Idaho State Police
Forensic Services
Pocatello Laboratory

Section I
Separation, Concentration, Analysis and the Identification of Ignitable Liquid Residues from Fire Evidence Samples

1.0 Introduction

The analysis of evidence from fires of suspicious origin encompasses a variety of sample types. Evidence collected ranges from burnt fire debris and liquids recovered at the fire scene to the suspect's clothing. The examination of the evidence may involve only an identification of ignitable liquid/residue present or it may involve the comparison of a liquid recovered at the scene with a liquid recovered from the suspect. The approach taken to the analysis of fire scene evidence is, for these reasons, broad and general in nature.

2.0 Recovery Methods

2.1 Separation and Concentration of Ignitable Liquid Residues from Fire Evidence Samples by Passive Headspace Concentration

2.1.1 General

2.1.1.1 This method serves to recover ignitable liquid residues from samples submitted as evidence in fire investigations.

2.1.1.2 This method utilizes activated charcoal impregnated polymer strips (ACS) to adsorb, and thus trap, ignitable liquid residues.

2.1.1.3 This method will recover the entire range of ignitable (flammable or combustible) liquids but may require solvent extraction to differentiate between a class IV and a class V ignitable liquid product (refer to 2.5.1).

2.1.1.4 This method is time efficient and does not consume or alter the sample.

2.1.2 ASTM Reference Method

Refer to ASTM standard practice E 1412-95, *Standard Practice for Separation and Concentration of Ignitable Liquid Residues from Fire Debris Samples by Passive Headspace Concentration.*

2.1.3 Application

2.1.3.1 This procedure is useful for samples which may contain a light to medium range (C4-C14) petroleum distillate product as suggested by an indicative odor. This method will recover heavy range distillates but with the limitation indicated in section 2.1.5.1.

2.1.4 Sensitivity

2.1.4.1 Capable of isolating quantities less than 0.1µL of an ignitable liquid residue from a sample.

2.1.5 Limitations

2.1.5.1 A solvent extraction is required in order to differentiate a kerosene class product (class IV) from a heavy petroleum product (class V).

2.1.5.2 Samples that contain high levels of light to medium range ignitable liquids are prone to displacement and thus loss of light petroleum product components. A shorter adsorption time and a larger ACS should be used for samples which, based upon olfactory screening, are suspected of containing larger concentrations of light to medium range petroleum products.[6,9]

2.1.6 Safety Concerns

2.1.6.1 Carbon disulfide is an extremely flammable, volatile liquid which by all routes of exposure, has adverse affects on the central nervous system with a NFPA health rating of 3 (severe). Care should be taken to protect all routes of exposure from contact with carbon disulfide as well as keeping the solvent well away from heat sources.

2.1.6.2 For further information regarding the hazards of exposure to carbon disulfide, refer to the material safety data sheets (MSDS) which follow this section.

2.1.7 Materials and Equipment

2.1.7.1 Solvents

2.1.7.1.1 Carbon disulfide (Fisher C184-500 or equivalent).
Purity of solvents is assured by analyzing blanks on each batch of solvent by GC-MSD.

2.1.7.2 Collection device

2.1.7.2.1 Activated charcoal polymer strips (ACS) (Albrayco Laboratories ACS-150-6PACK or equivalent)
Size used depends upon the presence, and intensity of, a characteristic ignitable liquid odor and the sample size. Approximate size 8 X10mm to 8 X 15mm.

2.1.7.2.2 Paper clips with serrated edges.

2.1.7.2.3 Securing of the ACS

Option One: Non-waxed dental floss.
Option Two: Magnet capable of securing paper clip to lid of friction lid can.

2.1.7.3 Heating system
Large oven which allows for uniform heating of friction lid cans at 50-60°C.

2.1.7.4 Glassware
2.1.7.4.1 2-mL widemouth autosampler vials preassembled with screw-top cap with PTFE/silicone septa (Agilent 5182-0865 or equivalent).
2.1.7.4.2 Glass vial microinserts (Agilent 5183-2088 or equivalent).

2.1.8 Passive Adsorption Procedure

2.1.8.1 To suspend the ACS strip over the sample, either (1) place a magnet on the lid of the can or (2) tie a length of non-waxed dental floss onto a paper clip. The length of dental floss should be proportional to the size of can that the clip will be suspended into.

2.1.8.2 Secure appropriately sized charcoal strip in paper clip.

2.1.8.3 Open friction lid can or evidence pouch (Kapak)® and suspend charcoal strip above sample. Reseal the container.

2.1.8.4 If strong odor of petroleum product exists, allow strip to collect sample at room temperature for 4-16 hours or place into a 50-60°C, closely monitored, oven for 1-2 hours. If an odor is not present, place friction lid can into a 50-60°C for 16 to 48 hours.

2.1.8.5 At the completion of the adsorption period, remove can from oven and allow to cool for approximately 30 minutes. Transfer charcoal collection device directly from can into a labeled 2mL-widemouth autosampler vial.

2.1.9 Elution Procedure

2.1.9.1 To elute the compounds trapped upon the charcoal, add approximately 200µL carbon disulfide (CS_2) to each vial. Seal vial and vortex. Place vial on its side to facilitate extraction. Vial may also be placed on rocker or rotator.

2.1.9.2 Transfer a portion of the carbon disulfide into labeled autosampler vial with microinsert, and seal. Place the vial containing the charcoal strip and the remaining extract into the refrigerator.

2.1.9.3 If the initial olfactory screening indicates the strong presence of an ignitable liquid in a sample, dilute extract with CS_2 prior to GC-MSD analysis.

2.1.10 Comparison Standards

2.1.10.1 Collection of petroleum product comparison standards with the charcoal strip device is periodically done to:

2.1.10.1.1 Check the adsorption efficiency of the charcoal.

2.1.10.1.2 Provide for a comparison standard collected in the same fashion as the case samples.

2.1.10.2 Preparation of charcoal strip comparison standards is as follows:

2.1.10.2.1 Place 1µL standard into a clean, unused quart sized friction lid can, and seal.

2.1.10.2.2 Prepare charcoal strip standard as described for collection device above.

2.1.10.2.3 Place prepared collection device into prepared friction lid can.

2.1.10.2.4 Process charcoal strip as with case samples.

2.1.11 Charcoal Strip Blanks

2.1.11.1 A charcoal strip blank will be run with each batch of cans placed into the oven.

2.1.11.1.1 Prepare charcoal strip blank as described for collection device above.

2.1.11.1.2 Place prepared collection device into a clean, empty quart sized friction lid can.

2.1.11.1.3 Process charcoal strip as with case samples.

2.1.12 Analysis

2.1.12.1 Analyze extracts by GC-MSD as outlined in **section 3.0** of this method.

2.2 Separation and Concentration of Ignitable Liquid Residues from Fire Evidence Samples by Solvent Extraction

2.2.1 General

2.2.1.1 This method serves to recover ignitable liquid residues from samples submitted as evidence in fire investigations.

2.2.1.2 This method applies the principle "Likes dissolves like". Any petroleum product in the sample is recovered with a short chain aliphatic hydrocarbon.

2.2.1.3 This method will recover the entire range of ignitable liquids.

2.2.1.4 This method will recover ignitable liquids over the entire range of concentrations.

2.2.2. ASTM Reference Method

Refer to ASTM standard practice E 1386-90, *Standard Practice for Separation and Concentration of Ignitable Liquid Residues from Fire Debris Samples by Solvent Extraction.*

2.2.3 Application

2.2.3.1 Samples which may contain a kerosene to heavy petroleum distillate product as indicated by:

2.2.3.1.1 Strong indicative odor.

2.2.3.1.2 GC/MSD data from analysis of ACS. A solvent extraction is required in order to differentiate a kerosene class product (class IV) from a heavy petroleum product (class V).

2.2.3.2 Samples which contain a high percentage of charred debris.

2.2.3.3 Samples which contain non-porous surfaces such as glass, or burned containers.

2.2.4 Sensitivity

2.2.4.1 This separation protocol is capable of isolating quantities smaller than 1μL of an ignitable liquid residue from a sample (ASTM E1386-95, 4.2).

2.2.5 Limitations

2.2.5.1 The extracting solvent also recovering interfering compounds inherent in the fire debris hampers this method. These compounds are the result of pyrolysis of solid fuels present at the fire scene and the combustion of organic compounds liberated during the fire process.

2.2.5.2 The evaporation step in this method may lead to the loss of light petroleum product components.

2.2.6 Safety Concerns

2.2.6.1 Carbon disulfide is an extremely flammable, volatile liquid which by all routes of exposure, has adverse affects on the central nervous system with a NPFA health rating of 3 (severe). Care should be taken to protect all routes of exposure from contact with carbon disulfide as well as keeping the solvent well away from heat sources.

2.2.6.2 Pentane is an extremely flammable, volatile liquid. Although pentane only has a NPFA health rating of 1 (slight), exposure though inhalation and ingestion has an adverse affect on the central nervous system. Skin contact causes irritation. Care should be taken to protect all routes of exposure from contact with pentane as well as keeping the solvent well away from heat sources.

2.2.6.3 For further information regarding the hazards of exposure to carbon disulfide, refer to ASTM E 752, *Practice for Safety and Health Requirements Relating to Occupational Exposure to Carbon Disulfide.* For information on both pentane and carbon disulfide, refer to the material safety data sheets (MSDS) which follow this section.

2.2.7 Materials

2.2.7.1 Solvents

2.2.7.1.1 Pentane (Fisher P400-4 or equivalent)
2.2.7.1.2 Hexane (Fisher H300-4 or equivalent)
2.2.7.1.3 Carbon disulfide (Fisher C184-500 or equivalent).
2.2.7.1.4 Purity of solvents is assured by analyzing blanks on each batch of solvent by GC-MSD.

2.2.7.2 Filter Paper

2.2.7.2.1 Whatman Grade 1 - Qualitative (27cm) or equivalent
2.2.7.2.2 Whatman 1PS -Phase separation (15cm) or equivalent

2.2.7.3 Glassware

2.2.7.3.1 Glass funnels
2.2.7.3.2 25mL to 2000mL beakers
2.2.7.3.3 2-mL widemouth autosampler vials preassembled with screw-top cap with PTFE/silicone septa (Agilent 5182-0865 or equivalent).
2.1.7.3.4 Glass vial microinserts (Agilent 5183-2088 or equivalent).

2.2.8 Solvent Extraction Procedure

2.2.8.1 Friction lid cans

Cover sample with solvent and place lid on loosely. Sample should be thoroughly moistened.

2.2.8.2 Kapak®-type pouches
Place pouch in 2-L beaker. Add sufficient solvent to thoroughly moisten sample.

2.2.8.3 Mix the sample and debris for approximately 5 minutes. A beaker may be used as a plunger to facilitate the extraction of flexible debris

2.2.8.4 Filter sample through phase separation paper supported with Whatman Grade 1 filter paper.

2.2.8.5 Allow sample to evaporate approximately 50%. Collect a 2mL sample. Place a portion of the partially evaporated sample into labeled autosampler vial with microinsert, and seal. Place the remaining partially evaporated sample into an additional autosampler vial for refrigerated storage.

2.2.8.6 Continue to evaporate remaining solvent. Concentrate extract down between 0.5 to 1mL. Place a portion of the sample into labeled autosampler vial with microinsert, and seal. Place the remaining sample into an additional autosampler vial for refrigerated storage.

2.2.9 Solvent Purity Check

2.2.9.1 A solvent blank will be run with each batch of solvent recovered extracts.

2.1.9.1.1 Place approximately 200mL of extraction solvent into a clean beaker.

2.1.9.1.2 Evaporate solvent to approximately 1mL.

2.1.9.1.3 The degree of solvent evaporation should be at least twice the extent used for questioned samples (ASTM E1386-95, 5.2.1).

2.2.10 Analysis

2.2.10.1 Analyze both the partially evaporated and evaporated solvent extracts by GC-MSD as described in section 3.0.

3.0 Analysis of Recovered Extracts

3.1 General

3.1.1 To detect the presence of an ignitable liquid residue in fire evidence samples, extracts recovered by either passive headspace or solvent extraction are analyzed with a gas chromatograph equipped with a mass selective detector (GC-MSD).

3.1.2 Post-run macros, which process the data to generate extracted ion profiles, assist with

the detection and identification of ignitable liquid residues.

3.2 ASTM Reference Method

Refer to ASTM Method E-1387-95, *Standard Test Method for Ignitable Liquid Residues in Extracts from fire Debris Samples by Gas Chromatography* and E 1618-97, *Standard Guide for Identification of Ignitable Liquid Residues in Extracts from Fire Debris Samples by Gas Chromatography-Mass Spectrometry.*

3.3 Materials and Equipment

3.3.1 Column Resolution Test Mixture (Restek #31224, Cerilliant ERR-002 or equivalent)

3.3.2 Ignitable Liquid Standards

Obtain as required. The following are representative of established classes of ignitable liquids but is not an all-inclusive list. Refer to *Ignitable Liquid Inventory* for a list of in-house standards.

Ignitable Liquid	Vendor
Pocket Light Fluid, Ronsonol	Cerilliant CSQ-2130A
Gasoline, Texaco	Cerilliant CSQ-2130B
Mineral Spirits, Klean-Strip	Cerilliant CSQ-2130C
Kerosene, Sunnyside	Cerilliant CSQ-2130D
Diesel, Texaco	Cerilliant CSQ-2130E
Liquid Sandpaper, Klean-Strip	Cerilliant CSQ-2130F
Lacquer Thinner, Klean-Strip	Cerilliant CSQ-2130G
Isopar H, Exxon	Cerilliant CSQ-2130H
Lamp Oil, Lamplight Farms	Cerilliant CSQ-2130I
Concrete and Drive Cleaner, Klean-Strip	Cerilliant CSQ-2130J
Odorless Charcoal Starter, Kingsford,	Cerilliant CSQ-2130K
LPA-142, Condea Vista	Cerilliant CSQ-2130L
Unweathered, 25% weathered, 50% weathered and 75% weathered gasoline	Restek 30096, 30097, 30098, 30099
Unweathered, 25% weathered, 50% weathered and 75% weathered mineral spirits	Restek 31225, 31226, 31227, 31228
Unweathered, 25% weathered, 50% weathered and 75% weathered kerosene	Restek 31229, 31230, 31231, 31232
Ignitable Liquid	**Vendor**
Unweathered, 25% weathered, 50% weathered and 75% weathered diesel	Restek 31233, 31234, 31235, 31236
C-7 to C-10 n-paraffin mixture	Alltech 628002 or equivalent
C-9 to C-12 n-paraffin mixture	Alltech 628003 or equivalent
C-11 to C-14 n-paraffin mixture	Alltech 628003 or equivalent
C-12 to C-18 n-paraffin mixture	Alltech 628003 or equivalent

Aromatic Hydrocarbon Mixtures	Alltech 629001, 629002, 629003, 629004, 629005, 629006, or equivalent

3.3.3 Instrumentation
Hewlett Packard 5890 Gas Chromatograph equipped with a Hewlett Packard 5971 Mass Selective Detector or equivalent.

3.3.4 Column
25 meter Hewlett Packard HP-5 [(5% PhMeSilcone) with 0.22 mm ID and 0.33 µm film thickness] or equivalent. The column, with appropriate carrier gas flow and temperature program, must have the capability to adequately separate the components of the *ASTM E1387*, or equivalent, test mixture (refer to 3.3.2.4.3).

3.4 GC/MSD Analysis

3.4.1 Instrumental Parameters

3.4.1.1 Injector Temperature: 280°C

3.4.1.2 Detector Temperature: 300°C

3.4.1.3 Carrier Gas: Helium

3.4.1.4 Temperature Program:

Initial Temperature:	40°C
Initial Time:	4.00 min
Ramp Rate:	8°C/min
Final Temperature:	290°C
Final Time:	10.00 min

3.4.1.5 Sample size: 1.0 - 2.0µL

3.4.2 Preparation for Analysis of samples by GC/MSD

3.4.2.1 Perform *Autotune*.
Refer to section 3.4 for *Autotune* evaluation criteria.

3.4.2.2 Programming of GC/MSD sequence run.

3.4.2.2.1 Load ARSON sequence from sequence menu.

3.4.2.2.2 Select ***Edit Sample Log Table*** from sequence pull-down. The following is an example of the sample log

table.

Sample Log Table for ARSON.M					
Line	Type	Vial	Date File	Method	Sample Name
1)	Sample	51	BLK-ACS	ARSON	QC ACS 02-01-01 ACS LOT# 062200
2)	Blank	75	BLANK	ARSON	Carbon Disulfide Blank Fisher Lot#950674
3)	Sample	53	006-2ACS	ARSON	P2001006 (1) ACS lot# 062200/CS2 lot#950674
4)	Blank	75	BLANK	ARSON	Carbon Disulfide Blank Fisher Lot#950674
5)	Sample	54	006-2SE	ARSON	P20001006 (2) Solvent e/Pentane lot#962473
6)	Sample	74	50EVGAS	ARSON	50% evap Sinclair gasoline lot#0500-1/CS2
7)	Sample	71	ASTM1387	ARSON	ASTM E1387 Column Resolution Mix*/CS2

* Program source and lot number under sample log table *Miscellaneous Information*.

3.4.2.2.3 In Sample Log Table, program questioned samples into sequence by laboratory and sample number. Sample name description should include method of recovery.

3.4.2.2.4 Quality Control Samples

3.4.2.2.4.1 In Sample Log Table, program quality control samples into sequence by laboratory number or date prepared. Information should include method of recovery.

3.4.2.2.4.2 For system blanks for charcoal strips or solvent purity check, designate BLK-ACS, BLK-SE or similar notation.

3.4.2.2.4.3 In-between Sample Blanks

To ensure that carry-over between samples is not occurring, program a carbon disulfide solvent BLANK between each case sample. TIC from BLANK should be place into case file.

3.4.2.2.4.4 QC Test Mixture

To establish that the system has the capability to resolve compounds outlined in ASTM E1387-95 and ASTM E1618-01, an ASTM E1387-90 column resolution check mix (Restek #31224 or equivalent) is analyzed with each analysis run. Program test mixture into each sequence run. TIC and selected ion profiles (SIP) print-outs should be place in ASTM E1387-90 binder.

3.4.2.2.5 Ignitable Liquid Standards

3.4.2.2.5.1 In Sample Log Table, program appropriate ignitable liquid standards

following the questioned samples. The source and lot numbers for commercially obtained products should be included. The source of locally obtained fuels (gasoline, diesel fuel, etc) should be described.

3.4.2.2.5.2 A copy of the relevant standard(s) should be placed into the casefile.

3.4.3 Post-run Selected Ion Profiles Macro

3.4.3.1 Included with the ARSON GC/MSD method is a post-run macro provided by Alcohol, Tobacco and Firearms (ATF). This macro generates the TIC and individually printed selected ion profiles, two per page. Individual profiles allow the analyst to see less abundant ions indicative of certain classes of compounds in greater detail than summed profiles.[6.13] This macro will initiate upon the completion of sample analysis. Ions included are as follows:

Alkanes	43	57	71	85
Aromatics	91	105	119	133
PNAs*	128	142	156	

* Polynuclear aromatics (Naphthalenes)

3.4.4 Command Line Selected Ion Profiles Macros

3.4.4.1 Two macros are available which provide for further options for data presentation to assist with interpretation. The macros are accessed under data analysis using the command line.

3.4.4.1.1 ***ARION***

On command line type ***MACRO "ARION", GO.***

This macro provides a custom header on the TIC and one page with combined selected ion profiles for ions characteristic for key ignitable liquid groups.

Alkanes	43	57	71	85
Aromatics	91	105	119	
Cycloalkane/alkene	55	69	82	83
Naphthalenes	128	142	156	

3.4.4.1.2 ***CUSTOM***

On command line type ***MACRO "CUSTOM", GO.***

This macro provides a custom header on each printout. Operator selects either a TIC or full-page version of the selected ion profiles indicated above for *ARION*. Macro also allows for defining of window size (X-axis)

and abundance (Y-axis) which allows for enhancement of low abundance compounds.

3.5 Maintenance Schedule for Hewlett Packard 5890 Gas Chromatograph/5971 Mass Selective Detector

3.5.1 When-in-use Maintenance

3.5.1.1 Autotune

3.5.1.1.1 Tune Requirements

Autotune should be performed at the prior to a sequence run and whenever the instrument pauses.

3.5.1.2 Interpretation of Autotune report

3.5.1.2.1 Tune Report

The Tune Report is printed as a result of performing an Autotune on the MSD. The report includes the final values of the MS parameters which were set by the tuning process. In addition the report includes the actual mass spectral data obtained using these parameters.

3.5.1.2.2 Interpretation

The major parameters which are used to evaluate the performance of the MSD are peak width, mass peaks, relative abundance and isotope ratio.

3.5.1.2.2.1 Peak Width *(Pw)*

- Peaks of the ions mass 69, 219 and 502 resulting from the fragmentation of PFTBA are plotted on the top section of the Tune Report.
- Peak widths should fall within a range of 0.4 to 0.6.
- If the peak width noted on the Tune Report falls outside of the acceptable range, troubleshooting procedures should be initiated.

3.5.1.2.2.2 Mass Peaks

- The lower portion of the Tune Report illustrates the PFTBA spectrum acquired during the

Autotune.

- Target values for the tune masses are 69±0.2 amu, 219 ±0.2 amu and 502 ±0.2 amu.
- If the mass assignments do not fall in this range, troubleshooting procedures should be initiated.

3.5.1.2.2.3 Relative Abundance

- The lower portion of the Tune Report provides the abundance of each tune mass reported as a percentage of the most abundant mass. Acceptable values are as follows:

Mass	*Relative Abundance*
69.0	*100%*
219.0	*>30%*
502.0	*>1%*

- If the relative abundance of each mass falls below the acceptable abundance, troubleshooting procedures should be initiated. A relative abundance for mass 502 of 1% or less may indicate a dirty ion source.

3.5.1.2.2.4 Isotope Ratio

- The lower portion of the Tune Report will indicate the isotope ratio reported for the tune masses 69, 219 and 502. Acceptable ranges for isotope ratios are as follows:

Isotope Mass	*Isotope Ratio*
70.0	*0.5 to 1.5%*
220.0	*2 to 8%*
502.9	*5-12%*

- If the isotope ratios reported on the Tune Report do not fall

within these limits, trouble-shooting procedures should be initiated.

3.5.2 Overview of Troubleshooting

In the advent that the MSD reports values for any of the above parameters which fall outside of the acceptable ranges, troubleshooting procedures will be initiated to determine the origin of the problem. Commonly encountered reasons for the MSD to not pass the tune criteria include:

Potential Source of Problem	*Manual Section Reference*
Calibration vial is empty	Hardware manual p. 4-40, 4-41
Excessive foreline or vacuum manifold pressure	Hardware manual p. 4-6, 4-14 to 4-15, 4-24 to 4-25
Dirty ion source	Hardware manual p. 4-45, 4-49, 4-52, 4-55
Calibration valve is not working correctly	Hardware manual p. 4-37, 4-40, 4-41
Bad signal cable connection	Hardware manual p. 4-36
Filament has failed or is not connected properly	Hardware manual p. 4-26 to 4-27
Bad ion source wiring connection	Hardware manual p. 4-36
Bad detector wiring connection	Hardware manual p. 4-40
Failed electron multiplier horn	Hardware manual p. 4-31, 4-33

For Additional trouble shooting information refer 5890 operating manuals and the hardware manual for the 5971.

3.5.3 As Needed Maintenance

Task	*Indications*	*Manual Reference*
Replace inlet/injection port seal Options: 1. Merlin Microseal™ Septum 2. Septa	▪ Longer or shifting retention time ▪ Loss of response ▪ Noisy detector signal Autotune indicates an air leak	Reference Manual p. 8-8 to 8-9
Replace inlet/injection port liner and O-ring	▪ Loss of response ▪ Visual Inspection	Operating Manual p. 2-4 to 2-5 Reference Manual p. 1-17 to 1-19, 6-8 to 6-9
Replace inlet/injection port base seal	▪ Ghost peaks ▪ Visual Inspection	Reference Manual p. 8-13

Clean inlet reducing nut	▪ When replacing inlet base seal and/or column	Reference Manual p. 35,54-55
Replace ion source filaments	▪ Evaluation of Autotune	Hardware p. 5-34 to 5-35
Clean ion source	▪ Evaluation of Autotune	Hardware p. 5-22 to 5-29
Replace column	▪ Evaluation of chromatography and Autotune	GC inlet: Operating Manual p. 2-2 to 2-3, 2-14 to 2-15. MSD: Hardware p. 3-4 to 3-5
Replace or clean split/splitless vent line trap	▪ Evaluation of split ratio ▪ Clogged trap will not provide proper split ratio	Reference Manual General on split mode, p. Cleaning procedure following.
Lubricate seals-Side plate O-ring	▪ Autotune indicates an air leak	Hardware p. 138-139

3.5.4 Weekly Maintenance

Task	*Manual Reference*
Check foreline pump oil fluid level	Hardware p. 5-8 to 5-11

3.5.5 Six Month Maintenance

Task	*Manual Reference*
Pump Maintenance ▪ Drain and replace foreline pump fluid ▪ Remove and inspect oil trap, refill or replace	Hardware p. 5-12 to 5-13
Check PFTBA calibration vial ▪ Refill if necessary	Hardware p. 5-20 to 5-21

4.0 Interpretation of Analytical Results

4.1 Petroleum Product Classification System

4.1.1 Classification system consists of eight major classes of ignitable (flammable or combustible) liquids.

Class Number (Class Name)	Peak Spread Based on n-Alkane Carbon Numbers (Unevaporated Liquid)	Examples
1 Light Petroleum Distillates (LPD)	C_4-C_{11}	Petroleum ether, Pocket lighter fuel, some rubber cement solvents, Skelly solvents, V M & P Naptha, Some camping fuels.
2 Gasoline	C_4-C_{12}	All brands and grades of automotive gasoline, including gasohol.
3	C_8-C_{12}	Mineral spirits. Some paint thinners.

Medium Petroleum Distillates (MPD)		**Some Charcoal starters, "Dry-cleaning" solvents. Some torch fuels. Some solvents for insecticides and polishes. Some lamp oils.**
4 **Kerosene**	**C_9-C_{17}**	**Number 1 fuel oil, Jet-A (aviation) fuel, insect sprays. Some charcoal starters. Some torch fuels, Some paint thinners. Some solvents for insecticides and polishes, some lamp oils.**
5 **Heavy Petroleum Distillates (HPD)**	**C_9-C_{23}**	**Number 2 fuel oil, Diesel fuel.**

0. **Miscellaneous**	**Variable**	**Single compounds. Turpentines, Specialty mixture that cannot be further classified into one of the categories below.**
0.1 **Oxygenated solvents**	**Variable**	**Alcohols, Esters, Ketones**
0.2 **Isoparaffins**	**Variable**	**Isoparaffin products. Some charcoal starters. Some copier fluids. Some aviation gasoline. Some lamp oils. Some solvents for insecticides and polishes. Some camping fuels.**
0.3 **Normal alkanes**	**Variable**	**Specialty products formulated from normal alkanes. Some lamp oils. Some solvents for insecticides and polishes.**
0.4 **Aromatic solvents**	**Variable**	**Light, medium and heavy "aromatic naptha" used as solvents for paints and plastics.**
0.5 **Naphthenic/paraffinic solvents**	**Variable**	**Specialty solvent/fuel products made from class 3 or Class 4 distillates treated to remove normal alkanes and aromatics, with higher cycloalkane content than isoparaffin products.**

4.2 Procedure for Interpretation of Chromatograms

4.2.1 Obtain a chromatogram with the major peaks on-scale (three-quarters to full scale).

4.2.2 Note in what region of the chromatogram the peaks reside.

4.2.2.1 Examine chromatogram to determine in what retention time range the peaks are present (light, medium or heavy region).

4.2.2.2 Examine chromatogram to determine the width of the carbon spread.

4.2.3 Compare sample chromatogram with chromatogram from a known standard obtained under similar conditions.

4.2.3.1 Note significant points of correlation.

4.2.4 To establish carbon number range, compare the sample chromatogram with

normal alkane chromatogram.

4.2.5 The analyst must consider and be prepared to explain any observed differences between the unknown (questioned sample) and a standard. Variables that should be taken into account include the influence of; evaporation, interference from burned matrix materials, sample preparation techniques and/or bacterial degradation (soil samples). Unexplained differences should preclude the identification as an ignitable liquid.

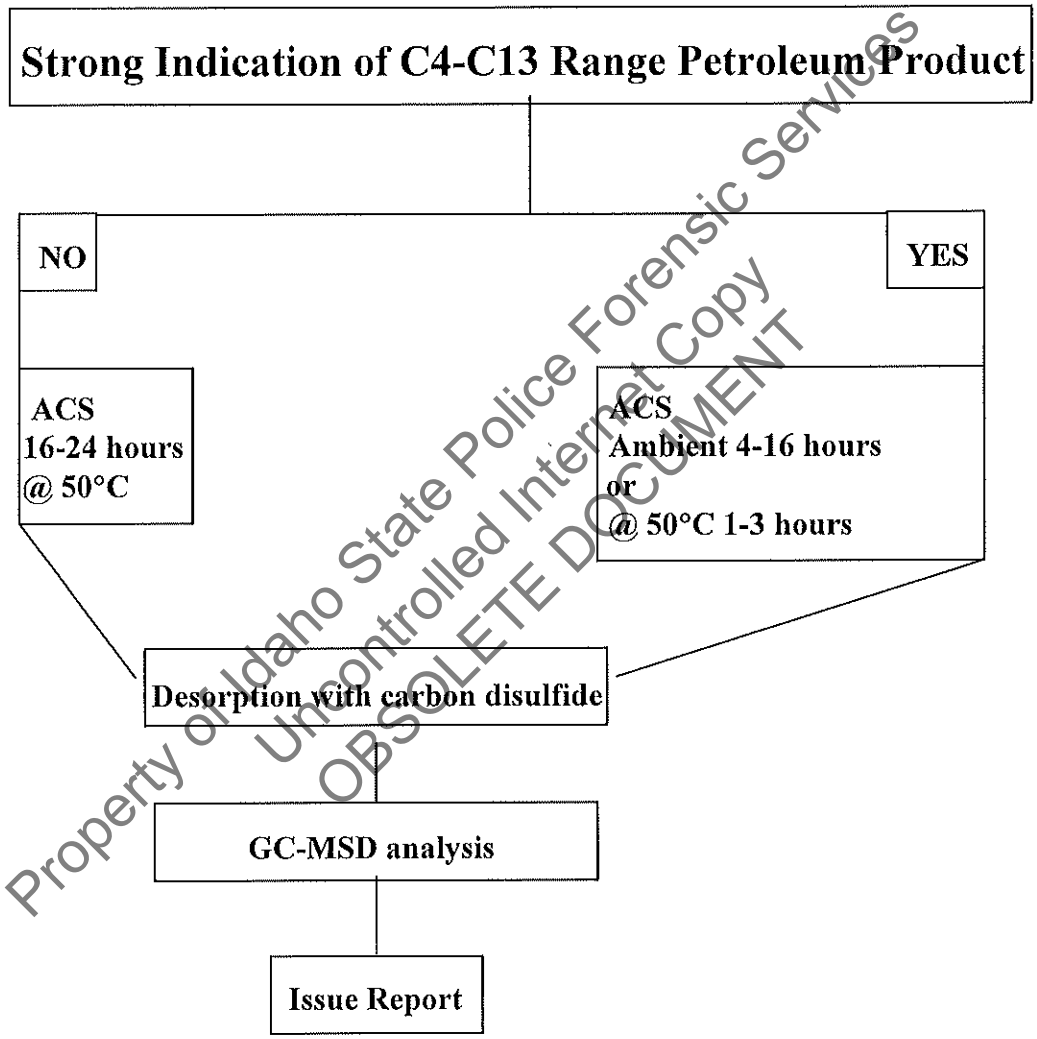
4.3 Criteria for Interpretation of Data

4.3.1 Refer to ASTM E 1618-01, *Standard Guide for Identification of Ignitable Liquid Residues in Extracts from Fire Debris Samples by Gas Chromatography-Mass Spectrometry.*

5.0 Analysis scheme for extraction of fire debris

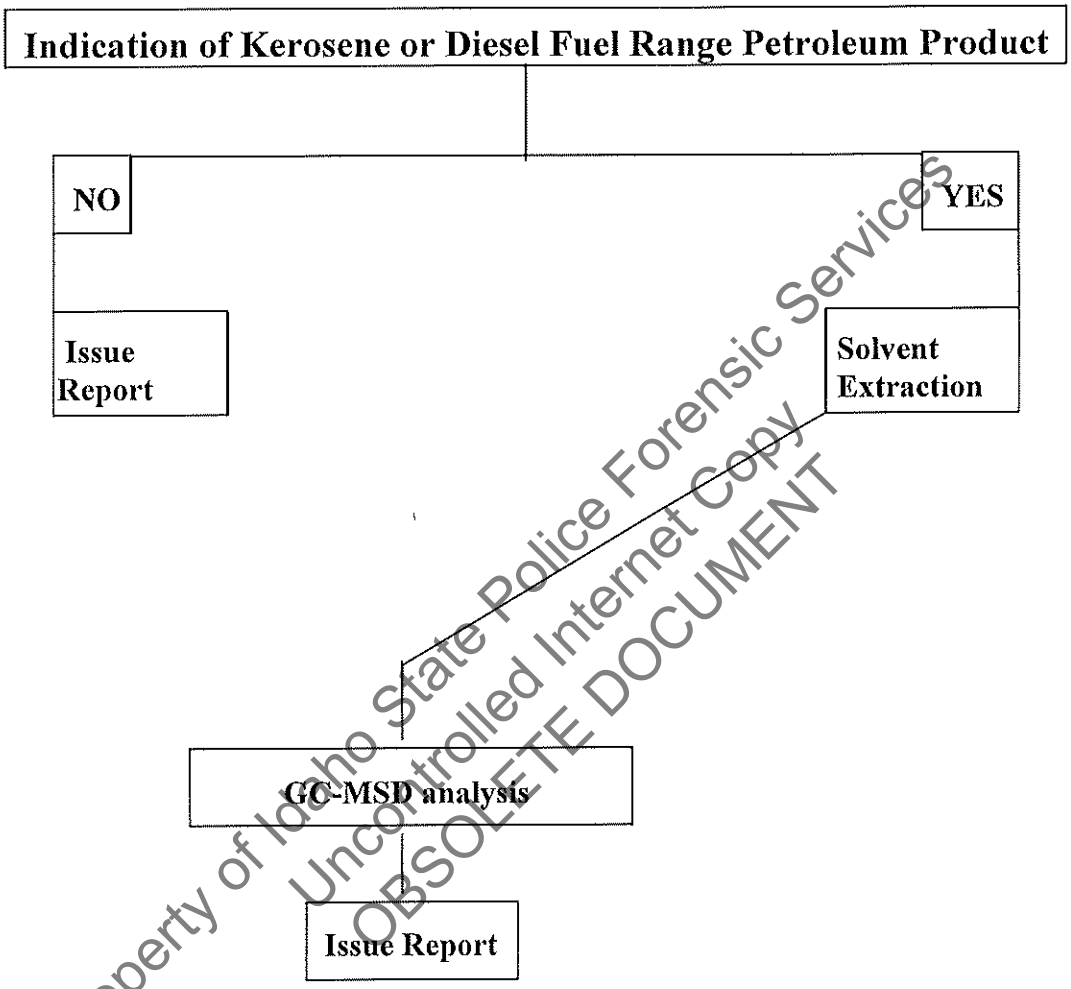
Olfactory Screening

Case 1:



5.0 Analysis scheme for extraction of fire debris (cont.)

Case 2:



6.0 References

6.1 ASTM Method E-1412-91, **Standard Practice for Separation and Concentration of Flammable or Combustible Liquid Residues from Fire Debris Samples by Passive Headspace Concentration.**

6.2 ASTM Method E-1412-95, **Standard Practice for Separation and Concentration of Ignitable Liquid Residues from Fire Debris Samples by Passive Headspace Concentration.**

6.3 ASTM Method E-1386-90, **Standard Practice for Separation and Concentration of Flammable or Combustible Liquid Residues from Fire Debris Samples by Solvent Extraction.**

6.4 ASTM Method E-1386-95, **Standard Practice for Separation and Concentration of Ignitable Liquid Residues from Fire Debris Samples by Solvent Extraction.**

6.5 ASTM Method E-1387-95, **Standard Test Method for Ignitable Liquid Residues in Extracts from Fire Debris Samples by Gas Chromatography.**

6.6 ASTM Method E-1618-94, **Standard Guide for Ignitable Liquid Residues in Extracts from Fire Debris Samples by Gas Chromatography-Mass Spectrometry.**

6.7 ASTM Method E-1618-97, **Standard Guide for Identification of Ignitable Liquid Residues in Extracts from Fire Debris Samples by Gas Chromatography-Mass Spectrometry.**

6.8 Dietz, W.R. **Improved charcoal packaging for accelerant recovery by passive diffusion.** J. Forensic Sci. **36(1):**111-21;1991.

6.9 Newman, R.T.; Dietz, W.R.; Lothridge, K. **The Use of Activated Charcoal Strips for Fire Debris Extractions by Passive Diffusion. Part 1: The Effects of Time, Temperature, Strip Size, and Sample Concentration.** J. Forensic Sci. **41(3):**361-370; 1996.

6.10 Arson Accelerant Detection Course Materials, presented at Alcohol, Tobacco & Firearms Laboratory, Rockville, Maryland, May, 1993.

6.11 Arson Analysis Workshop Materials, presented at Northwest Association of Forensic Scientist's Fall Meeting, Salt Lake City, Utah, October, 1996.

6.12 Advanced Fire Debris Course Materials, presented at National Forensic Science Technology Center, St. Petersburg, Florida, December, 1996.

6.13 Newman, R.; Gilbert, M.; Lothridge, K. GC-MS Guide to Ignitable Liquids. Boca Raton, FL: CRC Press: 1998.