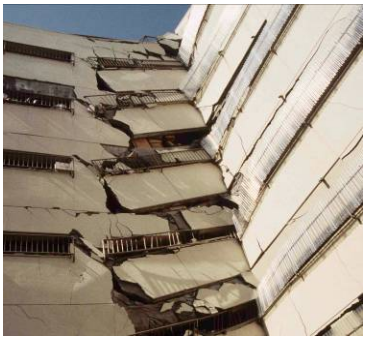
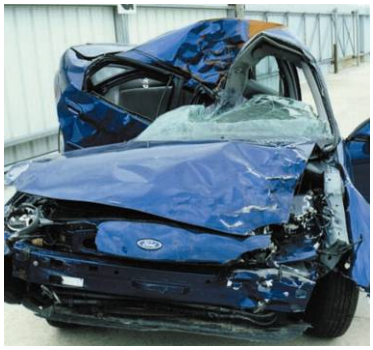


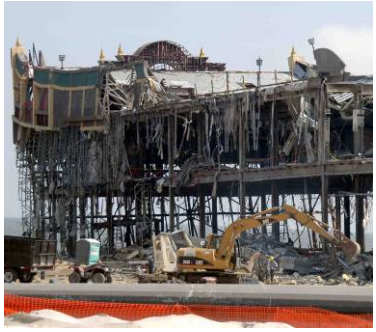
Engineering

Fire Investigations

Environmental Consulting



Specialty & Consulting



Catastrophe Response

Chemical Laboratory Testing

Ignitable Liquids on Clothing

Written by:

David Brien
Chief Chemist
Sacramento Service Center
Tel: 916-797-1503

Corporate Headquarters:

EFI Global, Inc.
8811 FM 1960 Bypass Road West
Suite 400
Humble, TX 77338
Tel: 281-358-4441
Tel: 800-334-0200
Fax: 281-358-2517
24 Hours: 888.888.2467

www.efiglobal.com

EFI Global
Complex Issues • Solid Solutions

In the course of an arson investigation one of the standard procedures is, when possible, to collect the clothing of arson suspects and have them tested for ignitable liquids. The hypothesis being that if the clothing tests positive for the same ignitable liquids that are found in the fire debris, it is good circumstantial evidence to place the suspect at the scene with an ignitable liquid.

This procedure of testing arson suspect's clothing is based on the premise that ignitable liquids will reside on the clothing long enough for the laboratory to be able to test and identify them. While it is certainly possible to do this successfully, the fire investigator should understand what limits or variations exist with this type of testing. It is a fact that eventually all common ignitable liquids will evaporate and be undetectable on clothing. The question then becomes "what is the golden time where a successful clothing sample can be collected?"

To better understand this process, a series of experiments were conducted in EFI Global's Forensic Laboratory in Rocklin, CA. In these experiments we attempt to identify and rank the contributing factors needed for the successful identification of ignitable liquids on clothing samples. Some possible factors to examine are listed below.

POSSIBLE CONTRIBUTING FACTORS:

Time: All ignitable liquids will evaporate with time creating a window where successful testing is possible. The hypothesis then becomes; what is this finite time where such testing can measure and identify ignitable liquids on clothing?

Type of Ignitable Liquid: Ignitable liquids come in a wide range of volatility. How does the class and type of ignitable liquid effect its residence time on clothing? The hypothesis is that heavier ignitable liquids would reside longer on clothing than lighter products.

Amount of Ignitable Liquid: The hypothesis to be tested is that when more ignitable liquid is present initially, it will reside longer on the clothing.

Type of Clothing: The hypothesis is that some types of clothing may be more absorbent or thicker and may protect ignitable liquids longer. Two different materials will be evaluated for gasoline retention.

Ambient Conditions: The hypothesis is that ambient conditions will affect the residence time of ignitable liquids on clothing. Factors such as temperature or wind may speed up evaporation while humidity or rain may increase the residence time. Due to the complexity of these factors. This area was not yet evaluated at EFI.

RESULTS:

Time: The hypothesis is that ignitable liquids will all evaporate with time. What is the finite time where such testing can measure and identify ignitable liquids on clothing?

The hypothesis was confirmed that a finite time will exist for ignitable liquids. The result for gasoline is listed below:

One drop gasoline on denim:	1 hour

Type of Ignitable Liquid: Ignitable liquids come in a wide range of volatility. The hypothesis was that heavier ignitable liquids would reside longer on clothing than lighter products.

The hypothesis was confirmed that heavier ignitable liquids were retained longer than lighter ignitable liquids. The effective residence times for some ignitable liquids on denim cloth are listed below.

One drop gasoline:	1 hour
One drop Medium Petroleum Distillates:	3 hours
One drop Kerosene:	More than 24 hours

Amount of Ignitable Liquid: The hypothesis to be tested is that the residence time on the material will increase with increased initial ignitable liquid concentrations.

The hypothesis was confirmed with gasoline. Higher initial mounts caused a dramatic increase in retention time. Results are listed below.

One drop gasoline on denim:	1 hour
20 drops gasoline on denim:	More than 48 hours

Type of Clothing: The hypothesis is that some types of clothing may be more absorbent or may protect the presence of ignitable liquids longer. Two different materials will be evaluated for gasoline retention.

The hypothesis was confirmed with gasoline. Heavier material substrates will retain the ignitable liquid longer than lighter materials. Results are listed below.

One drop gasoline on thin material	Less than 10 minutes
One drop gasoline on denim:	1 hour

DISCUSSION:

Not surprisingly the same factors that influence the retention time of ignitable liquids on clothing are those that effect fire debris. The relative effects are listed below in order of importance.

#1 Concentration: Low levels of gasoline on denim blue jean material could be detected for at least one hour. That is not a very big window to identify, apprehend and process a suspect. Higher levels of gasoline were detectable for at least two days on denim. Unfortunately one cannot always count on a sloppy arsonist.

#2 Type of Ignitable Liquid: As is true with fire debris, heavier ignitable liquids will be retained longer than lighter ones. Medium petroleum distillates (MPD) such as mineral spirits and charcoal thinner will be retained three times longer than gasoline and heavy petroleum distillates such as kerosene will be retained nearly 50 times longer.

#3 Type of Material: Our testing showed that low levels of gasoline can evaporate from thin material in less than 10 minutes. The same test with denim material increased the retention time to one hour. Other materials like leather or plastic in shoes may be even longer but were not evaluated at this time.

Please note: These results are based on a limited number of controlled laboratory tests. Many other factors may exist in the real world that can change the retention time of ignitable liquids on clothing such at temperature, weather, rain, storage of items, etc. The retention times listed here cannot necessarily be applied to all real world situations.

CONCLUSIONS:

The retention time of ignitable liquids on clothing can be less than 10 minutes or more than two days. The bottom line is the quantity and type of ignitable liquid makes all the difference. As an investigator, getting a good sample of clothing may be a matter of training, quick work and a bit of luck

As usual, it all comes back to the basics. If you want to have the best chance of collecting a useful sample collect suspect clothing as soon as possible, properly store clothing in an approved vapor tight container (not a paper bag), and have the clothing tested promptly by a qualified lab. Since you cannot know how sloppy the suspect had been, assume you have up to a couple of days to collect a meaningful sample.

EXPERIMENTAL METHODS:

EXPERIMENT #1A EFFECT OF TIME

Hypothesis: Ignitable liquids will evaporate with time and eventually decrease to a level where standard GC/MS analysis for ignitable liquids is not successful. There is a finite time where such testing can measure and identify ignitable liquids on clothing.

Test: In this test gasoline was chosen for the test liquid. Gasoline is by far the most prevalent ignitable liquid found in fire debris samples. It is also a relatively broad range mixture so it will give some additional information on weathering.

Sections of Kimwipe laboratory wipes were used as the test material. This product is a reinforced paper product which is known to be clean and uncontaminated.

The test materials were suspended from the bottom of the sash of a laboratory fume hood and the flow of air adjusted to 5 mph. Exactly 50 ul (microliters) of gasoline (approximately 1 drop) was added by analytical syringe to each test sample in the same physical location on the sample (middle in height and middle in width).

The samples were allowed to reside in the air flow for a period of time. The times selected were 10 minutes, 30 minutes, 60 minutes and 120 minutes.

After the set times the samples were sealed in epoxy coated quart metal cans with charcoal absorbent strips[1]. All samples were tested by the industry standard ASTM methods E1412 and E1618.

EXPERIMENT #1B EFFECT OF TIME

Hypothesis: Ignitable liquids will evaporate with time and eventually decrease to a level where standard GC/MS analysis for ignitable liquids is not successful. There is a finite time where such testing can measure and identify ignitable liquids on clothing.

Test: In this test gasoline was chosen for the test liquid. Gasoline is by far the most prevalent ignitable liquid found in fire debris samples. It is also a relatively broad range mixture so it will give some additional information on weathering.

Sections of denim cloth collected from the leg section of a pair of freshly laundered blue jeans were used as the test material. This material is the most prevalent type of pant type clothing encountered in suspect clothing testing.

The test materials were suspended from the bottom of the sash of a laboratory fume hood and the flow of air adjusted to 5 mph. Exactly 50 ul of gasoline (approximately 1 drop) was added by analytical syringe to each test sample in the same physical location on the sample (directly into seam of in center of material).

The samples were allowed to reside in the air flow for a period of time. The times selected were 10 minutes, 30 minutes, 60 minutes and 120 minutes.

After the set times the samples were sealed in epoxy coated quart metal cans with charcoal absorbent strips[1]. All samples were tested by the industry standard ASTM methods E1412 and E1618.

EXPERIMENT #2 TYPE OF IGNITABLE LIQUID

Hypothesis: Heavier and less volatile ignitable liquids will reside longer on clothing than will lighter more volatile products.

Test: In this test gasoline was compared with a medium weight petroleum distillate (paint thinner) and a heavy petroleum distillate (kerosene) as the test liquids.

Sections of denim cloth collected from the leg section of a pair of freshly laundered blue jeans were used as the test material. This material is the most prevalent type of pant type clothing encountered in suspect clothing testing.

The test materials were suspended from the bottom of the sash of a laboratory fume hood and the flow of air adjusted to 5 mph. Exactly 50 ul of gasoline (approximately 1 drop) was added by analytical syringe to each test sample in the same physical location on the sample (directly into seam of in center of material).

The samples were allowed to reside in the air flow for a period of time. The times selected were 10 minutes, 30 minutes, 60 minutes, 120 minutes, 180 minutes, and 240 minutes.

After the set times the samples were sealed in epoxy coated quart metal cans with charcoal absorbent strips[1]. All samples were tested by the industry standard ASTM methods E1412 and E1618.

EXPERIMENT #3 AMOUNT OF IGNITABLE LIQUID

Hypothesis: Ignitable liquids will evaporate with time and eventually decrease to a level where standard GC/MS analysis for ignitable liquids is not successful. The amount of ignitable liquid initially present will influence the finite time where such testing can measure and identify ignitable liquids on clothing.

Test: In this test gasoline was chosen for the test liquid. Gasoline is by far the most prevalent ignitable liquid found in fire debris samples. It is also a relatively broad range mixture so it will give some additional information on weathering.

Sections of denim cloth collected from the leg section of a pair of freshly laundered blue jeans were used as the test material. This material is the most prevalent type of pant type clothing encountered in suspect clothing testing.

The test materials were suspended from the bottom of the sash of a laboratory fume hood and the flow of air adjusted to 5 mph. Exactly 1000 ul (approximately 20 drops) of gasoline was added by analytical syringe to each test sample in the same physical location on the sample (directly into seam of in center of material).

The samples were allowed to reside in the air flow for a period of time. The times selected were 1 hr, 24hr, and 48 hrs.

After the set times the samples were sealed in epoxy coated quart metal cans with charcoal absorbent strips[1]. All samples were tested by the industry standard ASTM methods E1412 and E1618.

EXPERIMENT #4 TYPE OF CLOTHING

Hypothesis: The hypothesis is that some types of clothing may be more absorbent or may protect the presence of ignitable liquids longer. Several different materials will be evaluated for gasoline retention.

Test: In this test gasoline was chosen for the test liquid. Gasoline is by far the most prevalent ignitable liquid found in fire debris samples. It is also a relatively broad range mixture so it will give some additional information on weathering.

Sections of Kimwipe laboratory wipes and denim were used as the test materials (see experiments 1Aand 1B). The retention of ignitable liquids on these two materials will be compared.

The test materials were suspended from the bottom of the sash of a laboratory fume hood and the flow of air adjusted to 5 mph. Exactly 50 ul of gasoline (approximately 1 drop) was added by analytical syringe to each test sample in the same physical location on the sample (middle in height and middle in width).

The samples were allowed to reside in the air flow for a period of time. The times selected were 10 minutes, 30 minutes, 60 minutes and 120 minutes.

After the set times the samples were sealed in epoxy coated quart metal cans with charcoal absorbent strips[1]. All samples were tested by the industry standard ASTM methods E1412 and E1618.