LOG OF MEETING
DIRECTORATE FOR ENGINEERING SCIENCES

SUBJECT: Meeting of ASTM 15.10 Technical Subcommittee on Flammable *Liquid* Containers.

DATE OF MEETING: March 31, 2010

PLACE OF MEETING: U.S. Consumer Product Safety Commission, 4330 East West Highway, Bethesda, Maryland, Room 824

LOG ENTRY SOURCE: John Murphy, ESME

COMMISSION ATTENDEES:
Scott Ayer, ESFS
John Boja, CRC
John Murphy, ESME
Gregory Rea, LSM
Kate Sedney, ESHF

NON-COMMISSION ATTENDEES:
Tom Cray, No Spil (Attended via conference call)
Harold Cunningham
Dorothy Drago, DRAGO Expert Services
Brian Elias, WPI
John Ferguson, Scepter Corporation.
Grant Kernan, Blitz USA
John Lips, L&W Innovations, LLC
Philip Monckton, Scepter Corporation
Leonard Morrissey, ASTM International
Ali Rangwala, WPI
Roland Riegel, Underwriters Laboratory
Glen Stevick, BEAR INC
John Trippi, Midwest Can Co
Richard Ward, Perritt Laboratories Inc.
Joeseph Zicherman, IFT Inc.

SUMMARY OF MEETING:

The meeting convened at 10:00 am. Philip Monckton, Chairman of the 15.10 Technical Subcommittee on Flammable Liquid Containers (Subcommittee) called the meeting to order. The agenda was approved. The minutes of the last meeting were reviewed and approved.

Professor Ali Rangwala and Brian Elias from the Worcester Polytechnic Institute, Department of Fire Protection Engineering provided a presentation on their work for the technical subcommittee to develop a model that will predict the concentration of a gasoline/air mixture at a given height above the liquid surface in a gasoline container. The experimental method will vary key parameters of the container and measure the vapor concentration. Fuel concentration will be measured by two methods. WPI will use a butane IR sensor and gas chromatography to measure the vapor concentration inside the fuel container. The gas chromatography will use a grab sample technique. Some of the controlling properties in the test method are vapor pressure, weathering, volume of liquid fuel, temperature, and mixing by physical agitation. The model will be normalized to predict the vapor concentration at a given height above the surface of the gasoline as the controlling parameters change. When the vapor concentration (air/fuel) is above the lower explosive limit and below the upper explosive limit then ignition in the fuel container is possible. This information could be useful in predicting the circumstances when ignition may be possible inside a fuel container and may provide insight into the need for requirements for a flame arrestor in the standard. The Subcommittee had questions regarding the weathering of fuel used in the testing. WPI provided a hand out titled *"A Laboratory Test Methodology to Weather a Gasoline Sample."* A copy of the hand out is attached.

The subcommittee also discussed the need for a new standard that covers emergency one time use fuel containers. These fuel containers are intended to be stored in an automobile and then used when the automobile runs out of gasoline.

Two task groups were created. The first task group will address fuel container labeling and the second task group will address large fuel tanks. Large fuel tanks are generally larger than 6 gallons and may have attached wheels and a fill hose with a pump to dispense gasoline. The meeting adjourned at 3:00 PM.

A Laboratory Test Methodology to Weather a Gasoline Sample

Elias, B.F., Zalosh R.G., and Rangwala A. S.

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Introduction

Weathering can be defined as the slow decomposition of gasoline, due to evaporation. Gasoline is a mixture of several different hydrocarbons like pentane, isopentane, butane, ethanol methyl pentane, 2-2 dimethyl butane etc. Each of these hydrocarbons evaporates at a different rate. Thus certain compounds which are lighter, and therefore more volatile, will tend to evaporate faster than the heavier hydrocarbons. This leads to changes in the flammability of gasoline with time. So for example, flash point which is a measure of flammability will increase as gasoline is allowed to evaporate for some time. Characterization of the weathering process is important in order to test the flammability of different gasoline blends. Weathering is mainly a function of the following variables:

1. **Volume of fuel:** Increase in volume of fuel will reduce evaporation rate. This is because global mass loss rate is a function of surface to volume ratio.
2. **Temperature:** Increase in temperature results in increased evaporation. Typically there exists a linear dependency of mass loss with temperature (Fingas, 1996, Wu et al., 2000).
3. **Mixing:** Enhanced mixing will cause greater evaporation. In a laboratory environment, weathering can be accelerated by mixing the gasoline sample using a rotary motion.

This document provides a methodology to perform weathering of a gasoline sample in the laboratory. Controlling parameters that can be measured to evaluate the extent of weathering are the *Reid vapor pressure*, and *percentage mass loss*. Both parameters will be measured in this protocol.

Procedure:

Step 1:

Gasoline from a pump station will be characterized using Reid vapor pressure ASTM D323. The sample will be transferred to an airtight container and will form the baseline sample to be tested.

Step 2

A known mass of the gasoline sample will be placed in a rotary evaporator* and will be weathered until the mass decreases to the required percentage mass loss that is desired. The influence of temperature and initial volume will be determined using a curve fit from the experimental data. An earlier study (Wu et al., 2000) has shown that both temperature and initial volume of fuel follow a linear trend with the % mass loss due to weathering. The linear coefficients will be documented for different gasoline fuel blends.

Step 3

The weathered fuel sample will be characterized once again using the Reid vapor pressure ASTM D323 test standard. Thus % mass loss and Reid vapor pressure will be used to characterize the weathering of gasoline.

References:

1. ASTM D323-08, "Standard test method for vapor pressure of petroleum products (Reid Method)
2. Wu, N. Kolb, G. Torero, J. L., "The effect of weathering on the flammability of a slick of crude oil on a water bed," Comb. Sci. Tech.,161, 269-308, 2000
3. Fingas, M., "The Evaporation of Oil Spills: Variation with Temperature and Correlation with Distillation Data, *Proceedings of the 19th AMOP Technical Seminar*, Alberta, Canada, pp29-135, 1996.

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* A rotary evaporator is a device used in chemical laboratories for the removal of solvents from samples by evaporation. Temperature and mixing (rotary speed) can be varied to achieve different rates of evaporation. It works at ambient pressures

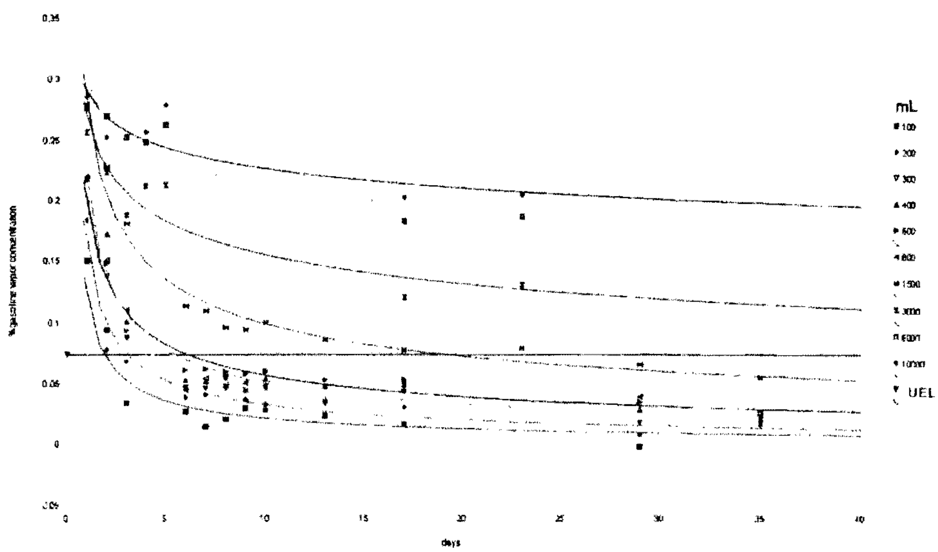
Aging protocol introduction:

Ten 5 gallon/18.93 liter capacity ASTM compliant PPG containers were filled with various amounts of commercially purchased 87 octane gasoline and left in a ventilated safety shed with their nozzles open. Amounts of gasoline exposed to summertime Berkeley. Calif ambient in the 10 PPGC's five gallon sized PPGC's were 100. 200. 300. 600. 900. 1200. 1500. 3000. 6000 and 10.000 ML. Nozzle openings were on the order of 0.75"/ 19 mm.

Within 30 days the smaller amounts of gasoline had evaporated completely. Monitoring of Vapor Pressure of Oxygen in the headspace of each container was conducted daily with the container measured at approximately the same. reference temperature.

In that environment, the partially filled containers were subjected to daily changes in temperature with attendant pumping - changes in evaporation rates related to diurnal cycling causing interchanges of hydrocarbon vapor and ambient air. The accelerated aging is due to evaporation and no heating or agitation is used.

Results for changes in gasoline vapor concentrations for various quantities of gasoline aged under identical ambient conditions in the same sized containers are plotted in the figure below:



Aging results for commercially obtained 87-octane gasoline stored at an approximately10° C (50°F) in a 5-gallon (18.93 Liter) PPGC complying with ASTM F-839 and F-852. Starting volumes ranged from 100 ml to 10 liters.