Sample Foundation -- GC/MS Identification of Gasoline Used in Arson.

Frederic M. Douglas

In the following sample foundation, a sample from the charred remains from a suspected arson fire to a residential structure is presented to the witness. The witness explains the GC/MS test results. The examining attorney has already established chain of custody and the scientific theory's validity.

Q. What is your occupation?

A. I am an analytical chemist at the California Department of Justice.

Q. What is an analytical chemist?

A. I analyze samples to determine their composition using scientific techniques and instruments.

Q. Please tell the jury about the types of samples that you analyze in your work.

A. Many of the specimens that we process are suspected of containing narcotics. I specialize in identifying specimens from suspected arson fires and explosives. One example, maybe an investigator gathers a sample from a burnt rafter in a structure fire. We identify the contents of the specimen. Usually, the detectives want to know if an accelerant was used to fuel the fire and if so, what accelerant was used. From time to time I also analyze body fluids and tissues for drugs and their metabolized remnants.

Q. Please tell the jury about your formal education.

A. I have a Bachelor's and Master of Science degree in Chemistry from M.I.T, and a PhD. in Analytical Chemistry from U.C. Berkeley.

Q. Could you tell the jury about the courses you took at U.C. Berkeley?

A. Yes, I took many courses in analytical chemistry. I took two semesters of general analytical chemistry. Then there was a survey course on analytical instruments, which included a laboratory component where we operated every device that our course covered. There was a seminar class on analytical instrument troubleshooting techniques where we learned how to identify instrument malfunctions and how to prevent false positives and false negatives.

Q. Did any of these courses cover the GC/MS instrument?

A. Yes, all of them. The professor for the seminar course, Professor G. See is known as one of the leading experts in the development of the use of the GC/MS instrument in hydrocarbon analysis.

Q. How long have you been an analytical chemist?

A. For about ten years, all of that time with the California Department of Justice.

Q. Have you published anything in the analytical chemistry field?

A. Yes, besides my theses I have written twenty articles on analytical chemistry, including a book on the GC/MS analysis.

Q. What is "GC/MS"?

A. That stands for "gas chromatography and mass spectrometry." It is a two-stage process. The gas chromatography device separates the sample into the different chemicals present by vaporizing the sample. Next the mass spectrometry machine identifies the different chemicals by measuring the mass of each chemical.

Q. How many of the articles that you published deal with GC/MS?

A. About half or my articles were on GC/MS, using the instrument for arson investigation, drug identification, and bomb blasting powder characterization.

Q. Is GC/MS testing reliable?

A. Yes, the GC is a superior separation tool and the MS provides specific results. When the GC is combined with the MS, you have an extremely effective analytical tool.

Q. What do you mean by "specific results"?

A. A specific result is when a test shows that only one brand of gasoline was used, with little likelihood of a false positive result. A nonspecific result is when a test produces a result indicated by more than one brand of gasoline. The nonspecific result gives many false positive results.

Q. What is a "false positive" result?

A. A false positive is when the test says one brand of gasoline was used when in fact another brand was used.

Q. Is GC/MS a specific test or a nonspecific test?

A. Specific. The GC by itself is not specific, but using the MS device with the GC gives a specific result.

Q. Are you familiar with any research that mentions that using MS with G.C. gives a specific result?

A. Yes, that was covered in my instrument lab class at Berkeley. The pioneering research was performed by Professor Ann L. Itical at Wisconsin. I read everything that Professor Itical wrote on the GC/MS combination.

Q. Is the GC/MS combination generally accepted in the scientific community as a way to identify the brand of gasoline used in an arson fire?

A. Yes, it is the preferred test.

At this point, counsel seeks to have the witness describe the GC process with a visual aid. The counsel follows proper courtroom procedure by showing the chart to the opposing counsel and marking the chart as exhibit #3.

Q. Your Honor, may the witness step down and approach the exhibit?

J. Yes, the witness may step down and approach the item marked exhibit #3 for identification.

Q. Thank you, your Honor. Looking at what is marked as exhibit #3 for identification, what is this?

A. This is a drawing of the equipment used in gas chromatography.

Q. What components does the GC include?

The witness points to each component while answering the question.

A. The GC has the injection port, the carrier gas, the column, the sample splitter, the detector and the output recorder.

Q. A small amount of the sample is dissolved. Then this solution is injected into the injection port, here, with a syringe. The injection port is hot so the sample vaporizes into a gas. The carrier gas pushes the sample, this way, through the column. Each chemical in the sample sticks to parts of the column in different ways; some chemicals stick to the column and do not come back off easily, while some chemicals do not stick at all. Most chemicals act somewhere in between. The greater the chemical sticks, the longer it takes for that chemical to travel through the column. When each chemical eventually leaves the column, the detector, at this end, measures it and the sample splitter sends part of the chemical to the mass spectrometer.

While the witness remains near exhibit #3, the counsel properly has another visual aid marked exhibit #4 for identification. The counsel displays exhibit #4 in front of the witness.

Q. Thank you, your Honor. Looking at what is marked as exhibit #4 for identification, what is this?

A. This is a drawing of the equipment used in mass spectrometry.

Q. What components does the mass spectrometer include?

A. *The witness points to each component in the drawing while answering.* The MS has an ionization chamber, an analyzer tube, an electromagnet, a detector, and an output recorder.

Q. How does the MS device work?

A. The splitter stream from the GC enters the MS's ionization chamber, in here, where each chemical receives an electrical charge. This electrical charge causes the molecules in the chemical to break apart into charged fragments. The charged fragments travel through the analyzer tube towards the electromagnet. Depending on the mass of the fragments, each fragment is affected differently by the electromagnet. When the fragments strike the detector, at this end, they lose their charge and the output recorder produces a mass spectrum for each component.

While the witness remains near exhibit #4, the counsel properly has another visual aid marked exhibit #5 for identification. The counsel displays exhibit #5 in front of the witness.

Q. Now looking at what is marked as exhibit #5 for identification, what is this?

A. This is a mass spectrum graph.

Q. What is a mass spectrum?

A. A mass spectrum is a graph of a sample's different fragments. Each pattern of fragments is unique to that substance. These peaks represent fragments with their respective molecular weights. If the technician properly analyzes the spectrum, the technician can identify the substance specifically.

Q. Your honor, may the witness return to the witness box?

J. Yes, the witness may return to the witness box.

Questioning resumes after the witness is seated.

Q. How does a technician analyze a mass spectrum?

A. Reference books or computer files exist with sample spectrums. The technician can compare these sample spectrums with the spectrum in question. Another way to analyze the spectrum is for the technician to run a separate test on a known sample of what the technician believes the substance to be. If the spectrums match, then the technician has determined the sample's identity.

Q. Have you had any training using the GC/MS?

A. Yes, I completed the California Department of Justice drug identification course and another arson accelerant identification course.

Q. Who taught these courses?

A. The drug identification course was taught by Dr. Mary Wana, the manager of the California State Drug Identification Institute. The arson course was taught by Johnny Blaze, head of the FBI arson accelerant identification and characterization laboratory. This course also had an explosives identification course taught by Guy Fawkes, Scotland Yard's chief forensic lab director. These courses concentrated on using GC/MS.

Q. How long were these courses?

A. They were both five-day courses.

Q. How long ago did you take these courses?

A. I took the drug identification course in 1990 and the arson course in 1995.

Q. What arson accelerant identification techniques were taught at the 1995 course?

A. The widely used ones, including GC/MS.

Q. How did you learn these techniques in the course?

A. The instructors explained the techniques, demonstrated how to use them, then we had to use them ourselves. It was a hands-on course. We also had to learn how to maintain the instruments.

Q. How did the instructors determine if you were proficient with the GC/MS?

A. We were tested with 20 sample compounds. The sample vials only had code numbers; only the instructors knew what was in each vial. We had to identify all the samples correctly to pass the course.

Q. How many times have you used the GC/MS?

A. Probably about a thousand times.

Q. And for what length of time has this been?

A. Since I took that drug identification course in 1990, so almost ten years.

Q. Have you ever identified a particular accelerant used in an arson fire?

A. Yes.

Q. Which accelerants have you identified?

A. Kerosene, fuel oil, barbecue lighter fluid, butane, propane, and gasoline. For gasolines, I also have identified what particular brand of gasoline was used.

At this time, the proponent establishes the chain of custody of the specimen. The proponent has approached the witness with the specimen marked as exhibit 6 for identification.

Q. This is what is marked as State's exhibit number six for identification. Do you recognize it?

A. Yes, it is the specimen I tested from the fire at 1234 Fluegel Street.

Q. How do you recognize it?

A. By my initials and the case number date on this tag.

Q. After you received this exhibit what did you do?

A. I started to prepare the GC/MS for analysis.

Q. What type of GC/MS do you have in your laboratory?

A. Our laboratory has a Perkins Deluxe model, which is commonly used in most forensic laboratories in the U.S.

Q. In what condition was the GC/MS in?

A. The GC/MS was in good working condition.

Q. How do you know that the GC/MS was in good working condition?

A. Other chemists use the same GC/MS. Before each chemist uses the GC/MS, the chemist must perform a series of preventive maintenance checks and maintenance services on the GC/MS. Our GC/MS had been used several times before I analyzed this specimen on the that very day.

Q. And what day was that?

A. April 31, 1998.

Q. Did you notice any deficiencies in the GC/MS device?

A. No.

Q. What did you do then?

A. I dissolved a small portion of the specimen in ether and injected into the injection port of the GC.

Q. Did you do anything else before you analyzed this sample?

Q. On this occasion how did you perform the test?

A. In the same way that I explained before. I compared the spectrum to a published spectrum chart.

Q. What are overlapping peaks?

A. Overlapping peaks mean that different chemicals in the specimen did not adequately separate during the GC process. This would make the results unreliable.

Q. Were there any overlapping peaks during the analysis of State's exhibit number six for identification?

A. No.

Q. What is a peak cluster?

A. A peak cluster occurs when chemicals have the same atomic number but different masses. This would make the parent peak difficult to determine, making the results unreliable.

Q. Did you see any peak clusters during the analysis of State's exhibit number six for identification?

A. No.

Q. Did you run any other samples before analyzing this sample?

A. Yes, I processed a standard sample of Chevron gasoline with Techroline fuel injection protectant before analyzing the specimen in exhibit number six.

Q. Did you do anything else to ensure the accuracy of the instrument's results?

A. Yes, I ran the GC/MS instrument again with another standard sample of Chevron gasoline with Techroline fuel injection protectant. I compared the mass spectrum of the two standard samples with the mass spectrum of the specimen from exhibit # 6. I observed that the three spectra were near identical.

Q. What substance did you determine State's exhibit number six for identification to be?

A. The substance in State's exhibit number six is definitely Chevron gasoline with Techroline fuel injection protectant.

Counsel moves to enter the three mass spectra into evidence. The court orders them to be entered into evidence without objection from opposing counsel.

The following sources were consulted in developing this sample foundation:

Vinal, Robert W., Annotation, *Admissibility and Reliability of Hair Sample Testing to Prove Illegal Drug Use*, 47 AM. JUR. PROOF OF FACTS 3D 203, 232-33 at § 21 (1998).

SCHLUETER, DAVID A., ET AL., Texas Evidentiary Foundations § 9-3(C)(3)(ii) (2d ed. 1992).