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Review Article In This Issue:

Fire Investigation
Part I: Scene Investigation

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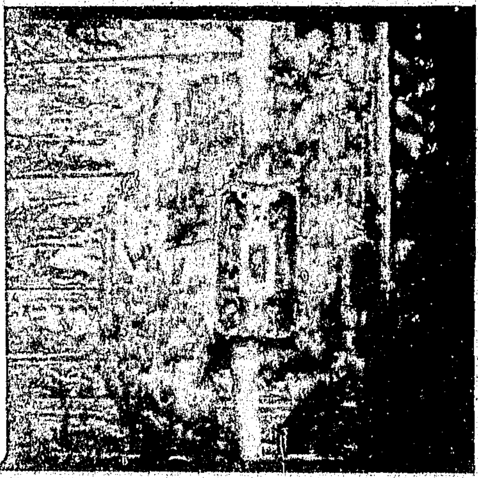

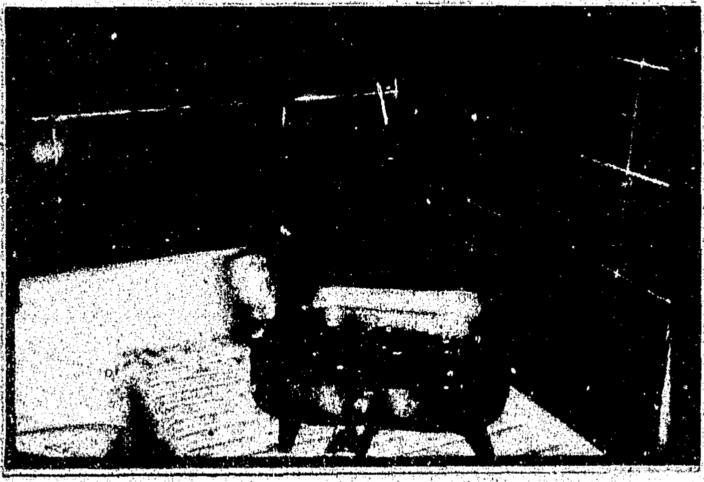

CRIME LABORATORY DIGEST

PUBLICATION POLICY

The Crime Laboratory Digest is published quarterly by the FBI Laboratory in cooperation with the American Society of Crime Laboratory Directors (ASCLD). It is intended to serve as a rapid means of communication between crime laboratories, permitting information of interest and value to be disseminated among crime laboratory scientists.

Inclusion of an article in the Crime Laboratory Digest in no way represents an endorsement or recommendation of any part of that article by the Federal Government, the Department of Justice or the FBI. Contributing authors assume total responsibility for the contents and accuracy of their submission. Questions or requests concerning an article should be directed to the contributing agency.

All submissions are subject to editorial review in accordance with the editorial policy established by the FBI Laboratory and ASCLD. The editorial staff of the Crime Laboratory Digest reserves the right to edit all articles for style, grammer and punctuation. Comments and letters to the editor are encouraged and will be published when appropriate and as space permits. These should be forwarded to:

Crime Laboratory Digest - Editor
FSRTC, FBI Academy
Quantico, Virginia 22135

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ON THE COVER

The cover, prepared by the Special Projects Section of the FBI Laboratory, depicts photographs taken during the investigation of a fire scene.

MESSAGE FROM THE ASSISTANT DIRECTOR IN CHARGE OF THE FBI LABORATORY

This past month, the FBI Laboratory celebrated the fifth anniversary of the opening of the Forensic Science Research and Training Center (FSRTC) at Quantico, Virginia. Coincidentally, the American Society of Crime Laboratory Directors (ASCLD), who assist with some of the FSRTC programs, were having their spring Board of Directors meeting and were able to share in the celebration. Our goals for this new facility were primarily twofold. One, through an enhanced research effort, was to provide a service to the law enforcement community by developing new techniques to support both FBI operations and the law enforcement community in the examination of evidence. The second goal was to provide both technical and nontechnical training, thus bringing these newest research developments to the forensic community.

On the research front, we have hired scientists in a number of disciplines including biology, chemistry and materials analysis to develop new analytical methods for examining trace evidence such as body fluid stains, plastics, automotive paints, soils and drugs. When these new methods are developed, we make every effort to inform the forensic community by publishing the research results in scientific literature, including the Crime Laboratory Digest. The training programs now offered at this new facility have expanded and enhanced our curriculum. The new facility, by providing more training space, permits the simultaneous instruction of various technical courses while using the latest scientific instruments. During the 5-year period, we have provided training to more than 5,000 law enforcement and forensic science personnel in over 25 different technical courses including serology, chromatography and specialized techniques in firearms identification.

One program the FSRTC has hosted which has had a great impact on the forensic community is the international symposia on different technical forensic topics. The symposia have brought together the research and training efforts of the FBI as well as other law enforcement agencies, academia and industry and focused them on specialized forensic topics. During the month of June, the FBI Laboratory hosted its eighth and ninth international symposia. An International Symposium on the Forensic Applications of Digital Image Processing was held the week of June 16-20. A total attendance of 55 individuals included representatives from the United Kingdom, Italy, Israel, Canada, New Zealand, Japan and the Federal Republic of Germany. Twenty-five plenary presentations were made emphasizing the development of new methods and technology to examine documents using digital image processing. The second symposium, the ninth in the series, was the International Symposium on Forensic Immunology, held June 23-26. This symposium featured 12 plenary presentations, 30 short papers and 2 panel discussions on various topics in forensic immunology. There were 175 individuals in attendance with representatives from 38 states and the countries of the United Kingdom, France, Italy, Japan, the Federal Republic of Germany and Canada.

Recently, I had the opportunity to attend the second International Symposium on the Analysis and Detection of Explosives which was held in Israel, June 29 - July 3. This symposium provided an update on the latest advances in explosive detection and analysis and was a follow-up to the first international symposium hosted by the FBI Laboratory in 1983 on the same topic. All of these symposia have brought together recognized experts in different specialized forensic science fields and have fostered the continued exchange of significant information on new developments in the forensic sciences.

In the future, in addition to continuing our research and training efforts, the FBI Laboratory plans to co-host two ASCLD recommended specialized symposia at the FSRTC in 1987. The first will be on latent print detection, co-hosted with the FBI Identification Division. The second will be on drug analysis, co-hosted with the Drug Enforcement Administration. The FBI Laboratory is proud to sponsor the forensic science symposium program, and with your continued support, we believe the FSRTC can provide an important service to the forensic community in the years ahead.

ROBERT S. GAST II

EDITOR'S COLUMN

In this issue of the Crime Laboratory Digest, part one of a two part review article on fire investigation is presented. The first part covers the fire scene investigation, and the second part, to appear in the January 1987 issue, will discuss laboratory analysis of fire debris. Also in this issue is an article by Allyson Simons from the Hairs and Fibers Unit of the FBI Laboratory concerning hairs found on laundered items. Tom Munson offers a practical guide for getting started with pyrolysis capillary gas chromatography. The results of a recent survey by Dr. Munson on pyrolysis capillary gas chromatography will appear in the October issue of the Crime Laboratory Digest.

At the recent American Society of Crime Laboratory Director's Board meeting held at the FBI Academy, interest was expressed in having articles published in the Crime Laboratory Digest on building a crime laboratory and managing a crime laboratory. Please contact the editor if you are interested in writing such an article. Additionally, at this most recent meeting there was an interest in providing information about employment opportunities in the forensic science community. Beginning in the October issue, we will publish current employment listings. Please forward information about relevant employment opportunities to the editor at the FSRTC, Quantico.

PROCEEDINGS OF INTERNATIONAL SYMPOSIA PUBLISHED BY THE FBI LABORATORY

Proceedings of three international symposia previously hosted by the FBI Laboratory and held at the FSRTC are available from the Government Printing Office. These are:

The Proceedings of the International Symposium on the Analysis and Detection of Explosives, stock number 027-001-00032-7, price $17.00.

The Proceedings of a Forensic Science Symposium on the Analysis of Sexual Assault Evidence, stock number 027-001-00037-8, price $9.50.

The Proceedings of the International Symposium on the Forensic Applications of Electrophoresis, stock number 027-001-00039-4, price $8.00.

To obtain copies of these publications, inquires should be directed to:

Superintendent of Documents
U.S. Government Printing Office
Washington, D.C. 20402

ERRATA

In our last issue, figure 2 on page 56 appears sideways. The figure is included in the feature article, "A Review of the FBI Laboratory's Gunshot Primer Residue Program" by John W. Kilty.

CENTRAL RESEARCH ESTABLISHMENT REPORTS

The Central Research Establishment (CRE), Home Office Forensic Science Service, Aldermaston, Reading, England, has provided the FBI Laboratory with copies of CRE Reports on completed research projects. By mutual agreement between the FBI and the CRE, these reports are available to all duly authorized law enforcement organizations in the United States. To obtain these reports, send a request from your crime laboratory director to:

Federal Bureau of Investigation
Colleen Wade, Librarian
Forensic Science Information
Resource System
Room 3589
10th and Pennsylvania, N.W.
Washington, D.C. 20535

The following CRE Reports are now available:

A Collection of Infra-Red Spectra of Paints and Fibres Obtained Using High Pressure,
D. K. Laing and J. M. Home,
CRE Report #372

The Detection of Trace Impurities in Soluble Food Dyes, J. R. Joyce and I. J. Humphreys,
CRE Report #373

Routine Determination of Opiates and Their Metabolites in Biological Fluids by Radioimmunoassay, P. A. Mason, B. Law, K. Pocock and A. C. Moffat,
CRE Report #376

An Assessment of the Use of Ultra-Violet Derivative Spectroscopy in Chemical Analysis, T. S. Bal and A. C. Moffat,
CRE Report #377

A Study of Leucine Aminopeptidase as a Possible Means of Identifying Semen, M. E. Lawton and J. G. Sutton,
CRE Report #378

The Use of a Vanillin-Sulphuric Acid Reagent to Distinguish Between Certain Barbiturates, H. M. Stevens,
CRE Report #379

Factors Affecting Voltage Conditions in Cross-Over Electrophoresis, S. M. Fletcher and P. Dolton,
CRE Report #382

Gas-Liquid Chromatographic Retention Indices of 1318 Substances of Toxicological Interest, R. E. Ardrey and A. C. Moffat,
CRE Report #384

The Assessment of Commercially Available Anti-H Reagents for Forensic Purposes, B. G. Lang and G. Horscroft,
CRE Report #385

Preparation of an Iodinated Barbiturate Derivative for Use in Radioimmunoassay, P. A. Mason and B. Law,
CRE Report #386

Evaluation of Specific Anti-Saliva Serum, S. M. Fletcher, P. Dolton and P. H. Whitehead,
CRE Report #389

Isoelectric Points (pl) of the Isoenzymes of Phosphoglucomutase, J. G. Sutton,
CRE Report #453

Species Identification of Blood and Saliva Stains by Elisa Using Monoclonal Antibody, S. M. Fletcher, P. Dolton and P. W. Harris-Smith,
CRE Report #457

Information on New Drug Captopril (Capoten), P. J. Gomm, A. R. Allan, T. S. Bal and M. M. Harding,
CRE Report #464

Information on New Drug Lormetazepam (Noctamid), P. J. Gomm, A. R. Allan, T. S. Bal and H. D. Poole,
CRE Report #465

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REVIEW ARTICLE

FIRE INVESTIGATION. PART I: SCENE INVESTIGATION

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This first review article will address fire scene investigation with the objective of determining origin and cause of a fire; the second article will address laboratory techniques in fire debris analysis. These articles are not intended to constitute a course of instruction, but they should provide a review for experienced forensic investigators and a perspective for investigators new to the field. Several different courses for fire scene/arson investigators are offered by state and federal law enforcement training centers such as the Bureau of Alcohol, Tobacco, and Firearms and the Federal Bureau of Investigation. Subjects such as interviewing techniques, determination of motive, development of substantiating documentation from records searches and testifying are outside the scope of what is to be presented here.

PREPARATION

Several elements are essential to effectively investigate a fire scene:

1. Mental Attitude

The investigator needs to be suspicious, but in a controlled manner. He must realize that he is investigating a "fire" and not necessarily "arson". An objective, unbiased approach is necessary to minimize the probability of overlooking, ignoring, or discounting evidence of potential value.

2. Permission

It is necessary that the police, fire department personnel and the owner/occupant of the property understand the basis for the investigator's right and duty to be on the premises and what his duties, obligations, and limitations are. In cases where the investigator is a member of, or working through, a law enforcement agency, the legal statutes will provide permission. In the case of a private investigator working for or under the direction of an insurer, the permission is obtained as a condition of the insurance policy.

3. Equipment

In addition to comfortable work clothes and boots or shoes, the investigator needs a variety of other equipment such as a compass, tape measures, shovels, lights, etc. Many of these items will be acquired as more fire scenes are investigated and as needed. The National Bureau of Standards Fire Investigation Handbook (NBS Handbook 134) lists two pages of basic equipment. Of utmost importance is good, reliable equipment for documentation including notebooks, a tape recorder and photographic equipment. Many scenes are investigated in remote areas where valuable time can be wasted while obtaining the proper tools or trying to work without them. Fire scenes are inconvenient enough to work even when the proper equipment is available.

4. Knowledge and Training

A basic knowledge of the chemistry and physics of combustion and fires as well as construction plumbing, electrical wiring, and legal and courtroom procedure will serve the investigator well, and he should avail himself of opportunities to increase his familiarity with them. There are a number of privately taught and government sponsored fire investigation courses and seminars available which can help to develop the rudiments of investigation. However, these courses cover the subject in a cursory manner and complement rather than substitute for training with a good, experienced fire investigator. Time and effort spent gaining proficiency with photographic equipment and reporting techniques cannot be underestimated. The ultimate product of the investigator's efforts is a report which conveys his observations and conclusions along with proper supporting documentation. If he fails at this point, all the previous work, no matter how well done, is either wasted or severely limited in effect.

5. **Specific Information**

Prior to beginning work on the fire scene, the investigator should have information about when (time and date) the fire started, who reported it, who was there at the time, who responded to it, how long it took to control it and who else had been on the scene or investigated it. This basic information will help in determining the area of origin, what fuel and heat sources were in the structure and how the fire spread.

SCENE - ORIGIN

It is desirable for the investigator to arrive at the fire scene as soon after the incident as possible. However, many times there is a considerable delay, and frequently the scene has not been secured. These factors need to be documented, as they can be of potential significance. Upon arrival at the scene, the investigator should observe and photograph the structure as it is found (as shown in Figure 1) along with its immediate surroundings and establish the proper geographic orientation.

FIGURE 1. Exterior wall, windows and portion of roof.

Items to be noted at this time include:

1. Safety hazards such as weakened walls, roofing, chimneys, etc. The investigator will be working around these structures, and attention to safety details can help avoid an accident.

2. Utility supplies, particularly gas and electric services and loose service wiring. The fire department will usually have secured these, but the investigator should know by his own inspection that valves are turned off, meters are pulled and loose wiring is dead.

3. Documentation of construction details such as type of roof, foundation building materials, etc., areas where fire broke through the roof, windows, walls, etc. and areas where smoke vented from the structure. This can often help determine the progression of the fire.

4. Items removed from the structure during overhaul. Examination of these items may begin to establish a pattern of the kinds of things expected to be present which are or are not there and things which would not normally be expected to be present but may be there and require justification. Examination of the contents of trash cans and wastebaskets may produce potential significant evidence.

5. After the outside safety and utility checks, external examination of the structure and results of the overhaul, a walk-through of the interior is in order. The primary purposes here are to locate dangerous conditions due to weakened floors, ceilings, walls and roof, to become familiar with the layout and to assess relative damage to the various areas. The interior of the structure should be photographed showing it as it was found.

6. A dimensioned, labelled sketch of the overall structure indicating locations of doors and windows and whether they were open or closed when found, utility service supplies to the structure, the fuse or breaker box and major items such as the water heater, air conditioners, washer, and dryer. It may be convenient to check for any evidence of forced entry and to document the condition of the fuse or circuit breaker box at this time.

7. The systematic examination of the structure is begun by examining the least involved areas first and working toward the areas of greatest involvement. In theory, this process should in most cases lead to the point(s) or area(s) of the fire's origin. As an area is examined, it may be necessary to make a separate detailed sketch of it. In any event, the area should be examined, with appropriate photographs taken and descriptive comments documented with regard to:

a) Type of room, such as bedroom, kitchen, bathroom, etc. (Figures 2 and 3).

b) Items present and their condition such as furnishings, pictures and personal items including contents of drawers and closets. Sizes of clothes can be important. Note things which are there and would be expected to be there as well as things which are present but would not necessarily be expected there. Also note the absence of items which might normally be present, such as personal photographs, guns, etc.

c) Position and condition of doors and windows. Do heat damage or smoke deposits indicate whether doors or windows were open or closed at the time of the fire? Position of light switches - on or off? (Figure 4).

d) Presence of high burn, low burn, vee patterns and extent and location of smoke damage.

e) Burn patterns which might indicate pour patterns or trailers.

f) Condition of ceiling. A hot, fast fire on the floor will sometimes create an almost identical pattern on the ceiling. On some textured ceilings, smoke deposits will sometimes be heavier on ridges facing toward the direction from which smoke has come, much as the western slopes of the Rockies receive more rain than the eastern slopes from moist air moving west to east.

g) Relative char or damage to faces of studs, door facings and furniture can frequently indicate which side was exposed to the highest temperatures and may be useful in assessing progress of the fire.

h) Alligatoring or blistering of wood (note Figure 4) can sometimes be of limited value in assessing whether a fire was fast developing or smoldering. Large scales with a shiny surface might indicate a fast developing fire, although this should not be assumed since type of wood and surface treatment can alter these effects.

The checklists shown in Tables 1 and 2 can serve as a guide to items which should be considered. It should be recognized that these lists are not all inclusive and should only be used as a guide. In addition, there is a danger of being too superficial or overly concerned with checking off items on the lists. A recommended practice would be to note pertinent items during the fire scene examination for use as documentation and as a reminder to consider the other items.

FIGURE 2. Kitchen sink, counter and cabinets.

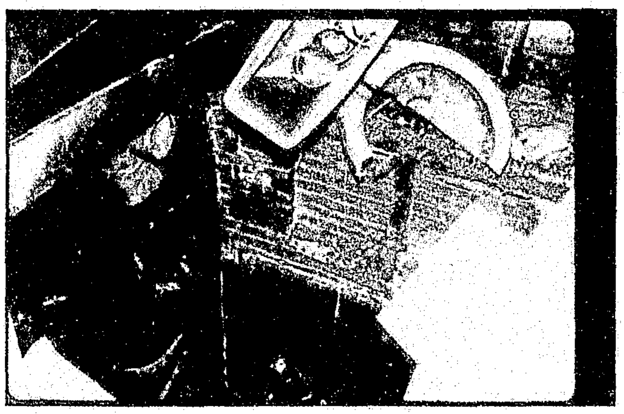

FIGURE 3. Bathroom wall, pipes and remnant of commode.

Table 1. FIRE SCENE EXAMINATION CHECKLIST

Checklist Items	Kitchen			Bathroom			Living Room			Dining Room		
		Cabinet	Cabinet		Closet	Closet			Closet			Closet
Utensils												
Pots/pans												
Appliances												
Food												
Beverages												
Cleaning materials												
Trash can												
Clock												
Furniture												
Pictures												
Windows (O/C/L)*												
Doors (O/C/L)*												
Lighswitches (On?)												
Ashtrays												
Shaving gear												
Cosmetics												
Hairdryer												
Radio												
Books/magazines												
Vacuum cleaner												
TV/stereo												
Lamps												
Carpet												
Fireplace												
Clothes												
Clothes hangers												
Shoes												
Jewelry												
Guns												
Tools												
Paint cans, etc.												
Pets												
Electrical service												
Gas service												

* Denotes O=open, C=closed, L=locked.

Table 2. FIRE SCENE EXAMINATION CHECKLIST

Checklist Items	Bedroom						Hall			Garage		Utility	
		Closet			Closet	Closet			Closet				
Utensils													
Pots/pans													
Appliances													
Food													
Beverages													
Cleaning materials													
Trash can													
Clock													
Furniture													
Pictures													
Windows (O/C/L)*													
Doors (O/C/L)*													
Lighswitches (On?)													
Ashtrays													
Shaving gear													
Cosmetics													
Hairdryer													
Radio													
Books/magazines													
Vacuum cleaner													
TV/stereo													
Lamps													
Carpet													
Fireplace													
Clothes													
Clothes hangers													
Shoes													
Jewelry													
Guns													
Tools													
Paint cans, etc.													
Pets													
Electrical service													
Gas service													

* Denotes O=open, C=closed and L=locked.

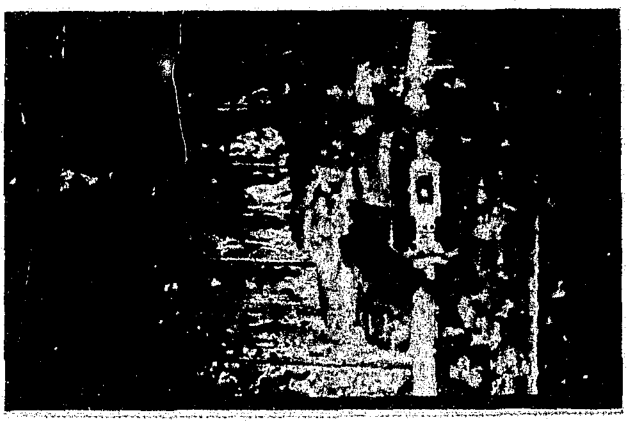

FIGURE 4. Light switch in "on" position and blistering of walls.

SCENE - CAUSE

When it is believed that the point(s) or area(s) of origin have been located, it is necessary to identify the cause of the fire. All possibilities of natural or accidental causes should be considered and must be eliminated before an incendiary cause can be fully substantiated. This must be done regardless of how obvious it may be that the fire was incendiary.

The most common natural causes of fire are lightning and spontaneous heating and ignition. For lightning to have been the cause, there must have been some history of lightning prior to the fire. There will usually be damage, sometimes but not always severe, to wiring or other conducting materials and frequently to one or more electrical appliances. Dates and times of inclement weather can be documented through the Department of Commerce, National Oceanic and Atmospheric Administration.

Spontaneous heating and ignition requires the presence of materials which are readily oxidized and confined in a location or orientation which deters dissipation of heat and which is usually close to another ignitable fuel source. Perhaps the classic example of this type of situation is cloth which has been used to wipe up turpentine or mineral spirits. The cloth fibers represent a relatively high surface area over which the combustible liquid can be distributed. If the cloth is placed in a pile in a location where heat generated by air oxidation of the turpentine is not readily dissipated, the temperature of the pile can rise. As the temperature rises the oxidation rate increases, and if there is sufficient air and fuel available, ignition can occur. Once ignition occurs, any other fuel load in the area is subject to ignition under proper conditions. Spontaneous heating and ignition requires a particular set of conditions and is not common, but it must be kept in mind as a possibility. In a similar manner, a pile of damp straw, hay or grass can ignite because of heat generated by bacterial action. A key point to remember in reference to spontaneous combustion is that it will not occur with petroleum based products alone. They may add to the fuel load after combustion but will not be the catalyst.

Accidental fires are much more likely to occur than fires started by natural causes. Among the most common accidental causes are careless flames such as matches and cigarettes, electrical origins such as circuit overloading which can result from too many or faulty appliances, poor wiring resulting from non-code installation or abraded insulation and misuse of appliances which might result in a grease fire while cooking or a fire from an iron left on and unattended (Figure 5). Other accidental fires may be the result of spillage, leakage or storage of flammable materials such as paint thinner, gasoline or charcoal lighter fluid near pilot lights or other open flames. Improper use or placement of space heaters or malfunctioning regulators on space heaters, furnaces and water heaters may also cause accidental fires.

When determining if damage was due to an accidental cause, it must be remembered that often the damage is a result of the fire rather than a cause of it. For example, a fire may destroy the insulation on electrical wires and result in damage which may be difficult or impossible to differentiate from damage which occurred prior to the fire. Examination of the immediate surroundings may shed more light on such a situation. If a series of shorted wires and wires from various circuits are found within an area which has sustained heavy fire damage, this might be an indicator that the damage was a result rather than a cause of the fire.

If no natural or accidental cause is identified, an incendiary cause can be suspected and the examination pointed in that direction. Even though there may be evidence of trailers, pour patterns or similar suspicious findings, it is still necessary to eliminate the natural and accidental causes. Because of the damage sustained and the usually haphazard conditions which exist at many fire scenes, there frequently are misleading signs which can lead an investigator toward an incorrect conclusion if he concentrates on them to the extent that he misses or ignores other factors. It is essential to keep an open mind and be thorough, methodical and objective.

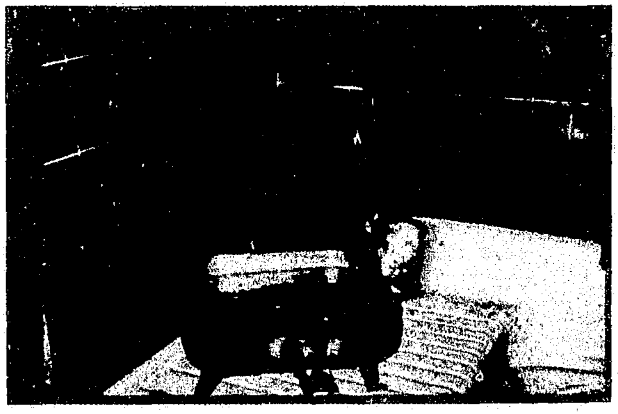

FIGURE 5. Electric skillet. Grease in skillet is possible cause of fire.

THEORY AND DOCUMENTATION

If a fire is thought to be a set fire, a theory of how it was set and its progress should be developed, substantiated and documented. This involves tracing the fire from its origin(s) and cause and explaining how the evidence observed supports the theory. The most effective documentation consists of a narrative report which includes photographs. Photographs will preserve the scene and relevant evidence regarding the cause and origin. They will also serve to illustrate important points in reports. A camera that produces negatives provides the best photographic documentation. Instant print film generally will not provide the quality needed. A 35mm camera is the ideal type of camera to use. It need not be highly sophisticated, but it should be a unit the investigator feels comfortable using. A variable lens is helpful. One that has a range of 28mm to 85mm is preferable, but if a fixed lens is chosen, one in the 50mm to 55mm range is the most useful. The flash unit is very important. Again, this need not be an expensive unit but must primarily have the power to compensate for the dark, carbonaceous material being photographed.

If debris samples are taken, they should be properly labelled, identified and sealed. The area the samples are taken from should be photographed before the samples are secured. It is good practice to not only describe where they are taken and the material they contain but to photograph each in place with identifying marks so that the reader knows exactly the area of interest. Two photographs of the debris samples should be taken; one close up to readily identify the sample and its identification marks, and a second photograph to show the sample in perspective to the overall area from which it was taken. The samples should be measured from two fixed points and so indicated on the diagram. If possible, it is best to measure and diagram the entire structure where the loss occurred. This further documents that the whole area has been inspected. Graph pads with ruled lines are most helpful when sketching the structure. When preparing the report with his theory and documentation, the investigator must consider the possibility it will be read or presented to someone that has little or no fire investigation knowledge. Therefore, the report must contain information that can be understood by the layman but still convey the expertise of the investigator.

SUMMARY

The complexity of fire investigations and the types of evidence potentially involved make it imperative that the investigator develop and follow a methodical, logical, thorough and open-minded approach to these investigations. It is also essential for accurate and thorough documentation to be a part of the investigation. Disposition of cases frequently occurs after a substantial lapse of time, and the file is the investigator's total record - it must be complete. This article has attempted to review elements which will promote effective fire investigation.

REFERENCES

Brannigan, F. L., Bright, R. G. and Jason, N. H., eds. (1980). Fire Investigation Handbook, NBS Handbook 134, U. S. Government Printing Office.

SUGGESTED READINGS

Anderson, R. C. (1967). Combustion and flame, J. Chem Ed. 44:248-260.

Fire Hazard Properties of Flammable Liquids, Gases and Volatile Solids, NFAP325M, (1969), National Fire Protection Association, Boston, Massachusetts.

French, H. M. (1979). The Anatomy of Arson, Arco Publishers, Inc., New York.

Kirk, P. L. (1969). Fire Investigation, John Wiley and Sons, New York.

A Pocket Guide to Arson Investigation, (1979), Factory Mutual Engineering and Research, Norwood, Massachusetts.

Yallop, H. J. (1980). Explosive Investigation, The Forensic Science Society, Harrogate England.

Yallop, H. J. (1984). Fire Investigation, Alan Cliff Association, Solihull, England.

HAIR EVIDENCE ON LAUNDERED ITEMS

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The question sometimes arises in crime laboratories as to whether a large amount of significance should be placed on hair associations where clothing evidence to be examined has been laundered. Since the purpose of laundering is to remove dirt, lint and extraneous material, it would be logical to assume that hairs would be removed from items during laundering. A review of the forensic science literature revealed that this question concerning hair evidence has not been addressed and has only recently been addressed for fiber evidence (Robertson and Olaniyan 1986).

In a three phase study the Federal Bureau of Investigation (FBI) Laboratory examined the following issues: Do hairs occur on items that have been laundered? Can hairs be transferred from one item to another item when they are laundered together? What happens to hairs located on items when they are laundered?

MATERIALS AND METHODS

Phase I

Can hairs be found on items that have been laundered? To answer that question employees of the Hairs and Fibers Unit of the FBI Laboratory provided items of clothing from their laundry after washing and drying. Seventeen items were examined for the presence of hairs after they were machine washed and machine dried. Both private and commercial machines were used. Items included were dress shirts, sweatshirts, knit shirts and a bath towel. Laundered items were visually examined and hairs were removed in the FBI Laboratory using a "scraping" procedure (repeated strokes with the edge of a spatula to remove surface debris). Hairs were collected and examined microscopically.

Phase II

To determine whether hairs can actually transfer from one item to another during laundering (machine washing and drying), the author laundered five items from which all human hairs had been removed (Group A) with other dirty items (Group B). Before washing, hairs were removed from Group A items by picking, scraping and taping. Laundering was done by machine washing and machine drying at a self-service laundry. The Group A items included a knit turtleneck shirt, an oxford cloth dress shirt, a pair of socks and a T-shirt. These items were laundered with items from which hairs had not been removed (Group B).

Phase III

Next, the author examined what happens to hairs on items during laundering. This was accomplished by placing "seed" hairs on eight recipient items, then laundering these items with eight non-recipient items. Seed hairs included 39 pubic hairs of Caucasian origin and 43 head hairs of Caucasian origin which were dyed black so they could be recognized readily as seed hairs upon recovery. After laundering, the recipient items, non-recipient items, washing machine lint trap and dryer lint trap were examined for seed hairs. Recipient items included a pair of blue jeans, a T-shirt, two pairs of panties, a pair of socks, a dress shirt, a sweatshirt and a towel. Recipient items were laundered with eight non-recipient items including two pairs of socks, a sweatshirt, two dress shirts, and three pairs of panties.

RESULTS AND DISCUSSION

Hairs do occur on items after laundering. Of the 17 laundered items examined for hairs in Phase I, 11 or 65% had human hairs or hair fragments on them. Human head hairs with roots present occurred on 7 or 41% of the items. Animal hairs were found on 71% of the laundered items. Results are listed in Table 1.

Table 1. Phase I Results: Number of Hairs Found on Different Types of Laundered Items

Item	*Composition*	*Human head hairs with root present*	*Human hair fragment*	*Other human hair*[a]	*Animal hair*
1 sweater	acrylic	0	1	0	Yes
2 shirt	cotton/poly[b]	0	1	5 L	Yes
3 shirt	cotton/poly	4	0	1 P	Yes
4 shirt	poly/cotton	7	3	8 L	Yes
5 knit shirt	nylon	3	1	1 B	Yes
6 T-shirt	cotton/poly	6	1	6 L	No
7 shirt	poly/cotton	0	0	0	No
8 shirt	poly/cotton	10	10	1 E	No
9 shirt	poly/cotton	0	1	0	No
10 towel	cotton/poly	0	0	0	Yes
11 sweatshirt	cotton/poly	0	1	0	Yes
12 sweatshirt	cotton/poly	0	0	0	Yes
13 shirt	cotton/poly	1	1	1 E	Yes
14 panties	nylon/cotton	0	0	0	Yes
15 undershorts	nylon	0	0	0	Yes
16 undershorts	nylon	0	0	0	Yes
17 knit shirt	cotton	4	16	2 B	No

[a] Hairs from L=limb, P=pubic, B=body and E=eye
[b] Polyester

At this point in the study it was established that human hairs can be found on laundered items. The next phase of the study was designed to establish whether hairs can be transferred from one item to another as a result of the laundering process.

In Phase II of this study five items from which all human hairs had been removed (Group A) were machine washed and dried with other dirty items (Group B). Human head hairs with roots present were found on two of the five (Group A) items after laundering with the Group B items. It was concluded that hairs can be transferred from one item to another during laundering.

In criminal investigations this would indicate that a secondary transfer has taken place. For example, if a victim's hairs are transferred to a suspect's clothing during commission of a crime and the suspect then washes these clothes, the victim's hairs could be transferred from the suspect's clothes to other items in the laundry. These other items may belong to the suspect or to a third person unrelated to the crime. The possibility of a tertiary or higher transfer exists, making it difficult to discern the significance of hair evidence recovered from laundered items in this example.

In order to further explore what happens to hairs during laundering, the third phase of this study was undertaken. Results are listed in Table 2. Seventy-seven percent of the seed head hairs were recovered as follows: 5% on recipient items, 5% on non-recipient items, 11% in the washing machine lint trap and 56% in the dryer lint trap. Sixty-nine percent of the seed pubic hairs were recovered as follows: 8% on recipient items, 10% on non-recipient items, 10% in the washing machine lint trap and 41% in the dryer lint trap. The missing hairs must have been lost down the drain or somewhere else in the system.

Table 2. Phase III Results: Seed Hairs Found on Recipient and Non-Recipient Items Laundered Together

Item[a]	*Composition*	*Seed hairs*[b] *placed on items before laundering*		*Seed hairs*[b] *found on items after laundering*	
		Inside	*Outside*	*Inside*	*Outside*
R1 blue jeans	cotton	5PH, 4HH	5PH, 5HH	1HH	1PH
R2 T-shirt	cotton	1PH, 2HH	2PH, 3HH	0	0
R3 panties	nylon	3PH, 2HH	1HH	0	0
R4 shirt	cotton/poly[c]	2PH, 3HH	3PH, 4HH	0	0
R5 panties	cotton	5PH	5PH	0	0
R6 towel	cotton/poly	5PH, 6HH	N/A	0	0
R7 sock	acrylic/nylon	1PH	2PH, 4HH	0	1PH
R8 sweat-shirt	cotton/poly	0	9HH	2PH,* 1HH	0
NR1 sweat-shirt	cotton/poly	0	0	0	0
NR2 socks	nylon	0	0	0	0
NR3 sock	acrylic/nylon	0	0	1PH, 1HH	0
NR4 shirt	cotton/poly	0	0	0	0
NR5 panties	nylon	0	0	0	0
NR6 under-shorts	nylon	0	0	0	1PH
NR7 shirt	cotton/poly	0	0	1PH, 1HH	0
NR8 panties	nylon	0	0	0	0

[a] R= recipient item NR= non-recipient item

[b] Seed hairs were either pubic (PH) or head (HH)

[c] Polyester

N/A= not applicable

*This item was treated as a non-recipient item for pubic hair

CONCLUSION

The following conclusions can be drawn from this study:

1. Human hairs can be found on items after laundering (on 65% of the items in Phase I).
2. Most human hairs are removed from items during laundering (85% of the seed pubic hairs and 90% of the seed head hairs in Phase III).
3. Hair transfers do occur during laundering (Phase II). In fact, hairs that remain on clothes after machine washing and drying are just as likely to be found on the item that they were on before washing as on another item in the laundry (Phase III).

The significance of hair evidence on laundered items must be determined on a case by case basis. The possibility of a secondary or higher level hair transfer resulting from the laundering process may dilute the significance of hair evidence in cases involving a suspect and a victim who launder their clothes or bedding together (e.g. people who share a common household). In other instances where the victim and suspect are associated only as a result of the crime, it would be useful to examine laundered items for hair evidence based on the results of Phase III which shows that hairs can remain on items through the laundering process.

REFERENCES

Robertson, J. and Olaniyan, D. (1986). Effect of garment cleaning on the recovery and redistribution of transferred fibers, J. Forensic Sci. 31:73-78.

GETTING STARTED WITH PYROLYSIS CAPILLARY GAS CHROMATOGRAPHY

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INTRODUCTION

According to a recent survey conducted by the Forensic Science Research and Training Center (FSRTC), more than 130 crime laboratories in the United States use pyrolysis gas chromatography for the examination of forensic samples. The use of this technique has been extensively reviewed, including a recent review in this publication (Wampler and Levy 1985). Pyrolysis capillary gas chromatography has been reported by several laboratories (DeForest 1968, Liebman et al. 1984, Munson and Vick 1985, Kawaoka 1986, and Ryland 1986) and is used by more than 40 crime laboratories (according to the FSRTC survey). Like pyrolysis gas chromatography, capillary gas chromatography has been extensively reviewed, including a recent review in this publication (Stafford 1984). However, judging from the many inquiries received by the FSRTC from examiners at various crime laboratories, there is a need for a "nuts-and-bolts" guide for setting up a system for pyrolysis capillary gas chromatography. Hopefully, this paper will provide such a guide. Rest assured that converting a functioning capillary gas chromatograph (GC) to pyrolysis operation is not difficult. In fact, after the initial installation and hardware modifications described in this paper have been completed, the conversion from the split/splitless injection mode to the pyrolysis mode (or the reverse) can be accomplished with considerable ease. During the Chromatographic Methods in Forensic Science training class, five capillary GC's in the GC Training Laboratory at the FSRTC are converted by one of the instructors from split injection operation to capillary pyrolysis in less than one hour.

MATERIALS AND METHODS

All of the data presented in this report were generated using a Hewlett-Packard (HP) 5890 gas chromatograph connected to an HP 5970B Mass Selective Detector controlled by an HP 236 computer (HP 59970 MS Chemstation using the 3.1 revision software) (Hewlett-Packard Co., Avondale, PA). The figures were drawn by the computer software using an HP 7475A plotter. A DB-5 bonded-phase fused silica column, 30 m by 0.25 mm I.D. with a 0.25 um film thickness (J & W Scientific, obtained from Alltech Associates, Deerfield, IL) was used. The pyrolysis was performed with a CDS Model 120 Pyroprobe system using a coil filament with a quartz sample tube (Chemical Data Systems, Oxford, PA.). The experimental conditions used are presented in Table 1.

Table 1. EXPERIMENTAL CONDITIONS

a. Pyrolysis	
Ramp	off
Temperature setting	800°C
Time	20 sec
Interface temperature *	200°C
Carrier gas flow rate *	50 ml/min
b. Gas Chromatography	
Injector temperature	250°C
Linear velocity at 40°C	70 cm/sec
Carrier gas	Helium
Oven temperature programs	
Grob test mix	30°C for 1 min 15°C/min to 100°C 3°C/min to 250°C
alkane test mix	40°C for 2 min 15°C to 280°C Hold 280°C for 4 min
polyethylene	40°C for 2 min 8°C/min to 300°C Hold 300°C for 21 min
Split ratio	40 to 1
Septum purge	0.5 ml/min
c. Mass Spectrometry	
Transfer line temperature	250°C
Electron multiplier voltage	-1600 volts
Scan range	35 to 350 amu
Scan rates	
Figs 1, 2A, 3A, 3B	2.2 to 2.5 scans/sec
Figs 2B, 4, 5A, 5B, 5C, 5D, 6A, 6B	3.2 to 3.7 scans/sec

* Except as noted otherwise

The following standard reference materials were used in this study: Grob test mix (Cat. No. 4176, Alltech Associates), n-alkane mix (Cat. No. NP-MIX-I, Alltech Associates), and low density polyethylene (ALATHON Type 7, density about 0.925, E. I. DuPont De Nemours, Inc., Wilmington, DE).

EQUIPMENT

Gas Chromatograph

This discussion assumes that one of the commercially available GC's designed for using fused silica open-tubular capillary columns is available and that the operator is proficient in using it. If there are any doubts at this point, study the information supplied by the instrument manufacturer and the aforementioned review article (Stafford 1984) and run some test samples to verify satisfactory performance of the GC before attempting the conversion to pyrolysis.

For proper operation of the pyrolysis system, determine the split ratio (the ratio between the carrier gas flow out the split vent and the flow down the column) for the injector system before and after installation of the pyrolysis interface. The flow out the split vent is measured directly by affixing an appropriate gas-flow measuring device onto the split vent. Measuring the flow down the capillary column is a bit more complicated but still not difficult. One can measure the flow directly, either at the end of the column before it has been connected to the detector or out the detector vent after shutting off all other gas flows to the detector. However, this technique is not very useful for an operating system because it involves disrupting the system. A better method is to measure the retention time of an unretained analyte (such as natural gas, liquid propane gas, or fuel from a disposable cigarette lighter) and calculate the flow rate. The unretained analyte will have eluted in one column volume (consider the column to be a cylinder with a volume equal to pi times the radius squared times the length). The flow in cc/min will be this volume (in cc) divided by the retention time for the unretained analyte in min. If the answer does not come out to be about 1.5 ± 0.8 cc/min for a 0.25 mm column, an error in measurement, calculation or consistency of units has probably been made. For running the test samples before and after installation of the pyrolysis interface, use a split ratio between 40 and 100 to 1.

Pyrolysis Unit

Of the 138 laboratories which reported performing pyrolysis capillary gas chromatography (in the FSRTC survey), 136 use the Pyroprobe (Chemical Data Systems, Oxford, PA). For the purpose of this discussion, it will be assumed that the pyrolysis unit to be used will be a Pyroprobe.

Capillary Column

A rather bewildering range of choices confronts one when choosing a capillary column. These include choice of supplier, length, internal diameter, and chemical composition of the stationary phase (as well as phase thickness and whether it is coated, bonded or cross-linked), with four to six choices of each except for phase composition, where there are dozens. However, one can make a single choice which will give, if not the best performance, at least a satisfactory performance with all of the samples one will likely encounter as evidence. Such a choice would be a 30 m, 0.25 mm I.D. SE54 bonded-phase (or cross-linked, or bonded and cross-linked) fused silica column with a 0.25 um film thickness. Those who gain experience with the performance of the system with the types of samples run most often may modify this choice to improve some aspect of the pyrograms obtained. A typical temperature program with this SE54 column would be 40°C for 2 min., 15°C/min. to 250°C and hold for 5 min. Once again, a bit of experience will help one select suitable modifications to this temperature program to improve the results for particular samples.

Leak Detection Device

Every laboratory using capillary GC should have an electronic instrument for

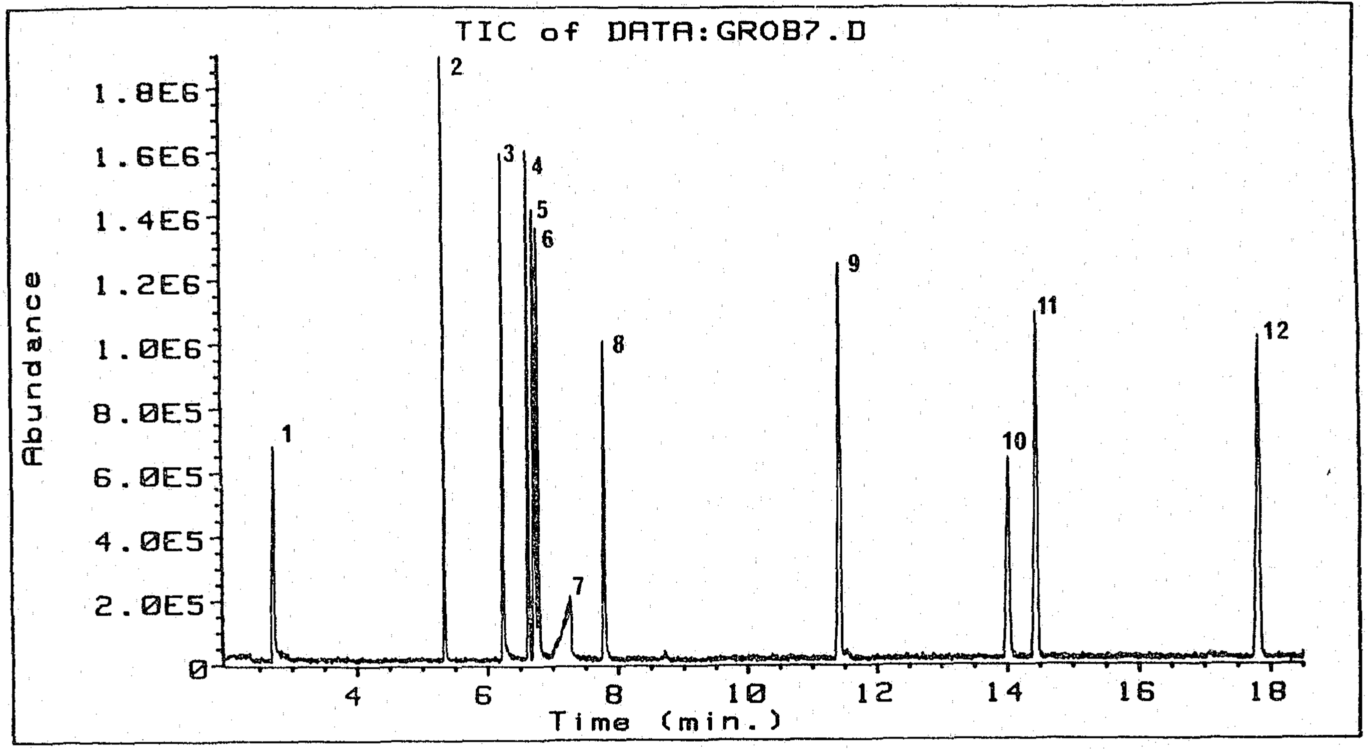

FIGURE 1. Grob test mix: (1) *2, 3-butanediol;* (2) *decane;* (3) *1-octanol;* (4) *undecane;* (5) *nonanal;* (6) *2, 6-dimethylphenol;* (7) *2-ethylhexanoic acid;* (8) *2, 6-dimethylaniline;* (9) *methyl decanoate;* (10) *dicyclohexylamine;* (11) *methyl undecanoate; and* (12) *methyl dodecanoate.*

detecting minute hydrogen and helium leaks. Such a device is especially useful for a pyrolysis system because several leak-prone connections are added to the injector side of the GC gas flow pathway. Although the $700 to $900 initial expense may seem high, leaks at the injector are one of the most common causes of poor chromatographic performance, and such a device can save many hours of frustration by quickly pinpointing the problem. One of the most commonly used devices is the Gow-Mac Leak Detector (available from Supelco, Inc., Bellefonte, PA, as well as other suppliers), although others may be available

INSTALLATION

To perform pyrolysis capillary GC, a heated pyrolysis interface chamber must be installed on the injector of the GC (except for certain Perkin-Elmer GC's which allow for direct insertion of the Pyroprobe into a modified capillary injector). Because addition of the interface will degrade GC performance slightly if done properly, and severely if done improperly, prior to installation it is desirable to establish "benchmarks" against which to measure subsequent performance.

The chromatogram in Figure 1 is of the Grob test mix which can be used for testing the entire injector-column-detector system of the GC. (In Figure 2, the chromatogram obtained using the split/splitless injector is compared to a second chromatogram obtained after installation of the pyrolysis interface). The peak shapes and relative heights indicate whether the system will perform satisfactorily with various classes of acidic, basic, polar and nonpolar chemicals (Grob et al. 1978). Because the components in the Grob test mix are relatively low boiling and because the interface-injector assembly may have one or more "cold spots" depending upon the injector design, a test mixture should be run for later comparison in order to check for possible "cold trapping" of less volatile components. Figure 3A shows the chromatogram obtained for an n-alkane mix (C20, C22, C24, C26) prior to installation of the pyrolysis interface. It seems self-evident that if the GC system will not perform satisfactorily at this point, the situation will not improve after conversion to pyrolysis.

The function of the interface chamber is to provide a heated space in which the sample can be pyrolyzed and from which the resulting pyrolyzate will be transferred to the GC injector. The interface chamber is connected to the GC injector via a needle assembly provided by the manufacturer of the Pyroprobe. It is necessary to have the needle assembly for the particular GC injector being used because the assembly is designed to replace the GC septum nut and must be the correct size. When a sample is pyrolyzed, the pyrolyzate is swept by carrier gas from the chamber into the injector via the needle assembly. Upon reaching the injector, the pyrolyzate proceeds exactly as if it were a vaporized sample which had been injected into the split injector with a syringe. The installation procedure consists of three important steps: installing the needle assembly, mounting the interface chamber upon the needle assembly, and establishing the carrier gas flow.

The installation of the needle assembly is easily accomplished once the correct size for the injector is obtained. The GC carrier gas is turned off, the pressure is allowed to decrease, and the injector septum nut is removed and replaced with the needle assembly. The needle assembly will probably come with a septum in it, but eventually one will have to be replaced, and there is a problem awaiting the unwary. The needle on the assembly has a small diameter in order to fit into the capillary injector and is very easily plugged by being pushed through a silicone-rubber septum. Prior to replacing the septum in the needle assembly, a hole larger than the needle should be cored through the septum (a gas-tight seal is not required around the needle).

Mounting the interface chamber will be easily accomplished if a new Pyroprobe and the appropriate mounting brackets have been acquired to fit an existing capillary GC. If this is not the case, the Pyroprobe supplier can furnish the appropriate mounting brackets. It is important to mount the interface chamber solidly to the GC because when one is inserting and removing the Pyroprobe from the interface chamber, tightening and loosening the retaining ring which contains the silicone-rubber seal around the probe exerts torque on the interface chamber. This process can stress the seal where the interface chamber connects to the needle assembly and cause leakage of the carrier gas. Adapting a pyrolysis unit from a packed-column GC to a capillary GC can be further complicated if the injectors on both systems are not horizontal (injector axis in the horizontal plane) or vertical, because the interface chamber will be configured for either a vertical or horizontal injector. The interface chamber is designed to keep the axis of the Pyroprobe in the horizontal plane by having the axis of the needle assembly at a 90-degree angle with the axis of the Pyroprobe for a vertical injector and aligned with the axis of the Pyroprobe for a horizontal injector. The chamber for a vertical injector can be used for a horizontal mount by rotating the chamber 90-degrees around both axes if enough space is available on the front of the GC to insert the Pyroprobe into the chamber from the side.

When the interface chamber has been mounted on the needle assembly and affixed to the GC with the appropriate brackets, the remaining installation step is to establish the carrier gas flow. The typical capillary injector has one source of incoming gas and three exiting pathways--down the column, out the split vent and out the septum purge vent. Disconnect the carrier gas supply just before the point where it enters the injector and connect it to the pyrolysis interface chamber. Seal off the fitting on the injector so that gas will not be able to flow out of the injector at this point. The pressure regulator and/or flow controller and all other portions of the capillary injector system will operate in the usual fashion. In the FSRTC GC Training Laboratory, in order to facilitate rapid conversion from pyrolysis to split/splitless injection modes, a three-way valve was installed in the carrier gas line of each GC so that the gas flow pathway change and sealing of the injector connection could be accomplished with a single turn of the valve handle rather than several plumbing changes.

Prior to testing the pyrolysis capillary

GC system, the final task is to pressurize the interface-injector system with the probe inserted (about 15 psi for the 30 m capillary column) and check for leaks. Then heat the interface-injector assembly to operating temperature (at least 150°C for the interface) and check for leaks again.

PERFORMANCE VALIDATION

After the system has been shown to be leak-free, test the performance of the interface-injector assembly by running the test samples again. Remove the Pyroprobe, seal the interface chamber with a septum, establish the same split ratio used for the earlier runs of the test mixes and check around the septum for leaks. Then rerun each of the test mixtures by injecting them directly into the interface chamber.

Figure 2 shows the chromatograms obtained for the Grob test mix with the GC system before (2A) and after (2B) installation of the pyrolysis interface. If everything went well, the chromatograms should be nearly the same as far as peak shape, retention time and peak heights (as those shown in Figure 2 are). If the peak heights and/or peak shapes are poor, the interface-injector assembly may have a leak. If the alkane peaks in the Grob test mix have good shapes and responses but some of the others do not, the hot stainless steel in the pyrolysis interface may be degrading some of the compounds. Repeated pyrolysis of some fairly large samples seems to improve this situation, perhaps by coating or deactivating the reactive sites.

Figure 3 shows the chromatograms obtained for the alkane test mix with the GC system before (3A) and after (3B) installation of the interface. The regular stepwise decrease in the C22, C24 and C26 alkanes when injected into the interface-injector assembly suggests a small amount of "cold-trapping", and hence, slightly degraded performance relative to before installation of the pyrolysis interface, but not enough to adversely affect the analysis of typical forensic samples.

With a pyrolysis system which can pass the tests just enumerated, it should be possible to generate very reproducible pyrograms. If the GC is operating properly, retention times for capillary runs should reproduce within ± 1 sec from one run to the next.

To avoid two problems which can lead to nonreproducible pyrograms, the size of the sample pyrolyzed should be kept small, less than 100 ug, even when large amounts of sample are available. The thermal energy put into the sample during pyrolysis causes bond breakage and the formation of radicals which are fragments of the original polymer molecules. If the concentration of radicals is high enough, rather than forming by intramolecular rearrangement of the radical molecules, some of the components of the pyrolyzate will be formed by radical-radical interactions, thus causing the composition (the number and relative amounts of the chemical components) of the pyrolyzate to vary with the sample size.

Another problem related to sample size can occur if the sample is not completely consumed during the pyrolysis period. Many samples are uniform mixtures of components, such as an evenly layered paint chip or a fragment of tape consisting of backing coated with an adhesive layer. Unless such samples are completely consumed during pyrolysis, differing relative amounts of the various components of the mixture may be produced each time, resulting in differing pyrograms. To test whether a sample has been pyrolyzed to completion, perform a second pyrolysis without removing the probe; obviously, if no peaks appear, no residual sample was present (an assumption underlying this test is that an appropriate system blank has been demonstrated--that is, pyrolysis of an empty quartz sample tube has resulted in no peaks in the pyrogram). If a sample material being pyrolyzed is, in fact, randomly heterogeneous, one should expect the pyrograms for repetitive runs to differ.

Obtaining an appropriate pyrogram from the pyrolysis of a well characterized polymeric material constitutes a suitable test for satisfactory performance of the entire pyrolysis system. Figure 4 presents a pyrogram for low density polyethylene. This material tests the system well for the entire volatility range generally found in pyrograms, and it will be used here to demonstrate potential problems with two operating

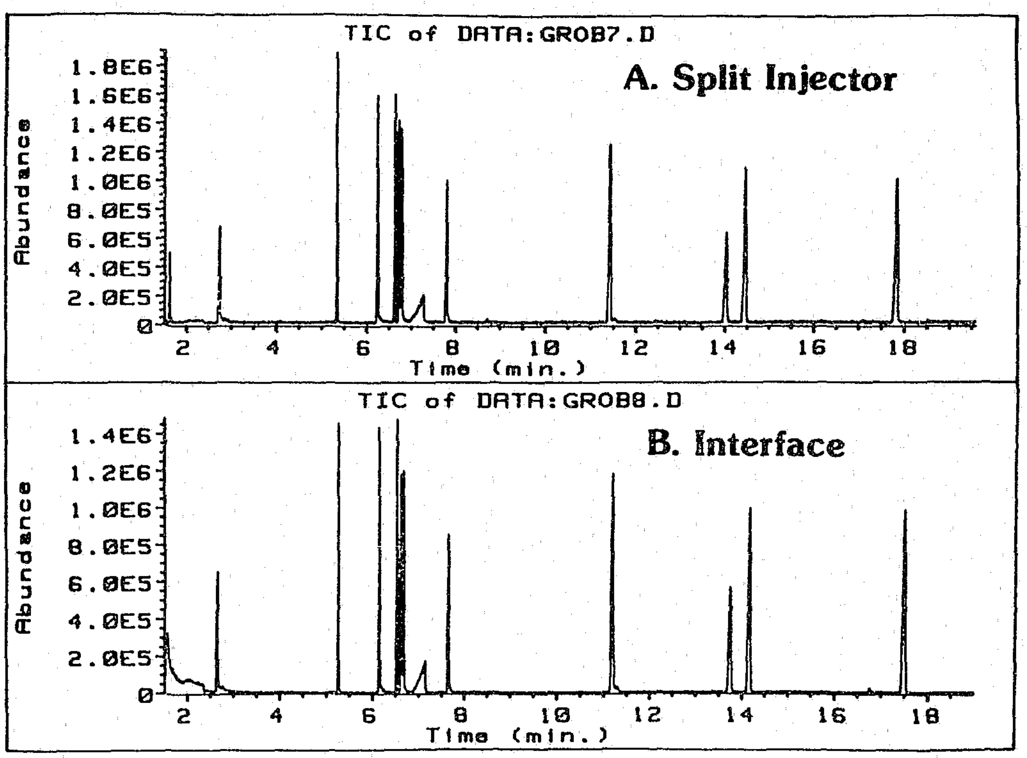

FIGURE 2. Comparison of Grob test mix in (A) *split injector; and* (B) *interface.*

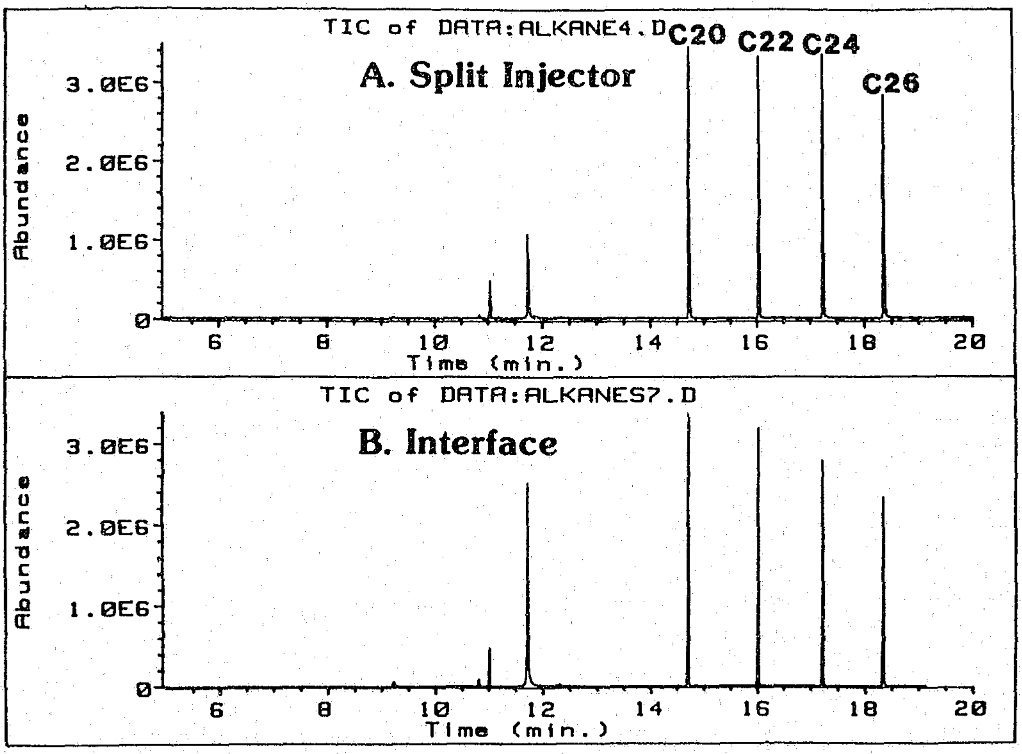

FIGURE 3. Comparison of alkane test mix in (A) *split injector; and* (B) *interface.*

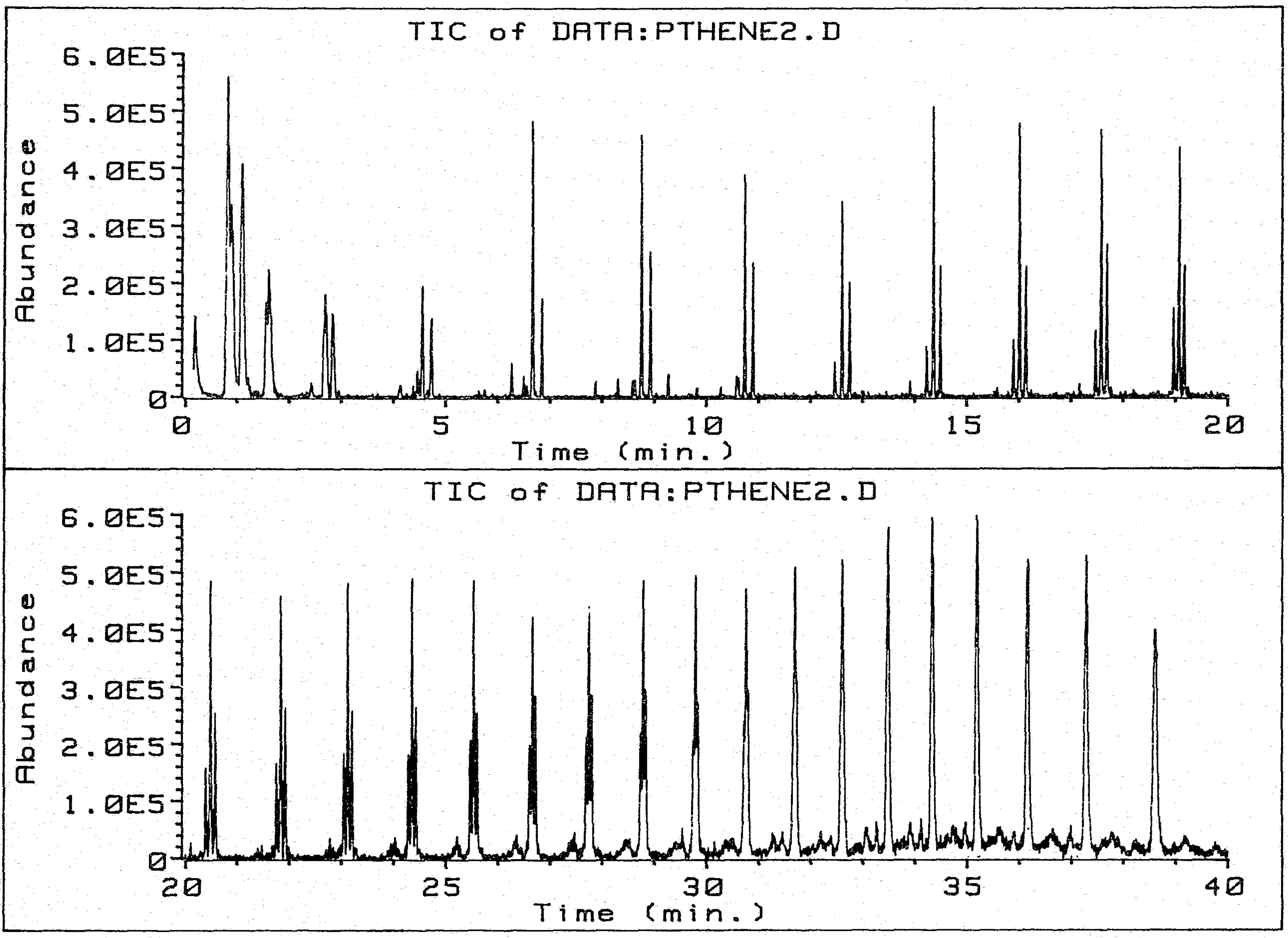

FIGURE 4. Capillary pyrogram of polyethylene.

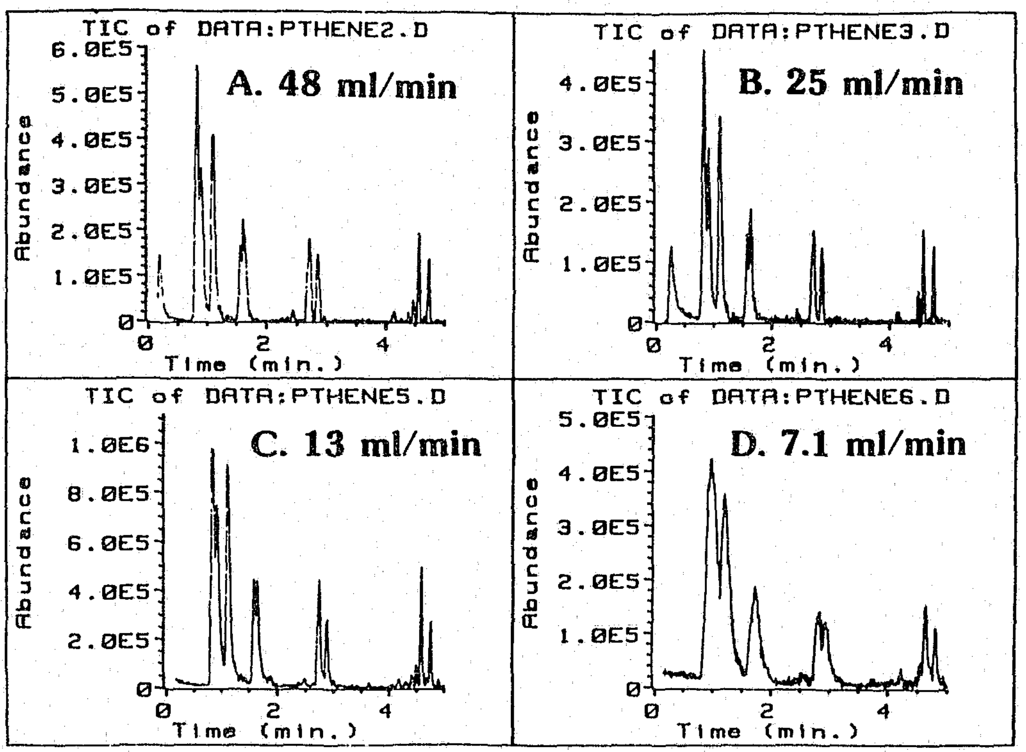

FIGURE 5. Comparison of a portion of the polyethylene pyrogram with interface carrier gas flows of: (A) *48 ml/min.;* (B) *25 ml/min.;* (C) *13 ml/min.; and* (D) *7.1 ml/min.*

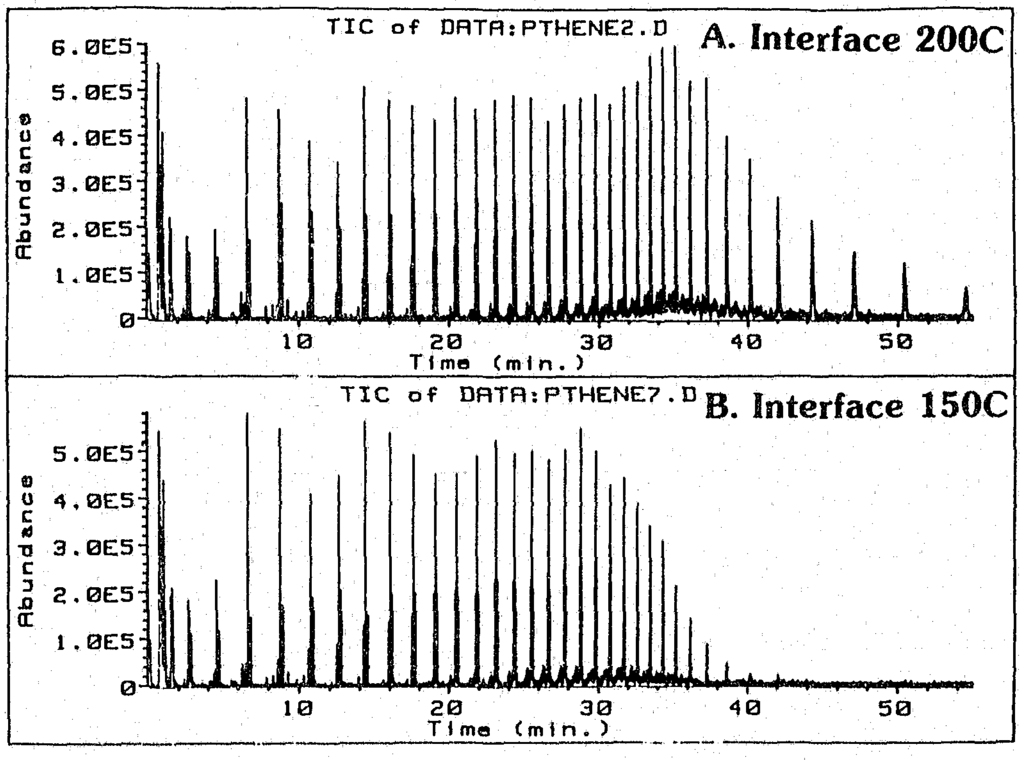

FIGURE 6. Comparison of the polyethylene pyrogram at interface temperatures of (A) *200°C; and* (B) *150°C.*

parameters of the pyrolysis system--carrier gas flow rate through the interface and temperature of the interface.

Increasing or decreasing the carrier gas flow through the pyrolysis interface at a given head pressure will increase or decrease the split ratio and concomitantly decrease or increase the amount of the sample pyrolyzate which goes onto the GC column. When routinely working with very small samples, one may wish to use a split ratio as small as possible to maximize the peak heights in the pyrogram. If the split ratio (and hence, the carrier gas flow) is decreased too much, the pyrolyzate will not be swept through the capillary injector rapidly enough to get the components added to the GC column as narrow bands, and resolution will be adversely affected. Figure 5 shows expanded views of the early portion of the polyethylene pyrogram using different carrier gas flows: A., 48 ml/min, a 38:1 split ratio; B., 25 ml/min, a 20:1 split ratio; C., 13 ml/min, a 10:1 split ratio; and D., 7.1 ml/min, a 5.6:1 split ratio. The sample size was decreased along with the split ratio in an attempt to keep the peak heights comparable. The resolution of those components which elute from the column prior to five min. is considerably diminished by the lowest flow rate. For this system, a split ratio of 10:1 appears to give satisfactory performance; however, anyone planning to use a split ratio of less than 20:1 should perform this experiment to determine the characteristics of the interface-injector system being used. This loss of resolution was not observed for the components which eluted from the column after five min., probably due to a band-narrowing effect resulting from condensation of the components at the head of the column at the start temperature. If the information in the early portion of the chromatogram is of no interest, the splitless injection technique might be useful for very small samples.

Some analysts prefer to have the pyrolysis interface at 150°C rather than 200°C because the probe seal area stays cooler, perhaps reducing "bleed" from the silicone-rubber seal as well as prolonging the life of the seal and causing fewer burned fingers. For most forensic samples, the lower temperature probably serves quite satisfactorily, but be aware of a potential problem. Figure 6 shows the pyrogram for polyethylene with the interface at 200°C (6A) compared to the pyrogram for polyethylene with the interface at 150°C (6B). If the main interest is in the late eluting materials, the lower interface temperature may not be suitable due to the rather serious "cold-trapping" of these components of the pyrogram.

SUMMARY

Setting up a new pyrolysis capillary GC system or adapting an existing pyrolysis GC system to a capillary GC is not a difficult task as long as correct carrier gas flow is established in a leak-free system and suitable operational parameters and compatible instrumentation are chosen. The use of test samples before and after installation of the pyrolysis unit onto the injector of the GC should indicate the source of most problems which may be encountered, as well as verify the proper performance of the pyrolysis capillary GC system.

If after some period of successful operation the pyrolysis GC system seems to be performing unsatisfactorily based upon the appearance of sample pyrograms, it might be helpful to rerun the test samples prior to taking corrective measures. It may be determined that the system is not malfunctioning after all.

REFERENCES

DeForest, P. R. (1969). Individualization of human hair: pyrolysis-gas chromatography. University of California, Berkeley, D. Crim. No. 70-6029 University of Microfilms, Ann Arbor, Michigan

Grob, K., Jr., Grob, G. and Grob, K. (1978). Comprehensive, standardized quality test for glass capillary columns, J. Chromatog. 156:1-20.

Kawaoka, K. (1986). Characterization of Polymers by Pyrolysis-Gas

Chromatography-Mass Spectrometry. In: Proceedings of the International Symposium on the Analysis and Identification of Polymers. U. S. Government Printing Office, Washington, D. C., in press.

Liebman, S. A., Levy, E. J. and Wampler, T. P. (1984). Developments in pyrolysis capillary GC, J. HRC and CC 7:172-184.

Munson, T. 0. and Vick, J. (1985). Comparison of human hair by pyrolysis-capillary column gas chromatography and gas chromatography-mass spectrometry, J. Anal. Appl. Pyrol. 8:493-501.

Ryland, S. (1986). Capillary Column Pyrolysis Gas Chromatography - Problems and Progress. In: Proceedings of the International Symposium on the Analysis and Identification of Polymers. U. S. Government Printing Office, Washington, D. C. Ext. Abs. (in press).

Stafford, D. T. (1984). The use of capillary column gas chromatography in forensic science, Crime Lab. Digest 11:25-32.

Wampler, T. P. and Levy, E. J. (1985). Analytical pyrolysis in the forensic science laboratory, Crime Lab. Digest 12:25-28.

REGIONAL FORENSIC SCIENCE ASSOCIATION MEETINGS

The Southern Association of Forensic Scientists (SAFS) will hold their 20th Anniversary Fall Symposium at the Auburn Conference Center in Auburn, Alabama from September 10-13, 1986.

The Program Chairman for the symposium is Ronald Singer. He can be contacted at the Jefferson Parish Crime Laboratory, 3300 Metairie Road, Metairie, Louisiana 70001 (telephone: 504-832-2320).

For further information, contact Carlos L. Rabren, Alabama Department of Forensic Sciences, P.O. Box 231, Auburn, Alabama 36831-0231 (telephone: 205-887-7001).

The Midwestern Association of Forensic Scientists (MAFS) will hold their 15th Anniversary Meeting in Springfield, Illinois from October 7-10, 1986.

The Program Chairman for the meeting is Ted Elzerman. He can be contacted at the Illinois Department of State Police, Bureau of Forensic Sciences, 726 South College Street, Springfield, Illinois 62707 (telephone: 217-782-4649).

For information regarding local arrangements, contact John Klosterman at the address listed above.

The Northwest Association of Forensic Scientists (NWAFS) will hold their Fall 1986 meeting at the Red Lion Riverside in Boise, Idaho from October 8-10, 1986.

For further information, contact Pam Server, Forensic Section, Bureau of Laboratories, 2220 Old Penitentiary Road, Boise, Idaho 83712 (telephone: 208-334-2231).

The California Association of Criminalists (CAC) will hold their Fall Semi-Annual Seminar at the Gene Autry Hotel in Palm Springs, California from October 8-11, 1986.

For further information, contact Faye Springer, California Department of Justice Forensic Laboratory, 1500 Castellano Road, Riverside, California 92509 (telephone: 714-782-4170).

The Mid-Atlantic Association of Forensic Scientists (MAAFS) will hold their Fall 1986 meeting at the Carousel Hotel in Ocean City, Maryland from October 23-24, 1986.

For further information, contact Amy Wong, Northern Regional Forensic Laboratory, P.O. Box 486, Merrifield, Virginia 22116 (telephone: 703-573-8636).

The Northeastern Association of Forensic Scientists (NEAFS) will hold their 12th Annual Meeting in Peabody, Massachusetts from October 24-25, 1986.

For further information, contact Dr. William Adams, Department of Chemistry/Physics, Salem State College, Salem, Massachusetts 01970 (telephone: 617-745-0556, ext. 2526).

The Midwestern Association of Forensic Scientists (MAFS) will hold their Fall 1987 meeting on Mackinac Island, Michigan from October 6-9, 1987. This meeting will be hosted by the Michigan State Police Forensic Science Division.

For further information, contact Richard E. Bisbing, Michigan State Police Laboratory, 6296 Dixie Highway, P.O. Box H, Bridgeport, Michigan 48722 (telephone: 517-777-9300).

NATIONAL FORENSIC SCIENCE ASSOCIATION MEETINGS

A symposium on forensic chemistry will be held in conjunction with the Annual Federation of Analytical Chemistry and Spectroscopy Societies Meeting from September 28 - October 3, 1986 at the Cervantes Convention Center in St. Louis, Missouri. Special consideration will be given to presentations discussing forensic applications of infrared and atomic spectroscopies, but other topics will be considered. The deadline for submitting titles is February 3, 1986.

For further information about the symposium, contact Dr. Robert Koons, FSRTC, FBI Academy, Quantico, Virginia 22135 (telephone: 703-640-6131).

The 39th Annual Meeting of the American Academy of Forensic Sciences will be held at the Town & Country Hotel in San Diego, California from February 16-21, 1987.

The theme of the meeting is "Biohazards in the Environment." Planned activities include plenary sessions and presentations of scientific papers. Abstracts should be forwarded by August 1, 1986.

For further information, contact the American Academy of Forensic Sciences, 225 S. Academy Boulevard, Colorado Springs, Colorado 80910 (telephone: 303-596-6006).

INTERNATIONAL FORENSIC SCIENCE ASSOCIATION MEETINGS

The Japanese Society of Electron Microscopy and the Science Council of Japan will host the XIth International Congress on Electron Microscopy (XI ICEM). The congress is scheduled for August 31 - September 7, 1986 in the Okazaki area of the city of Kyoto. The congress will be devoted to plenary sessions, symposia, workshops, public lectures and poster and/or oral presentations of contributed papers. Emphasis will be placed on the poster sessions. Symposia and workshops on recent topics in the technology and application of electron microscopy are among the scheduled activities. The official language of the XI ICEM is English.

For further information, contact Professor Kazuo Ogawa, Chairman, Executive Committee of the XI ICEM, Department of Anatomy, Faculty of Medicine, Kyoto University, Konoecho, Yoshida, Sakyoku, Kyoto 606, Japan (telephone: 075-751-7727; telex: 05422693 LIBKYU J).

The International Committee on Alcohol, Drugs and Traffic Safety (ICADTS) announces the 10th International Conference on Alcohol, Drugs and Traffic Safety to be held at the RAI-Congress Centre in Amsterdam, Netherlands from September 9-12, 1986.

The purpose of this conference will be to present the state of the art on Alcohol, Drugs and Traffic Safety. Through the years, attention has shifted from alcohol to alcohol and other drugs and from contributions by the medical and legal professions to other professions involved in safety research. These changes will be emphasized in this year's program. Special attention will be given to the role of drugs other than alcohol and on the application of available scientific knowledge to safety actions.

The provisional program includes sections on the following: experimental studies on the detrimental effects of alcohol and other drugs, epidemiology, general preventive actions, special preventive actions, systematic analysis and evaluation of potential counteractions. Keynote speakers will be invited to present state-of-the-art reviews for each part of the program. Papers of other speakers are expected to provide new empirical evidence in the fields of interest. Contributions of a technical or specialist nature will be concentrated in workshops or other special events such as poster sessions. Exhibition facilities will be provided.

The Chairman for the conference is C. L. A. Heijster.

For further information, contact Symposium Secretariat, QLT Convention Services, Keizersgracht 792, 1017 EC Amsterdam, Netherlands (telephone: 020-261372; Telex: 31578 inter nl. att. QLT)

The Canadian Society of Forensic Science will hold their 33rd Annual Meeting at the Sheraton-Brock Hotel in Niagara Falls, Ontario from September 15-19, 1986.

The theme of this year's meeting is "Environmental Risks and Forensic Science." This theme will be covered from a medical, legal, toxicological and environmental perspective.

The meeting will be devoted to plenary sessions, workshops and scientific sessions.

A plenary session on aircraft disasters is scheduled. A film entitled "Operation Overdue" which deals with the crash of the New Zealand Airline DC-10 into Mount Erebus will be shown. Also within this plenary session will be a presentation by an on-site investigator of the Air India 747 crash into the North Atlantic. Other presentations include Mass Disaster - Computerization, Impression and Casting Material Selection for Bite Impressions on Non-Living Subjects and Armamentarium for use in Forensic Odontology. Planned workshops include Gm-Km Blood Typing, Fiber Textile Identification and Manufacture, and Interpretations and Influence of Drugs on Driving.

Scientific papers are requested for presentation at this meeting. Titles and abstracts should be forwarded by July 15, 1986 to the Canadian Society of Forensic Science, 2660 Southvale Crescent, Suite 215, Ottawa, Ontario, Canada K1B 4W5 (telephone: 613-731-2096).

For further information, contact either Dr. Ray Prime, Program Coordinator or JoAnne Cottingham, Executive Secretary at the address listed above.

The Society for Forensic Haemogenetics will hold their 1986 Annual Seminar from October 23-24, 1986 at the Ministry of Justice in the Hague, the Netherlands. The major theme of this seminar is the application of DNA polymorphism to medical-legal problems.

For further information, contact A. D. Kloosterman, Dutch Forensic Science Laboratory of the Ministry of Justice, Volmerlaan 17, 2288 GD RIJSWIJK (Z.H.), The Netherlands (telephone: 70-408131)

The International Association of Forensic Toxicologists will hold their 24th Annual Meeting in Banff, Alberta, Canada from July 28-31, 1987. Among the planned activities is a special session on Postmortem Changes Affecting Toxicology.

Confirmed reservations are required. The deadline for making reservations is January 1, 1987.

For further information, contact Dr. Graham R. Jones, TIAFF 87, 4070 Bowness Road N.W., Calgary, Alberta, Canada T3B 3R7 (telephone: 403-427-4987).

The International Association of Forensic Sciences 11th Meeting will be held at the Hotel Vancouver in Vancouver, British Columbia, Canada from August 2-7, 1987. The meeting will be structured around plenary sessions, short paper sessions, technical exhibits, poster sessions and an arts and crafts exhibition. Special presentations by the International Academy of Legal Medicine and Social Medicine, and the International Study Group on National Unexpected Deaths are scheduled for the meeting. Plenary sessions include Collection and Presentation of Evidence, Conduct of a Criminal Trial and Sentencing the Offender.

Abstracts should be forwarded by December 31, 1986 to the International Association of Forensic Sciences, Suite 801, 750 Jervis Street, Vancouver, British Columbia, Canada V6E 2A9 (telephone: 604-681-5226).

INSTRUCTIONS FOR SUBMITTING ARTICLES

In order to facilitate rapid publication, submissions should conform to the following:

1. Manuscripts should be typed, double-spaced, on 8 1/2" x 11" paper. Submit three copies of the manuscript (one of which must be the original with glossy photographs).

2. Tables should be as simple as possible. Each table should be typed on a separate sheet of paper and should include a heading.

3. Graphs and diagrams should be submitted as sharp photographs on white glossy paper.

4. References in the body of the paper should refer to the author's (authors') name(s) and the date of publication. For example:

   According to Doe and Smith (1972)....

   ....has been discussed in the literature (Doe and Smith 1972; Weinburger et al. 1984; Jones 1981).

5. References at the end of the paper should appear in alphabetical order. Journal references should include the author's (authors') name(s), date of publication, title of article, journal name, volume number, and the beginning and ending pages of the article. Please use the following format:

   Davis, H. E. and Jones, B. A. (1978). Seasonal variations in plasma hormones, Biol. Reprod. 88:271-273.

   List articles or chapters within a book as follows:

   deHaseth, J. A. (1982). Fourier transform infrared spectrometry. In: Fourier, Hadamard and Hilbert Transformations in Chemistry, (Marshall, A. G., ed.) Plenum Press, New York, pp. 387-420.

6. Technical papers should be written in an Introduction, Materials and Methods, and Results and Discussion format.

7. When reference is made to a particular product, state the manufacturer of the product and the city and state of the manufacturer's headquarters. For example:

   Isotactic PS (Dow Chemical, Midland, MI)....

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