R. L. Brunelle,[1] *M.S.; D. D. Garner*,[1] *Ph.D.; and*
P. L. Wineman,[1] *Ph.D.*

A Quality Assurance Program for the Laboratory Examination of Arson and Explosives Cases

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ABSTRACT: Quality assurance in forensic laboratories is no less important than quality control in industry. The prosecutor, defense attorney, judge or jury and, of course, the defendant have every right to expect an analysis of the highest possible quality by the forensic scientist. The life or liberty of an individual may hinge on the analysis conducted by a forensic scientist and corresponding testimony in court. A quality assurance program has been implemented for arson and explosive cases. A statistically valid number of case examinations are reviewed annually for critical, major, and minor defects according to predetermined factors such as turnaround time, tests performed, conclusions reached, and notes taken. Questionnaires on the quality and responsiveness of the laboratories are sent to the submitters of evidence. The forensic chemists are subjected to blind testing semiannually. Laboratory-prepared samples disguised as actual cases are submitted to the various laboratories by special agents in the field and the reports are evaluated.

KEYWORDS: criminalistics, arson, quality assurance, explosives

Quality assurance in forensic science laboratories is no less important than quality assurance or control in government regulatory laboratories, clinical laboratories, or in industry. The prosecutor, defense attorney, judge or jury, and, or course, the defendant have every right to expect accurate and reliable results from forensic science laboratories. The very life or liberty of an individual may well depend on the analyses conducted by forensic scientists and their corresponding testimony in a court of law.

The concept of quality assurance is not new. It is effective quality assurance that led to the safe landing and return of man on the moon and the airline industry's excellent safety record. Commercial products such as televisions, automobiles, kitchen appliances, and others sell not only by their relative cost of purchase, but also on the basis of performance and reliability. The American citizen takes quality control for granted in everyday life, and if experience shows a product is not reliable, it does not sell.

Quality assurance programs in industrial, government regulatory, and clinical laboratories have been used for many years; however, the subject is still receiving considerable attention in these and other sectors [*1–10*]. Eleven papers were presented at the October 1980 Association of Official Analytical Chemists' symposium on quality assurance principles such as

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[1]Chief, Forensic Science Branch, and forensic chemists, respectively, Forensic Science Branch, National Laboratory Center, Bureau of Alcohol, Tobacco and Firearms, Rockville, MD.

human aspects, pertinent criteria, equipment standardization, reference standards, proficiency testing, methods, laboratory design, personnel, training, and management responsibilities [*11*].

The American Chemical Society has produced guidelines for sampling, testing, quality assurance, and data handling [*1*]. The Food and Drug Administration has provided guidelines that can be used for any laboratory to maintain or upgrade the quality of work performed and to improve the credibility of reported results. Their program includes operational guides for management, reports, quality assurance, and standard operating procedures [*4*]. Other quality assurance programs have also been considered and used by other regulatory agencies [*5,6,9,10*].

Although the work done has not been specifically identified as quality assurance, the forensic science community has made some progress in this field. The Crime Laboratory Proficiency Testing Program [*12*] and Criminalistics and Methods of Analysis Feasibility Study [*13*] were both funded by the Law Enforcement Assistance Administration and conducted by the Forensic Science Foundation. The first program tested laboratory proficiency for the analysis of several types of physical evidence, and the second study was an attempt to establish both a compendium of commonly accepted forensic science methods and a mechanism for their evaluation.

The American Society of Crime Laboratory Directors, since its inception, has attempted to improve the overall quality of forensic science laboratories through better communication, standardization of reporting terminology, establishment of training programs, and implementation of improved management concepts and procedures.

During the years 1971 through 1976, considerable progress was made in the evaluation and validation of methods by the Forensic Sciences Section of the Association of Official Analytical Chemists. This concept is not yet commonly acceptable to the forensic science community, as indicated in the final report by the Methods Advisory Committee [*4*]. Gradually, however, the concept of methods evaluation in the forensic sciences is becoming more acceptable. Crime laboratories are recognizing that it has been common practice in regulatory and industrial laboratories for many years. Good laboratory practices dictate the use of proven methods.

The most recent achievement in the area of quality assurance in the forensic sciences is the "Crime Laboratory Accreditation Standards and Program" sponsored by the American Society of Crime Laboratory Directors and adopted in August 1981 [*14*]. This program deals with essentially every important aspect of crime lab operation such as management controls, organization, quality control, personnel qualifications, security, safety, and many other aspects important to the effective operation of a forensic science laboratory. This program is a major accomplishment, and if crime laboratories follow the guidelines set forth in the program, the quality of crime lab performance will improve.

Components of a Quality Assurance Program

Because quality assurance is an essential part of sound analytical chemistry practice, there is a need for wider use of quality assurance in forensic science laboratories. It ensures consistency of lab performance by allowing for the detection and correction of potential problems and provides confidence to forensic scientists who must face both technical and legal challenges to their results.

Essential components of an effective quality assurance program have been described in the literature and are now fairly standard in the field of chemistry:

(1) employment of adequately trained personnel,
(2) use of evaluated and validated methods,
(3) adequate lab equipment and facilities,

(4) proper calibration and maintenance of equipment,
(5) use of control samples and standard samples,
(6) periodic testing for proficiency,
(7) use of replicate samples,
(8) collaborative studies with other labs,
(9) critique by the users of lab services,
(10) close monitoring of results by laboratory management, and
(11) mechanisms to correct identified deficiencies.

This paper discusses a quality assurance program implemented in 1981 by the Bureau of Alcohol, Tobacco and Firearms (ATF) for the laboratory examination of arson and explosives evidence. The program emphasizes: (1) research and methods evaluation to ensure use of reliable procedures, (2) standardized methods based on the results of evaluation studies, (3) multilaboratory collaborative studies to test the reliability of methods, (4) blind testing of forensic chemists on a periodic basis to determine examiner proficiency, (5) close monitoring of laboratory procedures and reported conclusions by review of case information by a quality assurance panel, and (6) solicitation of critiques from the users of laboratory services. Other important aspects of any quality assurance program such as training of personnel, calibration of equipment, standard reference samples, space requirements, safety, and security are considered basic and, as such, are not addressed in this paper.

Quality Assurance Program

Since the late 1960s, chemists in the ATF laboratories have examined physical evidence associated with explosives and arson investigations. Services include the examination of physical evidence, the issuance of reports of laboratory examinations, and the presentation of expert testimony in courts of law.

Recognition of the need to maintain high quality laboratory service led to implementation of collaborative testing of methods in 1972. The purpose was to evaluate techniques currently employed in the laboratory system and to standardize analytical procedures. While this type of evaluation of laboratory methods is essential, a more comprehensive quality assurance program was needed to ensure that all aspects of the services provided by the laboratories in the explosives and arson areas are of the highest possible quality.

Objectives

The objective of the quality assurance program was to maintain or improve the overall quality and uniformity of service provided to the users of that service. The quality assurance program for explosives and arson examinations in the ATF laboratory system involves a critical inspection of cases examined, augmented by the operational special collaborative testing project. This comprehensive approach ensures that proper tests and techniques are employed, maximum information is obtained from the examination of the evidence received, the results and conclusions are technically correct, and the presentation of the information is of high quality.

Mechanism

Each fiscal year, a statistically selected number of explosive and arson cases from each laboratory are critically inspected. The number of cases inspected is determined by the total number of explosive or arson cases examined during the year. Specific cases for inspection are determined by random selection. Table 1 gives the data necessary to determine the

TABLE 1—*Data necessary to determine the number of cases to be inspected from each laboratory.*[a]

Number of Cases Processed	Number of Cases to be Inspected
51- 90	13
91-150	20
151-280	32
281-500	50

[a]Values obtained from "Sampling Procedures and Tables for Inspection by Attributes," MIL-STD-1050, Department of Defense.

number of cases to be inspected from each laboratory. The number of cases to be reviewed is based on a normal level of inspection [*15*]. In subsequent years, the level of inspection can be reduced or increased depending on the information generated from the review.

Reviews are conducted by a panel of four senior arson or explosives chemists from the laboratory system, and separate panels review explosives and arson cases. The panels meet once a year and the cases are evaluated based on the criteria given below and the results of questionnaires sent to the original submitters of the cases (see Fig. 1).

The panel reviews all of the notes, tests performed, conclusions, and other information in each case file for defects. Any defects are classified as minor, major, or critical:

1. A *critical defect* is one that will prevent the use of the Report of Laboratory Examination for its intended purposes, for example, based on tests results in the case file, an incorrect conclusion was obtained, or the information in the file indicates that evidence was lost, contaminated, or altered unnecessarily.

2. A *major defect* is likely to reduce materially the usability of the Report of Laboratory Examination for its intended purposes. Examples of major defects are as follows: (a) additional definitive tests, which should have been done, were not performed; (b) based on test results in the case file, the conclusion was too strong; (c) based on test results in the file, the conclusion was too weak; (d) all of the examinations requested by the submitter, which could have been performed, were not conducted; (e) examiner's notes of the examination are missing or incomplete; and (f) excessive turnaround time affected the investigation or prosecution of the case.

3. A *minor defect* is one that is not likely to reduce materially the usability of the Report of Laboratory Examination for its intended purposes. Examples of minor defects are (a) one or more misspelled words are present in the report; (b) three or more typographical errors exist in the report; (c) an incorrect format was used; (d) turnaround time was excessive but did not adversely affect the outcome of the investigation; (e) the case should have been examined by a different laboratory in the ATF system; and (f) the case should not have been accepted by an ATF laboratory.

All defects found by the review panel are tabulated on the forms shown in Fig. 1. From this information an explosives case is classified as acceptable or as having a minor defect, a major defect, or a critical defect based upon the following definitions:

1. A case will be classified as having a *minor defect* if there are one or more minor defects and no major or critical defects.

DEPARTMENT OF THE TREASURY - BUREAU OF ALCOHOL, TOBACCO AND FIREARMS

REVIEW PANEL WORKSHEET FOR DEFECTS

CASE NUMBER

CLASSIFICATION OF CASE

MINOR DEFECTS - One or more minor defects with no major or critical defects.

MAJOR DEFECTS - One or more major and minor defects with no critical defects.

CRITICAL DEFECTS - One or more critical, major and minor defects.

	DEFECTS	NUMBER OF DEFECTS
MINOR	1. MISSPELLED WORDS	
	2. TYPOGRAPHICAL ERRORS	
	3. INCORRECT FORMAT	
	4. EXCESSIVE TURNAROUND TIME	
	5. WRONG LAB EXAMINED EVIDENCE	
	6. CASE SHOULD NOT HAVE BEEN ACCEPTED	
MAJOR	1. ADDITIONAL TESTS NOT PERFORMED	
	2. CONCLUSION TOO STRONG	
	3. CONCLUSION TOO WEAK	
	4. ALL REQUESTED EXAMINATIONS NOT CONDUCTED	
	5. EXAMINER'S NOTES MISSING OR INCOMPLETE	
	6. EXCESSIVE TURNAROUND TIME	
CRITICAL	1. INCORRECT CONCLUSION	
	2. EVIDENCE LOST, CONTAMINATED, OR ALTERED UNNECESSARILY	

REVIEWED DEFECTS CLASSIFIED AS:

☐ MINOR ☐ MAJOR ☐ CRITICAL

COMMENTS

NAME OF REVIEWER

DATE OF REVIEW

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FIG. 1—*Worksheet used by the review panel to evaluate laboratory cases.*

2. A case will be classified as having a *major defect* if there are one or more major defects and no critical defects. It may also contain minor defects.

3. A case will be classified as having a *critical defect* if there are one or more critical defects. It may also contain major and minor defects.

To determine user satisfaction with the services provided by the laboratory system and solicit suggestions for improving the services, a questionnaire is sent to the submitters of cases selected for inspection. The questionnaire, shown in Fig. 2, supplies information on the ultimate use of the laboratory services, such as the report having been used for investigative purposes or as evidence in a court of law.

DEPARTMENT OF THE TREASURY - BUREAU OF ALCOHOL, TOBACCO AND FIREARMS **LABORATORY QUALITY ASSURANCE QUESTIONNAIRE**	ATF LAB NUMBER	
QUESTIONS	YES	NO
1. WERE ALL OF THE EXAMINATIONS YOU REQUESTED COMPLETED BY THE LABORATORY		
2. WERE YOU SATISFIED WITH THE TIME REQUIRED BY THE LABORATORY TO EXAMINE YOUR CASE		
3. WAS THE INFORMATION SUPPLIED TO YOU BY THE LABORATORY IN THIS CASE USED TO:		
A. DEVELOP A SUSPECT(S)		
B. OBTAIN A SEARCH WARRANT		
C. OBTAIN AN ARREST WARRANT		
D. CORROBORATE A STATEMENT OF A WITNESS		
E. CONFIRM THE PRESENCE OF AN EXPLOSIVE		
F. OTHER (Specify)		
4. WAS THE REPORT OF LABORATORY EXAMINATION USED IN A COURT OF LAW		
5. WAS THE EXPERT TESTIMONY OF THE LABORATORY EXAMINER(S) REQUIRED IN THIS CASE		
6. IF YOU ANSWERED "YES" TO ITEM 5, PLEASE SUPPLY THE NAME AND TELEPHONE NUMBER OF THE PROSECUTING ATTORNEY		
7. COMMENTS ON ATF LABORATORY SERVICES		
8. NAME AND TITLE OF INDIVIDUAL COMPLETING THIS FORM	9. DATE	

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FIG. 2—*Questionnaire sent to submitters.*

After completing the review of the case file and the evaluation of the questionnaire, the chairman of the review panel in conjunction with the chief, Forensic Science Branch, prepares a report of review for the assistant director (Technical and Scientific Services). Included in the report are the statistical data on defective cases, pertinent information obtained from the user questionnaire, and recommendations (if any) of the review panel for corrective action.

Blind Testing

Upon the completion of methods evaluation studies and collaborative testing to validate the chosen methods, blind testing determines the proficiency of forensic chemists under real-life conditions. Previous efforts to evaluate laboratory methods and interpretive skills used samples that the forensic chemists knew were test samples. Although this approach is useful, a more realistic appraisal of lab and individual performance can be accomplished by using blind samples because the results should closely approximate the quality of work typically conducted in the laboratory. Blind samples are lab-prepared but disguised as actual case exhibits. At ATF, these lab-prepared samples are sent to special agents throughout the United States who disguise them and then submit them to the various ATF laboratories for examination.

Step 1—The chief, Forensic Science Branch, at the National Laboratory Center or his designate prepares and codes the samples for testing.

Step 2—The lab-prepared samples are forwarded to the Explosives Enforcement Branch of Criminal Enforcement where evidence labels are placed on the samples, bogus scenarios are created, and letters of transmittal are prepared. The disguised samples and corresponding letters of transmittal are sent to posts of duty in regions served by each ATF laboratory.

Step 3—Special agents in the various posts of duty assign actual investigation numbers to the evidence and submit the blind test samples and transmittal letter to the laboratory that serves their post of duty.

Step 4—The chief of each laboratory assigns the blind test samples to forensic chemists in the normal course of business to ensure that all forensic chemists are tested equally.

Step 5—Forensic chemists in each lab examine the blind test samples and submit a report of laboratory results in the normal course of business to the submitting special agent who then returns them to the Explosives Enforcement Branch of Criminal Enforcement.

Step 6— When all of the lab reports have been received by the Explosives Enforcement Branch of Criminal Enforcement, they are forwarded to the chief, Forensic Science Branch, at the National Laboratory Center, where the results of the tests are evaluated.

Step 7—The blind test results are evaluated and necessary corrective action is identified and implemented as necessary. The tests are conducted semiannually.

Results and Discussion

The results of multilaboratory collaborative studies based on methods evaluation are normally submitted for publication in scientific journals for the benefit of the forensic science community. Since the implementation of the quality assurance program, no critical defects have been identified and only one major defect has been reported by the explosives/arson review panel. The one major defect involved excessive turnaround time on the examination of the case. Excessive turnaround time has been identified as greater than 30 days, and on that case it was considered a major defect because the delay in receipt of the laboratory report enabled the suspect in the case to become a fugitive.

Less than 1% of the cases reviewed contained minor defects, and these defects involved only typographical errors, misspelled words, or use of improper reporting format. These problems do not affect the overall use of the laboratory report for its intended purpose. All blind tests so far have resulted in 100% correct identifications by the examiners tested.

Problems identified in the future by the quality assurance program that involve methods will be resolved by further evaluation studies and additional collaborative studies. Problems revealed by blind testing will be resolved by providing further training to those examiners having difficulty with their examinations followed by additional blind testing. Defects involving turnaround times, typographical errors, misspellings, and reporting format can be eliminated only by closer review by management of the laboratory reports prepared by individual examiners.

The quality assurance program has greatly improved the overall performance of the ATF laboratory system. The program builds confidence in the employees tested, enables potential problems to be detected early so that appropriate corrective action can be taken, and, probably most important, demonstrates to the users of our services, the courts, juries, and the defense that laboratory performance is monitored and effectively controlled and that results from the ATF laboratories will be reliable and equitable to all parties.

It is important to emphasize that certain steps are necessary before the implementation of a comprehensive quality assurance program. First, studies must be conducted to evaluate the existing methods for the examination of physical evidence. Second, collaborative studies involving outside laboratories should be conducted to test the ruggedness and reliability of methods chosen from evaluation studies. Third, standard approaches to the examination of evidence are necessary if uniform, reproducible results are to be obtained from one examiner to another or one laboratory to another. This is particularly crucial for quantitative determinations. Different analytical methods have varying degrees of accuracy and precision. Therefore, identical results on the same sample cannot necessarily be expected if different analytical procedures are used.

It is recognized that terms such as standard, validated, accepted, or other similar adjectives attached to the word *method* are highly controversial in the forensic science community. However, the use of standard methods for the examination of arson and explosives evidence has improved the accuracy, reliability, and reproducibility of results in the ATF laboratory system just as it has for other regulatory and industrial quality control laboratories.

Summary

A quality assurance program for the laboratory examination of explosives and arson evidence has been described. It measures and monitors laboratory performance and provides effective management control over laboratory performance for the examination of these classes of evidence. Potential problems can be detected early to enable prompt corrective action if necessary. The program concepts are applicable to nearly all classes of physical evidence encountered by the forensic science laboratory.

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Address requests for reprints or additional information to
Richard L. Brunelle
Forensic Science Branch
National Laboratory Center
Bureau of Alcohol, Tobacco and Firearms
Rockville, MD 20850