Waste Minimization Program. The objectives of the program are to reduce the generation of hazardous waste by reviewing and revising military specifications to prevent hazardous waste generation [7]. Air Force personnel were also directed by the Secretary of the Air Force and Chief of Staff to reduce the use of hazardous materials in the operation of our weapons systems and on our bases [8]. As a result of these directives, the Fuels Branch has been working with DFSC and ASTM to reduce and possibly remove these chemicals from military specifications and test methods. DFSC has created a data base of all the chemicals required by all of the specifications used to procure aviation turbine fuels. The data base has been a very valuable tool in determining which test methods and specifications need to be reviewed for possible hazardous materials. WL/POSF has been working with ASTM to develop possible replacements for some of the hazardous materials. In particular, toluene is used in many test methods. It has been proposed for some tests a 50/50 mixture of heptane and isopropanol may be used as a replacement. Additive manufacturers whose additives contain chemicals listed on the EPA's Chemical List have been contacted to look at potential alternate formulations for their additives. The Fuels Branch is also sponsoring a non toxic fuel system icing inhibitor (FSII) program, which is trying to replace the current FSII, diethylene glycol monomethyl ether, with a non toxic additive.

There still remains questions concerning the guidance the Fuels Branch has been given regarding the EPA 17 Chemicals. It is a Air Force Materiel Command (AFMC)

goal to reduce them by 50% before 31 December 1996 and to near zero by 31 December 1999, using 1992 baseline. The top five chemicals, Methylene Chloride, Perchloroethylene, Methyl Ethyl Ketone, Trichloroethane, and MIBK make up 90% of the EPA-17 purchased by AFMC in 1992 [9]. As mentioned, ASTM and the Fuels Branch are looking at alternatives but no mandates have been made. Once specific goals concerning specifications have been established the Fuels Branch, utilizing DFSC's data base will respond.

CONCLUSIONS

Removal of ODCs from military fuel and fuel related specifications has been first priority for the Fuels Branch of Wright Laboratory. Working with ASTM, many of the ODCs have been removed. The D4306 test method that still requires an ODC is being studied for replacements. The new peroxide test method has been successfully tested and is currently replacing the old test method that utilizes ODCs. It is envisioned that it will become an industry standard.

Although the Fuels Branch has not been mandated to remove the EPA-17 Chemicals from the specifications and test methods, potential substitutes are currently being considered. Environmentally friendly additives are being developed for fuels. ASTM and DFSC have shown great cooperation and commitment to help in the removal of these chemicals.

REFERENCES

[1] "The 33/50 Program: Forging an Alliance for Pollution Prevention", United States Environmental Protection Agency, August 1992.

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[3] "1994 Annual Book of ASTM Standards," Vol. 05.01, 1994.

[4] "1994 Annual Book of ASTM Standards," Vol. 05.03, 1994.

[5] "1994 Annual Book of ASTM Standards," Vol. 05.02, 1994.

[6] Kauffman, Robert E., "Development of a Rapid, Portable Hydroperoxide Test for Jet Fuels," American Chemical Society, San Diego, CA, March 1994.

[7] DGSC letter "DLA Hazardous Waste Minimization Program - Review and Revision of Specifications and Standards", dated 17 November 1988.

[8] Secretary of the Air Force letter "Air Force Pollution Prevention Program," dated 13 November 1991.

[9] S&T Environmental Leadership course notes, WPAFB, OH, 2 February 1994.