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Guide to

Field and on-site test methods for the analysis of waters

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Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Environment and Pollution Standards Policy Committee (EPC/-) to Technical Committee EPC/44, upon which the following bodies were represented:

Association of Consulting Scientists
 British Association for Chemical Specialities
 British Gas plc
 Chemical Industries' Association
 Convention of Scottish Local Authorities
 Department of the Environment for Northern Ireland
 Department of the Environment (Water Directorate)
 Department of Trade and Industry (Laboratory of the Government Chemist)
 Electricity Association
 Industrial Water Society
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 National Rivers Authority
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 Royal Society of Chemistry
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 Soap and Detergent Industry Association
 Water Companies Association
 Water Research Centre
 Water Services Association of England and Wales

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Foreword

This British Standard has been prepared under the direction of the Environment and Pollution Standards Policy Committee. It supersedes BS 1427:1962, which is withdrawn.

This guide describes methods for the analysis of industrial and other waters which can be undertaken outside the chemical laboratory, either as on-site or as field tests, when the purpose of the test is to characterize the water under test for either quality or control purposes. The tests are not intended for legal purposes. With some determinands which may be unstable after sampling, and which cannot be stabilized, field and on-site tests provide the most suitable means of obtaining reliable test results. The test methods are simple procedures for use by a non-chemist after suitable training as well as by the trained chemist.

This British Standard is not intended as a substitute for, or alternative to, other British Standards on the quantitative analysis of waters, namely BS 6068 and BS 2690, which remain the reference methods for use in a laboratory. The methods described in this British Standard are mostly based on the principles and/or procedures used in BS 6068 and BS 2690.

This revision of BS 1427 incorporates a corrigendum, widens the scope and range of the test methods to make the methods more generally applicable to industrial and other waters. It provides guidance on the use of available commercial test kits and test kit equipment. Since the original publication of the standard the range, type and quality of commercial test kits/apparatus have improved, producing significant benefits in terms of increased reliability and ease of use for field and on-site testing. The increased use, availability and quality of prepackaged chemicals and reagents have also reduced risks associated with the handling of chemicals and reagents and enhanced the accuracy and simplicity of testing.

The test procedures for the colorimetric and the instrumental test methods are specific to the colour comparator or instrument used. A test procedure is included within each test method but the detailed test procedure defined by the instrument manufacturer should be followed for all tests using commercial test kits.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 74, an inside back cover and a back cover.

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Section 1. General

1.1 Scope

This British Standard gives information and guidance on test methods for the analysis of industrial and other waters which are applicable outside the laboratory as field or on-site tests. No recommendation is given as to which test is applicable to a particular type of water nor does it imply that in any given case all tests or any particular suite of tests are necessary. The selection of tests depends on local requirements and conditions. Samples requiring preservation for subsequent analysis are outside the scope of this British Standard.

The test methods described in Section 3, Section 4 and Section 5 are applicable for use on clean or lightly polluted waters which may have been treated or modified for industrial use. Typically the types of water for which the tests are intended include the following:

- boiler water;
- cooling water;
- hot water system water;
- air conditioning system water;
- industrial air washing system water;
- potable water;
- ground water;
- surface water;
- process water;
- swimming pool water.

Certain heavily polluted waters can be routinely tested for control purposes for specific or consented determinands using the test methods included in this British Standard. Such waters include the following:

- sewage works effluents;
- selected industrial effluents.

Each test method identifies the analytical range covered by the method. The test methods described in this British Standard include titrimetric, colorimetric and instrumental analysis techniques. The technique used and the principle of the method are described within each test method and each method is self-contained within a standard format.

1.2 References

1.2.1 Normative references

This British Standard incorporates, by reference, provisions from specific editions of other publications. These normative references are cited at the appropriate points in the text and the publications are listed on page 73. Subsequent amendments to, or revisions of, any of these publications apply to this British Standard only when incorporated in it by updating or revision.

1.2.2 Informative references

This British Standard refers to other publications that provide information or guidance. Editions of these publications current at the time of issue of this standard are listed on page 73, but reference should be made to the latest editions.

1.3 Definitions

For the purposes of this British Standard, the following definitions apply.

1.3.1

on-site tests

quantitative chemical and physical tests undertaken on a site, typically for compliance monitoring or process control purposes, within a testing area with fixed or semipermanent facilities and equipment to enable water quality testing to be undertaken

1.3.2

field tests

quantitative chemical and physical tests undertaken at sites or locations without testing facilities, typically for incident investigation or routine monitoring purposes, using portable or transportable test equipment

1.3.3

commercial test kits

commercially packaged complete analytical systems in a portable kit format designed for field or on-site testing

NOTE They are intended as simplified, easy-to-use tests for analysis of water quality, usually within specified concentration ranges and designated sample matrices.

Section 2. Physical and chemical test methods: general information

2.1 Health and safety

The test methods described in this British Standard should be undertaken by non-chemists only after adequate training by a competent person (see 2.2). Where necessary, adequate supervision in undertaking the tests should be provided. Training in safe working practices should be provided for the test operator for the test function specific to the fixed testing site or as general instructions for field testing which should pay due regard to potential hazards of field operations.

NOTE 1 Attention is drawn to the Health and Safety at Work etc. Act 1974 [1] and the need for management to make adequate provisions for safe working.

It is the duty of the test operator to know and follow safe working procedures.

NOTE 2 Attention is drawn to the Control of Substances Hazardous to Health Regulations 1988 [2] (COSHH) which require a risk assessment to be undertaken and appropriate safety measures to be implemented when using potentially hazardous chemicals in test methods.

NOTE 3 The chemicals referred to in this British Standard are typical of chemicals used in a laboratory environment and hazard data sheets are obtainable from chemical suppliers. Commercial test kits may also incorporate hazardous chemicals and manufacturers provide warning notices and relevant hazard data sheets for test kits they manufacture.

This British Standard does not define safe working procedures for test methods or commercial test kits.

Suitable check lists for working practices should include the following general safeguards against potential hazards within routine control testing.

a) Personal safety precautions

- 1) Wear protective safety glasses when following test methods or when handling hazardous chemicals.
- 2) Wear appropriate protective clothing when sampling, testing or handling hazardous chemicals.
- 3) Do not smoke, drink or eat whilst testing or handling hazardous chemicals.
- 4) Do not lick adhesive labels.
- 5) Do not pipette solutions by mouth.
- 6) Because of potential microbiological contamination in water samples, always seal samples and wash hands after sampling or carrying out tests. Wash hands before leaving a site or field location.

b) Care in the workplace

- 1) Keep fixed site testing facilities clean and tidy.
- 2) Store chemicals and test kits safely using clear unambiguous labelling.
- 3) Clean up spillages immediately.
- 4) Hazardous chemicals are sold in protective packaging clearly marked with appropriate hazard warnings. They should be stored safely as directed on the label or material data safety sheet supplied with the chemical. Preparation of test reagents should be restricted to qualified staff unless the test operative is given specific training and instructions on preparation procedures.

c) General safeguards

- 1) Follow safe working procedures for the workplace.
- 2) Do not use damaged equipment, or broken or chipped glassware.
- 3) Ensure that safe working procedures for testing are known and followed.
- 4) Where chemicals are transported for field testing, identify protective containment.
- 5) Provide compulsory instructions to test operatives for the safe disposal of the waste material.

2.2 Training and supervision

Training is essential to safeguard the test operator and to achieve acceptable test results. This British Standard does not define the training required but it should include the following:

- a qualified person, such as a trained chemist with relevant experience, to act as the trainer;
- instruction on any potential hazards of the test method;
- instruction in the use of all test equipment used in the test method;
- instruction and practical demonstration of the test procedure by the trainer;
- supervised use of the test procedure by the test operator including, where possible, test analysis of known standards to demonstrate the ability of the trainee to use the test procedure correctly and achieve acceptable results. Unless a test operator can demonstrate acceptable colour discrimination for any visual colour comparison test method, the operator should not become an approved user for that particular test;
- instruction on safe working procedures both for the test method and the test location.

On-going supervision of unqualified personnel by a qualified person is essential for maintaining the acceptability of test results. Depending on circumstances supervision may be continuous or, less satisfactorily, intermittent. Supervision should include tests by the test operator on real samples which are then replicated by the qualified person. Where personal supervision is not available, suitable check standards should be supplied to the test operator for regular check test analysis at specified intervals. The check test results should be reported to a qualified person as part of the on-going supervision. Such test results should act as an on-going calibration check on both the test kit and the test operator.

2.3 Test facilities

Test results made outside the laboratory have potentially a significant random error associated with the physical and environmental conditions under which the test is carried out. Little can be done for open site testing but provision of a testing area within a fixed site is necessary for ensuring the quality of testing. For preference, this area should be used exclusively for testing and provide the following features.

Adequate environmental conditions, including provision of lighting and heating. Services including power outlets, running water and drainage. Bench top working space and cupboard storage space for chemicals and apparatus.

For health and safety reasons access should be restricted and the testing area locked when not in use.

2.4 Sampling

NOTE 1 Some instrumental test methods may be applied in situ by direct immersion of measuring electrodes into the body of water, which obviates the need for sampling.

Where sampling is necessary, it is essential to obtain representative samples, which should be tested as quickly as possible to retain sample integrity.

Sampling from enclosed vessels and sample lines may be hazardous and documented safe working procedures should be made available and used. This is particularly important where the system is at elevated temperature and/or pressure.

Open channel sampling or in situ testing in the field or on remote sites requires documented safe working procedures which should be followed. This includes sampling from boats.

Samples should be taken at or below points of turbulence to assist representative sampling.

In this British Standard spot sampling predominates. Where on-site time- or flow-weighted composite sampling is required, the collection bottle should be refrigerated and the composite sampling period kept to a safe minimum to reduce sample deterioration.

Turbidity and colour will interfere with many of the test methods used in this British Standard, particularly colorimetric test methods. It may be advantageous or necessary to clarify visibly turbid samples either by quiescent settlement then sampling the supernatant liquor or by filtration through a membrane or glass filter of known pore size. Simple purpose-designed easy-to-use filter systems for filtration on-site or in the field are commercially available and are recommended. Any determinand present in the removed particulate matter will not be included in the test result. It is not usual practice in field testing of waters to pretreat samples to solubilize particulate matter or release inactivated determinand. Such pretreatment is not identified in the test methods in this British Standard which typically measure only the soluble and reactive determinand. Any pretreatment is a matter for local decision and should be identified if used when reporting the test result. Pretreatment may only be used where such treatment will not invalidate the test method.

NOTE 2 Further details on sampling and sample preservation are described in BS 1328, BS 3285 and BS 6068-6.

2.5 Quality control

It is the responsibility of the user of any analytical test method to ensure that it is capable of producing results of the required accuracy. The use of the test methods given in this British Standard should not be taken as a guarantee that results will be of high accuracy. Additionally, the performance of the test methods will be affected by both non-standard test conditions, principally variable environmental field conditions and their use by non-chemists. As a consequence no performance data are given with the individual test methods. The performance data provided with the equivalent laboratory methods in BS 2690 or/and BS 6068 may be used as a guide for method performance or method selection.

2.6 Ranges of methods

The application range of each test method in this British Standard is stated within the test method. The stated range in many cases may be extended by using a smaller test portion or by predilution of the test sample. Depending on local requirements results may be quoted as “less than” for concentrations below a stated level or “greater than” for concentrations above a stated level. These upper and lower “levels of interest” should be clearly defined wherever they are applied. Where more than one application range is necessary for any determinand, alternative test methods for the different ranges may be required.

2.7 Selection and application of test methods

2.7.1 General

The test methods given in Section 3, Section 4 and Section 5 are recommended as being adequate for use for field and on-site testing purposes as opposed to being reference methods for use under laboratory conditions. Due regard has been given to current practice in the use of field tests and available experience and knowledge of existing commercially available systems. Most of the test methods included are based upon laboratory reference test methods but are commonly modified or utilized in a form to make them usable under field conditions. The selected test methods fall into three categories; colorimetric methods, titrimetric methods and instrumental analysis methods.

2.7.2 Colorimetric methods

NOTE Laboratory colorimetric test methods using spectrophotometers are not appropriate for field or on-site testing.

It is widely accepted practice to use commercial test kits based on visual colour comparison techniques for field or on-site testing. Commercial colour disc systems, because of their wide application, usage and availability, are used as the basic system for all the colorimetric test methods in this standard. Alternative visual colour comparison formats are commercially available for all the determinands measured by colorimetry within this British Standard. The different formats are identified in 2.9 and Annex A. The choice of format or manufacturer remains a local decision but should take into account the criteria defined within the individual test methods described in Section 3.

Portable photometer-based methods are becoming widely available from manufacturers and provide an instrumental alternative to visual comparison for the majority of the colour tests in this British Standard but there may be significant cost implications (see 2.9.3 and Annex A).

It is usual for manufacturers to supply a complete test system and it is essential always to use the kit in accordance with the manufacturer's instructions. Due care should be paid to the concentration values specified within the test kit as different concentration ranges are often used by different manufacturers. Additionally, determinands may be defined in different terms which are not directly equivalent. For example phosphate concentration may be expressed as P, P_2O_5 or as phosphate ion.

2.7.3 Titrimetric methods

The titrimetric test methods described in this British Standard are normally based upon laboratory reference test methods which are identified within the described test method. To assist ease of use in the field situation, indicator colour end-point methods only are recommended and instrumental end-points are not included. The test apparatus identified in reference methods may be used but equipment manufacturers now supply alternative apparatus specifically designed for field use which is simpler to use or provides greater safety. Provided such equipment meets the performance required for local use it may be utilized (see 2.9.4). The use of commercial prepacked ready-to-use or concentrated reagents is also recommended (see 2.10). Commercial drop count or tablet count titrimetric test kit methods are widely available for field and on-site testing. They are not generally recommended but may be acceptable dependent on local requirements (see 2.9.4).

2.7.4 Instrumental methods

The instrumental test methods described in this British Standard are based upon laboratory reference test methods which are identified within the described test method. Following normal convention, commercial instruments are not identified and only the general principles of the test instruments are described together with the test procedure. For all instrumental test methods described, instruments specially developed or adapted from laboratory systems are available for field use. All the parameters measured by instrumental test methods are temperature dependent. It is advised that, wherever possible, field instruments should have automatic temperature compensation and/or temperature measurement especially for in situ measurement.

2.7.5 Applicability of test methods

The test methods described were chosen on the basis of being both widely used and the best-suited techniques to fulfil the circumstances and needs of on-site and field testing by non-chemists. More than one test method is described only where it is necessary to cover a wider concentration range than would otherwise be possible. Brief reference is made to alternative test methods or method formats within individual test methods which, depending on local circumstances, may be more applicable.

NOTE Some important determinands are not included in this British Standard because of the absence of suitable field test methods. Annex B identifies some of the important tests which fall into this category.

2.8 Interferences

Because of the wide range of waters covered in this British Standard the information given on interferences cannot be comprehensive. There is always the possibility that the water under test may contain substances which will interfere with the test procedure. Test methods identify typical interfering substances but, in order to keep test methods as simple and as easy to use as possible, information on procedures for overcoming interferences is not normally included. The most common interference, particularly for colorimetric test methods, is visible turbidity, which is easily identified. The removal of turbidity and the means employed is dependent on local conditions and remains at the discretion of the analyst (see 2.4). Where the test method is similar or traceable to an existing British Standard, reference may be made to the standards for information on overcoming interferences. Prepackaged reagents may include reagents designed to minimize or eliminate known interferences. Commercial test kit systems may also specify sample pretreatment requirements designed to overcome interferences.

2.9 Apparatus and equipment

2.9.1 General

Portability and safety are essential requirements, particularly for field testing. Apparatus and equipment fabricated from suitable plastics material are widely used and available as alternatives to conventional laboratory glassware.

Commonly, commercial kits are housed in custom-made carrying cases designed to improve the safety, portability and ease of use of test kits. Care is necessary when selecting additional components for use with test kits.

The test equipment provided with commercial test kits is dependent on the test format selected. Test equipment associated with the various formats available is described in 2.9.2 to 2.9.5.

2.9.2 Visual colour comparison test kits

2.9.2.1 General

Test kits are commercially available based on liquid, glass, plastics and printed card colour standards. Competing systems differ in the number of colour standards provided, which affects the degree of discrimination afforded. All the colour standards except for the printed standards are transparent standards. The accuracy achieved is very dependent on the ability of the manufacturer to achieve consistency and accuracy of representation of the colour and colour density of the standards.

2.9.2.2 Colour disc comparator system

The test equipment consists of a comparator unit which holds the colour disc and the test cuvettes for both blank and test samples. Both discs and cuvettes are interchangeable and are selected as specified by the test kit manufacturer. The colour disc consists of a series of 8 to 10 discrete transparent glass or plastics standards, covering the test range, set around the circumference of the disc in ascending colour density. Alternatively the entire disc is made of transparent glass or plastics which has a continuously increasing colour density gradient around its circumference. Both types are permanently marked in concentration units of the determinand being measured, equivalent to the colour density of the test solution. Background illumination aids for use where natural light levels are poor are available from some manufacturers of colour disc systems.

2.9.2.3 Liquid colour standards comparator system

The test equipment consists of a series of individual liquid colour standards, covering the test range, sealed into identical glass ampoules. Evacuated test ampoules containing the test reagents act as the test cuvettes and are identical to the standard ampoules. Up to 10 standards are provided ensuring colour discrimination equivalent to the colour disc system.

2.9.2.4 Colour cube comparator system

The test equipment is simple and consists of combined twin cuvettes. One cuvette is made up of a series of colour segments of ascending colour density. The coloured-up sample is placed into the second, clear, cuvette to allow direct visual comparison. The small number of colour segments limits the range and discrimination of the test method.

2.9.2.5 Printed colour card comparator system

The test equipment is minimal and consists of stiff card on which is printed a series of colour standards equivalent to the colours of the range of the test method. The colour standards are viewed through the blank solution until a colour match is achieved against the coloured-up test sample viewed against a white background. Colour matching by reflectance is typically not as exact as by transparency matching and additionally colour printing needs to be exact.

NOTE 1 Colour standards may not be permanent. Verification against known standards should be carried out.

NOTE 2 Accurate testing is very dependent on the ability of the manufacturer to represent correctly the colour and colour density of the colour standards.

2.9.3 Portable colorimeter systems

Test kits incorporating portable colorimeters are becoming increasingly available. They provide superior colour discrimination and eliminate the operator-dependence of comparator systems. Advances in microelectronics have allowed a significant amount of complexity to be incorporated within miniature hand-held instruments. Available systems vary significantly in cost and complexity but typically are much more expensive than the colour comparator test kits. Selection is dependent on local needs.

2.9.4 Equipment for titrimetric field tests

Both complete test kits and individual field-use burettes of innovative design are commercially available. The systems are designed for portability and ease of use and can be utilized for most standard titrimetric tests. The simplest option consists of plastics burettes with an integral titrant reservoir. Manual or electrically operated piston-based titrators with digital readout offer a greater degree of accuracy and ease of use. Digital titrators should be regularly calibrated to ensure acceptable accuracy is maintained.

2.9.5 Equipment for instrumental tests

Advances in microelectronics have allowed the development of portable field-use test equipment based on standard laboratory test equipment. There is a wide choice of commercially available equipment. In the absence of formal testing protocols, selection of the most suitable equipment remains a local decision.

2.10 Reagents

2.10.1 General

Reagents of recognized analytical quality should always be used along with distilled or deionized water conforming to grade 3 of BS 3978:1987. The required reagents are specified within the individual test methods. Reagent manufacturers and suppliers market a very wide range of ready-made analytical quality reagents for a wide variety of tests. It is recommended that commercial ready-made reagents, where available, are used for the test methods in this British Standard to avoid making up the required test reagents under non-laboratory conditions.

2.10.2 Prepackaged reagents for colorimetric test kits

These are supplied by the manufacturer and are specific to each manufacturer's own test kit methods. Dependent on the manufacturer, these may be in liquid, powder or tablet form or a combination of different forms for different test methods. Reagents may also consist of single or mixed reagents. The reagents are not usually interchangeable between different systems and replacement refills for prepackaged reagents should normally be obtained from the test kit manufacturer.

2.10.3 Prepackaged reagents for titrimetric test kits

The test kit titrant solutions are frequently different in concentration from the titrants used in the described titrimetric test methods. They are considerably more concentrated, to reduce the titrant volume used, because of the small capacity of reagent cartridges or reagent containers used in portable titrimetric test kits. It is important to identify the correct calculation factors for the reagent strength used.

Tablet and drop test methods are alternative commercially available simplified titrations. They have much lower analytical accuracy expectations than conventional techniques. These tests are dependent on the accuracy and reproducibility of the tablets or test drops, which depend on manufacturing tolerances. End-point overshoot is another potential source of error. This is affected by the number of drop or tablet incremental additions. The greater the number of additions, the smaller the potential error.

2.10.4 Calibration and working standards

Water quality test kits are intended for testing waters which lie in the pH range 4 to 10 and standard solutions should preferably be within the same range, otherwise erroneous results may occur. Acid-based standards may be unsuitable and alternative standards prepared from neutral salts should be used. The relevant manufacturer should be consulted where any doubt exists regarding suitable standards.

Section 3. Colour disc comparator methods

NOTE It is important to emphasize that, in colour comparison methods, precision and accuracy are operator-dependent and are also influenced by the environmental test conditions. Therefore meaningful comparative performance data are not obtainable.

3.1 Determination of aluminium

3.1.1 General

The method employs commercial colour disc comparator test kits based on the analytical principle defined in method 30500-AID of the publication *Standard methods for the examination of water and wastewater* [3], which is a recognized reference method. Suitable commercial test kits based on this principle are available from several manufacturers.

A number of standard procedures based on a similar principle but using alternative chelation dyestuffs have been published, including BS 2690-106. Alternative commercial test kit systems using these alternative dyestuffs are available.

3.1.2 Scope of this method

This test method is recommended as a field and on-site test for the determination of aluminium. It is applicable to potable, raw, industrial, lightly polluted and swimming pool waters. This method determines only soluble reactive aluminium and complexed or insoluble aluminium is not measured.

The analytical range for aluminium is defined by the calibrated colour disc provided with the selected test kit (see 3.1.5.2).

NOTE Known interferences identified in the reference method affect test kit methods based on the same principle.

Iron and manganese are commonly present interferences. They can be masked by the addition of ascorbic acid which is commonly included in prepackaged reagents.

Prepackaged reagents supplied with the selected test kit may incorporate additional reagents for suppressing known major interferences. For routine testing in the field or on-site the effect of interferences should be ignored unless covered within the test kit manufacturer's instructions.

3.1.3 Principle

Eriochrome cyanine R dye chelates with soluble reactive aluminium in solutions buffered to pH 6.0 to produce a red-to-pink coloured complex with a maximum absorption at about 535 nm. The intensity of the developed colour is measured by visual comparison and is proportional to the concentration of reactive aluminium present.

3.1.4 Reagents

3.1.4.1 *Distilled or deionized water.* (See 2.10.1).

3.1.4.2 *Prepackaged reagents.* Only the test kit reagents supplied by the test kit manufacturer should be used (see 2.10.2). Reagents should be stored in accordance with the manufacturer's instructions and not retained beyond any recommended "use by" date.

3.1.4.3 *Stock standard solution, 100 mg/l of aluminium.* Dissolve 1.758 g of potassium aluminium sulfate ($\text{KAlSO}_4 \cdot 12\text{H}_2\text{O}$) in water and dilute to 1 000 ml in a one-mark 1 000 ml flask.

NOTE This solution is prepared as required. Standard aluminium solutions are commercially available but usually have an acid matrix and may be unsuitable as a test kit standard.

3.1.4.4 *Working standard solution.* The stock standard (3.1.4.3) should be diluted with water, using serial dilutions as appropriate, to provide suitable working standards.

NOTE A suitable working standard will have a concentration around the mid-point of the usable calibration range of the colour disc. Working standards should be prepared as required and discarded after use.

3.1.5 Apparatus

3.1.5.1 *Colour disc comparator*, as supplied with the test kit (see 2.9.2.2).

3.1.5.2 *Calibrated colour disc*, as supplied with the test kit, calibrated in milligrams per litre of aluminium (see 2.9.2.2).

The calibrated disc should cover the calibration range between 0 mg/l and about 0.5 mg/l to 1.0 mg/l of aluminium with acceptable discrimination for intermediate concentrations.

NOTE Some commercially available colour discs meet this criterion but additionally include a more extended concentration range with relatively poor discrimination and of doubtful accuracy. Use of the extended, higher concentration range of such discs should be avoided.

3.1.5.3 *Test cuvettes*, appropriate to the test method, supplied with the test kit.

3.1.5.4 *Stopwatch*.

3.1.5.5 *Thermometer*, range 0 °C to 60 °C, graduated in 0.5 °C steps, conforming to type C of BS 1704:1985.

3.1.6 Samples and sampling

Samples should be analysed with the minimum of delay after sampling and should not be stored for subsequent testing.

Visibly turbid samples should be clarified by settlement or filtration prior to testing as necessary (see 2.4).

Samples should be collected in clean, acid-washed polyethylene bottles.

3.1.7 Procedure

Measure the temperature of the test sample using the thermometer (3.1.5.5) and adjust if necessary to within the tolerances specified in the test kit manufacturer's instructions.

If the concentration of aluminium in the test sample exceeds the maximum in the range, dilute with distilled water (3.1.4.1) as necessary and note the dilution factor.

Avoid dilution factors greater than 10 for field and on-site testing purposes in order to minimize error and maintain test simplicity.

Follow the manufacturer's test kit instructions carefully. Ensure that the reagent additions and reaction times are as stipulated to allow the correct colour development equivalent to the concentration of aluminium in the test sample.

Insert the aluminium test kit colour disc (3.1.5.2) into the disc comparator (3.1.5.1). Place the test kit cuvette (3.1.5.3), containing the coloured-up sample, and a matching test blank cuvette, containing untreated test sample or prediluted test sample as appropriate, into the comparator cell holder. Visually match the colour density developed in the sample against the calibrated disc standards, as viewed through the test blank solution. The concentration of aluminium in the test sample or prediluted sample is equivalent to the concentration value displayed on the matching calibration disc standard.

NOTE Calibration is not required due to the use of a precalibrated colour disc.

A regular test on the working standard solution (3.1.4.4) is recommended for checking the colour standards and test reagents.

The test operator's ability to achieve acceptable visual colour discrimination should also be checked initially, using appropriate working standard solutions.

3.1.8 Expression of results

3.1.8.1 *Test sample*

The concentration of aluminium in milligrams per litre should be read directly from the calibrated colour disc.

3.1.8.2 *Prediluted sample*

The concentration of aluminium in the test sample should be calculated by multiplying the calibrated disc reading by the dilution factor.

3.1.9 Performance characteristics

Meaningful comparative performance data are not obtainable (see note to Section 3, on page 9).

The suitability of the test kit method for specific sample matrices may be established by comparative analysis of test samples and spiked test samples using the reference method and the test kit method under laboratory conditions.

NOTE Alternative test procedures consist of alternative comparator test kits (see 2.9.2) and portable photometer test kits (see 2.9.3). Systems meeting the test method recommendations are available from different manufacturers.

3.2 Determination of ammoniacal nitrogen

3.2.1 General

The method employs commercial colour disc comparator test kits based on the analytical principle defined in BS 6068-2.11, which is a recognized reference method. Suitable commercial test kits based on this principle are available from several manufacturers.

3.2.2 Scope of this method

This test method is recommended as a field and on-site test for the determination of ammoniacal nitrogen. This method is applicable to potable, raw, industrial, lightly polluted and swimming pool waters.

The analytical range for ammoniacal nitrogen is defined by the calibrated colour disc provided with the selected test kit (see 3.2.5.2).

NOTE Known interferences identified in the reference method affect test kit methods based on the same principle.

For routine testing in the field or on-site the effect of interferences should be ignored unless covered within the manufacturer's test kit instructions.

3.2.3 Principle

Ammonia reacts with alkaline phenol in the presence of chlorine to form a blue compound which shows maximum absorption at about 650 nm. This is termed the indophenol blue method. Catalysts are incorporated to assist the reaction. The intensity of the developed colour is measured by visual comparison and is proportional to the concentration of ammonia present.

3.2.4 Reagents

3.2.4.1 *Distilled or deionized water.* (See 2.10.1.)

3.2.4.2 *Prepackaged reagents.* Only the test kit reagents supplied by the test kit manufacturer should be used (see 2.10.2). Reagents should be stored in accordance with the manufacturer's instructions and not retained beyond any recommended "use by" date.

3.2.4.3 *Stock standard solution, 1 000 mg/l, as ammoniacal nitrogen.* 3.820 g of ammonium chloride (NH_4Cl) dried at 110 °C for 2 h should be dissolved in about 200 ml of water. This solution should be transferred to a 1 000 ml one-mark flask, diluted to the mark with water, and stored in a stoppered glass bottle. The solution is stable for at least 1 month.

3.2.4.4 *Working standard solution.* The stock standard (3.2.4.3) should be diluted with water, using serial dilutions as appropriate, to provide suitable working standards.

NOTE A suitable working standard will have a concentration around the mid-point of the usable calibration range of the colour disc. Working standards should be prepared as required and discarded after use.

3.2.5 Apparatus

3.2.5.1 *Colour disc comparator*, as supplied with the test kit (see **2.9.2.2**).

3.2.5.2 *Calibrated colour disc*, as supplied with the test kit, calibrated in milligrams per litre of ammoniacal nitrogen (see **2.9.2.2**).

The calibrated disc should cover the calibration range between 0 mg/l and about 1.0 mg/l to 2.0 mg/l of ammoniacal nitrogen with acceptable discrimination for intermediate concentrations.

NOTE Some commercially available colour discs meet this criterion but additionally include a more extended concentration range with relatively poor discrimination and of doubtful accuracy. Use of the extended, higher concentration range of such discs should be avoided.

3.2.5.3 *Test cuvettes*, appropriate to the test method, supplied with the test kit.

3.2.5.4 *Stopwatch*.

3.2.5.5 *Thermometer*, range 0 °C to 60 °C, graduated in 0.5 °C steps, conforming to type C of BS 1704:1985.

3.2.6 Samples and sampling

Samples should be analyzed with the minimum of delay after sampling and should not be stored for subsequent testing.

Visibly turbid samples should be clarified by settlement or filtration prior to testing, as necessary (see **2.4**).

3.2.7 Procedure

Measure the temperature of the sample using the thermometer (**3.2.5.5**) and adjust if necessary to within the tolerances specified in the test kit manufacturer's instructions.

If the concentration of ammoniacal nitrogen in the test sample exceeds the maximum in the range, dilute with distilled water (**3.2.4.1**) as necessary and note the dilution factor.

Avoid dilution factors greater than 10 for field and on-site testing purposes in order to minimize error and maintain test simplicity.

Follow the manufacturer's test kit instructions carefully. Ensure that the reagent additions and reaction times are as stipulated to allow the correct colour development equivalent to the concentration of ammoniacal nitrogen in the test sample.

Insert the ammonia test kit colour disc (**3.2.5.2**) into the disc comparator (**3.2.5.1**). Insert the test kit cuvette (**3.2.5.3**) containing the coloured-up sample, and a matching test blank cuvette, containing untreated test sample or prediluted test sample as appropriate, into the comparator cell holder. Visually match the colour density developed in the sample against the calibrated disc standards, as viewed through the test blank solution. The concentration of ammoniacal nitrogen in the test sample or prediluted sample is equivalent to the concentration value displayed on the matching calibration disc standard.

NOTE Calibration is not required due to the use of a precalibrated colour disc.

A regular test on the working standard solution (**3.2.4.4**) is recommended for checking the colour standards and test reagents.

The test operator's ability to achieve acceptable visual colour discrimination should also be checked initially, using appropriate working standard solutions.

3.2.8 Expression of results

3.2.8.1 Test sample

The concentration of ammoniacal nitrogen in milligrams per litre should be read directly from the calibrated colour disc.

3.2.8.2 Prediluted sample

The concentration of ammoniacal nitrogen in the test sample should be calculated by multiplying the calibrated disc reading by the dilution factor.

NOTE Where alternative concentration terms are given in the test kit or are required to be quoted the following conversion factors apply.

To convert from N to $(\text{NH}_4)^+$ multiply by 1.28;

To convert from N to NH_3 multiply by 1.21;

To convert from NH_3 to $(\text{NH}_4)^+$ multiply by 1.06.

3.2.9 Performance characteristics

Meaningful comparative performance data are not obtainable (see note to Section 3, on page 9).

The suitability of the test kit method for specific sample matrices may be established by comparative analysis of test samples and spiked test samples using the reference method and the test kit method under laboratory conditions.

NOTE Alternative test procedures consist of alternative comparator test kits (see 2.9.2) and portable photometer test kits (see 2.9.3). Systems meeting the test method recommendations given are available from different manufacturers.

3.3 Determination of bromine (as total residual bromine)

3.3.1 General

The method employs commercial colour disc comparator test kits based on the analytical principle defined in the publication *Chemical disinfecting agents in water and effluents and determination of chlorine demand: Methods for the examination of water and associated materials* [4], which is a recognized reference method. Suitable commercial test kits based on this principle are available from several manufacturers.

Bromine and bromine-releasing compounds are added to waters for disinfection purposes. The added bromine may therefore be present as free bromine or combined bromine, bromamines, both of which contribute to the total residual bromine.

NOTE Supplementary procedures can be used to differentiate between the free and combined bromine if required. These are not included in this method. Separate determination of free and combined bromine is not considered important for routine testing and may or may not be available with the different commercial test kit methods.

3.3.2 Scope of this method

This test method is recommended as a field and on-site test for the determination of bromine. It is applicable to potable, raw, industrial, lightly polluted, saline and swimming pool waters.

The analytical range for bromine is defined by the calibrated colour disc provided with the selected test kit (see 3.3.5.2).

NOTE Known interferences identified in the reference method affect test kit methods based on the same principle. Oxidized chromium and manganese and other oxidizing agents react with colorimetric reagent giving enhanced results. High bromine levels in the test solution will bleach the developed colour giving biased low results. Samples with a distinct bromine odour or where the developed colour is transient should be serially diluted to establish an optimum dilution for the determination. Prepackaged reagents supplied with the selected test kit may incorporate additional reagents for suppressing known major interferences. For routine testing in the field or on-site the effect of interferences should be ignored unless covered within the test kit manufacturer's instructions.

3.3.3 Principle

Bromine and bromamines both react with *N,N*-diethyl-1,4-phenylenediamine (DPD) in buffered solution to give a red colour which shows maximum absorption at about 520 nm. The intensity of the developed colour is measured by visual comparison and is proportional to the total residual bromine present. Free chlorine reacts similarly but is suppressed by the addition of glycine.

NOTE For the purposes of this method, total residual bromine can be defined as the sum of the free bromine and combined bromine present as bromamines. In swimming pool waters the term "active bromine" is equivalent to "total residual bromine".

3.3.4 Reagents

3.3.4.1 *Distilled or deionized water.* (See 2.10.1).

3.3.4.2 *Prepackaged reagents.* Only the test kit reagents supplied by the test kit manufacturer should be used (see 2.10.2). Reagents should be stored in accordance with the manufacturer's instructions and not retained beyond any recommended "use by" date.

3.3.4.3 *Stock standard solution.* It is not feasible to prepare and retain accurate bromine standard solutions. Bromine equivalent stock solution, 1 000 mg/l as bromine, may be prepared by dissolving 0.395 g of potassium permanganate (KMnO_4) in 200 ml of water. The solution should be transferred to a one-mark 1 000 ml flask, diluted to the mark with water, and stored in a stoppered amber glass bottle. The solution is stable for at least 2 months.

3.3.4.4 *Working standard solution.* The stock standard (3.3.4.3) should be diluted with water, using serial dilutions as appropriate, to provide suitable working standards.

NOTE A suitable working standard will have a concentration around the mid-point of the usable calibration range of the colour disc. Working standards should be prepared as required and discarded after use.

3.3.5 Apparatus

3.3.5.1 *Colour disc comparator,* as supplied with the test kit (see 2.9.2.2).

3.3.5.2 *Calibrated colour disc,* as supplied with the test kit, calibrated in milligrams per litre of bromine (see 2.9.2.2).

The calibrated disc should cover the calibration range between 0 mg/l and about 5.0 mg/l of bromine with acceptable discrimination for intermediate concentrations.

Test kits used for testing swimming pool waters treated with bromine-releasing compounds should have a range up to about 10 mg/l of bromine to cover the expected higher residual bromine content.

NOTE Some commercially available colour discs meet this criterion but additionally include a more extended concentration range with relatively poor discrimination and of doubtful accuracy. Use of the extended, higher concentration range of such discs should be avoided.

3.3.5.3 *Test cuvettes,* appropriate to the test method, supplied with the test kit.

3.3.5.4 *Stopwatch.*

3.3.5.5 *Thermometer,* range 0 °C to 60 °C, graduated in 0.5 °C steps, conforming to type C of BS 1704:1985.

3.3.6 Samples and sampling

Samples should be analysed with the minimum of delay after sampling. Undue sample agitation should be avoided and exposure to direct sunlight minimized. Samples should not be stored for subsequent testing.

Visibly turbid samples should be clarified by settlement prior to testing, as necessary (see 2.4). The standing period should be minimized to avoid loss of bromine.

3.3.7 Procedure

Measure the temperature of the sample using the thermometer (3.3.5.5) and adjust if necessary to within the tolerances specified in the test kit manufacturer's instructions.

If the concentration of bromine in the test sample exceeds the maximum in the range, dilute with distilled water (3.3.4.1) as necessary and note the dilution factor.

Avoid dilution factors greater than 10 for field and on-site testing purposes in order to minimize error and maintain test simplicity.

Follow the manufacturer's test kit instructions carefully. Ensure that the reagent additions and reaction times are as stipulated to allow the correct colour development equivalent to the concentration of bromine in the sample.

Insert the bromine test kit colour disc (3.3.5.2) into the disc comparator (3.3.5.1). Place the test kit cuvette (3.3.5.3) containing the coloured-up sample, and a matching test blank cuvette, containing untreated test sample or prediluted test sample as appropriate, into the comparator cell holder. Visually match the colour density developed in the sample against the calibrated disc standards, as viewed through the test blank solution. The concentration of bromine in the test sample or prediluted sample is equivalent to the concentration value displayed on the matching calibration disc standard.

NOTE Calibration is not required due to the use of a precalibrated colour disc.

A regular test on the working standard solution (3.3.4.4) is recommended for checking the colour standards and test reagents.

The test operator's ability to achieve acceptable visual colour discrimination should also be checked initially, using appropriate working standard solutions.

3.3.8 Expression of results

3.3.8.1 Test sample

The concentration of bromine in milligrams per litre should be read directly from the calibrated colour disc.

3.3.8.2 Prediluted sample

The concentration of bromine in the test sample should be calculated by multiplying the calibrated disc reading by the dilution factor.

3.3.9 Performance characteristics

Meaningful comparative performance data are not obtainable (see note to Section 3, on page 9).

The suitability of the test kit method for specific sample matrices may be established by comparative analysis of test samples and spiked test samples using the reference method and the test kit method under laboratory conditions.

NOTE Alternative test procedures consist of alternative comparator test kits (see 2.9.2) and portable photometer test kits (see 2.9.3). Systems meeting the test method requirements are available from different manufacturers.

3.4 Determination of chlorine

3.4.1 General

The method employs commercial colour disc comparator test kits based on the analytical principle defined in BS 6068-2.26, which is a recognized reference method. Suitable commercial test kits based on this principle are available from several manufacturers.

Chlorine and chlorine-releasing compounds are added to waters for disinfection purposes. The chlorine reacts with ammonia and organic amines present to form chloramines and may therefore be present as free or as combined chlorine, the sum of which is termed total chlorine.

High concentrations of up to 100 mg/l of chlorine are used for disinfection purposes. This test method is applicable provided the sample is diluted to bring it within the working range of the test method (see 3.4.5.2).

3.4.2 Scope of this method

This test method is recommended as a field and on-site test for the determination of chlorine. It is applicable to potable, raw, industrial, lightly polluted and swimming pool waters.

The analytical range for chlorine is defined by the calibrated colour disc provided with the selected test kit (see 3.4.5.2).

NOTE Known interferences identified in the reference method affect test kit methods based on the same principle.

Oxidized chromium, manganese and bromine and other oxidizing agents react with DPD giving enhanced results. High chlorine levels in the test or prediluted test portion will bleach the developed colour giving low-biased results. Samples with a distinct chlorine odour or where the developed colour is transient should be diluted serially to establish a suitable dilution level for the determination.

Prepackaged reagents supplied with the selected test kit may incorporate additional reagents for suppressing known major interferences. For routine testing in the field or on-site the effect of interferences should be ignored unless covered within the test kit manufacturer's instructions.

3.4.3 Principle

Free chlorine reacts with *N,N*-diethyl-1,4-phenylenediamine (DPD) in a solution buffered to about pH 6.2 to pH 6.5 to form a red coloration which shows a maximum absorption at about 520 nm. The intensity of the developed colour is measured by visual comparison and is proportional to the free chlorine present. The addition of excess potassium iodide quantitatively releases free iodine by reaction with combined chlorine and the addition of DPD produces a coloration which is proportional to the total chlorine present. This allows estimation of free and total chlorine separately. Typically commercial test kit methods measure both free and total chlorine.

NOTE For the purposes of this method, free chlorine can be defined as chlorine present as elemental chlorine, hypochlorous acid or hypochlorite ion. Combined chlorine is chlorine present as chloramines. Total chlorine is the sum of free and combined chlorine.

3.4.4 Reagents

3.4.4.1 *Distilled or deionized water.* (See 2.10.1).

3.4.4.2 *Prepackaged reagents.* Only the test kit reagents supplied by the test kit manufacturer should be used (see 2.10.2). Reagents should be stored in accordance with the manufacturer's instructions and not retained beyond any recommended "use by" date.

3.4.4.3 *Stock standard solution.* It is not feasible to prepare and retain accurate chlorine standard solutions. Chlorine equivalent stock solution, 1 000 mg/l as chlorine, may be prepared by dissolving 0.890 g of potassium permanganate in 200 ml of water. The solution should be transferred to a one-mark 1 000 ml flask, diluted to the mark with water, and stored in a stoppered amber glass bottle. The solution is stable for at least 2 months.

3.4.4.4 *Working standard solution.* The stock standard (3.4.4.3) should be diluted with water, using serial dilutions as appropriate, to provide suitable working standards.

NOTE A suitable working standard will have a concentration around the mid-point of the usable calibration range of the colour disc. Working standards should be prepared as required and discarded after use.

3.4.5 Apparatus

3.4.5.1 *Colour disc comparator,* as supplied with the test kit (see 2.9.2.2).

3.4.5.2 *Calibrated colour disc,* as supplied with the test kit calibrated in milligrams per litre of chlorine (see 2.9.2.2).

The calibrated disc should cover the calibration range between 0 mg/l and about 5.0 mg/l of chlorine with acceptable discrimination for intermediate concentrations.

NOTE Some commercially available colour discs meet this criterion but additionally include a more extended concentration range with relatively poor discrimination and of doubtful accuracy. Use of the extended, higher concentration range of such discs should be avoided.

3.4.5.3 *Test cuvettes,* appropriate to the test method, supplied with the test kit.

3.4.5.4 *Stopwatch.*

3.4.5.5 *Thermometer,* range 0 °C to 60 °C, graduated in 0.5 °C steps, conforming to type C of BS 1704:1985.

3.4.6 Samples and sampling

Samples should be analyzed with the minimum of delay after sampling. Undue sample agitation should be avoided and the exposure to direct sunlight minimized. Samples should not be stored for subsequent testing.

Visibly turbid samples should be clarified by settlement prior to testing, as necessary (see 2.4). The standing period should be minimized to avoid loss of chlorine.

3.4.7 Procedure

Measure the temperature of the test sample using the thermometer (3.4.5.5) and adjust if necessary to within the tolerances specified in the test kit manufacturer's instructions.

If the concentration of chlorine in the test sample exceeds the maximum in the range, dilute with distilled water (3.4.4.1) as necessary, and note the dilution factor.

Avoid dilution factors greater than 10 for field and on-site testing purposes in order to minimize error and maintain test simplicity. However, dilution factors up to 25 may be used where high chlorine disinfection levels are used.

Follow the manufacturer's test kit instructions carefully. Ensure that the reagent additions and reaction times are as stipulated to allow the correct colour development equivalent to the concentration of chlorine in the test sample.

Insert the chlorine test kit colour disc (3.4.5.2) into the disc comparator (3.4.5.1). Place the test kit cuvette (3.4.5.3) containing the coloured-up sample and a matching test blank cuvette, containing untreated test sample or prediluted test sample as appropriate, into the comparator cell holder. Visually match the colour density developed in the sample against the calibrated disc standards as viewed through the test blank solution. The concentration of chlorine in the test sample or prediluted sample is equivalent to the concentration value displayed on the matching calibration disc standard.

NOTE Calibration is not required due to the use of a precalibrated colour disc.

A regular test on the working standard solution (3.4.4.4) is recommended for checking the colour standards and test reagents.

The test operator's ability to achieve acceptable visual colour discrimination should also be checked initially, using appropriate working standard solutions.

3.4.8 Expression of results

3.4.8.1 General

Depending on local requirement, results may be quoted as free, combined and/or total chlorine by separately measuring free and total chlorine and subtracting free from total to give the combined chlorine.

3.4.8.2 Test sample

The concentration of chlorine in milligrams per litre should be read directly from the calibrated colour disc.

3.4.8.3 Prediluted sample

The concentration of chlorine in the test sample should be calculated by multiplying the calibrated disc reading by the dilution factor.

3.4.9 Performance characteristics

Meaningful comparative performance data are not obtainable (see note to Section 3, on page 9).

The suitability of the test kit method for specific sample matrices may be established by comparative analysis of test samples and spiked test samples using the reference method and the test kit method under laboratory conditions.

NOTE Alternative test procedures consist of alternative comparator test kits (see 2.9.2), and portable photometer test kits (see 2.9.3). Systems meeting the test method requirements given are available from different manufacturers.

3.5 Determination of colour

3.5.1 General

The method employs commercial colour disc comparator test kits based on the analytical principle defined in BS 6068-2.22, which is a recognized reference method.

Suitable commercial test kits based on this principle are available from several manufacturers.

The measurement of colour by visual comparison with platinum cobalt standards is a useful control test for measuring raw and potable water coloured by naturally occurring materials.

3.5.2 Scope of this method

This test method is recommended as a field and on-site test for the determination of colour. It is applicable to potable, raw, industrial and lightly polluted waters. The method is not applicable for other waters and industrial wastewaters contaminated by coloured impurities.

The analytical range for colour is defined by the calibrated colour disc provided with the selected test kit (see 3.5.5.2).

NOTE Known interferences identified in the reference method affect test kit methods based on the same principle. Turbidity interferes with the measurement of true colour and is removed by filtration. Highly coloured waters cannot be measured by this method.

3.5.3 Principle

Colour is measured by comparison of the sample with platinum cobalt standards. The colour intensity is expressed as Hazen units. True colour is due to dissolved or colloidal matter. The colour is enhanced by the presence of suspended matter and the sample needs to be filtered through a filter of pore size 0.45 µm before the true colour can be measured. The colour given by the unfiltered sample is called the apparent colour.

NOTE One Hazen unit corresponds to the colour of a solution containing a mixture of 1.0 mg/l of platinum as potassium chloroplatinate and 0.5 mg/l of cobalt as cobalt chloride.

3.5.4 Reagents

3.5.4.1 *Distilled or deionized water.* (See 2.10.1).

3.5.4.2 *Stock standard solution, 500 Hazen units.* 1.246 g of potassium hexachloroplatinate (IV) (K_2PtCl_6) and 1.00 g of cobalt (II) chloride hexahydrate ($CoCl_2 \cdot 6H_2O$) should be dissolved in about 500 ml of water. 100 ml of concentrated hydrochloric acid should be added and the solution diluted to 1 000 ml in a one-mark flask. The solution should be stored in a stoppered amber glass bottle and shaken before use. The solution is stable for about 6 months.

3.5.4.3 *Working standard solution.* The shaken stock standard (3.5.4.2) should be diluted with water, using serial dilutions as appropriate, to provide suitable working standards.

NOTE A suitable working standard will have a concentration around the mid-point of the usable calibration range of the colour disc. Working standards should be prepared as required and discarded after use.

3.5.5 Apparatus

3.5.5.1 *Colour disc comparator,* as supplied with the test kit (see 2.9.2.2).

3.5.5.2 *Calibrated colour disc,* as supplied with the test kit, calibrated in Hazen units (see 2.9.2.2).

The calibrated disc should cover the most suitable calibration range for local conditions with acceptable discrimination for intermediate concentrations. Different Hazen value ranges are commercially available often using cuvettes or tubes of different path length to alter the calibration range. The test is only valid where the calibrated colour disc is used with the correct cuvette or tube and the colour comparator specified or provided by the manufacturer.

3.5.5.3 *Test cuvettes and/or test tubes,* appropriate to the test method, supplied with the test kit.

3.5.5.4 *Stopwatch.*

3.5.5.5 *Thermometer,* range 0 °C to 60 °C, graduated in 0.5 °C steps conforming to type C of BS 1704:1985.

3.5.6 Samples and sampling

Samples should be analyzed with the minimum of delay after sampling and should not be stored for subsequent testing.

Samples should be clarified by filtration prior to testing for true colour, as necessary (see 2.4).

3.5.7 Procedure

Measure the temperature of the sample using the thermometer (3.5.5.5) and adjust if necessary to within the tolerances specified in the test kit manufacturer's instructions.

Follow the manufacturer's test kit instructions carefully.

Insert the colour test kit colour disc (3.5.5.2) into the disc comparator (3.5.5.1). Place the test kit cuvette (3.5.5.3) containing the sample, and a matching test blank cuvette, containing water, into the comparator cell holder. Visually match the sample colour against the calibrated disc standards, as viewed through the test blank. The concentration of colour in the test sample is equivalent to the value in Hazen units displayed on the matching calibration disc standard.

NOTE Calibration is not required due to the use of a precalibrated colour disc.

A regular test on the working standard solution (3.5.4.3) is recommended for checking the colour standards and test reagents.

The test operator's ability to achieve acceptable visual colour discrimination should also be checked initially, using appropriate working standard solutions.

3.5.8 Expression of results

The calibration disc gives the concentration of colour direct in Hazen units. Depending on whether the sample was filtered prior to measuring, the result should be reported as true or apparent colour.

3.5.9 Performance characteristics

Meaningful comparative performance data are not obtainable (see note to Section 3, on page 9).

3.6 Determination of copper

3.6.1 General

The method employs commercial colour disc comparator test kits but is not based on a recognized reference method. Commercial test kit manufacturers use a variety of colour reagents based on different analytical principles, the most popular being as follows:

- a) Cuprizone. (Oxalic acid cyclohexylidene hydrazide.)
- b) Zincon. (2-[[a-(2-hydroxy-5-sulfophenylazo)benzylidene]-hydrazino]benzoic acid monosodium salt).
- c) Bicinchoninate. (2,2'-biquinoline-4,4' dicarboxylic acid).

Laboratories typically employ atomic emission or absorption techniques to measure copper and colorimetric analysis is no longer widespread. The reagents historically used for colorimetric determination of copper were both sensitive and relatively specific. However, in the absence of meaningful comparison data no single reference method can be recommended. Selection is a matter of choice and should reflect local requirements after taking account of type and origin of sample.

3.6.2 Scope of this method

This test method is a field and on-site test for the determination of copper. It is applicable (depending on the colour reagent selected) to potable, raw, industrial, lightly polluted, saline and swimming pool waters.

The analytical range for copper is defined by the calibrated colour disc provided with the selected test kit (see 3.6.5.2).

NOTE Known interferences may be identified from the test kit manufacturer's literature. Prepackaged reagents supplied with the selected test kit method commonly incorporate additional reagents for suppressing known major interferences. For routine testing in the field or on-site the effect of interferences should be ignored unless covered within the test kit manufacturer's instructions.