

... would not be awarded
... circumstances that
... through transsexual
... female to male, had
... name and married a
... not adversely affect her
... hip with children or im-
... motional development.
... andall, — Colo App —,

... rly awarded temporary
... her, even though custody
... the mother, an Alabama
... virtue of Idaho divorce
... affidavit filed by father
... ces of mistreatment of
... eir stepfather and sug-
... idren's return to moth-
... would expose them to
... a v Ferreira, 9 Cal 3d
... ptr 80, 512 P2d 304.

... was repeatedly indis-
... her man, though there
... evidence of sexual infir-
... ere, though both chil-
... strong desire to live
... er, older boy who was
... wife, expressed some
... optive father, custody
... arded to husband, par-
... wife's mother testified
... ghly familiar with all
... to custody and she
... trial judge to award
... and. Dowell v Dowell
... 478.

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(Chapter 2)

IDENTIFICATION OF SUBSTANCES BY
NEUTRON ACTIVATION ANALYSIS

Sections Added:

- § 3.5. Legal Developments
- § 6.5. In General; Recent Developments
- § 29.5. Legal References

I. INTRODUCTORY COMMENT

A. INTRODUCTION

§ 3.5. Legal Developments [New]

Material prepared by the editorial staff of the publisher.

As to general list of recent cases in which neutron activation analysis results were successfully introduced, see § 6.5, infra, this supplement.

Acceptance of Neutron Activation Analysis at Appellate Level

As of the end of 1970, the admissibility of evidence of neutron activation analysis results had been upheld at the appellate level in two cases.

In *State v Coolidge* (1969) 109 NH 403, 260 A2d 547, rev'd on other grounds 403 US 443, 29 L Ed 2d 654, 91 S Ct 2022, reh den — US —, 30 L Ed 1120, — S Ct —, testimony as to neutron activation analysis of particles taken from the clothing of the murder victim and from the clothing of the defendant was admitted where the prosecution's expert attempted only to show that because four sets of particles were found to have various chemical elements in common and in such comparable abundance as to warrant the conclusion that each set had a common origin or source. However, evidence relating to the identification of hair samples taken from the clothing of the victim and from the pubic region of the defendant was inadmissible on the grounds that the prosecution's experts had used methods of analysis not acceptable to scientists in the field and that the scientific principle involved in making the analysis was not sufficiently established to have gained general acceptance in the field.

In *United States v Stifel* (1970, CA6 Ohio) 433 F2d 431, cert

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den 401 US 994, 28 L Ed 2d 531, 91 S Ct 1232, a murder prosecution, expert testimony as to neutron activation analysis of parts of a mailing tube used for a bomb was held to be admissible for the purpose of showing that the fragments were of the same "elemental composition" as comparable parts of mailing tubes to which the defendant had access, and that, "within reasonable scientific certainty," the fragments were "of the same type and manufacture." The opinion of the court contains a valuable background discussion on the evidential use of neutron activation analysis.

Two other appellate level cases have recognized the essential validity of neutron activation analysis as a test, but have rejected evidence obtained thereby on the grounds that the expert's opinion testimony as to the test results was not based on a reasonable scientific certainty (*State v Holt* (1969) 17 Ohio St 2d 81, 46 Ohio Ops 2d 408, 246 NE2d 365; see § 31, infra, this supplement), and that the prosecution failed to inform the defendant before trial that it intended to use a neutron activation analysis test (*United States v Kelly* (1969 CA2 NY) 420 F2d 26; see below).

In *State v Stevens* (Mo) 467 SW2d 10, cert den 404 US 994, 30 L Ed 2d 546, — S Ct —, a murder prosecution in which defendant was convicted due partly to identification by neutron activation analysis of hair from victim and defendant found on defendant's blood-stained shirt worn at time of murder, testimony of nuclear physicist established his own qualifications as expert witness, and prima facie case of accuracy and reliability of the computer used was established by physicist's testimony that at least every other day for a month prior to tests made in the instant case he checked the accuracy of the computer by feeding into it known data and checking the result with the known answer.

For an annotation collecting the cases dealing with the admissibility of neutron activation analysis evidence, see 50 ALR3d 117.

Necessity for Prosecution to Inform Defendant of Intention to Use Neutron Activation Analysis Test

In a federal criminal case, when the prosecution intends to use a neutron activation analysis test it should so inform the defendant prior to trial, or run the risk of having any evidence obtained from the test ruled inadmissible. In *United States v Kelly* (1969, CA2 NY) 420 F2d 26, a criminal conviction for narcotics violations was reversed because defendant was not made aware of the prosecution's use of a neutron activation analysis test until the

prosecution produced its first witness at the trial, and was therefore deprived of a chance to research the techniques and results of the test. Pretrial discovery of the chemical analysis of the drugs involved in the indictment had been ordered, and the appellate court held that the prosecution had a continuing duty to come forward with new scientific tests it made. In a dictum in *United States v Stifel* (1970, CA6 Ohio) 433 F2d 431, cert den 401 US 994, 28 L Ed 2d 531, 91 S Ct 1232, the court noted that when the prosecution intends to use a neutron activation analysis test, it must allow time for a defendant to make similar tests, and, in the instance of an indigent defendant, it must provide a means for payment for the tests. However, in *State v Coolidge* (1969) 109 NH 403, 260 A2d 547, revd on other grounds 403 US 443, 29 L Ed 2d 564, 91 S Ct 2022, reh den — US —, 30 L Ed 2d 1120, — S Ct —, the New Hampshire Supreme Court rejected defendant's contention that the evidence resulting from a neutron activation analysis test was inadmissible because he was not informed of its use by the prosecution prior to trial. The court stated that the prosecution was not required in advance of trial to reach a firm conclusion concerning its use of such evidence at the trial, and that the defendant was not prejudicially deprived of an opportunity to defend against such evidence, since he was in a position to call to the stand at the trial his own expert witness, who testified adversely to the conclusion advanced by the prosecution.

In *State v Kassow*, 28 Ohio State 2d 141, 57 Ohio Ops 2d 390, 277 NE2d 435, vacated on other grounds 408 US 939, 33 L Ed 2d 762, 92 S Ct 2876, a prosecution for murder in the course of a bank robbery, a neutron activation analysis was administered to defendant to determine whether he had fired a gun on the day in question. The results of the test, indicating that "gunshot residue was present" on defendant's right hand, were introduced into evidence. There had been a denial of defendant's pretrial motion for discovery and inspection, asking specifically for the right to review the scientific analysis of any items or tests taken with respect to lie detection or paraffin. On appeal, defendant contended that when a court overrules a timely defense motion for discovery and allows the state to introduce the results of a neutron activation analysis without first disclosing it to the defense, or allowing the defense to run its own test, there is a deprivation of the right to fair trial and to due process of law. However, the appellate court held that there was no such right of discovery in Ohio as that involved in *United States v Kelly*, supra, and that in view of defendant's failure to show prejudice in light of his counsel's comprehensive cross-examination of the state's

expert witness, there was no abuse of discretion in the denial of discovery and inspection.

B. FORENSIC APPLICATION

§ 6.5 [New] In General; Recent Developments

by R. M. and J. C. Watkins

The enthusiastic use of neutron activation analysis (NAA) by a variety of federal government agencies has been largely responsible for the growing acceptance of such evidence in both federal and state courts. The Alcohol and Tobacco Tax Division of the Internal Revenue Service, Treasury Department, has spurred the Post Office Department, the Food and Drug Administration, and others to follow its lead in using NAA to help solve numerous criminal and civil cases. Other public agencies now applying NAA in this field include the Air Force, the Army Criminal Investigation Laboratory, the U. S. Geological Survey, and the Federal Bureau of Investigation. The Chicago and Los Angeles police departments are using neutron activation analysis on the local level of law enforcement.¹ Figure 1 gives recent court cases involving NAA.

Figure 1. Recent Cases in Which Neutron Activation Analysis Results Were Successfully Introduced.

Case	Charge	Testimony By	Disposition	Evidence
1. U.S. v Melton Pits and Sharp March 3, 1970 Decatur, Alabama	Violation of IRS liquor laws	M. J. Pro, IRS	Melton: acquitted Pits: guilty Sharp: released	Soil and moonshine
2. Michigan v Enoch Chism January 26, 1970 Marshal, Michigan	First degree murder	C. Michael Hoffman, IRS	Guilty	Battery fragments, red crayon, and masking tape
3. U.S. v Fred Jackson Fritts December 15, 1969 Chattanooga, Tennessee	IRS liquor laws—conspiracy	Ken Snow, IRS	Not guilty	

1. Private communication: M. J. Pro to J. C. Watkins, March 25, 1970.

4. Florida v Jenkins December 11, 1969 Bartow, Florida	Burglary of Post Office	James Scott, POD	Guilty	Paint
5. U.S. v Harkins December 1, 1969 Dothan, Alabama	Conspiracy—Burglary	James Scott, POD	Guilty	Paint
6. U.S. v Owens & Harris November 25, 1969 Savannah, Georgia	Violation of IRS liquor laws	M.J. Pro, IRS	Both guilty	Sand mortar, concrete block, paint & soil samples
7. U. S. v Gutherie November 12, 1969 Birmingham, Alabama	Violation of IRS liquor laws	C. Michael Hoffman, IRS	Directed verdict of acquittal	Hair
8. Missouri v Stevens November 1, 1969 Missouri * Affd (1971) 467 SW2d 10 Cert den — US —, 30 L Ed 2d 546, — S Ct —	Murder	James Voght, University of Missouri	Guilty	Hair and sewing thread
9. U.S. v Thomas Jefferson Beck October 30, 1969 Gainesville, Georgia	Violation of IRS liquor laws	C. Michael Hoffman, IRS	Guilty	Paint
10. U.S. v Tim McCoy Strickland October 27, 1969 Columbia, South Carolina	Five counts including possession of unregistered distillery	Kenneth B. Snow, IRS	Guilty, all counts	Hair and soil
11. U.S. v Clyde and Carl Hudson October 21, 1969 Rutherfordton, North Carolina	Four counts to violate IRS laws	M.J. Pro, IRS	Clyde: Plead guilty Carl: Guilty by jury decision	Hair
12. U.S. v Freddie C. Ayers & Daniel Scott October 2, 1969 Decatur, Alabama	Burglary	James Scott, POD	Guilty	Paint & safe insulation

Figure 1.—Continued

Case	Charge	Testimony By	Disposition	Evidence
13. State of Ohio v Barbara Jean Shutt September 30, 1969 Cincinnati, Ohio	First degree murder	Ken Snow, IRS	Guilty	Gunshot residue
14. U.S. v Alfred E. Harflinger and James W. Nash September 22, 1969 Kansas City, Missouri	Violation of title 7 (possession of unregistered destructive device)	C. Michael Hoffman, IRS	Guilty	Black tape & soil samples
15. U.S. v Fred Jackson Fritts, et al September 15, 16 and 17, 1969 Chattanooga, Tennessee	Conspiracy and four other counts	Ken Snow, IRS	Guilty all counts	Moonshine
16. U.S. v Reid and Jones August 2, 1969 Muskogee, Oklahoma	Burglary	James Scott, POD	Guilty	Safe insulation
17. Colorado v Donald Everette Carroll Denver, Colorado	First degree murder	C. Michael Hoffman, IRS	Guilty	Gunshot residue
18. U.S. v Austin July 15, 1969 Tampa, Florida	Post Office burglary	James Scott, POD	Not guilty	Safe insulation
19. U.S. v Childers and Owens June 2, 1969 Athens, Georgia	Violation of IRS liquor laws	M.J. Pro, IRS	Hung jury — retrial set for later date	
20. Commonwealth of Virginia v Robert & Gene Thomas May 22, 1969 Mathews, Virginia	Burglary	James Scott, POD	Guilty	Paint
21. U.S. v Gibson, et al April 24, 1969 Macon, Georgia	Violation of IRS liquor laws	Richard Brunelle, IRS	Guilty	Soil and tarpaper

Figure 1.—Continued

Case	Charge	Testimony By	Disposition	Evidence
22. U.S. v Stifel April 1969, Ohio Affd (1970, CA6 Ohio) 433 F2d 431 *Cert den 401 US 994, 28 L Ed 531, 91 S Ct 1232	Murder	James Scott, IRS; C. Michael Hoffman, IRS	Guilty— Life imprisonment	Red tape, paper labels and metal
23. U.S. v Hemphil and Brown April 21, 1969 Nashville, Tennessee	Violation of IRS liquor laws	M.J. Pro, IRS	Guilty— each one year	Paint, soil, cloth
24. U.S. v Collins, et al March 25, 1969 Savannah, Georgia	Violation of IRS liquor laws	M. J. Pro, IRS	Not guilty	Concrete blocks, paint and moonshine
25. U.S. v Rider March 20, 1969 Rome, Georgia	Violation of IRS liquor laws	M. J. Pro, IRS	Not guilty	Soil
26. U.S. v Lynum February 25, 1969 Columbus, Georgia	Violation of IRS liquor laws	M. J. Pro, IRS	Guilty	Unidentified particles
27. West Virginia v Jones February 7, 1969 Beckley, West Virginia	Burglary	James Scott, POD	Guilty	Cinder-block, paint & plaster
28. U.S. v James Williamson, et al February 5, 1969 Aberdeen, Mississippi	Possession & transporting nontax paid distilled spirits	Ken Snow, IRS	Guilty all counts	Mash & moonshine
29. New York v Ernest Holley January 21, 1969 Buffalo, New York	Felonious possession of heroin	Richard L. Brunelle, IRS	Guilty	Heroin
30. U.S. v Richardson and Kennedy November 15, 1968 London, Kentucky	Conspiracy to violate IRS liquor laws	Maynard J. Pro, IRS	Richardson: guilty Kennedy: not guilty	Richardson: hair Kennedy: NAA and atomic absorption of copper and solder

Figure 1. —Continued

Case	Charge	Testimony By	Disposition	Evidence
31. U.S. v Powell, et al October 7, 1968 Dublin, Georgia	Violation of liquor laws	C. Michael Hoffman, IRS	Guilty	Paint
32. State of California v Dontanville April, 1968 Los Angeles, California, Superior Court	Murder	H. L. Schlesinger, Gulf General Atomic	Acquitted	Hair
33. Glen Eyre Farms v Kempton Co-Operative Grain Co. May, 1968 Danville, Illinois U.S. District Court	Oats, allegedly poisoned with mercury, killed several valuable race horses	H. R. Lukens, Gulf General Atomic	In favor of defendant	Oats
34. Commonwealth of Virginia v Langhorn E. Brown October 1, 1968 Virginia Beach, Virginia	Armed robbery	Kenneth Snow, IRS	Guilty	Soil
35. U.S. v Clifford T. Clark September 23, 1968 Greenville, South Carolina	Possession and transporting illicit whiskey	C. Michael Hoffman, IRS	Not guilty	Hair
36. U.S. v Reid and Jones August 2, 1968 Muskogee, Oklahoma Federal Court	Burglary	James Scott, Post Office Dept.	Guilty	Safe insulation
37. U.S. v Martinez and Handy July 8, 1968 Toledo, Ohio	Conspiracy to violate narcotics laws	Maynard J. Pro, IRS	Guilty	Heroin
38. U.S. v Hooks June 24, 1968 Charleston, South Carolina	Violation of IRS laws	Maynard J. Pro, IRS	Guilty	Paint
39. U.S. v P. Southern June 3, 1968 Athens, Georgia	Conspiracy to violate IRS laws	Maynard J. Pro, IRS	Guilty	Moonshine

Figure 1. —Continued

Case	Charge	Testimony By	Disposition	Evidence
40. U.S. v Burge and Speer May 21, 1968 Fresno, California	Burglary	James E. Scott, Post Office Dept.	Guilty	Paint
41. U.S. v Leonard F. Miller May 21, 1968 Atlanta, Georgia	Possession and operation of illicit distillery	Richard L. Brunelle, IRS	Not guilty	Rope and soil
42. U.S. v Pinkston, et al April 1, 1968 Indianapolis, Indiana Federal Court	Conspiracy, burglary	James E. Scott, Post Office Dept.	Guilty	Paint
43. U.S. v O'Neil April 1, 1968 Albany, Georgia	Production of illicit whiskey	C.M. Hoffman, IRS	Guilty	Pipe and pipe fittings
44. U.S. v White January 29, 1968 Winchester, Tennessee	Operating an illegal distillery	C. M. Hoffman, IRS	Guilty	Wheat paste
45. U.S. v Brown, et al January 24, 1968 Chattanooga, Tennessee	Conspiracy to violate IRS laws	Maynard J. Pro, IRS	Guilty	Paint and brazing material
46. U.S. v Liskey, Sr. January 22, 1968 Norfolk, Virginia	Manufacturing and passing counterfeit money	R. L. Brunelle, IRS	Acquitted	Soil
47. U.S. v Grimes November 27, 1967 Macon, Georgia	Transporting non-taxpaid distilled spirits	C. M. Hoffman, IRS	Guilty	Hair
48. Ohio v Watson November, 1967 Cleveland, Ohio	Murder—first degree	Maynard J. Pro, IRS	Guilty	Gunshot residue
49. U.S. v Diaz November 20, 1967 Ft. Benning, Georgia	Negligent homicide	R. L. Brunelle, IRS	Not guilty	Gunshot residue

Figure 1.—Continued

Case	Charge	Testimony By	Disposition	Evidence
50. State v Holt October 1965, Ohio Revd (1969, Ohio) 246 NE2d 365	Rape	W. Wahl, Union Carbide Tuxedo, N.Y.	Guilty	Pubic hair
51. U.S. v Shaw October 25, 1967 Biloxi, Mississippi Federal Court	Operation of illegal distillery	C. M. Hoff- man, IRS	Guilty	Head hair
52. Georgia v Fuller & McDade October 11, 1967 Griffin, Georgia	Manufactur- ing and pos- sessing nontaxpaid distilled spirits	K. B. Snow, IRS	Guilty	Soil
53. U.S. v Leach October 5, 1967 Aberdeen, Mississippi	Violation of IRS laws	R. L. Brunelle, IRS	Guilty	"Bondo" and copper tubing
54. Commonwealth of Virginia v Monday, et al July 24, 1967 Chesterfield County, Virginia	Conspiracy, violation of IRS laws	Maynard J. Pro, IRS	Guilty	Moonshine and soil
55. U.S. v Burman June 22, 1967 Cheyenne, Wyoming	Conspiracy	C. M. Hoff- man, IRS	Guilty	Gunshot residue
56. U.S. v Smith May 5, 1967 Colonial Heights, Virginia	Burglary	James Scott, Post Office Dept.	Guilty	Safe insulation and glass fragments
57. U.S. v Berry, Randall and Harrison June 13, 1967 Pensacola, Florida	Conspiracy, violation of IRS laws	Maynard J. Pro, IRS	Guilty	Soil
58. U.S. v Faulkner, Parham April 24, 1967 Rome, Georgia	Violation of IRS laws	Maynard J. Pro, IRS	Faulkner: Guilty Parham: Not guilty	Soil
59. U.S. v Leavell, Simmons and O'Berry February 21, 1967 Columbia, South Carolina	Firearms violation	C. M. Hoff- man, IRS	Guilty	Soil

Figure 1.—Continued

Case	Charge	Testimony By	Disposition	Evidence
60. U.S. v Dillon February 6, 1967 St. Louis, Missouri	Firearms violation	Maynard J. Pro, IRS	Guilty	Gun metal
61. Commonwealth of Virginia v Smith and Turner January 27, 1967 Bowling Green, Virginia	Post Office burglary	James Scott, Post Office Dept.	Guilty	Safe insulation and glass
62. Commonwealth of Virginia v Gilliam November 9, 1966 Hanover County Court, Virginia	Violation of Virginia laws, felony	H. L. Schlesinger, IRS	Guilty	Illicit spirits and soil
63. U.S. v Williams October 12, 1966 Charlotte, North Carolina	Violation of IRS laws	C. M. Hoff- man, IRS	Guilty	Pipe joint compound
64. Florida v Vaughn August 10, 1966 Jacksonville, Florida	Conspiracy to violate state liquor laws	Maynard J. Pro, IRS	Guilty	Moonshine
65. U.S. v Jessie McRoy Smith, et al. June 7, 1966 Washington, North Carolina, Federal Court	Conspiracy, violation of IRS laws	H. L. Schlesinger, IRS	Smith found guilty	Galvanized wire
66. U.S. v Theo Miller Simmons June 6, 1966 Gadsden, Alabama, Federal Court	Violation of IRS liquor laws	C. M. Hoff- man, IRS	Guilty	Paint
67. U.S. v George Doty, et al May 23, 1966 Tulsa, Oklahoma Federal Court	Conspiracy, violation of IRS laws	Maynard J. Pro, IRS	Guilty	Paint
68. U.S. v Woodrow Wilson Bregan, et al May 9, 1966 Bluefield, West Virginia, Federal Court	Conspiracy, violation of IRS laws	C. M. Hoff- man, IRS	Not guilty	Hair

Figure 1.—Continued

Case	Charge	Testimony By	Disposition	Evidence
69. U.S. v Johnnie Hal, et al December, 1965 Clarksdale, Mississippi, Federal Court	Conspiracy, violation of IRS laws	C. M. Hoff- man, IRS	Guilty	Soil
70. Commonwealth of Virginia v Powers June, 1965 Alexandria, Virginia, State Court	Murder	H. L. Schlesinger, IRS	Acquitted	Comparison of bullets
71. U.S. v Asby May 20, 1965 and October 16, 1965 Norfolk, Virginia, Federal Court	Manufactur- ing and possession of non- taxpaid whisky	H. L. Schlesinger, IRS	May 20, 1965: Hung jury Oct. 16, 1965: Guilty	Soil and grease
72. U.S. v Percy Flowers August 16, 1965 Wilmington, North Carolina, Federal Court	Conspiracy, violation of IRS laws	H.L. Schlesinger, IRS	Acquitted	Soil
73. State v Coolidge May, 1965 Manchester, N.H. AEd (1965) 109 NH 403, 260 A2d 547 *Revd on other grounds 403 US 443, 29 L Ed 2d 2022, reh den — US —, 30 L Ed 2d 1120, — S Ct —	Murder	C. M. Hoff- man and Maynard J. Pro, both of IRS	Guilty	Organic and inorganic particles
74. U.S. v Craps, Kneece and Johnson March 23, 1965 Aiken, South Carolina, Federal Court	Conspiracy, violation of IRS laws	Maynard J. Pro, IRS	Guilty	Paint
75. U.S. v Cornwell May, 1964 Southern District of Ohio, Federal Court	Attempted murder	H. L. Schlesinger, IRS	Guilty	Automobile body putty and adhesive tape

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Figure 1.—Continued

Case	Charge	Testimony By	Disposition	Evidence
76.* U.S. v Kelly December, 1968 New York, N.Y. Federal Court Revd on other grounds (1969, CA2 NY) 420 F2d 26	Narcotics violations	R.L. Brunelle, IRS	Guilty	Cocaine

Through support of the U. S. Atomic Energy Commission, research and development are continuing both at the Treasury Department and at General Atomic. These groups have cooperated closely on a number of projects and have carried out most of the work described below. Mr. Maynard Pro is the head of the Treasury Department group, while research at General Atomic is directed by Dr. Vincent Guinn. Only recently the Office of Law Enforcement Assistance of the U. S. Department of Justice has added its support to the General Atomic research program, so that work on applying NAA to criminalistics now is being carried on at triple the previous rate.

Forensic NAA Service Available

Increasing demand has prompted the General Atomic Division of General Dynamics Corporation to offer a nonprofit forensic neutron activation analysis service. As a part of this service, General Atomic has introduced a special kit for collecting gunshot residue samples from the hands of suspects in shooting cases (see Figure 2). A large number of law enforcement agencies across the country have obtained these kits.

The kit contains a supply of paraffin, an applicator brush, plastic gloves, a stainless steel spatula, a marking pen, polyethylene vials, polyethylene bags, a sample shipping box, literature references, and detailed and illustrated instructions on the application procedure. Paraffin casts taken from a suspect are shipped to General Atomic in San Diego, California, for irradiation and counting. Quantitative results on the barium and antimony pres-

* Material prepared by the editorial staff of the publisher.

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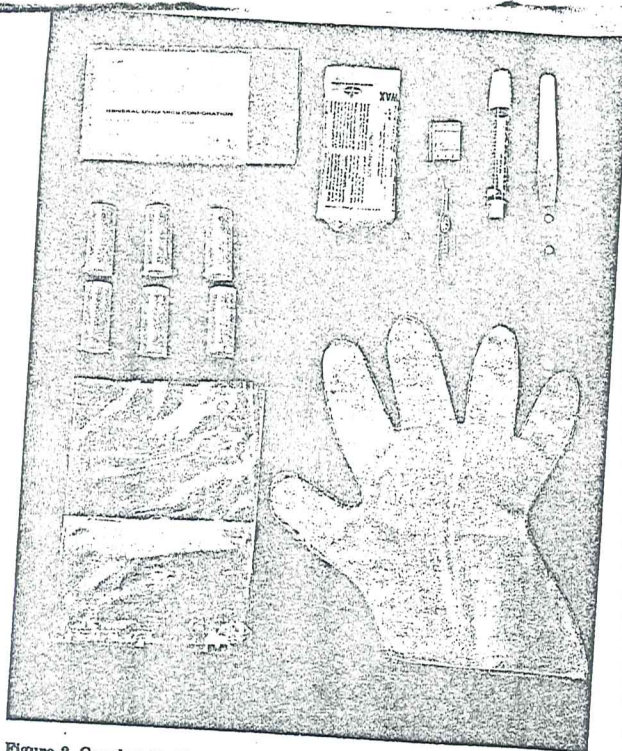


Figure 2. Gunshot Residue Removal Kit. The kit is used to take gunshot residue samples, for neutron activation analysis, from the hands of suspects in shooting cases. It contains, from left to right, sample shipping box, paraffin, applicator brush, marking pen, stainless steel spatula, polyethylene vials, polyethylene bags, and plastic gloves. Also included are literature references and illustrated instructions. (Courtesy of Patrick Whittle.)

ent in the sample can be made available within a few days. Should the evidence be introduced in court, expert witness testimony by the radiochemist who performed the analysis is available at cost. The neutron activation analysis of one sample costs \$190, with a charge of \$40 for each additional sample processed at the same

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time. The \$5.00 kit for taking the samples is replaced at no charge following General Atomic's analysis.

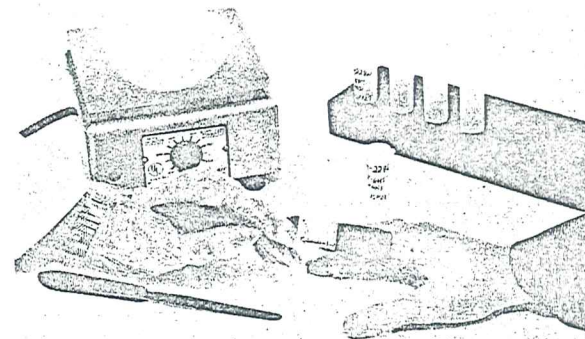


Figure 3A. Paraffin Application. Wearing plastic gloves, technician applies melted paraffin to a suspect's forefinger, web of hand and thumb. Paraffin is melted on electric hot plate rather than over a bunsen burner to avoid contamination from the wire gauze and ring stand required for open gas flame burner. (Photograph courtesy of General Dynamics, General Atomic Division, San Diego, California.)

Many other types of physical evidence besides paraffin casts can be analyzed by General Atomic's forensic service.

International Coordinator of Applications

At the request of the International Criminal Police Organization, the Laboratory Branch of the Alcohol and Tobacco Tax Division, U. S. Treasury Department, is acting as coordinator for all applications of NAA to criminalistics for member nations. Books, reports, and other data are being kept on file in Washington, D. C.

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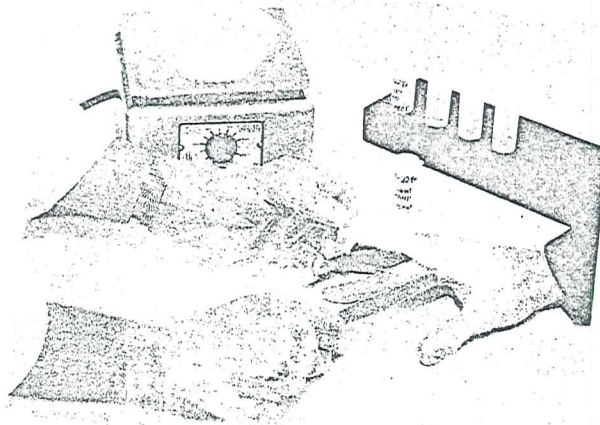


Figure 3B. Taking Paraffin Lift. Technician removes solidified paraffin from suspect's hand, placing the entire "lift" in a clearly marked plastic vial. The paraffin is irradiated in this vial. Counting for barium and antimony radioisotopes takes place after radiochemical separations are performed and the material has been placed in a clean container. (Photograph courtesy of General Dynamics, General Atomic Division, San Diego, California.)

Films on NAA

Three 16-mm color motion pictures dealing with NAA have been produced for the U.S. Atomic Energy Commission by General Atomic. All are available on a loan-free basis from regional libraries of the commission, or from the Audio-Visual Branch of the Division of Public Information, U. S. Atomic Energy Commission, Washington, D. C. 20545. Major U. S. embassies overseas also stock copies of these films.

The first film, *Neutron Activation Analysis*, is 40 minutes in length and is aimed at a highly technical audience, such as chemists and physicists. Forensic work is among the many applications covered, but the main stress is on a detailed explanation of how neutron activation analysis works.

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The second film, *The Atomic Fingerprint*, in 12½ minutes presents a simple, nontechnical explanation of the method and its many applications. It is recommended for general audiences.

The third film, *The Nuclear Witness: Activation Analysis in Crime Investigation*, is 28 minutes in length and was made especially for showing to law enforcement personnel and members of the legal profession. The description of NAA is nontechnical. Situations shown in the film, based on actual cases, are a murder, a burglary, and narcotics peddling. The burglary case revolves around the comparison of minute paint specks and concludes with a detailed courtroom examination of the chemist who performed the analysis.

Gunshot Residues

A larger and broader sampling of the general population has been taken in basic studies on the detection of gunshot residues conducted at General Atomic. For persons who had not recently fired a gun, average values of 0.032 micrograms of antimony and 0.37 micrograms of barium were determined. Antimony values seem to be more strongly indicative of whether or not a person has recently fired a gun, but both barium and antimony values must be considered. Occupations of persons tested included carpenter, technician, painter, mechanic, automobile mechanic, accountant, gardener, storekeeper, secretary, repairman. Of these, the two mechanics, who had greasy hands at the time the paraffin casts were made, showed amounts of both barium and antimony well above the average values. It was noted that the extra amounts of barium and antimony were probably from grease additives, and the resulting high values could be linked to their occupations. (See Figures 4A and 4B.)

Occupation	Sample	µg Ba	µg Sb
Painter	Right hand	0.453	0.008*
	Left hand	0.385	0.004*
Painter	Right hand	0.481	0.031
	Left hand	0.303	0.010*
Painter	Right hand	0.795	0.031
	Left hand	0.472	0.090
Carpenter	Right hand	0.310	0.065
	Left hand	0.290	0.058
Carpenter	Right hand	0.404	0.039
	Left hand	0.264	0.110
Storekeeper	Right hand	0.127	0.135
	Left hand	0.181	0.004*
Public accountant	Right hand	0.091	0.004*
	Left hand	0.103	0.004*
Television technician	Right hand	0.047	0.004*

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Secretary	Left hand	0.057	0.004*
	Right hand	0.137	0.011
Automobile mechanic	Left hand	0.068	0.012*
	Right hand	1.78	0.051
Automobile mechanic	Left hand	2.78	0.174
	Right hand	4.70	0.383
Watch repairman	Left hand	2.80	0.198
	Right hand	0.219	0.051
	Left hand	0.281	0.006*

Figure 4A. Neutron Activation Analysis of Paraffin Casts from Hands and Faces of Persons Who Had Not Recently Fired a Gun (μg Ba = micrograms of Barium; μg Sb = micrograms of antimony; * = equal to or less than)

Occupation	Sample	μg Ba	μg Sb
Gardener	Right hand	0.219	0.023
	Left hand	0.267	0.018
Heating and air conditioning repairman	Right hand	1.28	0.037
	Left hand	1.18	0.074
Student, laboratory technician	Right hand	0.116	0.012
	Left hand	0.059	0.005*
Student, laboratory technician	Right hand	2.68	0.074
	Left hand	0.346	0.023
Photographer	Right hand	0.220	0.069
	Left hand	0.257	0.069
Radioscope technician	Right hand	0.612	0.022
	Left hand	0.200	0.012
Radioscope technician	Right cheek	0.063	0.003*
	Left cheek	0.096	0.006*
Radioscope technician	Right hand	0.068	0.017
	Left hand	0.055	0.020
Radioscope technician	Right cheek	0.075	0.017
	Left cheek	0.118	0.017
Radioscope technician	Right hand	0.055	0.033
	Left hand	0.045	0.006*
Radioscope technician	Right cheek	0.059	0.007*
	Left cheek	0.174	0.009

Figure 4B. Neutron Activation Analysis of Paraffin Casts from Hands and Faces of Persons Who Had Not Recently Fired a Gun (μg Ba = micrograms of Barium; μg Sb = micrograms of antimony; * = equal to or less than) Continued.

Using a nuclear reactor available in the Washington area, the Treasury Department has successfully analyzed a number of paraffin casts. In a case submitted by the Maryland State Police, neutron activation analysis corroborated other evidence in the identification of a murder suspect (see Figure 5, case A). In another case a suspected suicide was verified by this method at the request of the U. S. Army Criminal Investigation Laboratory (see Figure 5, case B).

Case	Weapon	Right Hand		Left Hand	
		Barium	Antimony	Barium	Antimony
A	32-cal. automatic pistol	0.72	0.32	0.18	0.02
B	45-cal. automatic pistol	1.35	0.68	0.04	0.04

Figure 5.

A small number of test firings were made at General Atomic using a 30.06 rifle. Barium levels on the hands were indistinguishable from hand blanks. Although antimony levels were above the hand blank average, they were below those obtained from firing a 0.38-caliber revolver; they also overlapped the higher antimony hand blank values. Because so few cheek blanks have been analyzed, it was impossible to draw conclusions about the deposition of these two trace elements on the cheeks after the firing of the particular rifle used.

In the study of shotgun test firings, preliminary studies showed that barium is deposited on the hands. The amounts of antimony deposited on the hands by the shotgun were about the same as those left by a 0.38-caliber revolver. The small number of normal cheek blanks precluded a definite conclusion, but it was observed that levels of both elements on cheeks of persons firing the shotgun seemed to be higher than those of persons who had not recently fired any type of gun. Hopefully, more extensive tests will yield definite guidelines in the determination of trace element residues from shotguns and rifles. Figure 6 shows results of rifle and shotgun firings.

Weapon	Sample	μg Ba	μg Sb
Rifle	Right hand	0.226	0.058
	Left hand	0.354	0.133
	Right cheek	0.186	0.034
Rifle	Left cheek	0.095	0.005*
	Right hand	0.185	0.051
	Left hand	0.184	0.040
Rifle	Right cheek	0.069	0.075
	Left cheek	0.058	0.034
	Right hand	0.295	0.248
Shotgun	Left hand	0.277	0.300
	Right cheek	0.222	0.155
	Left cheek	0.124	3.47
Shotgun	Right hand	0.692	0.312
	Left hand	0.764	0.254
	Right cheek	0.122	0.045
Shotgun	Left cheek	0.144	0.021
	Right hand	1.13	0.461
	Left hand	0.300	0.107
Shotgun	Right cheek	0.130	0.037
	Left cheek	0.224	0.013

Figure 6. Results of Single Firings With a Rifle and a Shotgun (μg Ba = micrograms of barium; μg Sb = micrograms of antimony; * = equal to or less than)

Bullet Residues

The Treasury Department has found that barium, copper, and antimony residues are left on leather, paper, and fabric by commercially manufactured bullets from the major producers. Tests are now underway to relate the quantities of trace elements found to other variables, such as the caliber, bullet shape, and manufacturer of the cartridge.

The Maryland State Police submitted for analysis a man's shoe with two irregular rips. The shoe had been removed from a burglary suspect who denied being present at the scene of the crime and also denied that the holes in his shoe had been made by a bullet. Analysts moistened a piece of filter paper with one percent nitric acid and rubbed it over the suspected entrance hole; they took similar swabs at other points on the shoe. A third swab was taken from the barrel of the gun employed. Figure 7 shows the levels of copper and antimony found on the shoe and in the gun barrel.

Origin of Sample	Copper (counts/minute in photopeak)	Antimony (counts/minute in photopeak)	Ratio (Antimony/Copper)
Around entrance hole in shoe	128,054	15,720	0.11
Other parts of shoe	894	not detectable	
Gun barrel	109,391	12,285	0.12
Blank (filter paper plus 1% nitric acid)	351	185	

Figure 7.

Metals

Determination of trace element composition of metal objects has been extremely useful in a large number of criminal case investigations undertaken by the Treasury Department. One note of caution is necessary, however, in the analysis of very small metal fragments that contain nonalloyable components. In such situations a heterogeneous condition exists. Nonalloyable components are mixed unevenly throughout the metal material, so that the quantitative variations in the trace element concentrations increases for these components as the sample size decreases. Thus the accurate comparison of sample origins involving very small metal fragments is more difficult than the comparison of large samples.

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Copper Alloys

In seizing an unregistered distillery, revenue agents collected two pieces of insulated copper wire from a fuse box. Similar wire was taken later from a pump found in a suspect's car. Analysis at the Treasury Department showed that the specimens contained trace quantities of molybdenum, chromium, gold, antimony, silver, zirconium, and iron in the same relative abundance.

Copper electrical wire collected from a pump in an illicit distillery was compared with wire found inside the suspect's residence and outside his house. Analytical results are shown in Figure 8.

Description	Copper	Gold	Silver	Cobalt
Wire from pump—A	100	1.46×10^{-4}	6.0×10^{-3}	0.02
Wire from pump—B	100	1.45×10^{-4}	6.0×10^{-3}	0.02
Wire near house	100	1.45×10^{-4}	6.3×10^{-3}	0.03
Wire from house	100	1.46×10^{-4}	6.3×10^{-3}	0.03

Figure 8. Percentage of Radionuclides Found in Copper Wires

In yet another investigation of an illegal distillery, neutron activation analysis proved that a copper still cap and two scraps of copper metal from the suspect's house had the same relative amounts of gold, cerium, silver, zinc, cobalt, and chromium.

Iron Alloys

A steel burner stand taken as evidence from an illegal distillery was analyzed by NAA, along with a portion of a steel barrel found in the suspect's home. Antimony and zirconium were present in each sample in the same ratios.

Another case brought to the Treasury Department laboratory concerned a violation of the National Firearms Act. An illegal length Hopkins-Allen 12-gauge shotgun was discovered by the authorities; its barrel had been sawed off to 16 inches and had been fitted with a cut down stock. Subsequent investigation uncovered a portion of a 12-gauge shotgun at a suspect's place of business. The Treasury Department was asked to determine if the barrel were once part of the sawed-off weapon in question. NAA of the metal taken near the cut area on each specimen showed that both contained iron, manganese, iridium, and cobalt in the same proportions. This evidence, along with physical measurements taken on both the gun and suspected gun barrel, indicated beyond reasonable doubt that the cut barrel had been removed from the shotgun in question.

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NEUTRON ACTIVATION ANALYSIS

Chap. 2

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