

TECHNICAL NOTE

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Use of a Solid Absorbent and an Accelerant Detection Canine for the Detection of Ignitable Liquids Burned in a Structure Fire

ABSTRACT: Ignitable Liquid Absorbent™ (ILA), a commercial solid absorbent intended to assist fire scene investigators in sample location and collection, has been field tested in three separate room fires. The ability of the ILA to detect and absorb different amounts of gasoline, odorless paint thinner, and camp fuel on two different substrates after a full-scale burn was assessed against results from an accelerant detection canine and laboratory analysis using gas chromatography-mass spectrometry (GC-MS). The canine correctly alerted on most of the panels that contained an ignitable liquid after the fire, while the ILA indicator dye failed to indicate in the presence of gasoline and camp fuel. GC-MS results for ignitable liquid residue from each panel and from the ILA showed that ILA absorbed odorless paint thinner and camp fuel from most of the test panels, but failed to absorb gasoline from the panels on which gasoline was confirmed to be present.

KEYWORDS: forensic science, arson, ignitable liquid, accelerant detection canine, absorbent, GC-MS, ILA

Fire investigators have a variety of tools at their disposal to assist in the determination of the origin and cause of a fire. Examination of the scene may indicate that an ignitable liquid was used to accelerate the fire. Determining where to collect a sample from the suspected origin may be aided by the use of hydrocarbon detectors and/or accelerant detection canines. Evidence is usually collected for laboratory analysis by either physically removing material from the scene or by using an absorbent. Recently, a new product, ignitable liquid absorbent™ (ILA), has appeared on the market and is intended to combine both the function of indicating the best place to take a sample as well as absorbing suspected accelerant from the scene for subsequent laboratory analysis. The use of canines for detecting ignitable liquids at fire scenes (1–5) and collection of evidence from porous substrates using an absorbent (1,6,7) are well-established practices used at the fire scene. What is new about ILA is that it combines two absorbents (a polyolefin and a carboxylic acid) together with an indicator dye that changes color in the presence of hydrocarbons. (8) Data from the gas chromatography-mass spectrometry (GC-MS) analysis of ILA used to absorb gasoline (9) and a mixture of gasoline and diesel fuel (10) have been published. Here, we report the results of

field tests using an accelerant detection canine, ILA, and GC-MS to detect and/or recover different ignitable liquids from controlled burns conducted in a wood frame structure.

Materials and Methods

Room Burn Tests

Accelerated burns were conducted in three separate rooms, each room with a different accelerant: odorless paint thinner (medium petroleum distillate); camp fuel (light petroleum distillate) and regular gasoline (Table 1). The odorless paint thinner and camp fuel were purchased from Home Hardware, and the gasoline was purchased from an Irving Oil retail station. Onto the floor of each room was fixed six flooring panels onto which the accelerant was poured. Three of the flooring panels consisted of pieces of oriented strand board (OSB) and the other three panels consisted of pieces of OSB with foam carpet pad and carpet stapled to the surface of the OSB. Each flooring panel was 12 in² and was nailed to the floor to prevent movement during fire suppression. Immediately before burning the room, one of three different volumes of accelerant (50, 100, and 250 mL) was poured onto each of the three pieces of OSB and each of the three pieces of carpeted OSB.

TABLE 1—Description of three test burns in house.

Room	Type	Ignitable Liquid	ASTM Class
1	Bedroom	Odorless paint thinner	Medium de-aromatized product
2	Kitchen	Gasoline	Gasoline
3	Bathroom	Camp fuel	Light petroleum distillate

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Each room was furnished so as to contain a fire load typically found in a residential dwelling. In two of the rooms, the kitchen (Room 2) and bathroom (Room 3), the fire load was increased to allow for a more rapid fire. A thermocouple device (Model 199-KC-X-Y-DSS, Omega Engineering Inc., Stamford, CT) was used to monitor the temperature increase during each burn and was placed at the same level in each of the three rooms as follows: floor level; 30 in above the floor; 72 in above the floor; and 6 in from the ceiling (average height from floor to ceiling was *c.* 9 ft). In Room 1, the floor-level thermocouple was placed beside the bed and the remaining thermocouples were placed vertically above one corner of the bed. In the other two rooms, the thermocouples were arranged vertically from floor to ceiling in a single location. Video cameras were set up outside the house to capture the extent of the burns and aid in time/data gathering.

Trailers to the flooring panels were constructed from rolled-up tissue paper and were used to ignite the panels in each room. After ignition, the fire was allowed to burn freely until it began to progress into the adjoining hallway. The fire was not allowed to progress into the hallway because the fire suppression crews did not want the fire to extend into the already dilapidated structure and risk losing the entire building through fire spread into the concealed space between the upper and lower floors as well as within the lath and plaster walls.

Sample Collection

The ILA (Ancarro, Indianola, IA) was mixed according to the manufacturer's instructions and used as received. The detector canine was a female Labrador Retriever trained and certified through the Maine Criminal Justice Academy, State Farm Hydrocarbon Detection Canine program. Canine and handler had been working together for 6 years at the time this house burn was conducted.

Flooring panels of OSB and carpeted OSB without accelerant were examined by the canine before the room burns and the canine did not alert on any of the panels. After all the burns had been completed, the rooms were allowed to cool before examination. Time permitted only the bedroom (Room 1) to be searched by the canine detector and ILA to be applied to each flooring panel on site. The flooring panels from the other two rooms were removed, kept separate from one another, and placed on secure surfaces some distance from the building so as not to interfere with the remainder of the fire department's training and suppression activities. After removal of the flooring panels, the detector canine searched the panels and alerts were noted. The ILA was then mixed as per the manufacturer's instructions and spread over each of the flooring panels. Absorption time for the ILA was between 20 and 30 min for each panel. After the adsorption time had elapsed, the ILA from the panel was brushed off into a clean metal can and sealed for subsequent analysis for the presence of the ignitable liquid. ILA that became trapped in burn holes in the carpeted panels was removed by scraping. The whole panel was then placed into a nylon evidence bag and sealed for separate analysis for the presence of the ignitable liquid.

GC-MS

Each sample of ILA and each panel was extracted onto DFLEX-activated charcoal strips (Albrayco, Cromwell, CT) using a passive headspace concentration method based on ASTM method E1412 (11). Charcoal strips were eluted with between 300

and 600 μL of carbon disulfide. All extracts were analyzed by GC-MS using a method based on ASTM E1618 (12). An unused sample of ILA was also placed in a 1 L metal can and analyzed using the same conditions as the samples collected from the test burns. GC was performed on a 30 m \times 0.25 mm i.d. \times 0.25 μm film HPMS-1 capillary column (Agilent Technologies, Palo Alto, CA) using an Agilent 6890 gas chromatograph connected to an Agilent 5973 mass selective detector (MSD). The GC-MS conditions used were as follows: split injection (20:1) at 250°C; temperature programmed from 40°C (3 min isothermal) to 250°C at 8°C/min (post-run at 300°C held for 5 min); and helium carrier gas held at a constant flow rate of 1.2 mL/min. The sample injection volume was 1 μL , and the detector was operated in the full scan mode (30–300 a.m.u.) with a sampling rate of 9.4 scans/sec.

Results and Discussion

Structure

The test site was a century-old, one and one half story farmhouse in Upper Gagetown, New Brunswick, which was previously scheduled for demolition. The foundation was constructed from stone; there was an earth cellar under a portion of the house. The structure was a wood-frame (2" \times 4" stud) construction clad with wood shingles. There was an open veranda (no railings) around part of the main floor. The interior of the house contained a wood floor that was covered with linoleum in some places, and the walls were finished with lath and plaster. Some interior doors had been salvaged and so sheets of OSB were fitted in place of the doors and kept open during the test burns. The peaked roof was constructed from wood rafters and was covered with wood sheathing topped with asphalt shingles. All windows were of single-pane construction in wood frames and were kept closed during the burns. The house did not have electricity. A floor plan showing the rooms used in the tests within the structure is provided in Fig. 1. Weather on the day of the test burns was cool and overcast, and the temperature was *c.* 7°C with little or no wind.

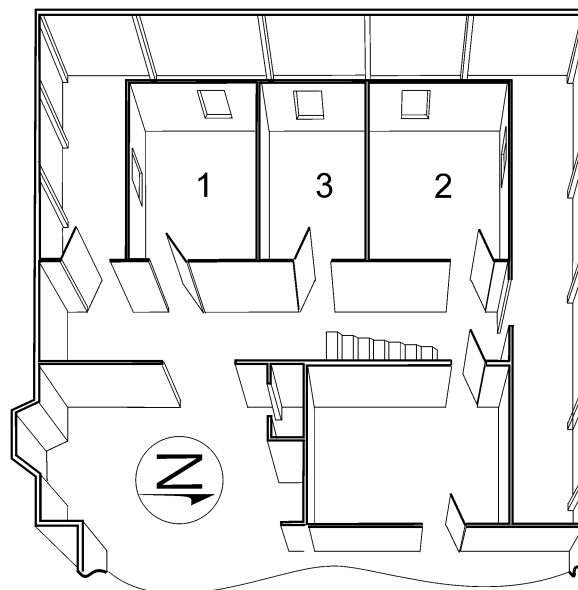


FIG. 1—Floor plan showing the location of the rooms in which the burn tests occurred.

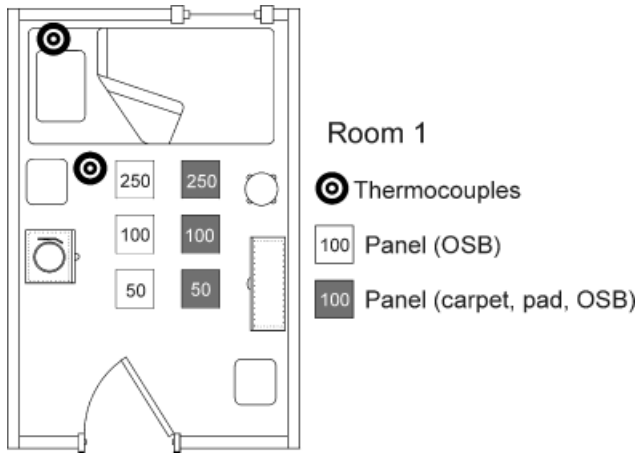


FIG. 2—Room 1 (bedroom) showing placement of flooring panels and amounts of ignitable liquid on each. Furniture (clockwise from top): bed, stool, cabinet, side table, stereo cabinet, side table.

Room 1—Bedroom Fire Accelerated With Odorless Paint Thinner

Room 1 was furnished as a bedroom with a fire load typical of this type of room (bed, cabinets, side table, chair, and stool). This room had a larger fuel load than the other two rooms. The flooring panels were secured and the accelerant was poured on the substrates as shown in Fig. 2.

The fire was allowed to burn for *c.* 2 min before suppression, with the recorded temperature increasing to a maximum of 190°C at the floor level and 672°C just below the ceiling. Total burn time was just over 3 min. After the room had cooled sufficiently, the canine was taken into Room 1 where she indicated on five of the six flooring panels in the room.

The test results for room 1 are given in Table 2. GC-MS results showed that after the fire, a significant amount of ignitable liquid was present on each of the six flooring panels. The canine did not alert on the OSB panel on which 50 mL of odorless paint thinner was poured. The ILA changed color only on the carpeted OSB flooring panels and demonstrated that ILA does not necessarily change color in the presence of an ignitable liquid if it is placed directly on a wood surface. Ignitable liquid was found in five out of six ILA samples using GC-MS. The amount of odorless paint thinner absorbed by the ILA from these five panels was significantly less than what actually remained on the panels after the fire (Fig. 3).

TABLE 2—Room 1: bedroom fire accelerated with odorless paint thinner.

Sample Volume (mL)	Substrate	Results			
		Canine	ILA (indicator dye)	ILA (GC-MS)	Laboratory GC-MS
50	OSB	—	—	+	+
50	Carpeted OSB	+	+	+	+
100	OSB	+	—	+	+
100	Carpeted OSB	+	+	+	+
250	OSB	+	—	+	+
250	Carpeted OSB	+	+	—	+

ILA, ignitable liquid absorbent; GC-MS, gas chromatography-mass spectrometry; OSB, oriented strand board.

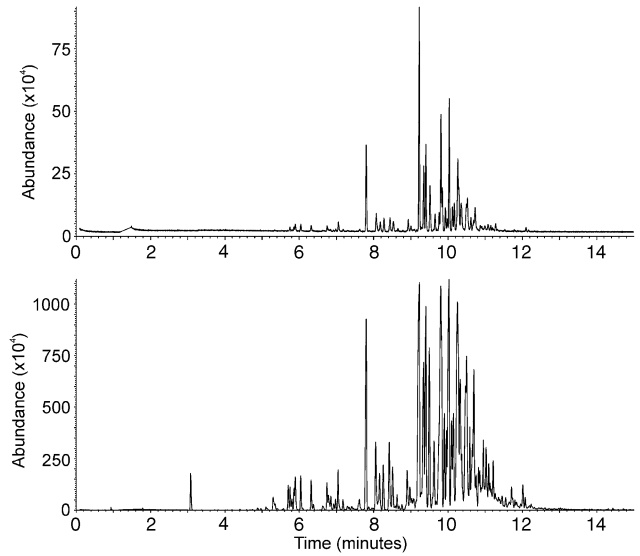


FIG. 3—Total ion chromatograms (TIC) of 50 mL odorless paint thinner on a carpeted OSB panel—postburn: DFLEX extract of the ILA that was applied to the panel (top) and DFLEX extract of the same panel after ILA was removed (bottom).

Room 2—Small Kitchen Accelerated With Gasoline

Room 2 was setup as a kitchen (Fig. 4). The relatively low fire load in this room was enhanced by the addition of some light combustibles (towels and shelving) in addition to the furniture.

The flooring panels were ignited immediately after the gasoline was added to reduce the chance of creating a vapor explosion. The fire burned for *c.* 10.5 min before suppression and had a total burn time of *c.* 11.5 min. Within seconds, the recorded temperature increased to a maximum 124°C at the floor level before cooling down to *c.* 50°C for most of the duration of the burn. It took some time for the room to become fully involved in the fire and the ceiling did not reach its maximum temperature of 555°C until 10 min after ignition.

Test results for Room 2 are given in Table 3. The canine alerted on five of the six flooring panels, while all six panels tested positive for the presence of gasoline when analyzed by GC-MS. The ILA indicator dye did not react to the hydrocarbons present on any

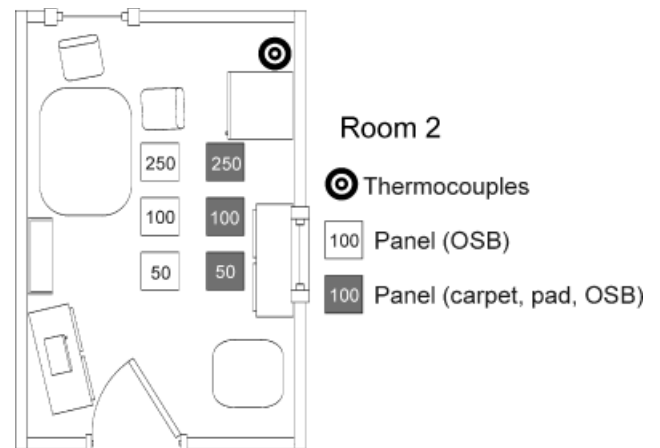


FIG. 4—Room 2 (kitchen) showing placement of flooring panels and amounts of ignitable liquid on each. Furniture (clockwise from top right): refrigerator, cabinet, small table, cabinet with microwave oven, shelf, large table, two wooden chairs.

TABLE 3—Room 2: kitchen fire accelerated with gasoline.

Sample Volume (mL)	Substrate	Results			
		Canine	ILA (indicator dye)	ILA (GC-MS)	Laboratory GC-MS
50	OSB	—	—	—	+
50	Carpeted OSB	+	—	—	+
100	OSB	+	—	—	+
100	Carpeted OSB	+	—	—	+
250	OSB	+	—	—	+
250	Carpeted OSB	+	—	—	+

ILA, ignitable liquid absorbent; GC-MS, gas chromatography-mass spectrometry; OSB, oriented strand board.

of the panels. Contrary to the findings of Byron (9), the ILA did not absorb gasoline from any of the panels. Data recently published by Mann and Putaansuu showed that, in the absence of external heating, ILA was a poor absorbent for gasoline from a concrete surface (10). A weak background of isoparaffinic hydrocarbons from the ILA was detected on all three OSB panels from this room; however, no isoparaffinic background was detected in the ILA applied to any of the three carpeted OSB panels. Tests in our laboratory confirmed that a background of isoparaffinic hydrocarbons can be generated from the ILA when it is heated to 60°C during passive headspace concentration and these results

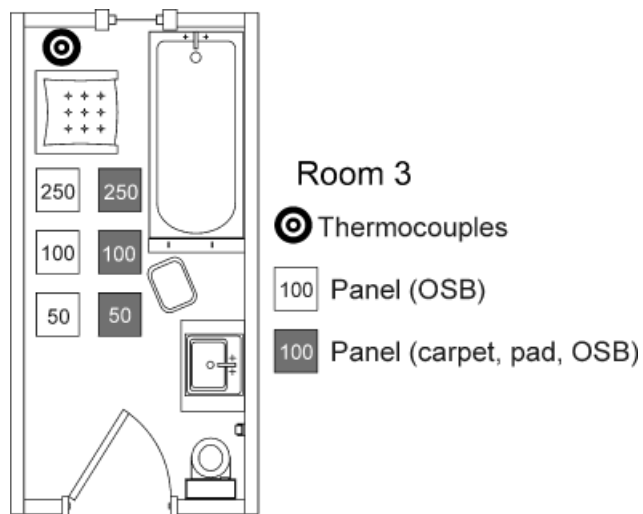


FIG. 6—Room 3 (bathroom) showing placement of flooring panels and amounts of ignitable liquid on each. Furniture (clockwise from top right): bath tub, laundry hamper, sink, toilet, arm chair.

are compared with those from one of the flooring panels (Fig. 5). An article written by the manufacturer of ILA states that “[w]hen tested in the laboratory with gas chromatography/mass

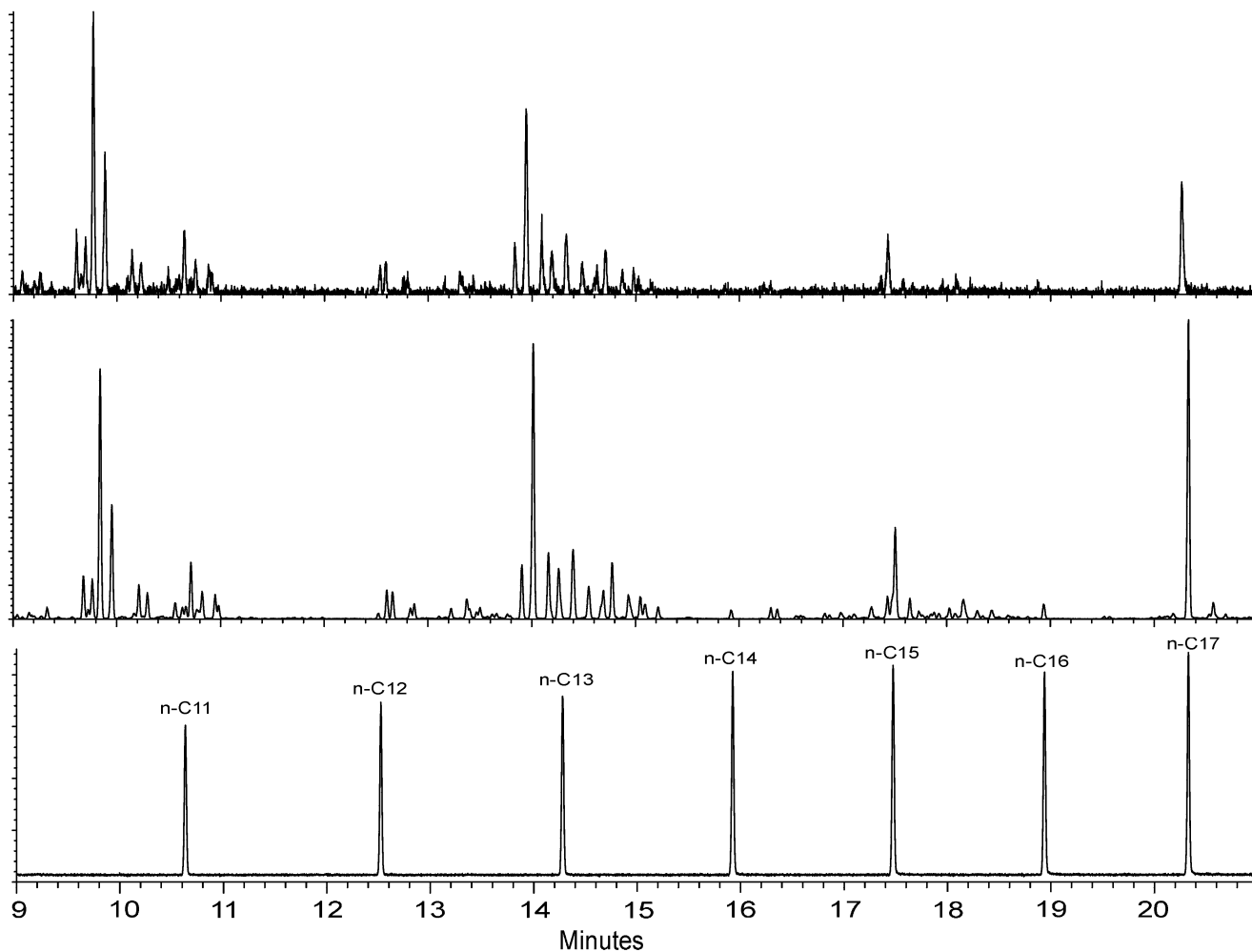


FIG. 5—Extracted ion profile (EIP) for alkane ions (m/z^+ 43, 57, 71, 85) from ILA on OSB flooring panel in Room 2 with 250 mL gasoline—postburn (top), EIP for alkane (m/z^+ 43, 57, 71, 85) from ILA analyzed in the laboratory (middle), and total ion chromatogram (TIC) of an n-alkane standard (bottom).

TABLE 4—Room 3: bathroom fire accelerated with camp fuel.

Sample Volume (mL)	Substrate	Results			
		Canine	ILA (indicator dye)	ILA (GC-MS)	Laboratory GC-MS
50	OSB	+	—	+	+
50	Carpeted OSB	+	—	—	+
100	OSB	+	—	+	+
100	Carpeted OSB	+	—	+	+
250	OSB	+	—	+	+
250	Carpeted OSB	+	—	—	+

ILA, ignitable liquid absorbent; GC-MS, gas chromatography-mass spectrometry; OSB, oriented strand board.

spectrometry (GC/MS), ILA shows components that are clearly discernable from ignitable liquid components” (8), indicating that some background hydrocarbons may be expected from the ILA.

Room 3—Small Bathroom Accelerated with Camp Fuel

Even though Room 3 was a bathroom, the fuel load was increased by addition of a chair (foam cushion, upholstered) and some towels (hanging from the shower curtain rod). The ignitable liquid was added to each panel (Fig. 6) and, as with Room 2, was immediately ignited to prevent excessive evaporation of the liquid.

The total burn time for this room was 4.5 min, with suppression beginning just before 1 min of burn time had elapsed. Temperature increase at all levels was rapid, with the floor reaching a maximum of 322°C after 40 sec and the ceiling reaching a maximum of 600°C after 50 sec.

The test results for Room 3 are given in Table 4. All six flooring panels were confirmed by GC-MS to have ignitable liquid on them

after the fire was extinguished. The canine alerted to all six panels. The ILA indicator dye did not change color for any of the panels. The GC-MS analysis of the ILA samples showed that the ILA had absorbed ignitable liquid from four of the six panels; however, the amount of camp fuel absorbed by the ILA from each panel was significantly less than what actually remained on each panel (Fig. 7).

Conclusions

Three different ignitable liquids in three different room configurations were burned on specially constructed floor panels. In each room, three OSB panels and three carpet/pad/OSB panels were burned. Differences in the fuel loads and accelerant used in each room affected the speed at which the rooms became involved in the fire and the overall temperature increase during the fire. Post-fire GC-MS analysis of the panels showed that volatile hydrocarbons were present on all 18 panels from the three rooms. Overall, the accelerant detection canine performed well and alerted on 16 of the 18 panels. The canine did not alert on one OSB panel containing gasoline and one OSB panel containing odorless paint thinner. The ILA indicator dye did not perform as well as expected and only changed color on the three carpeted panels containing the paint thinner. The ILA did absorb the odorless paint thinner from five out of six panels; and the camp fuel from four out of six panels, however, the amount of ignitable liquid recovered from these panels was low compared with the amount of ignitable liquid that actually remained on each panel. In the room ignited with gasoline, the ILA inexplicably did not absorb gasoline from any of the six panels tested even though gasoline was shown to be present on all six panels after the fire.

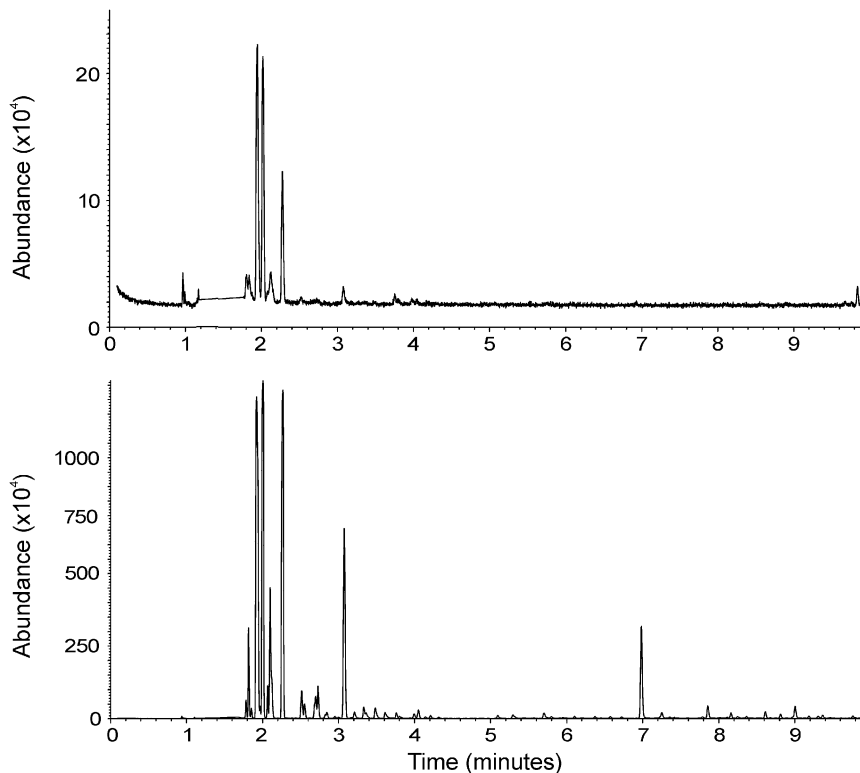


FIG. 7—Total ion chromatograms (TIC) of 50 mL camp fuel on an OSB panel—postburn: DFLEX extract of the ILA that was applied to the panel (top) and DFLEX extract of the same panel after ILA was removed (bottom).

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