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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).

EFFECTS OF CONTAINER SIZE AND VOLATILITY ON RELATIVE DETECTABILITY OF ACCELERANTS BY PURGE AND TRAP VERSUS HEATED HEADSPACE METHOD

by

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The use of gas chromatography (GC) as an analytical tool for potential accelerant detection in fire debris samples has been an established technique for over 20 years.[1,2] The ancillary methods for sampling or isolating potential accelerants from the debris prior to actual injection onto the GC have been the subject of extensive studies. Essentially the pre-isolation methods in use fall into four general categories: headspace,[3,4] solvent extraction,[1] distillations,[4-6] and vapor adsorption-desorption on solid supports (purge and trap).[7-16] A number of excellent descriptive reviews of these methods are available[16-21] many of which point out the advantages and disadvantages thereof.

Up until recently headspace and heated headspace were the most extensively used[20,22-25] (e.g., a 1978 survey of 96 forensic labs reported that approximately 75% used these techniques compared to less than 50% for distillation, and about 20% for solvent extraction[25]). More recently purge and trap concentration methods developed for environmental air sampling[26-28] have been adapted to debris sample analysis.[7-16] These methods, which essentially purge volatiles from the sample onto a solid adsorbent such as charcoal or Tenax and then desorb the trapped volatiles either thermally[11,12,14,15] or with a solvent[7-10,13,16] for GC analysis, have gained wide acceptance in the industry due to their greater sensitivity, applicability to accelerants over a wider volatility range, and ease of operation.

A number of comparisons of the volatile sampling methods have appeared in the literature, though actual published quantitative data is limited. In one study purge and trap on Tenax followed by thermal desorption was found to be 200 times more sensitive than heated headspace for gasoline and various fuel oils and 100 times more sensitive for charcoal lighter.[14] In another, vapor trapping on a charcoal-coated wire followed by thermal desorption appeared to be about 20-100 times more sensitive than heated headspace.[18] Another study reported that purge and trap on charcoal followed by solvent desorption resulted in a 100-fold increase in sensitivity relative to heated headspace.[29] A fairly similar detection enhancement was also noted for steam distillation relative to heated headspace.[4,29] Others have simply reported minimum detection limits for the technique they used. For example, accelerant amounts of less than 1 ul[15] down to as low as 0.1 ul[10] in a sample can be detected using various purge and trap methods.

Most comparisons have been with respect to heated head-space, probably due to its being the most widely utilized technique for years. Many cases that are now reaching litigation have had laboratory analysis done in part or entirely by heated headspace. Furthermore the heated headspace method is still utilized by many forensic labs primarily as a quick screening method. It is troublesome to me that most of the published quantitative comparisons between purge and trap and heated headspace were done under conditions which were heavily biased against the headspace. For example, one study utilized larger n-alkanes (typical fuel oil components) in a one-gallon container for comparison purposes even though the headspace's biggest shortcomings are in the analysis of less volatile substances[30] or samples in large containers.[4] The purpose of this paper is to clarify certain published aspects of the comparison between the heated head space versus purge and trap (solvent desorption) techniques, particularly stressing the importance of sample container size and accelerant volatility.

Experimental Procedure

GC analysis were performed on Hewlett-Packard Models 5830 and 5840 gas chromatographs equipped with 6' x 0.125" stainless steel columns packed with methyl silicone (OV-101, 3%) on chromosorb WHP. Oven temperatures were held at 50°C for 3 min, then programmed from 50 - 200°C (250° in some cases) at 10°/min. Area counts for the desired components were determined utilizing at least duplicate injections of each sample and the appropriate attenuations on the instrument.

A standard hydrocarbon mixture containing 45mg each of toluene, m-xylene, and n-decane in 100 ml of carbon disulfide was prepared (hydrocarbon concentrations of 0.45 mg/ml). Different volumes of this standard solution were added to a Kimwipe within either clean metal or glass containers ranging in volume from 4 oz to 1 gal for heated headspace analysis or in a one-quart jar for purge and trap analysis. Alternately, 1 ul amounts of each of the three pure compounds were directly added to the appropriate size container. Samples for the headspace method were placed into an oven (90°C) for 30 min, then a 3 cc vapor sample was withdrawn with a gas syringe and injected onto the gas chromatograph. Purge and trap analysis was performed using an apparatus similar to that utilized in an earlier comparative study[29] was set up. Heated nitrogen was purged through the jar containing the test volatiles in an oven (80°C) for 20 min at a flow rate of 2 + 0.5 l/min (corresponding to about 40 volume changes) and trapped on an glass tube packed with activated charcoal and located outside of the oven. Volatiles were subsequently desorbed from the charcoal tube with 1.5-2 ml of carbon disulfide and this solution then concentrated to 1.0 ml (or smaller volumes where noted). Generally 5 ul injections of this solution were made onto the gas chromatograph.

Regular leaded gasoline was also comparatively tested by both the head space and purge and trap techniques. For this purpose small volumes of gasoline (0.1 to 10 ul) were applied to a kimwipe in a quart jar and nitrogen purged through the container within a heated oven (80°C) as before. Carbon disulfide (1 - 2 ul)

was used to elute the trapped volatiles off of the charcoal trap, and, following concentration to 0.5 ml, 1 ul of the resulting solution injected onto the GC. For the heated headspace method an 8 oz metal can containing from 0.1 to 10 ul of gasoline was used, and 3 cc volumes withdrawn and injected onto the GC. The toluene, m-xylene, and trimethylbenzene (two partly resolved) peaks were monitored as being representative of components found prominently in gasoline.

Comparative analysis on samples from actual suspected arson cases were performed in much the same manner. Heated headspace analysis was done by withdrawing 2 cc volumes of vapor directly from the heated original container (90°C) and injecting onto the GC. Purge and trap analysis was performed on approximately 1/3 to all of the original sample (depending on the individual sample size) after it was transferred to a fresh one-quart jar. The carbon disulfide eluate was concentrated to 0.2 to 0.3 ml and injection volumes of 2-4 ul made onto the GC. Commparison of the chromatograms of each sample by both techniques was done more on a qualitative basis.

Results

Effect of Sample Container Size on Heated Headspace. One ul quantities of toluene, m-xylene, and n-decane or 10 ul of the standard solution containing 0.45 mg/ml each of the same compounds were added to different size containers and, after heating each sample for 1 hr, 3 cc volumes of the resulting headspaces were injected onto the GC. The GC detector response(in area counts) for each of the three components is summarized in Table I. Also indicated is the amount of each component that should have been injected in the given sample size from the appropriate container. This was calculated from the standard vapor pressures (at 90 °C) of toluene (406 Torr), m-xylene (165 Torr), and n-decane (54 Torr) (determined using the Antoine equation[31]), the mole fraction of each component in a given volume, Dalton's Law of partial pressures, and the ideal gas law. It is informative to note that although equal quantities of the three standard compounds were added to each sample the greatest area count was

consistently recorded for toluene and the least for n-decane, in qualitative agreement with the calculations using the respective standard vapor pressures. In accord with the calculations, area counts for all 3 components were the greatest in the smallest container, and fell off with increasing container size.

Purge and Trap GC Analysis Using Standard Solution. Various quantities of the standard solution were analyzed by GC after first sampling them by way of the purge and trap method (Table II). Reasonably linear responses, dependent on the amount of each component present, were obtained. In three cases (100, 10, and 5 ul volumes of standard solution) concentrating the eluate to a smaller volume before injection onto the GC resulted in a correspondingly more sensitive response. In contrast to to the heated headspace analysis, fairly similar amounts of all three components were found in most samples. A 10 ul volume of the same standard solution was analyzed by GC after heated headspace sampling from an 8 oz container. Comparison of the area counts for the individual components in this analysis to the same quantity of standard solution analyzed by purge and trap methods indicated slightly stronger responses for all three by the latter technique, consistent with the calculated amounts of each component sampled in both procedures. It should be pointed out that the amounts of volatiles calculated to be detected by the purge and trap technique in Table II assumes complete transfer of the volatiles from the container to the eluted solution. This is optimistic as actual recoveries of volatiles such as toluene, xylene, and decane using positive flow purge and trap have been shown to range anywhere from about 20 to 70%, and are flow dependent.[10] Preliminary studies in this lab indicate somewhat similar recovery ranges for the purge and trap method we used, but more quantitative work needs to be done.

Comparison of Heated Head-Space and Purge-trap Methods For Gasoline Detection. Similar volumes of regular gasoline were analyzed by GC after first processing by the purge-trap method out of a 1 qt container or the heated space

out of an 8 oz can. The toluene, m-xylene, and trimethylbenzene components in gasoline were monitored, and the respective area counts are noted in Table III. The observed area responses were reasonably linear with respect to the amount of gasoline used by both procedures. This time when equal amounts of gasoline were sampled by both methods using the dilutions and sample sizes noted, larger area counts were recorded for these gasoline components by heated headspace (especially for toluene). However, it should be pointed out that for most samples only 1 ul out of 0.5 ml of eluted solution was analyzed in the purge and trap method (a dilution of 500), compared to 3cc out of a total volume of 237 cc (roughly a 100-fold dilution by heated headspace). In the last entry (Table III) where the standard solution was analyzed by purge and trap after more extensive concentration of the eluate (Table III), responses closer to that from heated headspace were obtained. Based on this data and that of Table II it would appear that many of the components of gasoline (especially hydrocarbons with 7-9 carbons) could be detected with reasonably comparable sensitivity by heated headspace from an 8 oz sample container as they could by purge and trap analysis followed by solvent elution in which 1/100th of the total eluate is analyzed by GC (e.g., 5 ul out of 0.5 ml). These studies are oversimplified in that they neglect any matrix effects and volume exclusions in actual debris samples.

In an effort to compare these two methods for actual potential accelerant detection, 112 debris samples (most of which were either in 1/2 pint or quart cans) from 45 different cases over the period of April to December of 1983 were comparatively analyzed (Table IV). Fourteen samples, which were either inconclusive or negative by heated headspace were more definitively identified by purge and trap. In eleven of these, accelerants were positively identified, while in three others components attributable to background were found. It is interesting to note that 9 of these samples in which purge and trap proved more sensitive were in quart containers, one was in a gallon can and the other four were in 1/2-pint cans.

Even more revealing is the nature of the accelerants detected in these debris samples. Table V classifies the 24 samples in which positive accelerant identification was obtained by both methods as well as the 11 samples where only the purge and trap method led to a positive identification. In the latter case essentially only medium to low volatility petroleum products were found (i.e., diesel fuel and petroleum distillate products such as charcoal lighter or kerosene), whereas with the samples in which heated headspace also gave positive results, gasoline was the dominant mixture detected. It should be pointed out that the two samples in which gasoline was detected by purge and trap but not by heated headspace were those in which extensive aging (>95%) had occurred. Two other samples ultimately found to contain a mixture of diesel fuel and gasoline by purge and trap indicated essentially just gasoline by heated head space. In cases when both methods were successfully used to detect an accelerant, the chromatograms obtained by purge and trap were usually, somewhat more sensitive, clearer and contained a broader range of characteristic components of the particular petroleum product. Nevertheless the chromatograms obtained from the headspace analysis were easily adequate to make a positive identification.

Conclusions

For GC analysis of compounds in the toluene volatility range following heated headspace or purge and trap sampling the comparative sensitivities are pretty much a function of the dilution inherent in the methods. Very similar responses for the two techniques are expected for purge and trap carried out on a given quantity of this type of compound using 1/100th of the eluted carbon disulfide solution versus injecting a 3 cc volume of heated headspace from an 8 oz (237 cc) container (roughly a similar dilution disregarding vapor pressure effects). Maintaining this same dilution in the purge and trap analysis would suggest that it would become comparatively more and more sensitive than heated headspace out of larger containers (e.g., quart or gallon).

Furthermore, with slightly less volatile compounds (e.g., xylene and decane) the sensitivity by way of the headspace method is lessened due to lower vapor

pressures and consequent lower vapor densities of these compounds. With the even less volatile hydrocarbons, typical of fuel oils, the relative sensitivity of heated headspace would continue to decline consistent with what has been reported in some of the previous comparisons,[14,29] (though the large one-gallon containers used for heated headspace in those studies tend to accentuate the lower sensitivity).

Another advantage of the purge-trap technique, however, is the ability to further concentrate the eluted solution of volatiles down to as little as microliters of total volume, and thus being able to inject nearly all of the eluted volatiles at one time.[10,14] In theory, this could result in as much as a 100-fold sensitivity enhancement of the purge and trap method relative to the general method described in this work. Thermal desorption methods do have this advantage relative to solvent desorption of injecting essentially all of the trapped volatiles rather than just a fraction.[12,14,15] However these processes suffer from being a one-time only injection, and the solvent elution-concentration suffers from partial or considerable evaporation of trapped volatiles.[14]

Essentially it comes down to the following considerations when comparing sensitivities: in the purge and trap method a significant fraction of the volatiles from a container can be transferred onto the solid absorbent barring saturation effects,[21] and it then becomes a function of what fraction of the resulting eluate is transferred to the GC. In contrast the heated headspace sensitivity depends not only on what fraction of the total headspace is actually sampled (container size and quantity of debris within) but also on the volatilities of the components therein.

The analysis of actual samples from suspected arson cases was revealing. In many cases the same result was recorded by both methods, which is not susprising since the type of accelerant found in most of the positive cases was the fairly volatile gasoline. In the cases where a negative or uncertain reading by head space became a positive identification by purge & trap the accelerant found was of lower volatility and/or the samples were packaged in larger containers. In

previous studies, purge and trap analysis was able to clarify even greater proportions of inconclusive or negative results by the heated headspace,[13,14] but the gallon containers used in the latter method likely contributed to its relative insensitivity.

Overall the purge and trap method of analysis is superior to the heated head space. This is particualrly true when analyzing samples in large containers or when the accelerant is relatively non-volatile (e.g., fuel oils). Nonetheless, one cannot automatically assume that the purge and trap method is always two or more orders of magnitude more sensitive than heated headspace. With accelerants in the gasoline range and small container sizes or larger containers nearly filled with debris the heated headspace can give at least reasonably comparable sensitivities. Thus heated headspace can still serve the forensic lab as a quick and reasonably sensitive screening method.

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Table I. Effect of Container Size on Detectability of Volatiles By Heated Headspace

Container size[a]	---Detector Response to Volatiles--- Toluene		m-xylene		n-decane	
	ng[b]	response[c]	ng[b]	response[c]	ng[b]	response[c]
4 oz	8400	3090	3400	1650	1110	731
32 oz	1100	710	426	450	139	208
64 oz	530	220	213	132	70	61
128 oz	260	130	107	95	35	45
8 oz[d]	25	8.3	10	3.2	3.4	1.7
32 oz[d]	6.3	2.2	2.6	2.0	0.85	1.2

[a]1 ul of toluene. m-xylene and n-decane, 3cc headspace sample at 90°C, see experimental. [b]Calculated quantity of compound contained in 3 cc headspace sample. [c]Area counts X 10^{-3}, mean of 2 or 3 repetitions. [d]10 ul of standard solution containing 0.45 ug/ul each of toluene, m-xylene and n-decane.

Table II. Purge and Trap GC Analysis of Standard Solution of Volatiles

Volume of standard solution[a]	Quantity of each component(ug)	Detector Response, Area Count X10^{-3} Toluene	m-Xylene	n-Decane
100	225	64	74	59
100	450[b]	120	133	112
50	113	27	19	23
25	56	17	12	13
10[c]	25,10,3.4[d]	8.3	3.2	1.7
10	23	9.3	4.9	6.6
10	45[b]	18.3	12.8	12.4
5	56[e]	17.3	20.2	11.2
5	113	26.5	26.4	22.0

[a]Containing 0.45 ug/ul of each component, sampled in quart jar (80°C) with 20 min nitrogen purge, eluted with 1.5-3 ml of carbon disulfide which was concentrated to 1 ml, 5 ul injections of the eluate were made onto the GC. [b]Eluate concentrated to 0.5 ml, 5 ul injection size. [c]Sampled in 8oz container by heated headspace (see Table I). [d]Toluene, m-xylene, n-decane, respectively. [e]Eluate concentrated to 0.2 ml, 5 ul injection. [f]Eluate concentrated to 0.1 ml, 5 ul injection.

Table III. Comparative GC Analysis of Components in Gasoline Using Purge and Trap Versus Heated Headspace

---Detector Response, Area Counts X 10^{-4}---

Volume of gas used	--Purge & Trap[a]-- Toluene	Xylene	C_9H_{12}	--Heated Headspace[b]-- Toluene	Xylene	C_9H_{12}
10 ul	16.4	20.6	23.9	146	101	42.1
5 ul	11.2	14.2	13.4	78.3	57.3	13.7
1.0 ul	-	-	-	27.9	15.5	6.5
0.5 ul	-	-	-	9.3	7.2	2.6
0.3	0.8	1.2	1.1			
0.2	-	-	-	4.1	2.2	0.9
0.1[c]	0.6	1.7	0.7	1.9	1.4	0.5

[a]Carbon disulfide eluate concentrated to 0.5 ml, 1 ul injection volume, see experimental. [b]8 oz container 3 cc injection, see experimental. [c]Concentrated to 0.2 ml, 1 ul injection.

Table IV. Comparative Analysis of Actual Debris Samples by Heated Headspace and Purge and Trap

Method	Number of samples	Negative	Inconclusive	Background only	Positive
Heated Headspace	112[a]	53	17	18	24
Purge and Trap	112[b]	49	7	21[c]	35[c]

[a]Sampled from original containers (56 1/2-pint, 46 qt, 10 other. [b]Contents (1/3-all) transferred to purge and trap vessels. [c]The 14 added identifications were in the following containers: 9 qt, 4 1/2 pint, 1 gal.

Table V. Nature of Accelerants Detected

		--------Type--------		
	Total	Gasoline	Mid-range petroleum distillate[a]	Diesel fuel
Samples identified by both methods	24	17[b]	7	0[c]
Additional Samples Identified only by Purge and Trap	11	2[d]	5	4[e]

[a]Charcoal lighter, paint thinner, kerosene, etc. [b]Two of these were identified as lighter fluid. [c]Petroleum product of low volatility indicated in two cases. [d]More than 95% evaporated (fire-aged). [e]Two of these also contained gasoline.

AAN Notes

* Another issue of the AAN has finally been compiled and the next issue of the AAN is even started!! There has been renewed interest and support in the survival of the AAN and with the help of all readers it will survive. Please don't be apathetic. Support the AAN with whatever you can, note material, articles, job inquiries, etc.

Ron Thaman
Editor, AAN

* James V. Vandiver of the Department of Army has sent the AAN several articles for publication that are in German. If any reader of the AAN would be willing to translate some or all of each article, please get in touch with the editor.

* Has any reader of the AAN developed his/her program to perform laboratory management functions? The readers of the AAN would be interested in seeing a program (preferably in BASIC) that would log in and record cases and perform status type functions.

* * * SEMINAR * * *

CALIFORNIA ASSOCIATION OF CRIMINALISTS

FALL SEMINAR

PLACE: TOWN AND COUNTRY HOTEL
SAN DIEGO, CALIFORNIA

DATES: OCTOBER 24-27, 1984

CONTACT: JIM STAM or JOHN SIMMS
SAN DIEGO POLICE DEPARTMENT
FORENSIC SCIENCE SECTION
801 WEST MARKET STREET
SAN DIEGO, CA 92101
PHONE: (619) 236-6505

The San Diego area is one of the most desirable locations in the entire country and the seminar will be well worth attending.

Submitted By:

Robert R. Ogle, Jr.
Public Relations Committee

* * * * * * *

Symposium on Recent Advances in Arson Analysis and Detection by Bureau of Alcohol, Tobacco and Firearms

Background

The Bureau of Alcohol, Tobacco and Firearms (ATF) Laboratories have been assisting state and local agencies in investigating fires since 1970. ATF special agents have been involved in the fight against arson since 1977. Within the framework of statutory authority provided by Title II of the Gun Control Act of 1968 and Title XI of the Organized Crime Control Act of 1970 (commonly known as the Explosives Control Act), ATF's enforcement approach has been structured toward the investigation of arson for profit schemes involving commercial or industrial interstate activities, especially those schemes perpetrated by members of organized crime, white-collar criminals, members of organized "arson rings," or violent criminals.

Working hand-in-hand with state and local investigators and other Federal law enforcement agencies in arson task forces, ATF has both initiated and assisted in arson investigations. While arson is basically a local problem, a coordinated effort among Federal, State and local agencies is imperative if the continuing arson epidemic is to be curtailed.

In addition to its participation in arson task forces, ATF has developed and provided training to state and local agencies in two major areas: 1) State-of-the-Art Arson Laboratory techniques for chemists and 2) Arson-for-Profit Investigation for investigators. During the past three years ATF has trained approximately 150 chemists and 1300 investigators.

To continue the training of state and local chemists, ATF is offering a Symposium on Recent Advances in Arson Analysis and Detection. The one-day workshop will be held at the American Academy of Forensic Sciences Meeting in Las Vegas on Tuesday, February 12, 1985.

Symposium Topics

During the one-day seminar, attendees will participate in discussions ranging from cause and origin to pre-analysis clean-up and GC/MS techniques.

Some of the topics to be discussed are:

- Basic Cause and Origin - it's importance to laboratory analysis
- Clandestine Drug Laboratories - Hazards/Incendiary Devices/Boobytraps
- Accelerant Detection Dogs
- GC/MS Applications
- Pre-analysis Clean-up Techniques
- Survey of Sorption/Elution Techniques

Attendance

Registration will be coordinated with the American Academy of Forensic Sciences, 225 S. Academy Boulevard, Colorado Springs, CO. A modest registration fee will be charged, to cover costs (final cost to be determined). Luncheon and refreshments at breaks will be included with registration.

More Information

For additional information and pre-registration, please contact Rick Tontarski, ATF-National Laboratory Center, 1401 Research Boulevard, Rockville, Maryland 20850 [(202)294-0420].

University of Delaware

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Below and on succeeding pages is a calendar listing law enforcement and security seminars the University of Delaware will conduct in Wilmington during the period October 1, 1984 to June 30, 1985. For more detailed information on each seminar, please feel free to contact me at the above address or call (302) 573-4400.

Also, we would be pleased to display your publication(s) for seminar participant pick-up. If interested, please contact me so we might discuss the logistics involved.

Submitted by:

Jacob Haber,
Program Specialist

UNIVERSITY OF DELAWARE
Division of Continuing Education

1984-1985 Law Enforcement and Security Seminar Schedule

OCTOBER

Oct. 15-16	Drugs and Narcotics: Usage and Investigative Techniques. Fee: $325
Oct. 15-16	Polygraph Operators' Seminar: The Multiple Technique Approach. Fee: $275
Oct. 15-17	Intelligence Operations. Fee: $395
Oct. 18-19	Informant Management. Fee: $295
Oct. 22-23	Internal Affairs Investigation. Fee: $250
Oct. 22-24	Financial Crime: Detection and Investigation. Fee: $350
Oct. 25-26	Fire and Arson Investigation. Fee: $235
Oct. 29-30	Dispatcher Stress and Burnout Reduction. Fee: $235
Oct. 31-Nov. 1	Employee Theft: Investigation and Prevention. Fee: $325

NOVEMBER

Nov. 14-16	Managing the Criminal Investigation. Fee: $300
Nov. 15-16	Polygraph Seminar: Advanced Chart Interpretation and Numerical Analysis. Fee: $275
Nov. 15-16	Physical Security: Practices and Technology. Fee: $395
Nov. 19-21	Robbery and Burglary Investigation. Fee: $300.
Nov. 19-21	Public Safety Radio Dispatchers' Seminar. Fee: $235
Nov. 20	Credit Card Crime and Fraud Seminar. Fee: $195
Nov. 27-28	Fire Detection Systems. Fee: $325
Nov. 27-28	Crime Analysis. Fee: $275
Nov. 28-30	K-9 Unit Management Seminar. Fee: $350

DECEMBER

Dec. 3-7	Practical Homicide Investigation. Fee: $400
Dec. 10-14	Investigators' Usage of the Personal Computer. Fee: $695
Dec. 10-12	Perspectives on Police Management. Fee: $350
Dec. 13-14	Police Civil Liabilities Seminar. Fee: $275
Dec. 17-18	Intrusion Detection Systems. Fee: $350
Dec. 17-18	Developing and Implementing a Police Stress/Burnout Program in Your Department. Fee: $275

JANUARY

Jan. 9-11	Police Interview and Interrogation. Fee: $325
Jan. 10-11	Alarms Systems and Theft Prevention. Fee: $350
Jan. 14-15	Tactical Approaches to Crimes in Progress. Fee: $275
Jan. 16-17	Supervisory Principles for Communication Center Personnel. Fee: $325
Jan. 17-18	Computer Security: Detection and Investigation. Fee: $350
Jan. 21-25	Investigators' Usage of the Personal Computer. Fee: $695
Jan. 22-23	Terrorism in the 1980s. Fee: $350

FEBRUARY

Feb. 4-5	Cargo Security. Fee: $395
Feb. 13-14	Dispatcher Stress/Burnout Reduction. Fee: $235
Feb. 21-22	Hospital Security Seminar. Fee: $375
Feb. 27-28	Family Violence Intervention. Fee: $250

MARCH

Mar. 5-6	Mounted Police Unit Seminar. Fee: $325
Mar. 13-15	Robbery/Burglary Investigation. Fee: $300
Mar. 18-19	Internal Affairs Investigation. Fee: $250
Mar. 18-19	Premises Survey and Security Plans. Fee: $325
Mar. 18-22	Investigators' Usage of the Personal Computer. Fee: $695
Mar. 25-26	Fire and Arson Investigation. Fee: $235
Mar. 27-29	Financial Crime: Detection and Investigation. Fee: $350

APRIL

Apr. 8-9	Vice Control Seminar. Fee: $250
Apr. 10-12	Public Safety Radio Dispatchers' Seminar. Fee: $235
Apr. 1	Managing the Criminal Investigation. Fee: $325
Apr. 22-23	Intrusion Detection Systems. Fee: $350
Apr. 22-24	Police Interview and Interrogation. Fee: $325
Apr. 29-30	Tactical Approaches to Crimes in Progress. Fee: $275

MAY

May 8-10	Supervisory Principles for Communication Center Personnel. Fee: $325
May 9	Credit Card Crime and Fraud Seminar. Fee: $195
May 13-14	Computer Crime: Detection and Investigation. Fee: $350
May 15-16	Video Security Systems. Fee: $375

JUNE

June 3-7	Investigators' Usage of the Personal Computer. Fee: $695
June 6-7	Dispatcher Stress/Burnout Reduction. Fee: $235
June 10-11	Wireless Technology: In Protection, Investigative and Surveillance Application. Fee: $350
June 17-18	Police Civil Liabilities Seminar. Fee: $275
June 17-18	Fire Detection Systems. Fee: $350

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AAN WELCOMES THE FOLLOWING NEW SUBSCRIBERS

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Oregon State Police Crime Lab
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Government Laboratory,
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