

Arson Analysis Newsletter

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Columbus, Ohio 43085
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The AAN solicits contributions from forensic scientists, arson investigators, and interested parties which have some unique or routine analysis which helps in the identification of flammable liquid or explosive residues. Articles herein express the views and opinions of the authors, which are not necessarily those of the AAN or Systems Engineering Associates (SEA).

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The Analysis and Identification of Weathered or Fire-Aged Gasoline
at Various Stages of Evaporation

by

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In the field of fire debris analysis, the chemist may analyze as many as 1500 samples a year or more. In approximately 50% of all cases submitted for analysis, no accelerants are detected. However, in the remaining 50% of the cases submitted, a wide variety of accelerants are isolated and identified.

An accelerant is classified as something that intensifies a fire. Common accelerants are flammable liquids such as alcohol, lighter fluids, gasoline, kerosene, lamp oils, fuel oils and others. Most flammable liquids used as accelerants are not composed of just one chemical. Most are composed of a various number of chemicals with a wide boiling range. Gasoline, for instance, has an initial boiling point of 83°F (28.3°C) where the most volatile chemicals begin to distill off and a final boiling point of approximately 400°F (204°C) where the most nonvolatile chemicals that comprise gasoline are boiled off.¹ If a flammable liquid is involved in a fire, the most volatile chemicals will be consumed first, thus concentrating the more nonvolatile chemicals of the flammable liquid.²

Most chemists that analyze fire debris samples use one type of gas chromatographic technique or another for the primary analysis.^{2,3,4} In each gas

chromatographic technique used, a library of flammable liquid standards can be obtained for the purpose of identifying residual flammable liquids on fire debris samples. When a flammable liquid is exposed to a fire, the more volatile chemicals will be consumed. When this sample is analyzed by gas chromatography, the chromatogram obtained may be different from the original chromatogram of the fresh flammable liquid. This weathered or "fire-aged" flammable liquid can still be identifiable as the particular flammable liquid even though it shows differences from the original flammable liquid.

This paper will illustrate the changes that occur to gasoline (a common accelerant) as it is evaporated. The evaporation process simulates what actually occurs to a flammable liquid when it is exposed to fire.²

Procedure

A 125 ml portion of fresh Shell regular gasoline was secured for this evaluation. A sample of the fresh gasoline was placed in a 2 ml vial. Two microliters (2 ul) of n-tetradecane ($n-C_{14}$) was added to the gasoline as an internal standard. The internal standard was used mainly for the purpose of showing that the gas chromatograph was operating properly.

The remaining gasoline was then placed in a beaker and heated. Samples of the gasoline were secured at different stages of evaporation. These samples were labeled and diluted with ethyl ether in 2 ml vials, again 2 ul of $n-C_{14}$ were added.

1 ul samples of the resulting solutions were chromatographed on a Hewlett-Packard 5880 gas chromatograph. The conditions used for this analysis are as follows:

Dectector: Flame Ionization (FID)
Air 400 cc/minute
Hydrogen 30 cc/minute

Column: Length 10'
Diameter 1/8"

Stainless Steel
Solid Support Supelcoport
Mesh 80/100
Liquid Phase 3% SE 30
Injection Port Temperature 300°C
Detector Temperature 300°C

Oven Temperature Profile:

Initial Temperature 80°C
Final Temperature 300°C
Temperature Program 10°C/minute

Carrier Gas: Helium at 24cc/minute

Results and Discussion:

Figures 1 through 11 are the chromatograms obtained in this evaluation. These chromatograms illustrate the changes which occur in gasoline as it is allowed to weather. It can be shown by comparing Figure 1 with successive chromatograms of the weathered gasoline that the volatile chemicals are driven off or consumed as fresh gasoline is allowed to evaporate. It can also be observed that the more nonvolatile chemicals that comprise gasoline increase in concentration relative to the volatile chemicals in gasoline as the gasoline evaporates. If Figure 1, the chromatogram of the fresh gasoline, is compared with Figure 3, the chromatogram of 80% evaporated gasoline, the changes that occur due to the weathering process can be observed. In Figure 1 (fresh gasoline) the chemicals present in the greatest concentration are the chemicals eluting before the retention time at 2.40 minutes. In Figure 3 (80% evaporated gasoline), the chemicals which eluted at 2.70 minutes are now only present in minute

quantities. The chemicals of greatest concentration are now eluting at 2.40 minutes to 5.00 minutes.

Again if Figure 3, the chromatogram of 80% evaporated gasoline, is compared to Figure 6, a chromatogram of 92% evaporated gasoline, further changes can be noted. In Figure 6 there are no identifiable chemicals eluting before approximately three minutes and the chemicals in greatest concentration are those eluting between 5.0 minutes to 7.9 minutes. These chemicals that are now eluting in high concentration in Figure 6 are visible in small concentration on the chromatogram of fresh gasoline, Figure 1.

If the chromatogram of the gasoline which was evaporated to almost the fullest extent possible, 99.90% evaporated (Figure 11), is studied, it can be seen that the majority of the chemicals present now are eluting after 7.00 minutes. This chromatogram appears very different from the chromatogram of fresh gasoline, Figure 1. However, this chromatogram is characteristic of extremely fire-aged gasoline and is reproducible.

Conclusions:

It has been shown by this evaluation that gasoline changes as it is exposed to heat. This change is caused by the evaporation of the volatile chemicals present in fresh gasoline and the increase of the relative concentration of the more nonvolatile chemicals. This weathering or "fire-aging" process is a reproducible characteristic of gasoline. This characteristic of gasoline not only enables the forensic chemist to isolate weathered flammable liquids, but actually identify them.

References

- ¹"Gasoline", The Encyclopedia of Industrial Chemical Analysis, Edited by Foster Dee Snell and Leslie S. Ettre, Volume 13, Interscience Publishers.
- ²"Arson Analysis Newsletter: Accelerant Analysis Gasoline", by Robert L. Graves, et al, U.S. Department of Alcohol, Tobacco and Firearms, AAN, Volume 1, Number 5.
- ³"Arson Analysis Newsletter: Automated Analysis of Fire Samples", by Ronald N. Thaman, Systems Engineering Associates, AAN, Volume 1, Number 5.
- ⁴"Arson Analysis Newsletter: Forensic Science", by Geoffery Davis, published by American Chemical Society, Washington, D.C., pp. 108-109, 1975.

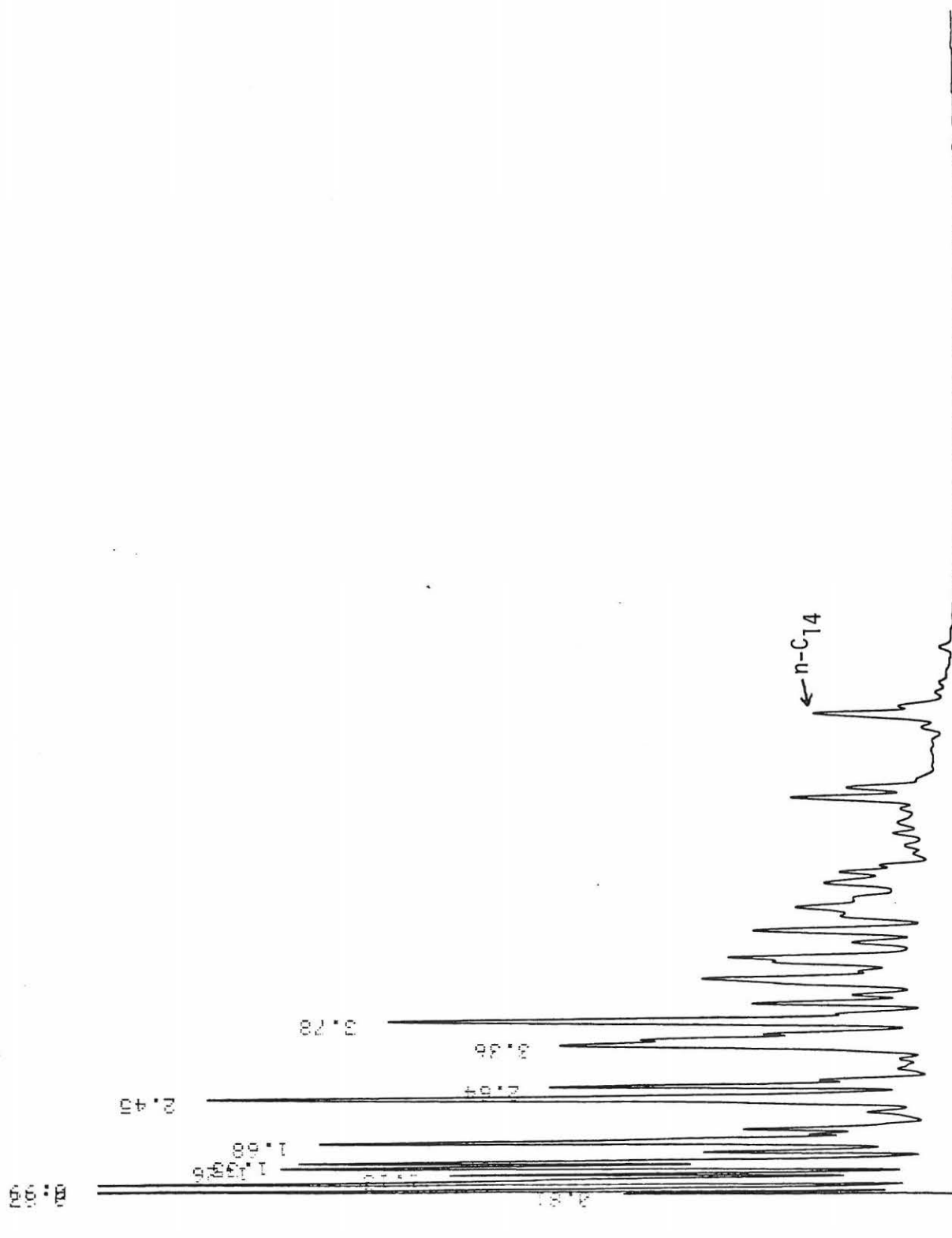


FIGURE 1: Fresh Gasoline.

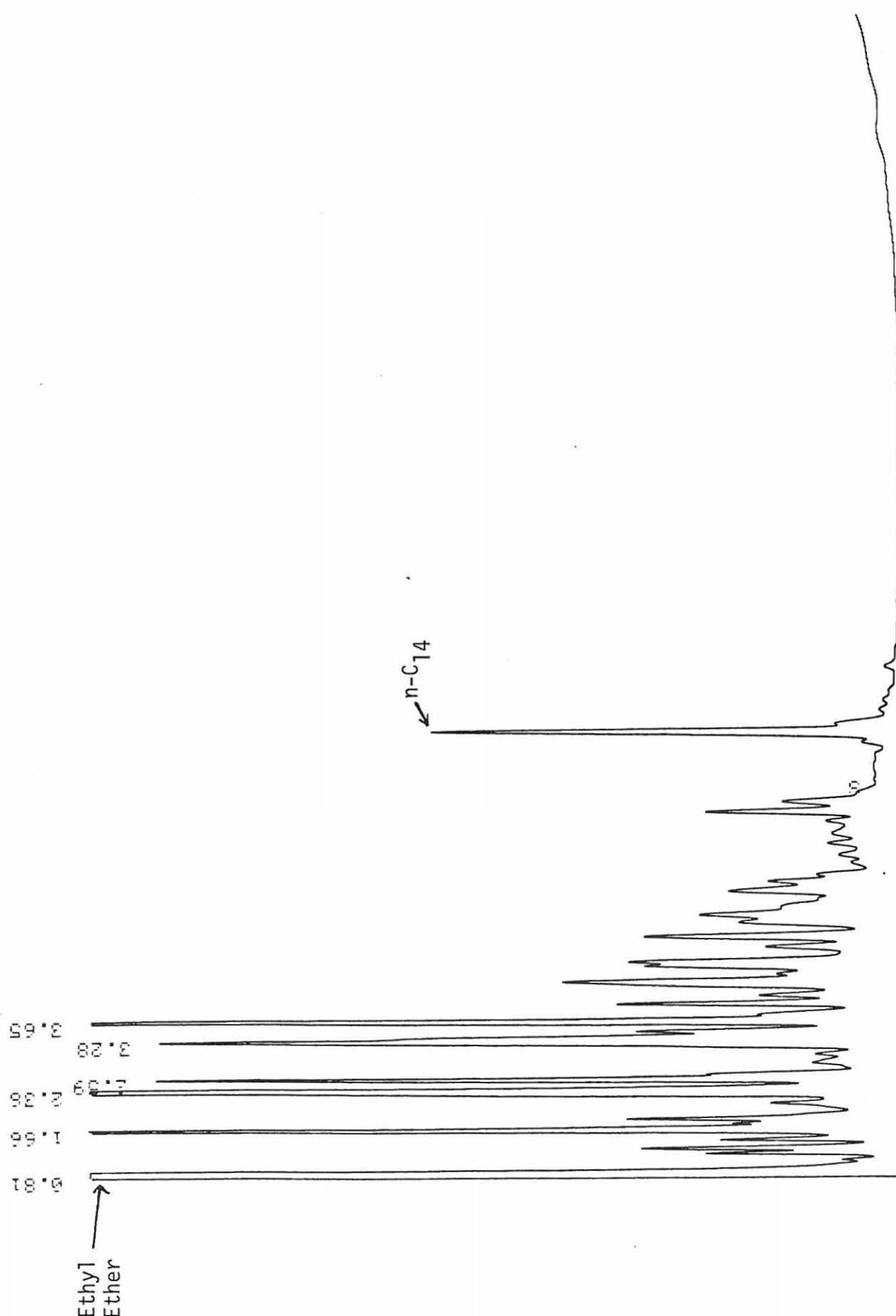


FIGURE 2: 60% Evaporated.

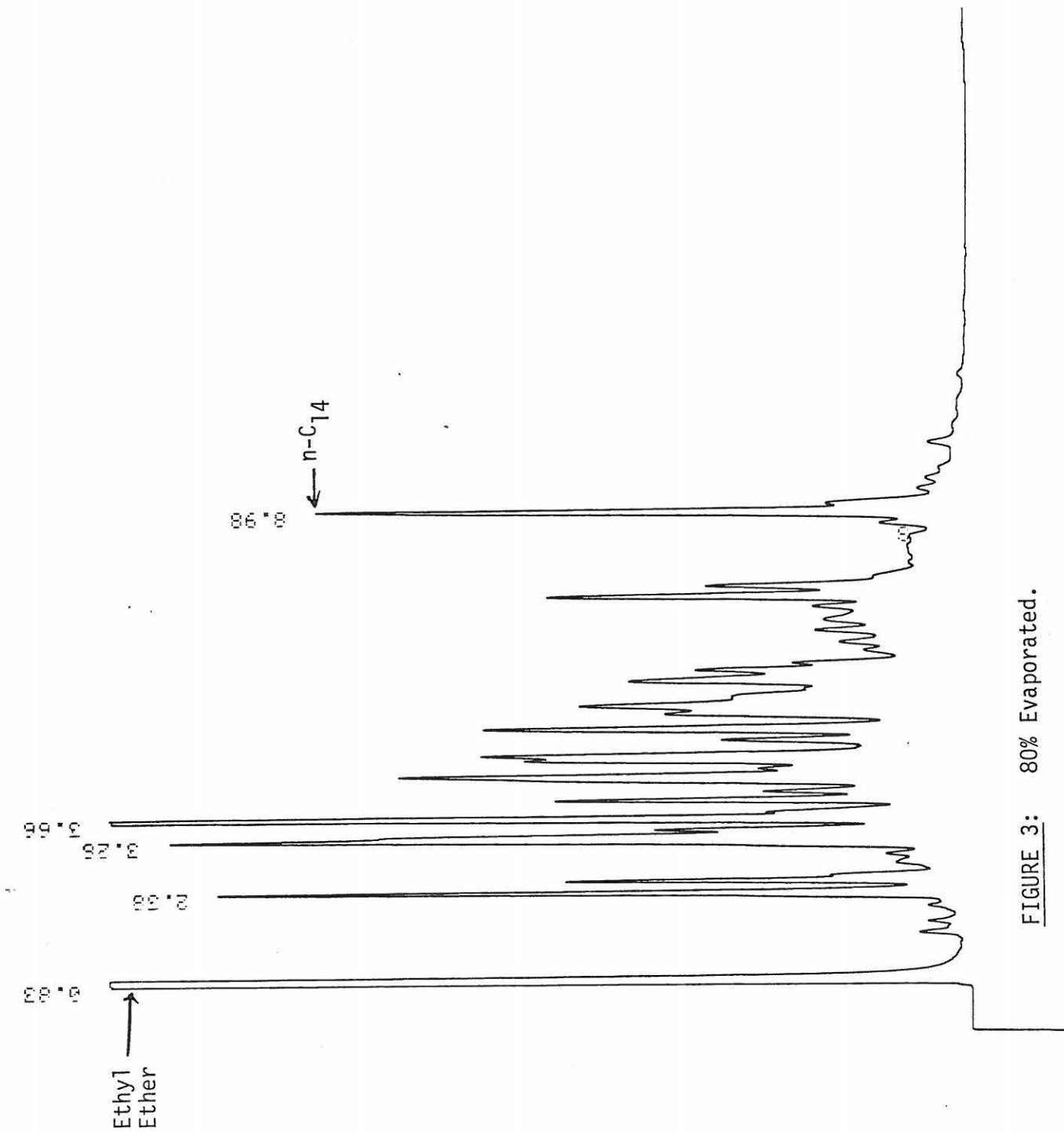


FIGURE 3: 80% Evaporated.

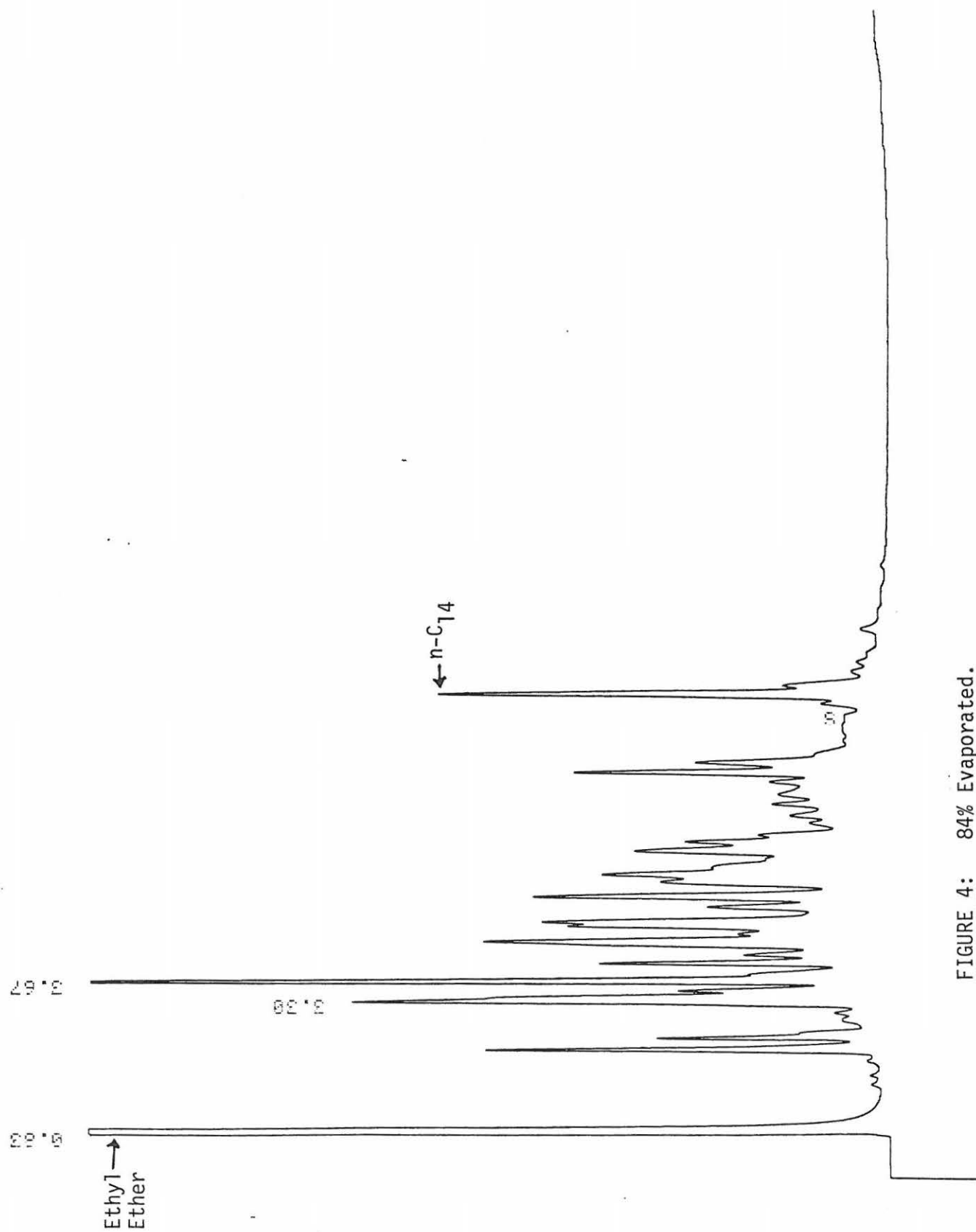


FIGURE 4: 84% Evaporated.

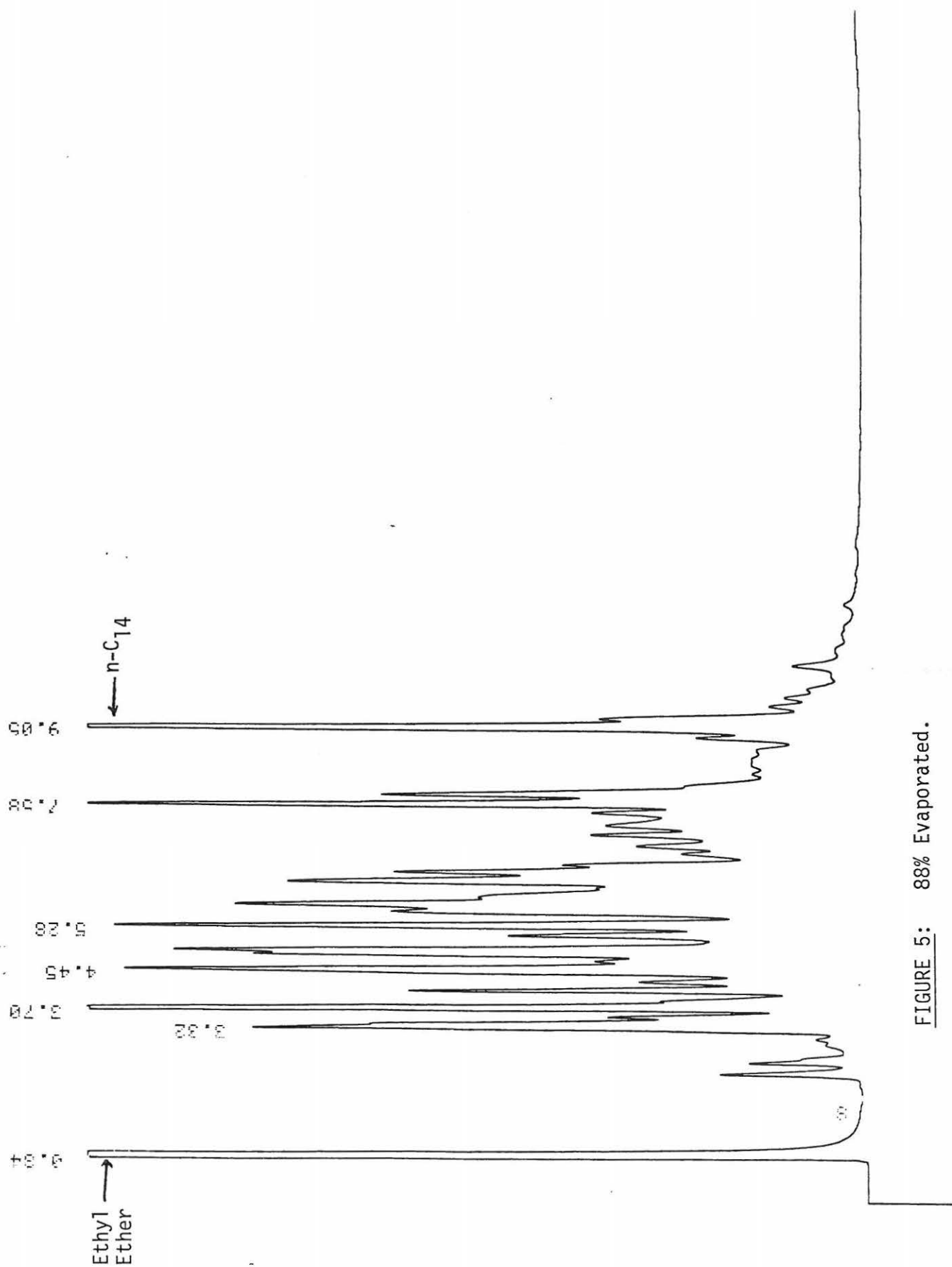


FIGURE 5: 88% Evaporated.

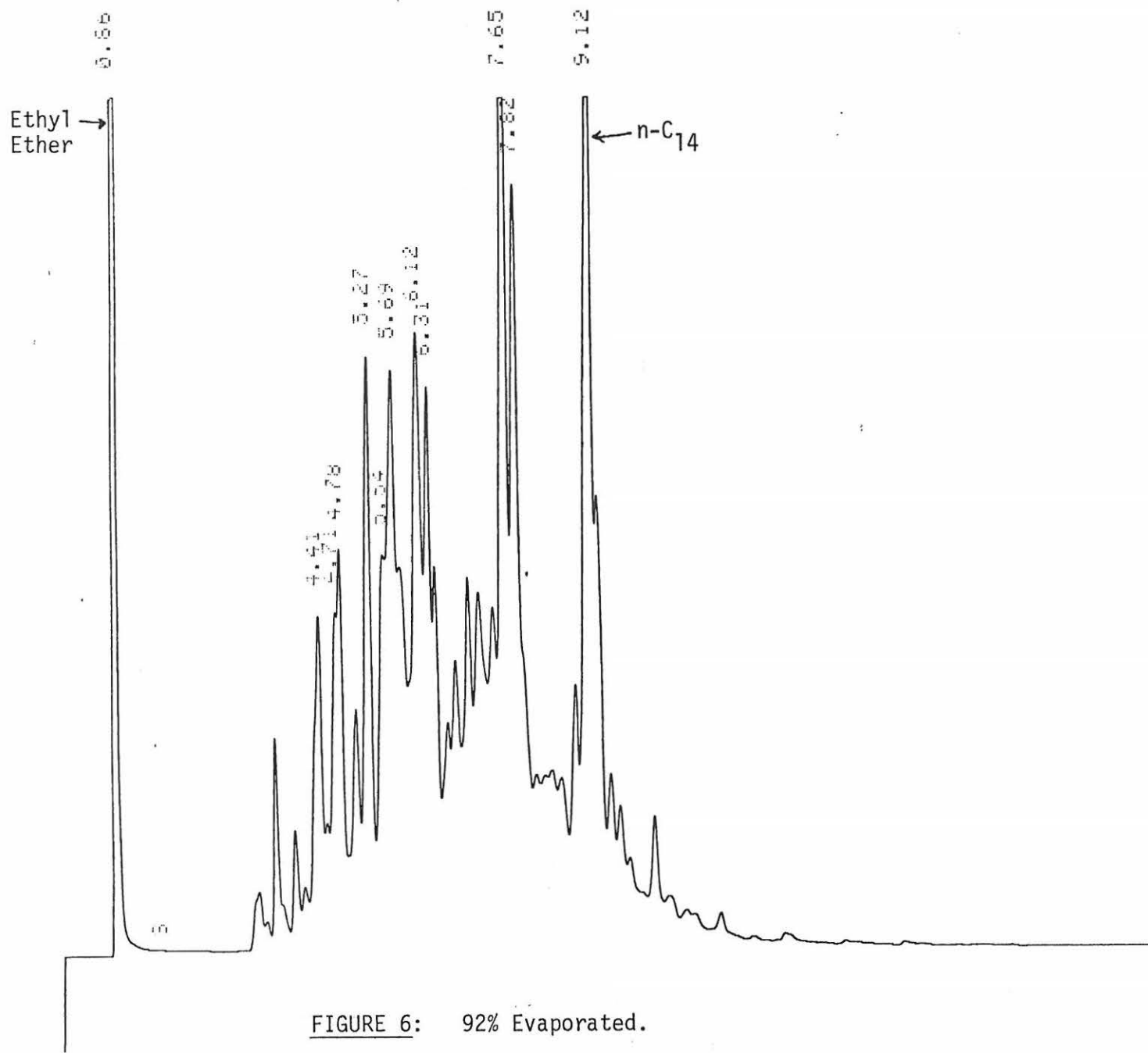


FIGURE 6: 92% Evaporated.

[illegible][illegible]

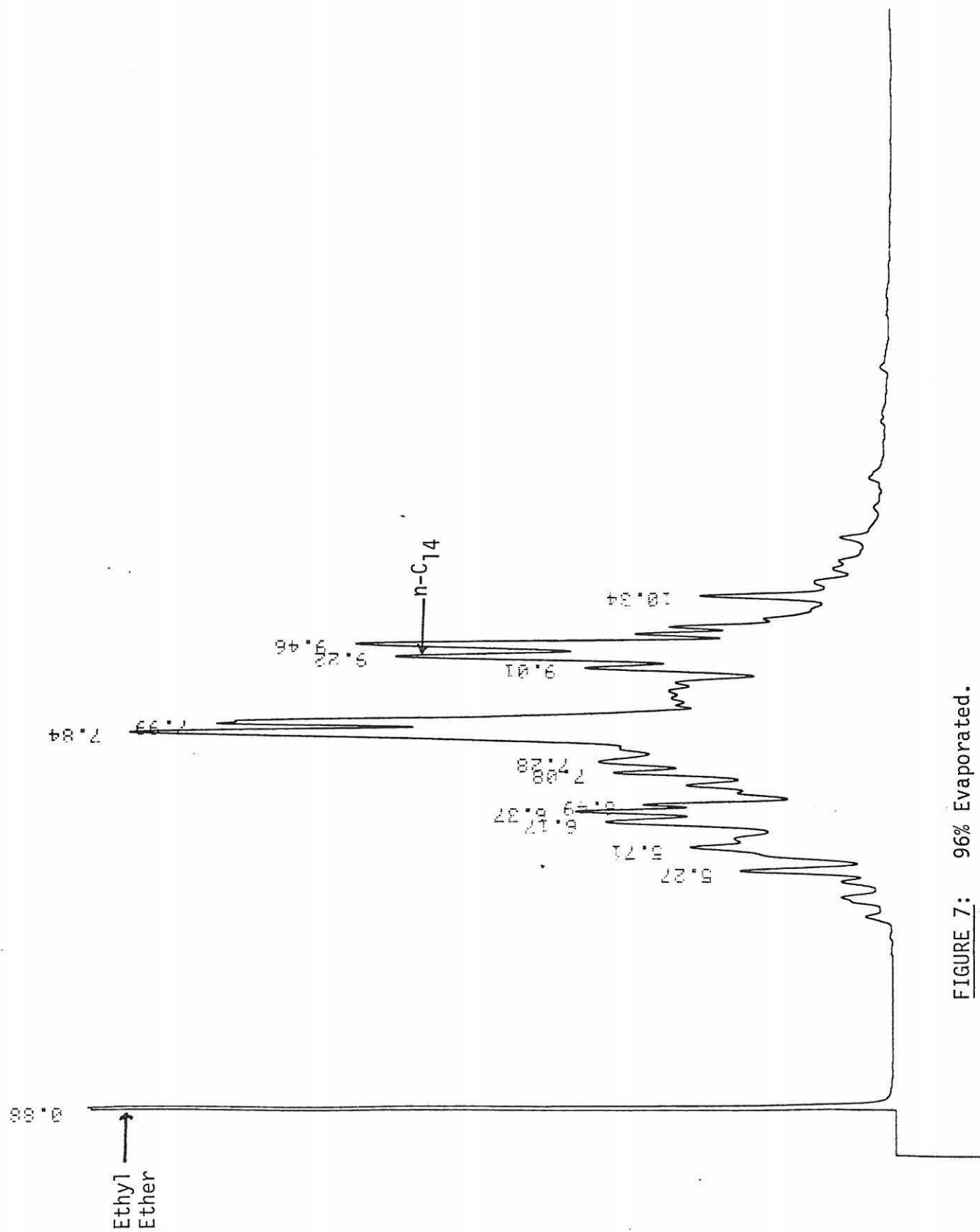


FIGURE 7: 96% Evaporated.

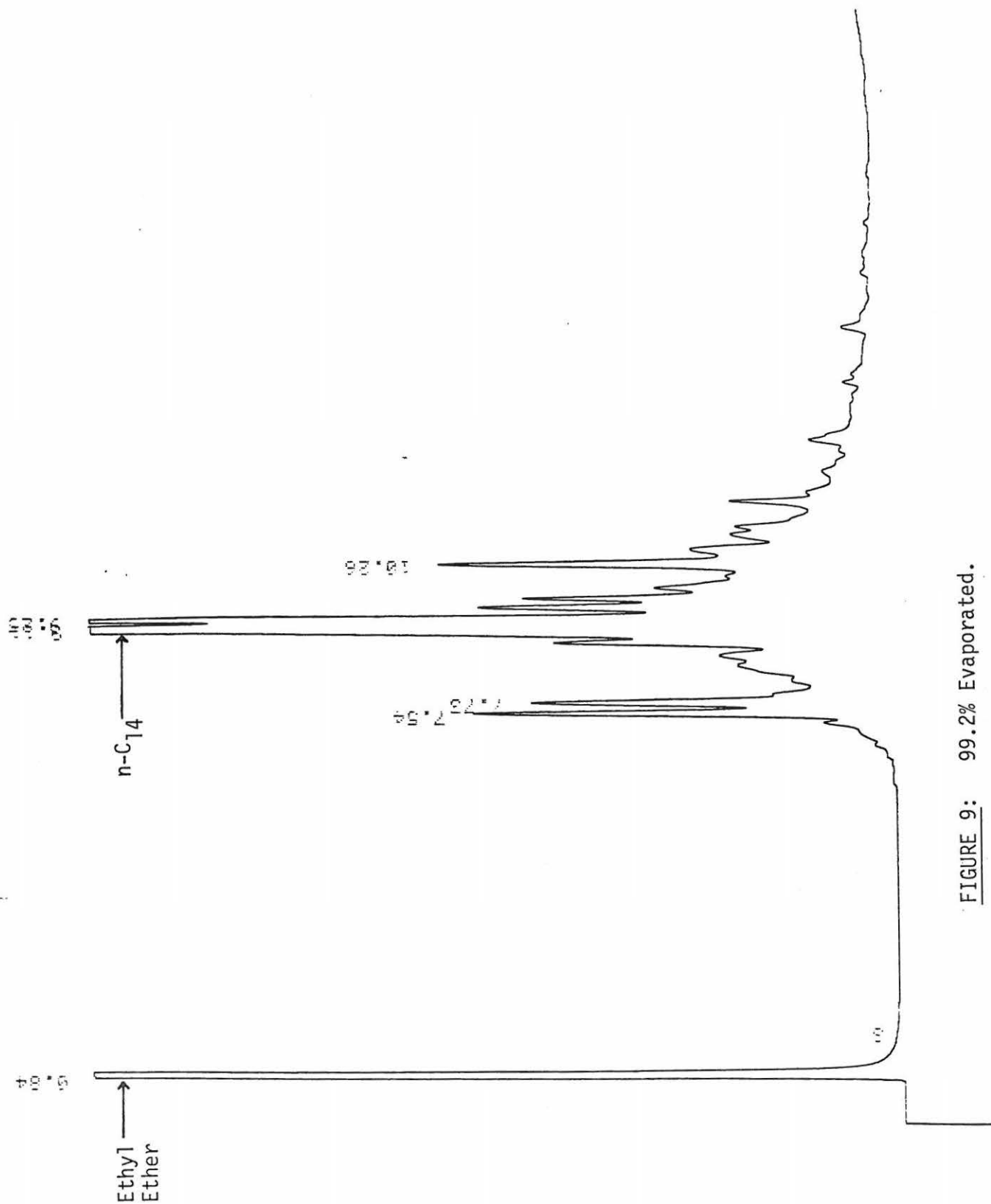


FIGURE 9: 99.2% Evaporated.

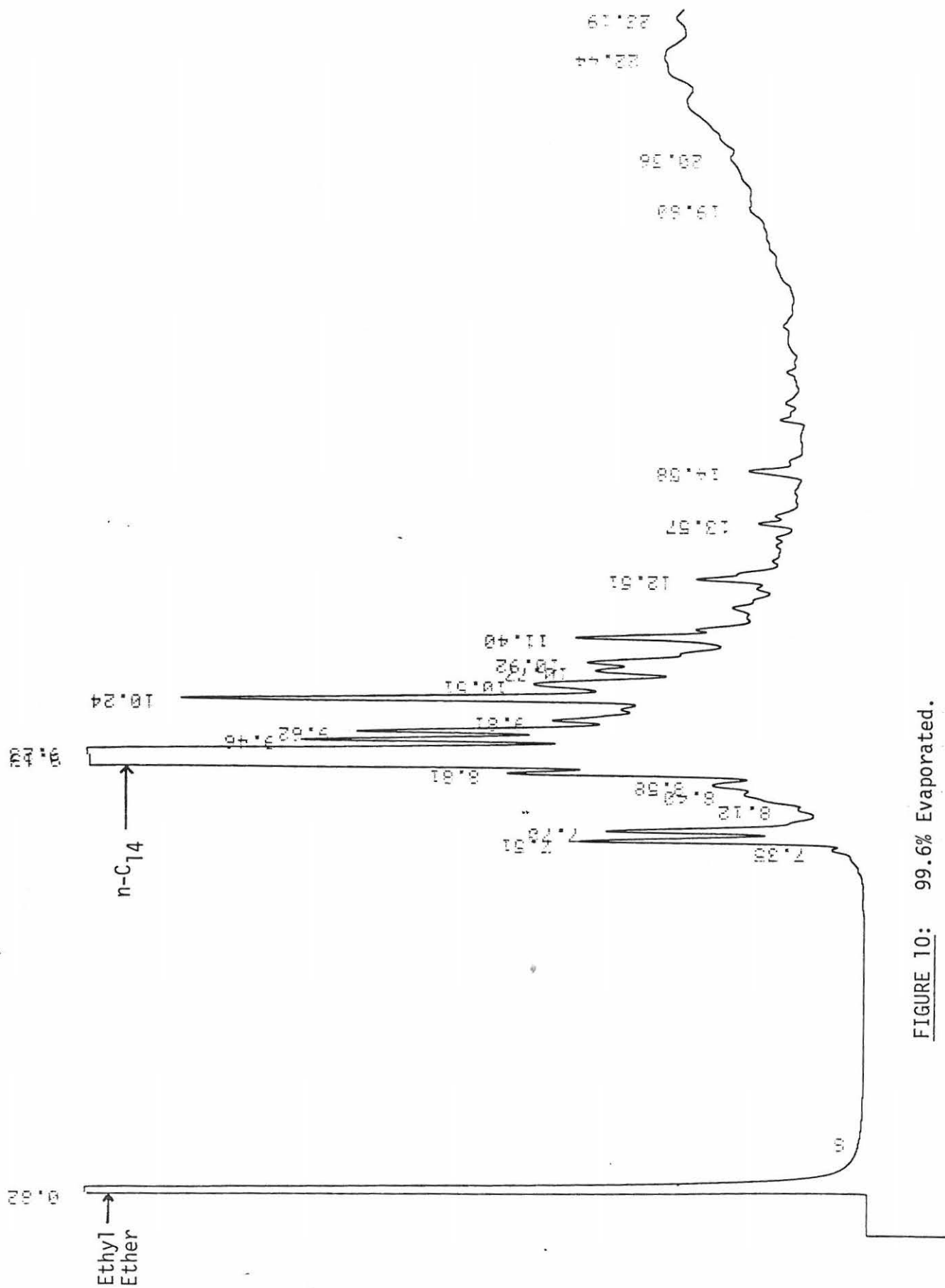
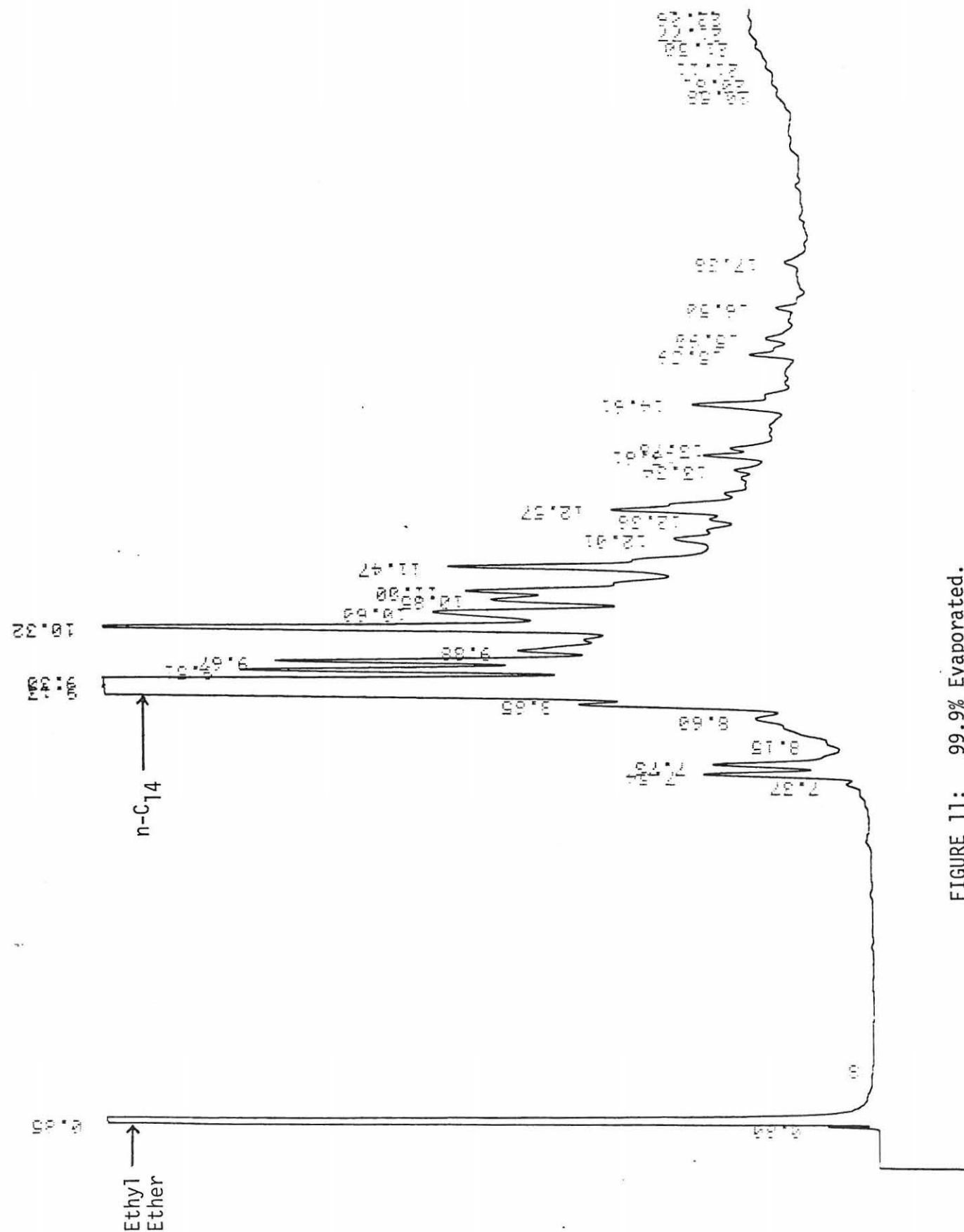


FIGURE 10: 99.6% Evaporated.

FIGURE 11: 99.9% Evaporated.



Anti-Arson Program in Connecticut

Henry C. Lee, Ph.D.
Chief, Forensic Science Laboratory
Connecticut State Police

and

Craig Appel
Program Manager, Arson Control Assistance Program
Connecticut Justice Commission

The effective control of arson requires interdisciplinary approaches at all sectors in our society. Based upon this concept, Connecticut's Governor's Arson Task Force was formed in 1979 to work with different levels of public and private agencies to attack the arson problem in Connecticut. Increases in arrests and convictions marked the program's progress during 1980, the first year of Connecticut's demonstration anti-arson project. It was also a year in which Connecticut built a productive foundation for future arson control. In this paper, we will discuss the type of physical evidence received and analyzed by Connecticut's State Police Forensic Laboratory. A report on the number of arsonists arrested and convicted is included. Training activities for public safety and prosecutorial personnel conducted in Connecticut during the first year of anti-arson project is being discussed.

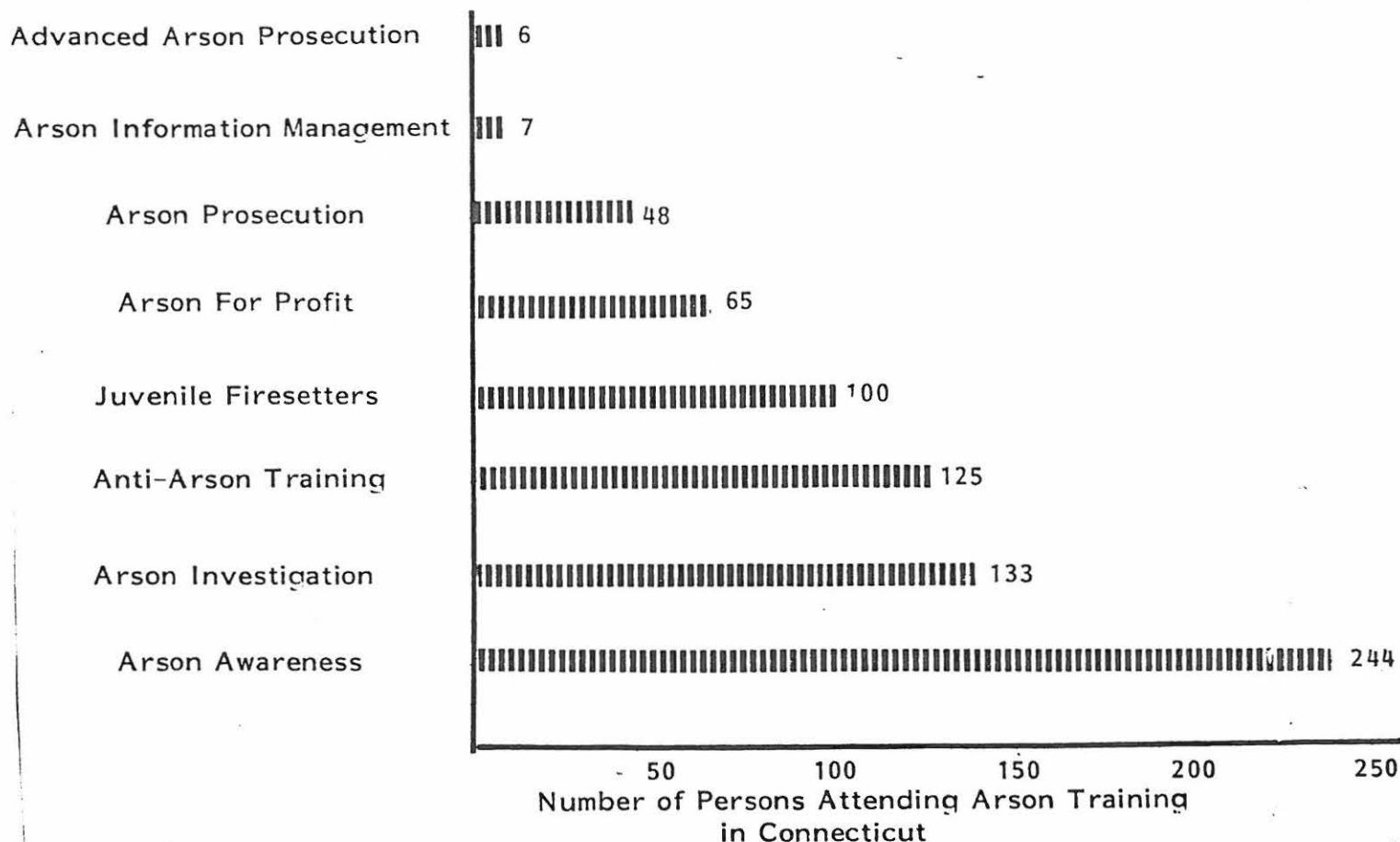
Program Description

According to the Connecticut Fire Marshal's Annual Report, there were a total of 12,540 fires in 1976, 21,948 fires in 1977 and 21,346 fires in 1978. Among those reported fires, the number of fires identified as "incendiary fires" grew from 899 in 1976 to 1,473 in 1978, an increase of over 60 percent. The growth in the category of "suspicious fire" was from 1,404 in 1976 to 3,677 in 1978 or a 160 percent increase. In 1978 these two types of fires destroyed property valued over \$10,979,000 and accounted for 30 percent of

the total property loss reported. To deal with the rising arson problem, a Governor's Arson Task Force was set up in 1979. The task force was charged with the responsibility for formulating a better response to the arson problem. In December of 1979, the task force received a \$600,000 grant from the Law Enforcement Assistance Administration to coordinated arson investigation, prosecution and prevention efforts in Connecticut. Connecticut's insurance industry matched this award by adding an additional \$158,000. The State of Connecticut also added to this award by contributing an additional \$67,000. Six cities, Bridgeport, Enfield, Hartford, New Haven, Stamford and Waterbury were targeted as demonstration communities. The task force identified the following five areas that required priority attention:

- (1) improve the coordination of investigation and enforcement efforts.
- (2) provide speedy and adequate forensic laboratory and technical supports.
- (3) improve the effectiveness of prosecution.
- (4) provide better training for the fire investigator.
- (5) develop arson warning and prevention systems.

During the project year, eight intensive 100 hour training programs were implemented. Over 728 individuals were trained in a wide range of anti-arson techniques. The program assisted public safety personnel in acquiring basic as well as advanced knowledge in various aspects of arson control.



These training programs have improved the knowledge of investigative units in their ability to more accurately determine the cause of fire. It also improved their ability to recognize and collect physical evidence at the arson scene.

Physical Evidence from Arson Cases

1980 was a year of progress for Connecticut's ability to provide accurate and speedy identification of accelerants in fire debris. An arson laboratory was set up in the recently constructed State Police Forensic Laboratory. An account of approximately \$100,000 was allocated from federal, state and private resources in order for the forensic laboratory to improve its capabilities in arson evidence analysis. New equipment and additional personnel were added during the year to handle the large increase in volume of physical evidence submitted to the laboratory by arson investigators. The following table shows the total number of cases submitted and the number of items examined by the laboratory.

Number of Cases Submitted to Laboratory for Analysis of Accelerants

<u>Year</u>	<u>No. of Cases</u>	<u>No. of Items Examined</u>
1977	2	7
1978	21	76
1979	118	354
1980	717	1,835

As the above table indicates, there was a large increase in the number of arson cases submitted to the forensic laboratory for accelerant analysis. For example, the increase from 118 cases in 1979 to 717 in 1980, represented a 512 percent increase. These increases demonstrate that the forensic laboratory has gained widespread acceptance by the fire investigator.

In addition to the accelerant evidence, other types of physical evidence collected from arson scenes and were submitted, at an increase rate of submission to the laboratory for examination. The following table shows the types of analysis requested by submitting agencies:

	<u>Type of Analysis Requested</u>		
	<u>1978</u>	<u>1979</u>	<u>1980</u>
Accelerants	76	354	1,835
Timing Devices	0	2	14
Chemical Analysis	0	11	46
Blood	1	7	52
Fingerprints	3	21	74
Glass and Soil	0	0	5
Toolmarks	0	1	12
Footprints	0	0	3
Clothing	0	1	43
Other	0	1	17

Traditionally, accelerants are generally the only class of evidence collected at an arson scene. However, during the training programs, laboratory staff stressed the need for investigators to collect other classes of evidence, i.e., blood fingerprints, and clothing. For example, in 1978 in addition to identification of accelerants, only 4 other analysis requests were made.

Since the implementation of the arson training program, as shown in the above table, the laboratory received a large increase in the submission of other types of physical evidence. In 1979, 44 requests were received by the laboratory. These requests included timing device identification, chemical analysis of powder residues, identification and grouping of blood stains, fingerprint processing, toolmarks, clothing and reconstruction. In 1980, 266 requests were submitted increasing the classes of physical evidence to include glass, soil and footprints. Many important arson cases were successfully prosecuted due to the laboratory's findings after the examination of these other classes of physical evidence.

Investigation and Prosecution

Nationally, arson arrest and conviction rates are relatively low, about 9 persons arrested, 2 convicted, and 0.7 incarcerated per 100 fires as incendiary or suspicious. This compares with 21 arrests, 6 convictions and 3 incarcerations per 100 UCR index crimes. In Connecticut, during 1978 out of 5,150 incendiary and suspicious fires only 353 arrests were made and 33 were convicted, with 23 persons confined. Thus, the arrest and conviction rates from Connecticut were below the national average — about 6.8 persons arrested, 0.6 convicted and 0.4 person incarcerated per 100 incendiary or suspicious fires.

However, during 1980, Connecticut made substantial improvements in investigation and prosecution of arson cases. Major achievements in training and technical supports enhanced local government's ability to follow through an investigation. Quantity and the quality of investigations made significant improvements. The arrest rate for arson cases increased from 312 in 1979 to 500 in 1980, or by 60 percent.

The adoption of a vertical prosecution model is beginning to result in substantially increased prosecution. The conviction rate has increased 80 percent from 1979 to 1980. Improvements in investigations also resulted in a dramatic increase in guilty pleas by defendants, which resulted in significant cost reducing benefits and reduced court disposition time.

In summary, the anti-arson project in Connecticut has demonstrated that with the coordination of resources and training, improved forensic laboratory services and application of new investigation and prosecution strategies, the arson problem can be controlled. Connecticut's arson control assistance project results are summarized in the following table.

	<u>1979</u>	<u>1980</u>	<u>% Change</u>
FIRES	10,160	13,361	+33
Incendiary	1,820	2,582	+41
Suspicious	3,790	4,283	+11
Undetermined	4,550	6,541	+43
POLICE			
Investigations	2,188	2,071	-5
Arrests	312	500	+60
COURT CASES	66	80	+21
Convictions	40	72	+80
Non-convictions	26	8	-69
LABORATORY ANALYSIS	118	717	+512

AA Notes

- * The follow is a list of three abstracts of articles presented at the Interamerican Congress of Forensic Science, November 2-5, 1982. Thanks to John DeHaan.

The Recovery of Explosives Residues at Trace Level, T.S. HAYES^{*}
MSc PhD CChem MRSC and D.F. WARDLEWORTH BSc CChem MRSC,
Royal Armament Research and Development Establishment, EM2
Branch, Royal Arsenal East, Woolwich SE18 (UK).

Considerable effort has been concentrated on means of detecting the vapours of explosives and of confirming their identity. The majority of these identification procedures, when applied at trace levels, are heavily dependent on the presence of a minimum of contaminants. This paper presents a novel technique for the thermal desorption of volatile explosives and their recovery by a Tenax trap using a purpose-built contact heater. Application of this technique to detect gelignite residues is described. For those samples where a recovery technique is employed which gives a contaminated extract, a liquid-liquid extraction procedure which takes advantage of the solvent partition characteristics of selected explosives is detailed. A general procedure is given for the clean recovery of several commonly encountered explosives from their admixture with contaminants. High recoveries of NG, EGDN, PETN, TNT and RDX from solution can be achieved. Both recovery procedures have particular application to the GLC/ECD identification of explosives on plastic surfaces.

Recent Advances in Arson Investigation: Combined Techniques of Field and Laboratory Accelerant Detection, D.L. MAUZY, California Department of Justice, Santa Barbara Criminalistics Laboratory, 820 Francis Botello Road, Goleta, CA 93117.

Recovery of accelerant residues from arson suspects clothing is discussed. The use of sawdust to recover accelerant residues from concrete is illustrated. A recently adjudicated case involving trapping of accelerant vapors at an arson scene, with subsequent laboratory analysis, is discussed. These techniques are based upon a dynamic, heated headspace method involving adsorption and subsequent elution of accelerant vapors from activated charcoal. This method has been previously described in detail by D. Tate in the Sept. 1981 issue of the California Association of Criminalists Newsletter. Integral with these laboratory techniques is the use of a non destructive infrared hydrocarbon vapor detector. This detector is described in detail. Its application and the widespread use of this instrument by the Santa Barbara Fire and Arson Investigators Association is reviewed. The instrument responds to a broader range of accelerants than some other instruments. The instrument has shown itself to be largely free of false positives. The instrument is non destructive, and has been used to trap and retain an accelerant on charcoal.

In Use Report of a Varian Vista Gas Chromatography System for Arson Analysis - WAYNE PLUMTREE & MEL KONG

A Vista 401 chromatographic data system including a Vista Model 6000 G.C., a Vista Model 6500 G.C. and an Apple II+ microcomputer are described. The laboratory has found a wide range of performance capabilities with different detectors (FIE, TSD and FPD) and different column configurations (capillary and packed). The laboratory has experienced some discrepancies between prepackaged methods expectations and actual results and software limitations. These experiences will be described with respect to arson analysis. Methods to maximize the systems capabilities and use a headspace concentrator will be presented.

- * The Corporate Laboratories of Systems Engineering Associates are pleased to announce that Dr. Ajibola Ibidunni or "Bola" (as he likes to be called) is now a staff metallurgist. Bola graduated from The Ohio State University with a B.S., M.S. and Ph.D. in Metallurgical Engineering.

* From the Journals:

** A good article appeared in the Journal of Forensic Science, Volume 27, Number 4, October 1982, titled "A Quality Assurance Program for the Laboratory Examination of Arson and Explosive Cases," Brunelle, Garner and Wineman.

* * * * *

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