OSAC 2025-S-0005
Standard Test Method for Distance Determination (Gunshot Residue Distance and Shot Pellet Pattern Distance)

Firearms & Toolmarks Subcommittee
Physics/Pattern Interpretation Scientific Area Committee (SAC)
Organization of Scientific Area Committees (OSAC) for Forensic Science

OSAC Proposed Standard

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Foreword

This standard test method document was proposed by the Firearms & Toolmarks Subcommittee of the Organization of Scientific Area Committees (OSAC) for Forensic Science. This document is intended to provide procedures for distance determinations performed by forensic firearm and toolmark examiners.

Laboratory policy may inform examiners as to which steps in the process are appropriate.

Keywords: *distance determination, gunpowder pattern, gunshot residue, shot pattern, modified griess, sodium rhodizonate, dithiooxamide (DTO)*

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1 Scope

This document provides standard procedures for conducting distance determinations. These procedures include the most commonly used techniques. Other techniques may be available and appropriate but are beyond the scope of this document. Following these procedures, an examiner or technician will be able to conduct, document, and report on the results of a distance determination.

2 Normative References

2.1 ANSI/ASB Best Practice Recommendation 068, *Best Practice Recommendations for the Safe Handling of Firearms and Ammunition*.

2.2 ANSI/ASB Standard 093, *Standard Test Method for the Examination and Testing of Firearms*.

3 Terms and Definitions

For purposes of this document, the following terms and definitions apply.

3.1
distance determination

The process of determining the distance from the firearm, usually the muzzle, to a substrate based upon patterns of gunpowder or gunshot residues deposited upon that substrate. Where multiple projectiles, such as shot, have been fired, the spread of those projectiles is also indicative of distance.

3.2
witness panel

Any variety of substrates used to record gunpowder and gunshot residue deposition and/or shot patterns.

4 Requirements

4.1 Background

When a firearm is fired, gunshot residues in the following forms can be discharged from the firearm and deposited on nearby evidence:

- Unburned and/or partially burned gunpowder particles
- Soot
- Vaporous lead
- Nitrite residue

- Other particulates

These gunshot residues, along with the morphology of a bullet hole in an evidence item, can be used to estimate the distance between the firearm/muzzle and that evidence item.

Additionally, when a firearm loaded with multi-shot cartridges or shotshells is fired, the dispersion of that shot and the presence of buffer material may be evaluated to estimate a distance.

4.2 Equipment and Materials

The following is a non-exhaustive list of equipment and materials used in distance determination:

- Stereomicroscope
- Various light sources
- Various test substrates
- Personal protective equipment (PPE)
- Photography scales
- Measuring devices
- Camera
- Copper and lead controls
- Nitrite-treated cotton control swabs
- Clothing iron or other suitable heat source
- Chemicals/reagents (See Appendix A for reagent preparation instructions)

4.3 Use of Task Relevant Information

The laboratory procedures shall address the use of task-relevant, contextual information, including its limitations. Examples of such information may include an autopsy report or crime scene notes.

4.4 Test Preparations

4.4.1 Use appropriate PPE to include gloves, lab coat, and eye protection when using chemical reagents and handling evidence contaminated with chemical and/or biological hazards. Consider the use of a fume hood or other respiratory protection.

4.4.2 Ensure that the firearm is unloaded prior to examination and follow all appropriate measures for safe handling.

4.4.3 Perform function testing and test firing prior to distance determination testing.

4.5 Evidence Handling

4.5.1 Documentation of the condition of the evidence packaging as received and marking of the packaging shall be in accordance with laboratory protocols.

4.5.2 The evidence shall be marked for identification in accordance with laboratory protocols.

4.6 Documentation

4.6.1 Documentation of observations shall be made contemporaneously during the examination process.

4.6.2 Documentation shall include depictions or descriptions of observations, including the sequence and results of any chemical testing, as well as conclusions drawn by the examiner, to the extent that another examiner, without the benefit of the specimens themselves, can review the case record and understand what analysis was conducted and the basis for any conclusions.

4.6.3 Acceptable forms of documentation include but are not limited to, worksheets, laboratory notes, sketches, photographs, or a combination thereof for the general documentation of the entire examination process.

4.6.3.1 Photography/digital imaging shall be performed of the evidence as received, prior to any chemical processing. Additional photography/digital imaging shall be performed of any subsequent chemical test results. If chemical reactions occur that cannot be photographed, document the reason(s) (e.g., "purple color present, faded in a few seconds, not photographed").

4.6.4 The following shall also be documented:

- Chemical reagents used
- Results of reagent positive and negative control(s) (see Section 4.9)

4.7 Initial Examination

4.7.1 Determine and document the following, as appropriate:

- The overall condition of the evidence item (e.g., heavily blood-soaked, location of cuts made to remove the garment from the victim)
- Location of any suspected bullet holes/pellet patterns (e.g., measurements to reference points on the garment, photographic depictions of hole(s) with scale in *X* and *Y* coordinates)
- Fabric/material type
- Any potential trace or biological evidence on the evidence item
    - Consult laboratory protocols for preservation policy

4.8 Visual and Microscopic Examination

4.8.1 Visual examination pertains to the presence of observable physical characteristics and residues on the evidence. All observations shall be documented. The examiner should also consider other means of visualization such as infrared or other alternate light sources. The microscopic examination is generally performed with a stereoscope.

4.8.2 The following characteristics may be observed:

- Ripping or stellate tearing
- Burned or singed areas
- Melted synthetic fibers
- Heavy vaporous lead residue
- A visible ring of residue around the perimeter of a hole (i.e., bullet wipe)
- Smoke residue
- Particulate lead shavings or solidified droplets
- Unburned gunpowder
- Partially burned gunpowder
- Buffer material
- Wad impact/pattern
- Pellet pattern

4.9 Chemical Processing

4.9.1 After visual and microscopic examinations are complete, chemical processing may be conducted.

4.9.1.1 When a shot pellet pattern is visualized, consult laboratory protocols to determine if chemical processing is necessary.

4.9.1.2 The chemical tests described below are commonly used; however, variations of the following procedures can be used if validated.

4.9.2 The following procedural sequence shall be followed for chemical testing: Nitrate Test, Griess/Modified Griess Test, Dithiooxamide (DTO) Test, and then Sodium Rhodizonate Test to prevent chemical interference.

4.9.3 The laboratory procedures shall address limitations of the chemical processing to include factors such as the condition of the items and the presence of blood, dirt, or other masking materials. The presence of these materials shall be documented.

4.9.4 The Nitrate Test utilizes a color chemistry reaction to indicate the presence of nitrates.

4.9.4.1 Nitrate Test Procedure

- Perform the positive control test by using a known particle of gunpowder. Process the particle as described below. Perform the negative control test utilizing the procedure below on an area of the evidence away from the bullet hole. If controls do not perform as expected, do not continue with testing until the cause has been corrected and expected results have been achieved.
- Place one particle of suspected gunpowder into a clean spot plate.
- Place one to two drops of the nitrate testing solution onto the particle.

- Document the results of the test.
    - A dark blue color reaction constitutes a positive reaction for nitrates.
    - No color reaction indicates a negative test result.

4.9.5 The Greiss/Modified Greiss Test is a chemical test for the detection of nitrite residues (burned or partially burned gunpowder deposited). The direct application procedure is typically used for porous items such as clothing through which the acetic acid solution can penetrate. The reverse application procedure is typically used for thick or non-porous items that cannot be penetrated by the acetic acid solution.

4.9.5.1 Modified Greiss Direct Application Procedure

- Perform the positive control test by testing the corners of the sensitized blank (see Appendix A.2.7) using nitrite cotton swabs (see Appendix A.2.8). Perform the negative control utilizing the procedure below on an area of the evidence away from the bullet hole. Document the results of control tests. If controls do not perform as expected, do not continue with testing until the cause has been corrected and expected results have been achieved.
- Place the sensitized blank, emulsion side down, over the area being tested. Index reference points.
- Soak a piece of nitrite-free cheesecloth or filter paper with 15% acetic acid solution (see Appendix A.2.6) and place it over the reverse side of the evidence.
- Apply heat and pressure until the acetic acid solution-treated cheesecloth or paper is dry.
- Separate the sensitized blank and the questioned item.
- Document the results of the test.
    - An orange or orange-red color reaction on the paper constitutes a positive reaction for nitrites. This may appear as an orange haze or as individual particulate reactions, the latter of which may be interpreted as indicated in Section 4.12.1.2.
    - No color reaction indicates a negative test result.

4.9.5.2 Reverse Modified Griess Application

- Complete the control tests as described in Section 4.9.4.1.
- Apply the side of the sensitized blank that will be in contact with the area being tested with 15% acetic acid solution.
- Place the sensitized blank over the questioned area. Index reference points.
- Place a piece of nitrite-free cheesecloth or filter paper over the sensitized blank or evidence, depending on what is being used for a blank.
- Apply sufficient heat to vaporize the acetic acid solution. Separate the sensitized blank and the questioned item.
- Document the results of the test.
    - An orange or orange-red color reaction on the paper, corresponding to the area tested, constitutes a positive reaction for nitrites. This may appear as an orange

haze or as individual particulate reactions, the latter of which may be interpreted as indicated in 4.12.1.2.

- No color reaction indicates a negative test result.

4.9.6 The DTO Test is a chemical test for the detection of copper residues, which may be found at the periphery of a hole caused by the passage of a copper-containing bullet. The test may be applied directly or via a transfer procedure. The direct application procedure is typically used when the color of the substrate allows for the visualization of a positive test result, whereas the transfer procedure is typically used when the color of the substrate may mask a positive test result.

4.9.6.1 DTO Direct Application Procedure

- Perform a positive control test using a copper standard. Treat a piece of filter paper (or suitable substitute) with the ammonium hydroxide solution and place the standard in contact with the filter paper. Apply the DTO solution as described below. Perform the negative control utilizing an area of the evidence away from the bullet hole. Document the results of control tests. If controls do not perform as expected, do not continue with testing until the cause has been corrected and expected results have been achieved.
- Lightly spray or drop the ammonium hydroxide solution (see Appendix A.2.2) on the area being tested.
- Lightly spray or drop the DTO solution (see Appendix A.2.1) on the area of evidence being tested.
- Document the results of the test.
  - A dark greenish-gray color reaction, corresponding to the area tested, constitutes a positive reaction for copper.
  - No color reaction indicates a negative test result.

4.9.6.2 DTO Transfer Procedure

- Complete the control test as described in 4.9.5.1.
- Saturate an area of a piece of filter paper with the ammonium hydroxide solution.
- Place the ammonium hydroxide-treated filter paper over the area being tested.
- Place a second piece of dry filter paper over the first and apply moderate pressure for approximately five seconds.
- Remove both pieces of filter paper and apply the DTO solution onto the tested area of the filter paper.
- Document the results of the test.
  - A dark greenish-gray color reaction, corresponding to the area tested, constitutes a positive reaction for copper.
  - No color reaction indicates a negative test result.

4.9.7 The Sodium Rhodizonate Test is a chemical test for the detection of lead (e.g., from vaporous lead (smoke), particulate lead, and/or residues at the periphery of a hole caused by the

passage of a bullet). The test may be applied directly or via a transfer procedure. The direct application procedure is typically used when the color of the substrate allows for the visualization of a positive test result, whereas the transfer procedure is typically used when the color of the substrate may mask a positive test result.

4.9.7.1 Sodium Rhodizonate Test Direct Application Procedure

- Perform a positive control test using cotton swabs (or a suitable substitute) dampened with 15% acetic acid solution (see Appendix A.2.6) and rubbed against a lead standard. Process this swab utilizing the procedure below. Perform the negative control test utilizing the procedure below on an area of the evidence away from the bullet hole. Document that controls performed as expected. If controls do not perform as expected, do not continue with testing until the cause has been corrected and expected results have been achieved.
- Spray the sodium rhodizonate solution (see Appendix A.2.3) onto the area being tested.
- Apply a buffer solution following either Option 1 or Option 2, below.
    - Option 1: Spray the tartrate buffer solution onto the area being tested, followed by 5% hydrochloric acid solution. (see Appendix A.2.4 and Appendix A.2.5)
    - Option 2: Spray the potassium chloride (KCl) buffer solution onto the area being tested. (see Appendix A.2.6) Document the results of the test.
- Using Option 1, a color change from red-pink to blue-violet is a confirmatory result for lead, and is known to fade quickly.
- Using Option 2, a color change to blue-violet is a confirmatory result for lead, and is known to fade quickly.
- No color reaction indicates a negative test result.
- Both sides of a hole should be tested if there is a question of entrance versus exit.

4.9.7.2 Sodium Rhodizonate Test Bashinski Transfer Procedure

- Complete the control test as described in Section 4.9.6.1.
- Dampen a piece of filter paper with the acetic acid solution and place it over the area being tested.
- Cover the dampened filter paper with several layers of dry filter paper (or suitable substitute).
- Apply moderate pressure with a hot iron or other similar heat source until the filter paper is dry.
- Remove the filter paper and spray the sodium rhodizonate solution on the tested area of filter paper.
- Apply the desired buffer solution following either Option 1 or Option 2, below (see Appendices A.2.4 and A.2.5).
    - Option 1: Spray the tartrate buffer solution onto the filter paper, followed by the 5% hydrochloric acid solution (see Appendices A.2.4 and A.2.5).
    - Option 2: Spray the KCl buffer solution onto the filter paper (see Appendix A.2.6).

- Document the results of the test.
- Using Option 1, a color change from red-pink to blue-violet is a confirmatory result for lead, and is known to fade quickly.
    - Using Option 2, a color change to blue-violet is a confirmatory result for lead, and is known to fade quickly.
    - No color reaction indicates a negative test result.

4.10 Witness Panel Creation

Witness panels are created with known distance patterns for comparison to any pattern of residues observed on the evidence. Witness panels shall be processed with the same testing method outlined in Section 4.9. Witness panel creation and processing shall be documented. Laboratories shall have a protocol regarding retention of witness panels.

4.10.1 The suspected/associated firearm should be used to reproduce residue patterns. If a suspected/associated firearm is not available but the firearm model and barrel length can be determined, it may be acceptable to use a substitute firearm. If a substitute firearm is used, this must be documented and reported.

4.10.2 The same ammunition that was used in the incident should be utilized. If this is not feasible, ammunition with similar characteristics should be utilized. The ammunition used must be documented and reported.

4.10.2.1 When choosing similar ammunition, factors such as ammunition brand, bullet design, caliber/gauge, powder type, shot size, wad/buffer material type, and wad type shall be considered.

4.10.3 For most situations, white cotton twill cloth is suitable as a substrate. However, there may be instances where the characteristics of the evidence item make white cotton twill cloth unsuitable (e.g., synthetic or perforated fabrics). In such instances, it may be necessary to replicate the evidence material, or to utilize a portion of the evidence item for creating known distance patterns. The type of substrate used must be documented.

4.10.3.1 Consult laboratory policy for the utilization of evidence for the creation of known distance patterns.

4.10.3.2 Mark witness panels used for the collection of known distance patterns in accordance with laboratory protocols. Markings shall be unambiguous such that the distance, shot sequence, and other testing conditions can be known.

4.10.4 Securely mount the witness panel to a rigid backing that will easily permit the passage of a bullet or shot pellets (e.g., a piece of cardboard).

Securely mount the firearm to prevent its inadvertent movement (e.g., in a vice or rest) or hold it in accordance with laboratory policy. Typically, the firearm is positioned such that the barrel is perpendicular to the witness panel.

Fire the firearm and selected ammunition at the center of the witness panel at various muzzle-to-target distances. Measure the distances using a tape measure, laser measuring device, or other appropriate measuring instrument.

4.10.5 When creating witness panels, multiple witness panels with patterns both smaller and larger than the questioned pattern shall be produced. Depending on case circumstances, it may be most practical to fire into the witness panels at a predetermined interval (e.g., contact, 3", 6", etc.). Once the bracket has been determined, the bounds should be duplicated to demonstrate reproducibility.

4.10.5.1 When choosing choosing witness panel distances, consider expected differences in ammunition, variations normally expected from shot-to-shot, environmental factors, the dynamic nature of the event, evidence handling or packaging, etc.

4.10.6 When no residues are found on the evidence, it may be necessary to find the maximum distance (drop-off) at which residues are deposited using the given firearm/ammunition combination.

4.11 Known Shot Pellet Pattern Creation

Witness panels are created with known distance shot pellet patterns for comparison to any pattern observed on the evidence. Known shot pellet pattern creation and processing shall be documented. Laboratories shall have and follow a protocol regarding retention of witness panels.

When no pellet spread is noted, known shot pellet patterns may be treated with the same chemical processing noted in Section 4.9 above.

Whether pellet spread is present or not, the presence of buffer material and/or impacts or holes from wads may also be factors to consider when producing and interpreting witness panels.

4.11.1 The suspected/associated firearm should be used to reproduce shot pellet patterns. If a suspected/associated firearm is not available but the firearm model and barrel length can be determined, it may be acceptable to use a substitute firearm. If a substitute firearm is used, this shall be documented and reported.

4.11.1.1 Factors affecting the pattern of shot pellets include but are not limited to, ammunition, barrel length/choke, gauge/caliber, and powder type/charge.

4.11.2 The same ammunition that was used in the incident should be utilized. If this is not feasible, ammunition with similar characteristics should be utilized. The ammunition used shall be documented and reported.

4.11.3 A sturdy substrate such as cardboard, poster board, foam board, or similar material is a suitable substrate for testing involving shot pellet patterns.

4.11.3.1 Mark substrates used for the collection of known shot pellet patterns in accordance with laboratory protocols.

4.11.4 When creating witness panels, produce patterns both smaller and larger in diameter and lesser and greater in density than those found on the evidence item to provide an estimated bracket of distance. Once the bracket has been determined, the bounds should be duplicated to demonstrate reproducibility.

4.11.4.1 When choosing witness panel distances and bracketing, consider expected differences in ammunition, variations normally expected from shot-to-shot, environmental factors, the dynamic nature of the event, etc.

4.11.4.2 Witness panels beyond the outer limits of the bracket should be collected to demonstrate the pattern continues to change in diameter and density.

4.12 Interpretation of Observations and Results

4.12.1 Physical Effects: Observations of the visual and microscopic examination may be interpreted as follows:

4.12.1.1 Indicative of a contact shot:

- Ripping or stellate tearing of evidence
- Burned or singed areas
- Melted synthetic fibers
- In these circumstances, the firearm may not be needed, and/or it may not be necessary to produce witness panels

4.12.1.2 Indicative of a near contact shot:

- Burned or singed areas
- Melted synthetic fibers
- Heavy vaporous lead residues
- Dense smoke residue

4.12.1.3 Indicative of the passage of a bullet

- A visible ring of residue around the perimeter of a hole (bullet wipe)

4.12.1.4 Indicative of the discharge of a firearm:

- Smoke residue
- Particulate lead shavings or solidified droplets
- Unburned gunpowder

- Partially burned gunpowder
- Buffer material
- Pellet pattern

4.12.1.5 The absence of the characteristics listed above should not be considered evidence of a particular distance/range. Rather, it is the presence of these characteristics, coupled with all case-relevant information, that should be considered when rendering an opinion.

4.12.2 All observations and the results of the chemical tests should be interpreted in conjunction with one another. Inconsistencies may result from explainable reasons; for example, a less sensitive method was employed (transfer), or characteristics of the evidence (lead-free ammunition). Based on the circumstances and methods employed, an examiner may find one test result more reliable, or the inconsistencies may result in inconclusive results.

4.12.2.1 Nitrite Residues: When a discernible pattern of nitrite particles is detected, it may be possible to provide an estimated bracket of distance by comparison with witness panels created for this purpose. The distance at which nitrite residues are no longer detected can be determined by testing the suspect firearm and ammunition at various known distances.

4.12.2.2 Copper Residues: The presence of copper bullet wipe is consistent with the passage of a copper-containing bullet. These residues alone cannot be utilized to establish a distance bracket.

4.12.2.3 Vaporous Lead Residues: When a discernible pattern of vaporous lead residues is detected, it may be possible to provide an estimated bracket of distance by comparison with witness panels created for this purpose. The distance at which vaporous lead is no longer detected can be determined by testing the suspect firearm and ammunition at various known distances.

4.12.2.4 Non-Vaporous Lead Residues (e.g., bullet wipe, wad impact mark): The presence of lead bullet wipe is only consistent with the passage of a bullet. These residues alone cannot be utilized to establish a distance bracket. In certain circumstances, the use of lead-free ammunition may preclude a positive reaction with this detection method.

4.12.2.5 Distance determination conclusions are typically reported in a “greater than” and “less than” bracket of distances. This is done by comparing the patterns developed via the witness panels to the patterns from the evidence.

4.12.2.6 When selecting the bracket of distances, consideration shall be given to the reproducibility of known distance patterns and the ability to differentiate between patterns from different distances. A low level of reproducibility or difficulty in differentiating between patterns from different distances may necessitate a wider bracket.

4.12.2.7 When selecting the bracket of distances, the quality of the evidence shall be considered. Factors such as, but not necessarily limited to, the completeness of the pattern, apparent rough handling, improper packaging, contamination (e.g., blood), and environmental factors may necessitate a wider bracket.

4.12.2.8 The lack of observed/detected residue is not conclusive evidence of a muzzle-to-garment distance that exceeds the maximum distance. Other factors, such as intervening objects, residue degradation, the presence of blood or other masking materials, or rough handling of evidence, can also preclude the detection of gunshot residues.

4.12.3 Test Reports

The test report shall include the following:

- A description/physical classification of any item that is examined.
- The methodology used in the analysis to render conclusions, to include the following:
  - performance of a visual or microscopic examination
  - chemical tests performed
  - firearm and ammunition used in testing
- The locations tested on the evidence (e.g., left shoulder of jacket) and all conclusions reached (e.g., hole consistent with the passage of a bullet, an estimated range of muzzle-to-garment distance).

Annex A
(informative)

Foundation Principles

A.1 General

The standard outlined in this document is grounded in the generally accepted body of knowledge and experience in the field of firearm and toolmark examination.

A.2 Reagent Preparation

A.2.1 Dithiooxamide Solution

- Add 0.2 gram of dithiooxamide to 100 milliliters of ethanol (EtOH) and mix.
- Store the solution in a capped bottle.
- Utilizing these proportions, mix the quantity desired.

A.2.2 Ammonium Hydroxide Solution

- Add 20 milliliters of ammonia hydroxide to 80 milliliters of distilled H_20 and mix.
- Store the solution in a capped bottle.
- Utilizing these proportions, mix the quantity desired up to a 40% solution if desired.

A.2.3 Sodium Rhodizonate Solution

- Place a small amount of sodium rhodizonate in a beaker and add sufficient distilled H_20 to make a saturated solution approximately the color of strong tea (if sediment is noted at the bottom of the beaker, the solution is saturated).
- Make only enough for immediate use.
- The solution will be disposed of after use and WILL NOT be stored.

A.2.4 5% Hydrochloric Acid Solution

- Mix 5 milliliters of hydrochloric acid (HCl) in 95 milliliters of distilled H_20.
- Store in a capped bottle.
- Utilizing these proportions, mix the quantity desired.

A.2.5 Buffer Solution for Sodium Rhodizonate Test

1. Option 1

2.8 pH Buffer Solution:

- Dissolve 1.9 grams of sodium bitartrate and 1.5 grams of tartaric acid in 100 milliliters of distilled H_20.
- Utilize heat and agitation for ease of dilution.
- Store in a capped bottle.
- Utilizing these proportions, mix the quantity desired.
- Spray 5% HCl solution.

2. Option 2

Potassium Chloride (KCl) Solution:

- Dissolve 0.75 gram of KCl in 50 ml of distilled or deionized water.

A.2.6 15% Acetic Acid Solution

1. Add 150 milliliters of glacial acetic acid in 850 milliliters of distilled H_20.
2. Store in a capped bottle.
3. Reduce above proportions if less than 1000 milliliters are needed.

A.2.7 Sensitized Blank/Photo Paper Preparation

1. Add 0.5 gram of sulfanilic acid to 100 milliliters of distilled water and mix.
2. Add 0.28 gram of α-Naphthol to 100 milliliters of methanol and mix.
3. Once both the solutions in the steps above are prepared, mix them together in a clean photo tray.
4. Saturate pieces of filter paper or desensitized photo paper in this solution.
5. Once the now sensitized blanks are dry, test two opposite corners utilizing nitrite test swabs to ensure the paper is reactive to nitrites and then store in an appropriate plastic or paper container.
6. Utilizing these proportions, mix the quantity desired.
7. A commercially available substitute (i.e., Quantofix) and validated equivalent can also be used.

A.2.8 Nitrite Test Strips

1. Dissolve 0.6 gram of sodium nitrite in 100 milliliters of distilled water.
2. Saturate pieces of filter paper or cotton swabs in this mixture.
3. After swabs/strips have dried, store them in an appropriate airtight plastic or glass container. Utilizing these proportions, mix the quantity desired.

A.2.9 Nitrate Testing Solution

1. Option 1

Diphenylamine:

- Add 20 milliliters of concentrated sulfuric acid to 0.3 gram of diphenylamine and mix.
- Slowly add sulfuric acid-diphenylamine solution to 10 milliliters of glacial acetic acid and mix.

2. Option 2

Diphenylbenzidine:

- Add 1 milligram of N, N'-Diphenylbenzidine per 10 milliliters of concentrated sulfuric acid. The mixed solution should be stored in a brown glass bottle.

Annex B

(informative)

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