Letters to the Editor

Teaching of Forensic Anthropology in the United States[1]

Sir:

In 1978, a questionnaire/letter was sent to members of the Physical Anthropology Section of the American Academy of Forensic Sciences in preparation for a paper to be given at the Forensic Science Educators Session at the 1979 Academy meetings. The results of this Session were summarized in a memorandum by Cordell Brown and W. W. McGee, who had organized and chaired the Session. The comment in the memorandum regarding the forensic science education program for physical anthropology stated that "Dr. Brooks described the rather unusual status of forensic anthropology in education; no recognized degree programs!" Apparently, of all those Sections whose representatives presented papers at this Session, Physical Anthropology was the only Section without any type of degree program, at least as indicated by the results of the brief survey conducted.

When this lack of degree programs was mentioned to other members of the Physical Anthropology Section, they suggested that a thorough survey of the Section membership be undertaken with a more detailed questionnaire. During the late spring and summer of 1979, a letter with a series of open-ended questions (Table 1) was sent to all the then-provisional members, members, and fellows of the Physical Anthropology Section of the Academy. A total of 35 letters were sent initially, and responses were received from 26 people. Subsequently, other individuals requested copies of the questionnaire during meetings of the American Association of Physical Anthropologists in 1980, and one additional response was received, making a total reply from the Physical Anthropology Section members of 27, or a 75% level of response.

Of the 75% who responded, two individuals were from the same university, four do not hold a university position but are members of research institutions and teach workshops or seminars, and one is no longer directly active in research or teaching.

Results of the Survey

Table 2 lists the total responses and types of replies to the various questions asked. Since this was an open-ended questionnaire, intended to solicit as much information as possible rather than limited replies, the responses cannot easily be translated into percentages or statistically significant figures. The information provided varied in specifics and descriptions, so Table 2 contains a summary of those individuals who stated they are participating in a particular workshop, class, laboratory, or field course. In the following discussion of the results, the data from Table 2 are cited and the accompanying descriptions provided by the respondents are used to amplify or explain the results.

The responses to the questionnaire (Table 1) included not only details as to the length of workshops, their sequences, and courses offered, but also outlines of these workshops or courses. Some individuals also sent copies of syllabi or handouts to students, workbooks, and bibliographies. Information was frequently added as to proposed courses and designs for future forensic science programs.

The seminars or workshops given by 14 of the respondents are attended by law enforcement personnel, coroners, medical examiners, or others interested in participating. These are part of a training program in one instance and lectures only as a part of an overall foren-

[1] Presented at the 32nd Annual Meeting of the American Academy of Forensic Sciences, New Orleans, La., 20-23 Feb. 1980.

TABLE 1—*Sample of letter sent to members of the Physical Anthropology Section of the American Academy of Forensic Sciences.*

Dear

On the basis of the interest expressed at the Forensic Anthropology Section meetings regarding a brief review of the current status of forensic anthropology in education, I am attempting to expand my informational base so as to present a more detailed report to our Section at the New Orleans meetings. I am sending this letter to all members of the Forensic Anthropology Section of the Academy in the hope that the response will be broader than last year, and also that we can discuss possibilities for future educational programs.

There are three major aspects of teaching forensic anthropology, and you may be involved in only one of these, or all three. I would appreciate your response to these questions, even if it is a complete negative, as, in this survey, I am as interested in lack of programs, courses and workshops as I am in their presence.

1. Do you offer workshops for the police, coroners, or others, on forensic anthropology or problems of human identification?
   a. If so, could you send me information on what you teach, to whom and for how long?
   b. Does your institution give credit for these courses?
   c. How frequently do you offer these workshops (rarely, every year, every 6 months, on request, etc.)?
2. Do you teach a course or courses in forensic anthropology in your Department?
   a. If so, could you send me the title, a brief outline or syllabus and the type of students in the course (anthropology or archaeology, criminal justice, pre-medical or pre-dental students)?
   b. How frequently do you offer the course and does it involve a laboratory?
3. At your institution is there a degree offered in criminal justice?
   a. If so, have you established a program leading to a combined degree in criminal justice/forensic anthropology, and could you send an outline of the requirements?
   b. Does your department offer a B.A. or M.A. level "track" in forensic anthropology within the broader aspect of physical anthropology?
4. Are any of the students who have taken your course, or participated in your program, presently hired as forensic anthropologists (paraprofessionals) on the basis of your training?
5. Does your institution not offer any of the first three aspects of teaching forensic anthropology, so that essentially any forensic work you are doing is independent of the institution?

Thank you for your help, and I hope to see you at the New Orleans meetings.

Sincerely yours,
Sheilagh T. Brooks
Professor of Anthropology

sic science workshop for three individuals; most (twelve) of the seminars or workshops involved human identification. Five people included some type of field technique session and four had a laboratory session. Credit was given for these seminars or workshops only at three institutions. Four respondents participated in workshops once a year; one, twice a year; eight, often; and one, rarely.

Question 2, which concerns the teaching of courses in forensic sciences within a departmental program, received much more varied responses (see Table 2). Only six of the respondents did not teach any type of forensic physical anthropology course, one hoped to begin a class in the future, and twelve are currently teaching this type of course, although not always on a regularly scheduled basis. The topics included in the forensic science courses varied from a survey of techniques through a coordinated program with criminalists, odontologists, medical examiners, and physical anthropologists to only forensic physical anthropology. In both types of courses a field session demonstrating field search procedures, grid systems, and exhumation techniques is sometimes offered. Students taking these classes

TABLE 2—*Responses to questionnaire. Thirty-six letters were sent to members and there were 27 responses (75%).*

QUESTION 1

Members giving seminars or workshops: 14 yes, 9 no
Seminar or workshop includes
  Training program: 1 yes
  Lectures only in a forensic science workshop: 3 yes
  Human indentification: 12 yes
    With field techniques: 5 yes
    With laboratory: 4 yes
  Credit given by university: 3 yes, 8 no
Frequency of workshops: often, 8; every six months, 1; once a year, 4; rarely, 1

QUESTION 2

Members giving forensic physical anthropology course: 12 yes, 6 no, 1 planned for future
Courses include
  Human osteology: 4 yes
  General forensic science: 2 yes
  More than one type of course: 3 yes
  Individual instruction: 5 yes
  Courses with laboratory: 17 yes
  Courses with laboratory and case work: 8 yes
Frequency of courses: once a year, 6; every other year, 2
Courses offered in cooperation with medical school or law enforcement agency: 5 yes
Availability of program leading to anthropology/forensic physical anthropology degree: 0 yes, 21 no
Availability of biology/anthropology degree: B.A., 0; M.A., 0; Ph.D., 1

QUESTION 3

Availability of criminal justice degree: 9 yes, 11 no
Availability of criminal justice/anthropology degree: 0 yes
Forensic physical anthropology available in
  B.A. program: track, 1; specialty, 5
  M.A. program: track, 3; specialty, 4
  Ph.D. program: track, 1

QUESTION 4

Students obtaining positions related to the forensic sciences: 8

QUESTION 5

Independent forensic science research: 21
  With university orientation through publicity: 5

were, according to the majority of replies, anthropology majors, although some classes also drew pre-dental, pre-medical, biology, or criminal justice students.

A great many of the respondents teach courses in human osteology for anthropology majors; these courses can be used by those interested in the forensic science aspects of human identification. To some extent, these classes can be divided into two groups: those that involve laboratory sessions and osteometry and those that are less complex in their orientation. Both types of courses usually include sex and age determination (dental and skeletal methods of age determination techniques), ethnic determination, stature, human or nonhuman identification, determinations of prehistoric or recent origins, pathology, environmental or cultural influences on the skeleton, some discrete trait information, facial

reconstruction, and the effects of violence on the skeleton. These latter two subjects are most frequently listed in classes that are more oriented towards forensic physical anthropology.

In essence these classes in human osteology or forensic physical anthropology are described as applied human osteology and osteometry or applied physical anthropology. Where the course includes field sessions teaching various archaeological techniques, then this is apparently conceived as a class in applied or forensic archaeology [*1*].

Eight of the individuals who are teaching both forensic and human osteology classes require case work on the part of their students. This may involve students either working on previously completed forensic science cases and writing up the results of their own investigations or working with the instructor and assisting in a case that is current that semester. Many of the forensic science classes will include one or more sessions on presenting testimony, on legal processes, and on the ethics of the forensic sciences. A number of those teaching in universities responded that although they were not teaching official forensic science classes, both undergraduate and graduate students were allowed to study forensic physical anthropology individually with that faculty member for university credit.

Although from the first brief survey there was no evidence of a forensic anthropology degree program, Question 3 (Table 1) was an attempt to determine whether, if an institution offered a degree in criminal justice, there might be a combined degree in criminal justice/forensic anthropology. Nine respondents indicated that their institutions offered a degree in criminal justice (one in the Sociology Department), but there appears to be no institution with a combined degree program. Some respondents indicated cooperation between themselves and members of the criminal justice program, with students from that program being encouraged to take classes in human osteology, human identification, or forensic physical anthropology.

In answer to Question 3b regarding B.A. or M.A. level "tracks" in forensic anthropology, the replies as listed in Table 2 indicate a higher number of what are called "specialties" rather than official tracks, five at the B.A. level and four at the M.A. level. In most of these cases the respondents described the specialty as involving individual contact with the interested student and having the student assist on forensic science cases or various types of independent research or studies. No one responded that his institution had actually developed a recognized degree program in forensic anthropology, although one individual hoped in the future to establish such a program at the M.A. level.

Various people replied that they had students who were interested in positions as forensic anthropologists, perhaps as paraprofessionals with a B.A. or M.A. degree, but none had obtained this type of job. Eight of the respondents stated that their students had positions in jobs related to the forensic sciences. Among the replies to this question was one from a Section member whose students had obtained Ph.D.s, were now teaching physical anthropology at universities, and had become members of the Physical Anthropology Section of the Academy.

The majority (21) of the members responding to this questionnaire replied that their forensic science research was essentially independent of their university position. Many stated that they served as consultants to the local medical examiner, coroner, or law enforcement agency. Only a few said that the forensic science cases on which they worked were oriented towards their position at the university, usually through publicity.

Summary and Conclusions

As of the end of the academic year (summer) of 1980, there are no recognized degree programs in forensic anthropology, not even combined criminal justice/forensic anthropology programs. The Physical Anthropology Section is, at this time, apparently still the only Academy Section without some type of recognized degree program. To balance these apparent negative aspects there are ongoing, well-developed cooperative workshops and

seminars between members of the Physical Anthropology Section and members of law enforcement agencies and medical examiners' and coroners' offices. In addition, classes in forensic physical anthropology of various types are being offered in universities as service courses for criminal justice majors or as part of track, more frequently specialty, training for physical anthropology students interested in the applied aspects of human identification or forensic physical anthropology. A number of individuals who responded to the questionnaire indicated that they are planning expanded programs in human osteology that will include more of the aspects of forensic physical anthropology and applied archaeology, and some are already involved in teams teaching coordinated courses in the forensic sciences including odontology, criminalistics, and pathology.

While the educational programs that concern forensic physical anthropology were considered, the question arose as to the training of the current membership of the Physical Anthropology Section of the Academy. What were their educational backgrounds in forensic physical anthropology? In the 1980/1981 listing of Section members, totaling 42 individuals, 35 members have Ph.D. degrees, three have M.A. degrees, three have either D.D.S. or M.D. degrees, and one member has both an M.D. and a Ph.D. degree. There is no indication that any of these people have had a specialized series of courses in forensic physical anthropology prior to their participation in forensic science or prior to their being called upon to resolve human identification problems. The Section membership appears to be applying its training and skills derived from either a physical anthropological, medical, or dental education to problems of forensic physical anthropology. Possibly a specific degree program in forensic sciences is not necessary for forensic physical anthropology. Perhaps the "tracks" and "specialty" orientations being provided to students in physical anthropology at B.A., M.A., and Ph.D levels are better bases than a specific set of forensic science degree requirements for developing the breadth of background needed for practicing forensic physical anthropology.

There is the potential that forensic physical anthropologists are developing within the pattern of requirements for degrees in Anthropology Departments, especially at the graduate level. Confirmation for this suggestion is derived from the respondent whose students had completed their Ph.D. degrees, obtained teaching positions in physical anthropology at universities, and are now practicing forensic physical anthropologists and members of the Section. In addition, most of the Section's provisional members, members, and fellows hold teaching positions in universities or research positions in museums or other types of research institutions. Almost none of the current members of the Section holds a full-time forensic physical anthropological position, although most of them serve as consultants or in some other capacity, usually teaching, for the local or regional law enforcement agencies or medical examiners' or coroners' offices. In these aspects, the membership of the Physical Anthropology Section differs from the membership of other Sections within the Academy, so that a comparison of the educational training and background available in forensic physical anthropology should be expected to diverge widely from those Section members of the Academy practicing in forensic jurisprudence, toxicology, or criminalistics or others more specifically trained for full-time forensic science positions.

Sheilagh T. Brooks, Ph.D.
Department of Anthropology
4505 Maryland Parkway
University of Nevada, Las Vegas
Las Vegas, Nev. 89154

Reference

[*1*] Bass, W. M. and Birkby, W. H., "Exhumation: The Method Could Make the Difference," *FBI Law Enforcement Bulletin*, Vol. 47, No. 7, 1978, pp. 6–11.

Discussion of "Firearms Identification Evidence"

Sir:

In the article "An Overview of Firearms Identification Evidence for Attorneys. I: Salient Features of Firearms Evidence," in the January 1981 issue (pages 153 to 158), the statement is made that "the angle of ricochet of a bullet is totally unpredictable except under controlled conditions on the surface of a body of water." This statement is not borne out by the literature [*1,2*] or by my experience. I have found that if the conditions of the ricochet are carefully reproduced the angle of ricochet can be predicted.

The article further states, "When tests are performed under such controlled circumstances, the angle of reflection will equal the angle of incidence...." On the contrary, Haag [*3*] has shown that when a bullet ricochets off water the angle of reflection is normally greater than the angle of incidence.

James L. Norris
Laboratory of Criminalistics
County of Santa Clara
San Jose, Calif.

References

[*1*] Jauhari, "Bullet Ricochet from Metal Plates," *Journal of Criminal Law, Criminology and Police Science*, Vol. 60, No. 3, 1969.
[*2*] Jauhari, "Mathematical Model for Bullet Ricochet," *Journal of Criminal Law, Criminology and Police Science*, Vol. 61, No. 3, 1970.
[*3*] Haag, "Bullet Ricochet from Water," paper presented before the California Association of Criminalists, May 1979.

Author's Reply

Sir:

I appreciate the comments made by James L. Norris. I saw no conflict between my general statement and his assertions. If, indeed, he has gone beyond reading the literature alluded to and, in fact, has "found that if the conditions of the ricochet are carefully reproduced the angle of ricochet can be predicted," I would suggest that if this is new, different, and significant, the experiments be explained, shown, and published so that we may all share in that enlightenment.

With regard to the other quoted statements, I remain firm in my belief that once the critical angle of 29° or lower is used in controlled ricochet tests upon water, the angle of reflection may be greater than the angle of incidence. Normally, it would be interesting to see what tests performed by Mr. Norris have led him to a differing, yet not conflicting, opinion. May I be so bold as to suggest that possibly this apparent interest will stimulate Mr. Norris to experiment and publish regarding this interesting question.

Robert J. Joling, J. D.
Joling, Rizzo & Willems, S.C.
5603 Sixth Avenue
Kenosha, Wisc. 53140

Discussion of "Examination of Fibers by Small Angle Light Scattering"

Sir:

With reference to the recent papers by Bresee and co-workers [*1-3*] on the use of small angle light scattering for discrimination amongst single fibers, we would like to raise the following points.

In their initial study [*1*] the authors used fiber lengths of 1.0 cm. No subsequent details are given on whether repeated trials have been carried out on fragments less than 5 mm in length. Most fibers transferred in contact cases are shorter than 5 mm [*4*]. Preliminary iden-

tification of such fragments as to the commonly encountered generic types can be accomplished in a few moments by an experienced fiber examiner using a polarizing microscope. The method is based on that described by Culliford in 1963 [5].

Positive determination of chemical composition can be achieved with diamond cell infrared spectroscopy, which has now been successfully applied to fiber samples of less than 1 mm in length (0.5 μg). The sample is squashed, but recoverable [6]. Other infrared techniques are also applicable to single fiber samples of less than 5 mm in length [7] with excellent results. Different cross-sectional shapes can also be easily recognized by an experienced examiner without the need to cut cross sections.

One of the most frequent questions facing the forensic fiber examiner in court is "How common are these fibers?" Without exact identification of chemical composition (maintained by Bresee to be unnecessary, provided enough points of similarity are recorded) we cannot begin to answer this question. Much work on this problem is currently being carried out in England using data bank material obtained from the results of infrared spectroscopy and microspectrophotometry on fibers encountered in case work.

The authors claim that SALS can discriminate between fibers of the same type subjected to different laundering methods or outdoor exposure. The example used is Dacron 242. Such treatment may well affect the physical characteristics of the fiber, but this is of little use as a comparative feature whilst the problem of individual fiber characterization remains. Dacron 242 is unusual in being one of the few "octalobal"-shaped polyesters on the market, but on the basis of only examining five samples, how can they be sure that all the other SALS patterns of polyesters from various manufacturers would show no repetition? If presented with "unknowns" can they be sure whether they are dealing with fibers originating from the same or from different manufacturers? No real evidence is presented to suggest that SALS provides a better solution to this problem than that offered by conventional microscopical techniques. It is also known that physical properties of polyesters can vary within one and the same product of a particular manufacturer [8].

Garments submitted to forensic laboratories are not usually new. SALS was used by the authors to *identify* only new unadulterated samples. Subsequent treatment was shown to vary these patterns. In case work it would not be possible to obtain and refer to a "standard" unused sample, even if it was known exactly what fiber was being dealt with, which might be difficult to establish because of alterations to the SALS patterns induced by treatment since new.

If physical characteristics as affected by different conditions of use are to be used as criteria for comparison, is it not a dangerous possibility that an error in judgment may be made by failure to consider the possibility of how a suspect's garments may have been treated *between* commission of an offense and the subsequent submission of the garment to a crime lab for examination? For example, repeated washing or dry cleaning in an attempt to remove bloodstains might lead to a difference in physical characteristics between fibers in the garment and fibers previously found at the crime scene, leading to an erroneous conclusion that they did not originate from a common source when the reverse is in fact true.

No mention is made of the great importance of color comparison in forensic fiber examination, or whether the presence of dye may alter the SALS patterns, particularly for very dark colors or in spun-dyed fibers. It is, of course, possible to remove dyes, but the possibility then exists that the solvent used might alter the surface characteristics.

It is refreshing to see new methods of analysis being applied to fiber examination; however, we feel that the main value of this technique may lie in future supplemental comparisons, but that it cannot be considered as an alternative to established analytical techniques.

M. Grieve, B.Sc.
E. Garger, B.S.
USACIL-EUROPE
APO New York 09757

References

[1] Bresee, R. R. and Donelson, D. S., "Small-Angle Light Scattering for Analysis of a Single Fiber," *Journal of Forensic Sciences,* Vol. 25, No. 2, April 1980, pp. 413-422.

[2] Bresee, R. R. and McCullough, E. A., "Discrimination Among Acrylic Fiber Types by Small-Angle Light Scattering of Single Fibers," *Journal of Forensic Sciences,* Vol. 26, No. 1, Jan. 1981, pp. 184-192.

[3] Bresee, R. R. and Crews, P. C., "Using Small-Angle Light Scattering to Discriminate Among Single Fibers Subjected to Consumer-Like Uses," *Journal of Forensic Sciences,* Vol. 26, No. 1, Jan. 1981, pp. 51-57.

[4] Pounds, C. A. and Smalldon, K. W., "Transfer of Fibers Between Clothing Materials During Simulated Contacts and Their Persistence During Wear. Part 1—Transfer," *Journal of the Forensic Science Society,* Vol. 15, No. 1, Jan. 1975, pp. 17-29.

[5] Culliford, B. J., "The Multiple Entry Card Index for the Identification of Synthetic Fibers," *Journal of the Forensic Science Society,* Vol. 4, No. 2, Dec. 1963, pp. 91-97.

[6] Laing, D. K. and Dudley, R. J., "An Assessment of the High Pressure Diamond Cell for Infrared Spectrophotometry," Report 308, Home Office Central Research Establishment, Aldermaston, United Kingdom, 1979.

[7] Cook, R. and Paterson, M. D., "New Techniques for the Identification of Microscopic Samples of Textile Fibers by Infra-red Spectroscopy," *Forensic Science International,* Vol. 12, No. 3, pp. 237-243.

[8] Heuse, O., "Zur zerstorungsfreien Artbestimmung von textilen Faserstoffen mit Hilfe der Interferenzmikroskopie," Projektbericht, Bundeskriminalamt, Wiesbaden, Federal Republic of Germany, 1980.

Author's Reply

Sir:

Small-angle light scattering (SALS) does not take the place of microscopy, infrared spectroscopy, or any other method of analysis. Like any analytical technique, SALS has its own unique character, applications, and limitations. These applications and limitations are easily seen by comparing SALS to microscopy. The two chief advantages of SALS over scanning electron microscopy (SEM) are the ability of SALS to measure optical properties and the inherently greater sensitivity of SALS to objects in its accessible size range. The two chief advantages of SALS over optical microscopy (OM) are SAL's ability to provide structural information inaccessible by OM, such as the optical sign of small spherulites, and SAL's ability to provide quantitative information about size and shape to a greater accuracy and without the depth-of-field limitations of OM. On the other hand, the two chief disadvantages of SALS are greater difficulty in data interpretation and smaller size range accessibility compared to microscopic methods. Of course, many more differences cited here should serve to indicate that SALS, like other methods of analysis, has its own peculiar capability.

It evidently needs to be emphasized that our intended use of SALS is not fiber identification. We have never claimed to identify any fiber by SALS. The strength of the technique lies in structural characterization instead. We believe that in a society characterized by widespread consumption of a relatively small number of fiber generic groups, relatively limited evidential power results from generic group identification. If performed to sufficient detail, structural characterization and comparison of evidence found at a crime scene and in a suspect's possession may lead to greater evidential power. Characterization of polymer chemical constitution by infrared spectroscopy represents an example of this. We have merely suggested adding physical structural characterization by SALS (and several other techniques) to the arsenal of analytical methods available to the forensic scientist for structural characterization. I believe that if a fiber is characterized extensively enough using both chemical and physical methods of analysis, a composite picture is obtainable that is unique and can serve to "fingerprint" a fabric. Hence the role of SALS in forensic fiber examinations.

It is true that if consumer use alters fibers' physical structure a criminal may modify the physical properties of his fibers by use such as multiple launderings of his textiles after a

crime is committed. This is a serious problem. However, the problem is not unique to SALS. It is common to any method of analysis sensitive enough to detect consumer-induced structural changes in fibers. It should be pointed out that the chemical as well as the physical structure of fibers is altered by common use. We are currently working on methods of analysis sensitive enough to detect these chemical structural changes. They will parallel SALS and other methods of physical structure characterization in providing a detailed structural profile of consumer-used fibers. The less sensitive methods of analysis preferred by Messrs. Grieve and Garger will still be available for cases where these new methods will not work, but much can be gained by their availability.

In response to the more trivial points raised by Messrs. Grieve and Garger: First, organic dyes are not large enough in size to scatter light. Consequently, we did not examine color, except for one case of a commonly used aggregated inorganic pigment. Second, we are well aware of the fact that short fibers are more apt to be shed from a fabric than long fibers. We took a "worst case" example of highly crimped acrylic fibers and found that good, reproducible SALS patterns were obtainable from 5-mm fiber lengths. In addition, we provided an alternate procedure that could be used should, somehow, a "worst than worst case" fiber be examined. Consequently, SALS is entirely appropriate for analysis of short lengths of single fibers characteristic of forensic evidence. Third, SALS is used for physical structural characterization, which is quite different from determination of chemical structure by infrared spectroscopy as advised by Messrs. Grieve and Garger. Consequently, the two analytical methods provide different types of information and one cannot do the job of the other.

Randall R. Bresee, Ph.D.
Textile Science
Kansas State University
Manhattan, Kansas 66506

Quality Control

Sir:

The addendum to our paper, "The Trapping, Storing, and Subsequent Analysis of Ethanol in In-Vitro Samples Previously Analyzed by a Nondestructive Technique," which appears on pages 671 through 677 of this issue, makes reference to a quality control problem with the silica gel used in trapping alcohol. We have studied this problem and have located the difficulties.

The original columns contained approximately 250 mg of 20-40 mesh silica gel. After two years of successfully trapping and analyzing alcohol in breath samples, the system seemed to develop difficulties. We found that the silica gel had been changed to a 12-28 mesh size. In an attempt to solve this problem we placed an alcohol solution into a simulator, pumped the vapor into a 4011 AS Intoxilyzer, and produced a 0.47% alcohol reading. A silica gel column was attached to the outlet tube and a second Intoxilyzer was attached in series to this tube. This allowed us to use the second Intoxilyzer to monitor any alcohol breaking through the tube. The 12-28 mesh silica gel did *not* trap the alcohol in the 715-mL vapor sample. Using this procedure and 30-60 mesh silica gel we determined that the minimum amount of silica gel needed to trap all of the alcohol in a 4011 AS cell when using a >0.40% alcohol solution in a simulator was between 150 and 175 mg (Table 1).

Columns were then packed with 172 mg and 200 mg of 35-60 mesh silica gel. The columns were used to trap alcohol samples and then analyzed by gas chromatography (Table 2).

TABLE 1—*Determining minimum amount of silica gel required.*

Weight of 30-60 Mesh Silica Gel in Column, mg	Concentration of Alcohol Solution Used, %	Average % of Alcohol Breaking Through the Trap
50	0.47	32.1
100	0.47	12.5
150	0.47	3.7
172	0.42	0.0
200	0.47	0.0

TABLE 2—*Results of analysis by gas chromatography.*

Silica Gel Used in 35-60 Mesh, mg	Intoxilyzer Reading, %	Collected Sample Analyzed by Gas Chromatography, %
172	0.06	0.06
172	0.11	0.11
172	0.16	0.16
172	0.21	0.21
200	0.06	0.06
200	0.27	0.26

The major problem with the silica gel was the particle size coupled with the relatively high flow rate of the Intoxilyzer. Because of the high flow rate of the instrument and its fairly small cell volume, it is important to use a large mesh size and a minimum amount of silica gel. This results in a 100% trapping efficiency and a need for a small volume of liquid to remove the alcohol from the gel. Based on the preceding data our recommendations are as follows:

1. The silica gel particle size is an important factor. The 35-60 mesh silica gel produces acceptable results.
2. It is recommended that the collection tubes be packed with 175 mg of silica gel. This amount is capable of holding the trapped vapor containing the equivalent of 0.47% alcohol solution. The smaller amount of silica gel facilitates analysis by gas chromatography.
3. Each lot of silica gel must be tested to ensure its effectiveness. A sound quality control system must be incorporated in the manufacture of the traps.
4. When transferred to a water/*n*-propanol solution the sample *must* sit at least 1 h and be carefully mixed before injection.

When using gas chromatography, liquid injection, and flame ionization detection we recommend these procedures:

1. Carefully transfer the contents of the tube into 0.6 mL of a 0.2% *n*-propanol solution in a flat-bottom container (which spreads the gel). Gently swirl the container to mix the silica gel and *n*-propanol solution. Do not shake! Allow it to sit for at least 1 h. Swirl again and inject. Use the *n*-propanol as an internal standard.
2. Dilute standards 50/50 v/v with a 0.4% *n*-propanol solution and inject.
3. Make sure all samples and standards are 0.2% in *n*-propanol.

Donald R. Wilkinson
David Sockrider
Carol Bartsch