

Australian Standard[®]

Forensic analysis

Part 2: Analysis and examination of material



This Australian Standard® was prepared by Committee CH-041, Forensic Analysis. It was approved on behalf of the Council of Standards Australia on 2 May 2012. This Standard was published on 31 May 2012.

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- Australian and New Zealand Forensic Science Society
- Australian Association of Forensic Physicians
- Australian Federal Police
- Consumer Action
- Expertise, Evidence and Law Program, School of Law, University of New South Wales
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Forensic analysis

Part 2: Analysis and examination of material

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PREFACE

This Standard was prepared by the Standards Australia Committee CH-041, Forensic Analysis. This Standard is the result of a consensus among the representatives of the Committee to produce it as an Australian Standard.

This Standard is part of a series which, when complete, will include—

AS

5388 Forensic analysis

5388.1 Part 1: Recognition, recording, recovery, transport and storage of material

5388.2 Part 2: Analysis and examination of material (this Standard)

5388.3 Part 3: Interpretation

5388.4 Part 4: Reporting

This Standard sets out standard practices for the forensic examination and analysis of physical material, in order to obtain results to assist an investigation, with the potential that a conclusion reached may be presented to a court of law or other tribunal. The provisions of this document are aimed at qualified personnel with demonstrated competence in the use of appropriate scientific procedures and techniques in a forensic context. Physical material may be examined in turn by a number of examiners with different areas of expertise.

The terms ‘normative’ and ‘informative’ have been used in this Standard to define the application of the appendix to which they apply. A ‘normative’ appendix is an integral part of a Standard, whereas an ‘informative’ appendix is only for information and guidance.

The committee wishes to acknowledge the support provided by the Attorney General’s Department in the development of the Forensic Analysis series (AS 5388) as an Australian Government initiative.

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STANDARDS AUSTRALIA

Australian Standard
Forensic analysis**Part 2: Analysis and examination of material****1 SCOPE**

This Standard specifies requirements for the forensic examination and analysis of physical material from crime scenes, persons and related areas and objects.

This involves one or more of the following steps:

- (a) Recording.
- (b) Sampling.
- (c) Presumptive testing or assessment.
- (d) Instrumental analysis.
- (e) Comparisons.
- (f) Recording results.

NOTE: It should be noted that though the analysis of digital or analogue electronic evidence is excluded from the scope of this Standard, such digital evidence may be accompanied by or contained within physical media or equipment having possible evidential value.

2 REFERENCED AND RELATED DOCUMENTS**2.1 Referenced documents**

The following documents are referred to in this Standard:

AS

- 5388 Forensic analysis
- 5388.1 Part 1: Recognition, recording, recovery, transport and storage of material
- 5388.3 Part 3: Interpretation
- 5388.4 Part 4: Reporting

ISO/IEC

- 17025 General requirements for the competence of testing and calibration laboratories

Act

National Measurement Act, 1960, taking into account amendments up to Act No. 137 of 2008. Commonwealth of Australia, Department of Innovation, Industry, Science and Research

Codes

Australian Code for the Transport of Dangerous Goods by Road and Rail (ADG Code), Seventh edition 2007, Commonwealth of Australia

Fundamentals of forensic DNA typing, 2009, J. Butler, Academic Press, Burlington

Evaluation of forensic DNA evidence, 1996, National Research Council, National Academy Press, Washington DC

Manuals and Guides

Australasian Guidelines for Digital Imaging Processes, v2, 2004, SMANZFL EESAG

Manuals and Guides

ISO/IEC Guide 98-1 Uncertainty of measurement (series)

Manual of Good Practice for the Feed Industry, Section 5—Methods of sampling and analysis, CAC/RCP 54–2004

NATA Technical Note 13, User checks and maintenance of laboratory balances, May 2010

NATA Technical Note 17, Guidelines for the validation and verification of chemical test methods

NATA Technical Note 33, Guidelines for estimating and reporting measurement uncertainty of chemical test results

NOHSC: 2012 (1994) National Code of Practice for the Labelling of Workplace Substances

SWGDRUG Recommendations, Fourth edition, 2008, DOJ DEA and ONDCP CTAC

UN Guidelines on Representative Drug Sampling, United Nations Office on Drugs and Crime, ENFSI Drugs Working Group

2.2 Related documents

Further information may be found in the following Standards:

AS

- 1470 Health and safety at work—Principles and practices
- 1940 The storage and handling of flammable and combustible liquids
- 2030 Gas cylinders (series)
- 2375 Guide to the selection, care and use of clothing for protection against heat and fire
- 2675 Portable first aid kits for use by consumers
- 2706 Numerical values—Rounding and interpretation of limiting values
- 2850 Chemical analysis—Interlaboratory test programs—For determining precision of analytical method(s)—Guide to the planning and conduct
- 2865 Confined spaces
- 2931 Selection and use of emergency procedure guides for the transport of dangerous goods
- 3765 Clothing for protection against hazardous chemicals (series)
- 4757 Handling and destruction of drugs
- 5239 Examination of ignitable liquids in fire debris

AS/NZS

- 1336 Recommended practices for occupational eye protection
- 1337 Eye protectors for industrial applications
- 1715 Selection, use and maintenance of respiratory protective devices
- 1716 Respiratory protective devices
- 2161 Occupational protective gloves (series)
- 2243 Safety in laboratories (series)
- 4360 Risk management
- 4501 Occupational protective clothing (series)

ISO

20473 Optics and photonics—Spectral bands

Act

Victorian Crimes Act, 1958, Section 464 (example only)

Codes

Australian Code for the Transport of Explosives by Road and Rail, Third edition 2009, Commonwealth of Australia, ISBN 978 0 642 32747 5

National Directory for Radiation Protection, Radiation Protection Series Publication No. 6, ARPANSA

NIST Recommended Practice Guide: Particle Size Characterization. Special Publication 960-1, January 2001, Chapter 2, Powder Sampling

US Department of Homeland Security, Guide 100–96. Guide for the selection of chemical detection equipment for emergency first responders, Third edition, January 2007

Manuals and Guides

ISO/IEC 17025 Field Application Document, Forensic Science Supplementary Requirements for Accreditation

ISO/TS 2004 Guidance for the Use of Repeatability, Reproducibility and Trueness Estimates in Measurement Uncertainty Estimation, ISO/TS 21748:2004

World Health Organization, Laboratory Biosafety Manual, Third edition, Geneva 2004

3 DEFINITIONS AND ABBREVIATIONS

For the purpose of this Standard, definitions and abbreviations are included in Appendix A.

4 UNDERPINNING PRINCIPLES AND REQUIREMENTS

4.1 General

The purpose of conducting forensic analyses on collected material is to make objective observations, measurements and deductions to determine one or more of the following unknowns:

- (a) The location and identification of unknown physical material.
- (b) The source attribution of the material.
- (c) The weight, concentration or some other property of the material.
- (d) What the material may have been subjected to and what changes to the material may have occurred.
- (e) Links between a number of samples of material.
- (f) Links between the material and a person or persons.
- (g) Links between physical material and a place or places.
- (h) The exclusion of a link between physical material and a particular person, place or thing.
- (i) The identity of a person.
- (j) Circumstances leading to or contributing to an incident.
- (k) The physical and mental state of a person.
- (l) The cause of death.

NOTE: The list is not exhaustive.

4.2 Procedures

The procedures involved in the examination of material shall be defined and carefully controlled to minimize the risk of inadvertent contamination, alteration or destruction and to ensure that the analytical results obtained are reliable.

NOTE: Except where alteration is part of an analytical process, for example, chemical derivatization.

All procedures conducted for forensic purposes and used in the handling, transport, storage, preparation, sampling and analysis of material, and which could reasonably be expected to impact adversely on subsequent testing, shall be documented and shown to be fit for purpose prior to their application unless delay would jeopardize any subsequent analysis or impact on personal safety or national security.

4.3 Training and competency

Persons carrying out any analysis, comparative examination or identification test shall have undertaken appropriate training and have been assessed as competent to carry out the examination, analysis or test. Ongoing competency shall be demonstrated.

NOTES:

- 1 Ongoing competency may be demonstrated by participation in proficiency testing, collaborative trials or other methods of assessment.
- 2 Formal qualifications may be required for some examinations under relevant legislation.

Full records of training, assessment and ongoing competence shall be maintained.

4.4 Instrumentation

Analytical techniques should be chosen or applied according to—

- (a) the type of material being examined;
- (b) what is to be determined or measured;
- (c) the sensitivity required;
- (d) obtaining optimum results;
- (e) the availability of suitable instrumentation and operators; and
- (f) the non-destructive or destructive nature of the technique.

Instrumentation shall be properly maintained and operated as outlined in ISO/IEC 17025. The proper functioning of the instrumentation and its software shall be documented along with proof of continuing proper functioning.

Instrumentation used in comparative techniques shall be fit for purpose.

5 ACCEPTANCE OF PHYSICAL MATERIAL RECEIVED FOR EXAMINATION

5.1 Acceptance and rejection of physical material for analysis

Not all material received by a forensic facility will be suitable for analysis, for example—

- (a) the material is packaged inappropriately such that its integrity is compromised;
- (b) the material is inappropriate for the testing requested;
- (c) the material has been determined to be no longer relevant to the investigation;
- (d) continuity of the material has been compromised;
- (e) the analysis is unlikely to yield evidence of probative value or less likely to provide evidence of probative value than other evidence submissions; and
- (f) appropriate reference to the materials is not provided.

NOTE: Depending on the facility, it may not be able to carry out the testing.

The forensic facility shall have written criteria for the acceptance or rejection of material for examination. These criteria should be available to its clients. If the facility varies its criteria in any instance, then the facility shall advise clients of any limitations or qualifications that may ensue, in any subsequent examination, analysis or testing of the material and/or the interpretation of any subsequent results.

The facility shall have procedures for vetting of casework to ensure that only material relevant to each case is submitted for analysis.

The facility should make appropriate scientific and/or technical personnel available to discuss analytical needs and likely outcomes with clients. Conferences involving representatives from all interested parties may be appropriate to discuss what analyses and/or examinations are to be carried out and in what order. Such conferences should be coordinated and recorded.

Once accepted items may be retained by the client or stored at the forensic facility until commencement of analysis or examination. Materials shall be stored under tamper-evident seals.

5.2 Analyses across more than one location or discipline

Where examination is required by more than one facility or more than one area within a facility, the facility should have policies guiding the preferred order in which examinations take place.

Under some circumstances, a documented examination plan may be required.

5.3 Item documentation

All required documentation (whether digital or hardcopy) should be completed prior to submission of the material for analysis or examination and should include or be linked to the following information as appropriate:

- (a) Relevant case information.
- (b) All types of forensic examination requested.
- (c) A list of items submitted (and their respective item identifiers).
- (d) Whether an item contains any hazard (e.g. biohazard, sharps).
- (e) A unique case identifier.
- (f) Date of collection.
- (g) The location the item was collected from.
- (h) The name or identifier of the person who collected the item.
- (i) The name or identifier of the person requesting the examination.
- (j) The name or identifier of the person submitting the item.
- (k) Contact details for the person requesting the examination.
- (l) Where appropriate, the names of any suspects, victims or complainants.

5.4 Items examined and collected by the same individual

Items collected at a crime scene or elsewhere by an individual and retained in that individual's possession until analysis should be documented in a similar fashion to that detailed in Clause 5.3.

6 ITEM CONTINUITY

6.1 Item management system

In addition to items being submitted for examination, the movement of items between forensic disciplines and/or locations shall be managed (and recorded) via an item management system. At any point in time, the location of an item shall be identified by either—

- (a) the storage location within the facility; or
- (b) the forensic officer who has possession of the item.

The item management system used for tracking the location and possession of items (whether electronic or paper based) shall be robust and auditable, and shall include the following information:

- (i) A unique identifier for each individual item.
NOTE: An item may comprise a number of objects, for example, the contents of an ashtray, clothing from a washing machine or a maggot mass.
- (ii) A brief description of each individual item.
- (iii) Records of transfer of each individual item, from the time and date it is received or collected until its destruction or return to its rightful owner.
- (iv) Records of each person involved in the chain of custody of each individual item.
- (v) Records of the actual holder of an individual item at all stages of its examination.
- (vi) The storage location(s) of each individual item.
- (vii) Records of any changes made to the item management system by users.

The system, whether paper based or electronic, shall record sub-sampling and maintain a link to the items from which they were sampled.

The system shall record the movement of items out of the forensic facility.

6.2 Security of items in storage

Access to storage areas shall be by authorized personnel only.

Access to areas containing valuable and portable items, such as drugs, currency or firearms, should have additional restrictions or security measures.

6.3 Security of items during examination

The following storage procedures apply:

- (a) When not under examination, items shall be stored in a secured (controlled access) storage area.
- (b) Items that are undergoing extended examination shall be stored within a secure (controlled access) examination area in a condition protecting against loss or contamination.
- (c) While under examination, items shall not be left unattended without appropriate measures taken to protect against contamination and to maintain the integrity of the items.
- (d) Where physical material is destroyed during or at the completion of examination, the reasons for such destruction shall be recorded in the case notes or covered by documented procedures.
- (e) Once an examination is complete, items should be returned to their original packaging, sealed and returned to the designated forensic storage area.

NOTE: Where items cannot be returned to their original packaging, new packaging should be used containing the same information and the original packaging retained or its condition suitably described in the case notes.

- (f) The item may then be further packaged and sealed as described in AS 5388.1.

7 OCCUPATIONAL HEALTH AND SAFETY

Occupational health and safety in forensic facilities is covered by the relevant Australian Standards (see Clause 2.1) and other documents such as NOHSC: 2012 (1994) and the ADG Code. Examiners and analysts shall be aware of any legislation relevant to occupational health and safety during the course of their work.

Health and safety information relevant to testing in the field is also included in AS 5388.1.

8 RECORDING PHYSICAL MATERIAL RECEIVED FOR EXAMINATION

8.1 General

Once the examiner has retained the material for analysis or received it from the appropriate person or storage location, and recorded it on an appropriate item management system, the analysis process begins by recording the state of material as received.

8.2 Note taking

The primary method of recording information relating to the examination of physical material is by making contemporaneous notes. Contemporaneous notes may be recorded in a number of ways, such as handwritten notes, typed notes or dictation.

Notes shall be permanent and the identity of the note taker and case manager (if different) shall be apparent as well as when the notes and any alterations were made. Notes should conform to relevant requirements of ISO/IEC 17025.

Case notes should include or be linked to the following information:

- (a) The continuity details (including date, time of receipt, case designation and item designation).
NOTE: Details may be recorded electronically. The facility's procedures should be suitably documented.
- (b) A description of any packaging.
- (c) Date and location of examination.
- (d) A description of the material received for examination.
- (e) The condition of the material received.
- (f) Any general observations about the material received for examination that may be relevant.
- (g) Any visual examinations carried out on the item and the results thereof.
- (h) Measurements of the material (where applicable).
- (i) Any relevant diagrams.
- (j) Results of any presumptive testing carried out on the item.
- (k) Any confirmatory testing carried out in situ.
- (l) Procedures used.
- (m) The sampling technique used to prepare for analysis.
- (n) If relevant, the location of the sample(s) taken from an item and the reason(s) why the item was so sampled.
- (o) Details of persons involved in examination and testing.

8.3 Photography

Photographic records and equipment shall be fit for purpose in regards to the level of detail recorded and colour fidelity such that they convey an appropriate representation of the items examined.

Any photographs shall be appropriately filed together with relevant information from the case or securely attached to the relevant case notes. Storage of electronic images as part of a case file should comply with jurisdictional policies and the *Australasian Guidelines for Digital Imaging Processes*. If analogue photography is used, negatives should be retained and filed appropriately according to jurisdictional requirements.

A mechanism for recording the date when images are taken shall be used. The record may be in the form of digital metadata and if so, should be retrievable if required. The record may also be handwritten, implied by the position of the record in the contemporaneous notes, or in another form, but shall be fit for purpose.

Photography should be considered where material is likely to be subjected to destructive testing (see also Clause 10.2).

8.4 Weighing and measuring physical material

The weight or size of the material received for examination may be important, particularly where a quantitative analysis is required. Any equipment and software used for such measurement shall be fit for purpose and appropriately calibrated and maintained.

Where measurements are recorded manually and the material being measured is not of a permanent nature, the measurements should be made, recorded and the record checked.

Measurement traceability for critical measurements shall be as defined in ISO/IEC 17025.

The facility shall have policies on the rounding of numerical values and the use of significant figures.

It is recognized that different disciplines may require different levels of accuracy in quantitative determinations. Procedures should comply with relevant guidelines and standards.

9 PRESUMPTIVE AND PRELIMINARY TESTS

Presumptive or preliminary tests shall follow current written methods. Reagents used and results obtained shall be properly noted and any equipment used shall be properly maintained.

Where appropriate reference materials/standards and control samples exist, they shall be used to help assure the accuracy and/or reliability of presumptive and preliminary tests.

Further information on presumptive and preliminary tests is given in Appendix B and further requirements and guidelines for the interpretation of presumptive and preliminary tests can be found in AS 5388.1.

10 ORDER OF EXAMINATION

10.1 General

The order of examination refers to the sequence of examinations to be conducted on the physical material and should take into consideration investigative priorities and case information.

Forensic facilities should have written procedures to cover common sequences of analysis. Individual case circumstances may, however, require variation of the sequence. Any significant variation from usual procedures shall be noted in the case notes along with the reasons for such variation.

10.2 Preservation of evidence

Where the quantity of physical material is limited or the examination is likely to consume or alter the material, the order of examination shall be planned and implemented so as to ensure that, as far as practicable, non-destructive techniques are given priority and conducted before any destructive techniques are attempted. Such considerations should not, however, jeopardize the primary aim of maximizing evidential value (see Clause 10.3).

10.3 Destructive techniques

Certain destructive techniques yield such valuable information that their use is justified.

Many chemical tests, for example, gas chromatography and mass spectrometry, are by their nature destructive.

Where practicable, consideration should be given, based on risk, to the retention of sufficient material for retesting. This may include retaining part of the original material or part of an extract or other material derived from that original material.

The photographic recording of material should be considered prior to any testing or analysis process where material is likely to be destroyed during the test or analysis and where photographic recording may be of assistance in explaining the process or source of the material.

10.4 Special considerations

Analysts and examiners should be aware that certain substances are subject to detailed legislative requirements.

The collection of physical material shall comply with all relevant national and jurisdictional laws and regulations.

11 SAMPLING

11.1 General

In some instances the item itself or material on the item will require sampling for analysis.

Sampling of items of forensic interest may be carried out for either or both of the following two reasons:

- (a) To obtain material in a form suitable for analysis.
- (b) To obtain a representative sample of the material received.

11.2 Sampling to obtain physical material in a form suitable for analysis

11.2.1 *Material to be analysed may be apparent but not in a form suitable for analysis*

Material shall be transformed into a form suitable for analysis.

Further guidance can be found in Appendix C and obtained from AS 5388.1.

11.2.2 *Material to be analysed may be visible but a choice must be made between one or more possible areas of material of interest*

Material shall be sampled after consideration of relevant case information.

Further guidance can be found in Appendix C and obtained from AS 5388.1.

11.2.3 *Instrumental methods must be used to obtain material suitable for analysis*

Material shall be transformed into a form suitable for analysis.

Further information on such methods of obtaining material for analysis is available in Appendix C.

11.3 Sampling to obtain a representative sample

11.3.1 General

Where only part of the physical material relevant to an investigation is examined or analysed, steps should be taken to help ensure that the part that is analysed is a representative sample of the whole.

There are a number of sampling procedures that may be applied and options are outlined in Clauses 11.3.2 and 11.3.3. Sampling procedures are most often applied to drug seizures where multiple units or large quantities of drugs require analysis. However, such procedures may also apply to other forms of forensic evidence. UN and SWGDRUG guidelines may be of relevance in sampling of drugs.

11.3.2 Sampling from a bulk quantity

NOTE: Refer to the *Manual of Good Practice for the Feed Industry* (See Clause 2.1).

Where the material presents as a bulk quantity, for example, a block of heroin, the material should, in general, be homogenized prior to sampling. Once homogenized, a single sample may suffice for analysis though, if quantification is important, multiple samples may result in more accurate results. Exceptions exist, such as bulk explosives and radioactive materials.

If non-homogenized material is to be analysed for quantification, several samples should be collected and analysed separately. A larger number of samples might be required for non-homogenized material.

11.3.3 Sampling from a population

Where physical material presents as a population of units (discrete items) with similar external characteristics (e.g. for DNA typing, ethnicity; for unfired cartridge cases, calibre; for fibres or particles, colour, shape, lustre and/or length), a representative sampling procedure may be applied.

When considering a group of items, a sampling rule should be applied to the population. If there are different groups of external characteristics, they shall be separated into as many groups as there are dissimilarities. Each group shall be considered as a discrete population and shall be sampled separately.

When examining enclosed material, if differences are subsequently observed in the appearance of the contents, then the sampling procedure shall be stopped and the sampling rule shall be reapplied prior to proceeding with the examination.

11.3.3.1 Arbitrary sampling

A sample consisting of a number of discrete units should be randomly selected from a population in such a way that the sample is representative of the whole population. Examples include the following:

- (a) *Objects in a population of similar objects* Where an item comprises a number of apparently identical objects, the recommended method of the United Nations Drug Control Programme (UNDCP) states the following:
 - (i) Where the population of units is less than ten, sample each of the units,
where $N < 10$, then $n = N$
 - (ii) Where the population of units is greater than or equal to ten and less than or equal to one hundred, a sample of ten is collected,
where $10 \leq N \leq 100$, then $n = 10$

- (iii) Where the population of units is greater than one hundred, a sample of the square root of the population is collected,

where $N > 100$, then $n = \sqrt{N}$.

NOTE: N = population size and n = sample size.

- (b) *Individuals in a population* If the criteria specified in Clause 11.3.3.1(a) were followed for DNA typing, a state with a population of around 6 million would require databases comprising around 2500 individual Caucasians and smaller databases for other ethnic groups. Whilst possibly desirable and achievable over time, it is generally accepted that useful estimates of the frequency of particular DNA profiles can be obtained with databases of a few hundred individuals or less.

NOTE: Refer to the *Evaluation of forensic DNA evidence* and *Fundamentals of forensic DNA typing* (see Clause 2.1).

11.3.3.2 Statistical sampling

If inferences about a population are to be made from the analysis of a sample from that population, the sample should be collected in such a way as to be representative of that population. There are a number of statistical approaches that may be used to achieve this. Such approaches are outlined in Appendix D.

11.4 Sub-samples

Collection of sub-samples from physical material may be required in various circumstances, for example, when the material consists of a mixture of several different substances that require different treatment for the purposes of analysis.

If not immediately analysed, sub-samples collected from a sample shall be—

- (a) properly packaged as per the requirements for the material (see AS 5388.1);
- (b) properly labelled as per the requirements for recording and continuity; and
- (c) able to be linked to the original sample from which it was collected.

The collection of a sub-sample shall also be recorded in the examiner's notes, as per the normal requirements for note taking (Clause 8.2).

12 ANALYSIS AND EXAMINATION OF PHYSICAL MATERIAL

12.1 General

Forensic science uses both analytical and comparative techniques. Many processes in forensic science combine elements of both.

Both analytical and comparative techniques share a common scientific methodology but the emphasis placed on particular aspects of that methodology will vary depending on the type of analysis or examination being undertaken.

12.2 Scientific methodology

12.2.1 General

Scientific method consists of the collection and assessment of relevant data through objective observation. This is followed by the formulation of a hypothesis and the testing of that hypothesis through comparison and/or analysis. The results of the analysis, comparison and hypothesis testing are then interpreted. Interpretation is described in AS 5388.3.

In a forensic context this process can be divided into the stages outlined below (Clauses 12.2.2 to 12.2.4).