Designation: E3253 – 21

An American National Standard

# Standard Practice for Establishing an Examination Scheme for Intact Explosives[1]

This standard is issued under the fixed designation E3253; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This practice covers the evaluation, selection, and application of techniques to establish examination schemes for use by forensic explosives examiners to identify intact (unexploded) low and high explosives. A foundation for a consistent approach to the analysis of intact explosives is provided. Methods for the development of identifying information that follows an efficient order of testing are described.

1.2 This practice establishes requirements for the use of visual, physical, analytical, and instrumental techniques that provide structural and chemical information for an identification of a high or low explosive material.

1.3 Techniques used in the examination of explosives include visual and microscopical inspection, physical characterization, ignition susceptibility testing, chemical and spot testing, and instrumental methods.

1.4 The minimum requirements for identification of commonly encountered explosives and explosive materials are listed.

1.5 This standard is intended for use by competent forensic science practitioners with the requisite formal education, discipline-specific training (see Practice E2917), and demonstrated proficiency to perform forensic casework (refer to the T/SWGFEX Suggested Guide for Explosives Analysis Training).

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.7 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

## 2. Referenced Documents

2.1 *ASTM Standards:*[2]

E620 Practice for Reporting Opinions of Scientific or Technical Experts

E860 Practice for Examining And Preparing Items That Are Or May Become Involved In Criminal or Civil Litigation

E1732 Terminology Relating to Forensic Science

E2917 Practice for Forensic Science Practitioner Training, Continuing Education, and Professional Development Programs

E2998 Practice for Characterization and Classification of Smokeless Powder

E2999 Test Method for Analysis of Organic Compounds in Smokeless Powder by Gas Chromatography-Mass Spectrometry and Fourier Transform Infrared Spectroscopy

E3196 Terminology Relating to the Examination of Explosives

E3255 Practice for Quality Assurance of Forensic Science Service Providers Performing Forensic Chemical Analysis

2.2 *Other Resources:*

Technical/Scientific Working Group for Fire and Explosion Analysis (T/SWGFEX) Suggested Guide for Explosive Analysis Training[3]

## 3. Terminology

3.1 *Definitions*—For definitions of terms used in this standard other than those listed in 3.2, see Terminology E1732 and Terminology E3196.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *detection, n*—an analytical signal from a recognized analyte was generated and can be tentatively identified (**1**).[4]

3.2.2 *identification, n*—assigning an analyte (analytical signal) to one of the set of known individual chemical compounds or to a group/class of compounds.



[1] This practice is under the jurisdiction of ASTM Committee E30 on Forensic Sciences and is the direct responsibility of Subcommittee E30.01 on Criminalistics.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from National Institute of Standards and Technology (NIST), 100 Bureau Dr., Stop 1070, Gaithersburg, MD 20899-1070, https://www.nist.gov/system/files/documents/2018/09/21/twgfex_suggest_guide_for_explosive_analysis_training.pdf.

[4] The boldface numbers in parentheses refer to the list of references at the end of this standard.

3.2.2.1 *Discussion*—Identification of individual compounds can be required to identify an analyzed sample as one of a definite kind/type/grade/brand of products, material compositions, formulations, etc. (**1**).

3.2.3 *ignition susceptibility test, IST, n*—a qualitative and destructive test in which a small amount of sample is exposed to a flame or heat.

3.2.3.1 *Discussion*—Determining the reactivity of the sample is useful in terms of initial characterization and safe handling.

3.2.4 *intact explosive, n*—an explosive that has not undergone decomposition due to deflagration or detonation and generally has a discernible morphology.

3.2.4.1 *Discussion*—Intact explosives can be present in large (grams) or small (single particle) quantities. Post-blast explosive residues can contain both combustion products and intact explosive material.

## 4. Summary of Practice

4.1 Multiple techniques and methods are used in the identification of explosives.

4.2 Examination of suspected explosives starts with macroscopical and microscopical observations and, when appropriate, an ignition susceptibility test (IST). The interpretation of these initial tests requires that the examiner has a working knowledge of explosives. While characteristics observed by visual examination and IST results can indicate an explosive, it is necessary to use additional analytical techniques to identify the suspected explosive compound or its key components.

## 5. Significance and Use

5.1 This practice is designed to assist the forensic explosives examiner in selecting and organizing an analytical scheme for identifying intact explosives. The amount and condition of the sample, as well as the availability of applicable instrumental techniques, will determine the selected analytical scheme.

5.2 The forensic explosives examiner considers relevant issues about the case investigation and submitted items, such as sample size, complexity and condition, environmental effects, and collection methods used. Considerations include test methods, sample preparation schemes, test sequences, and acceptable degrees of sample alteration and consumption that will be different for each case submission.

5.3 This practice provides the minimum criteria for identifying explosive material. The examiner determines an analytical scheme that uses techniques to correctly identify the material, which could include oxidizers, fuels, binders, and detection agents.

5.4 This practice is used in conjunction with the referenced documents.

5.5 This practice does not attempt to address all the issues regarding sample analyses. There could be additional tests or analyses performed to provide further discrimination and characterization of samples.

## 6. Analytical Scheme for Examination of Intact Explosives

6.1 The identification of an intact explosive is accomplished by a variety of analytical techniques (**2-5**). A combination of multiple techniques and methodologies that provides structural and chemical information about an explosive, could be required to make an identification. The examiner shall be familiar with the limitations and applicability of each technique used (refer to T/SWGFEX Suggested Guide for Explosives Analysis Training).

6.2 Some of the techniques listed below can alter or destroy the sample. For example, an ignition susceptibility test (6.6) consumes the material, solvent extraction alters the composition, and grinding a sample for X-ray powder diffraction (6.13) changes particle morphology. A portion of the original sample should be preserved for potential future examination; however, preservation will depend on the submitted sample size, sample preparation and analytical techniques used.

6.3 A review of the general technique descriptions, listed in 6.4 – 6.13 and outlined in Fig. 1, provides guidance for the selection of appropriate methods. More detailed schemes for the examination of intact explosives are outlined in Fig. 2 (Low Explosives) and Fig. 3 (High Explosives). The major steps in Fig. 2 and Fig. 3 are numbered to correspond to the discussions presented in this standard (for example 6.6, Ignition Susceptibility Test and 7.2, Black Powder). If limited sample is available, use an analytical scheme that yields the most information and consumes the least amount of sample. Fig. 2 and Fig. 3 do not imply that other examinations should be excluded or that the order of the procedures in the figures is predetermined.



6.4 *Visual/Macro and Microscopical Exams:*

6.4.1 Begin with a review of the information submitted with the evidence, including the condition of the packaging and labeling, and document any potential for cross-contamination between samples.

6.4.1.1 Record any potential for cross-contamination or discrepancies and take this into account in the final evaluation of the analytical data.

6.4.2 Conduct a visual and stereo microscopical assessment of each item, prior to when the packaging permits, and after opening the evidence packaging. Provide a written description of the general condition, size, shape, and color of each sample and photograph when possible.

6.4.2.1 This preliminary assessment provides information for the selection of an analytical scheme and can identify complexities in the review of analytical data obtained.

6.4.3 The processing of intact explosives should be separated in space from residue evidence samples to prevent incidental contamination. If space does not allow for this, then process intact explosives and residue evidence separately by time. Ensure appropriate precautions are in place to prevent contamination (**6-13**).

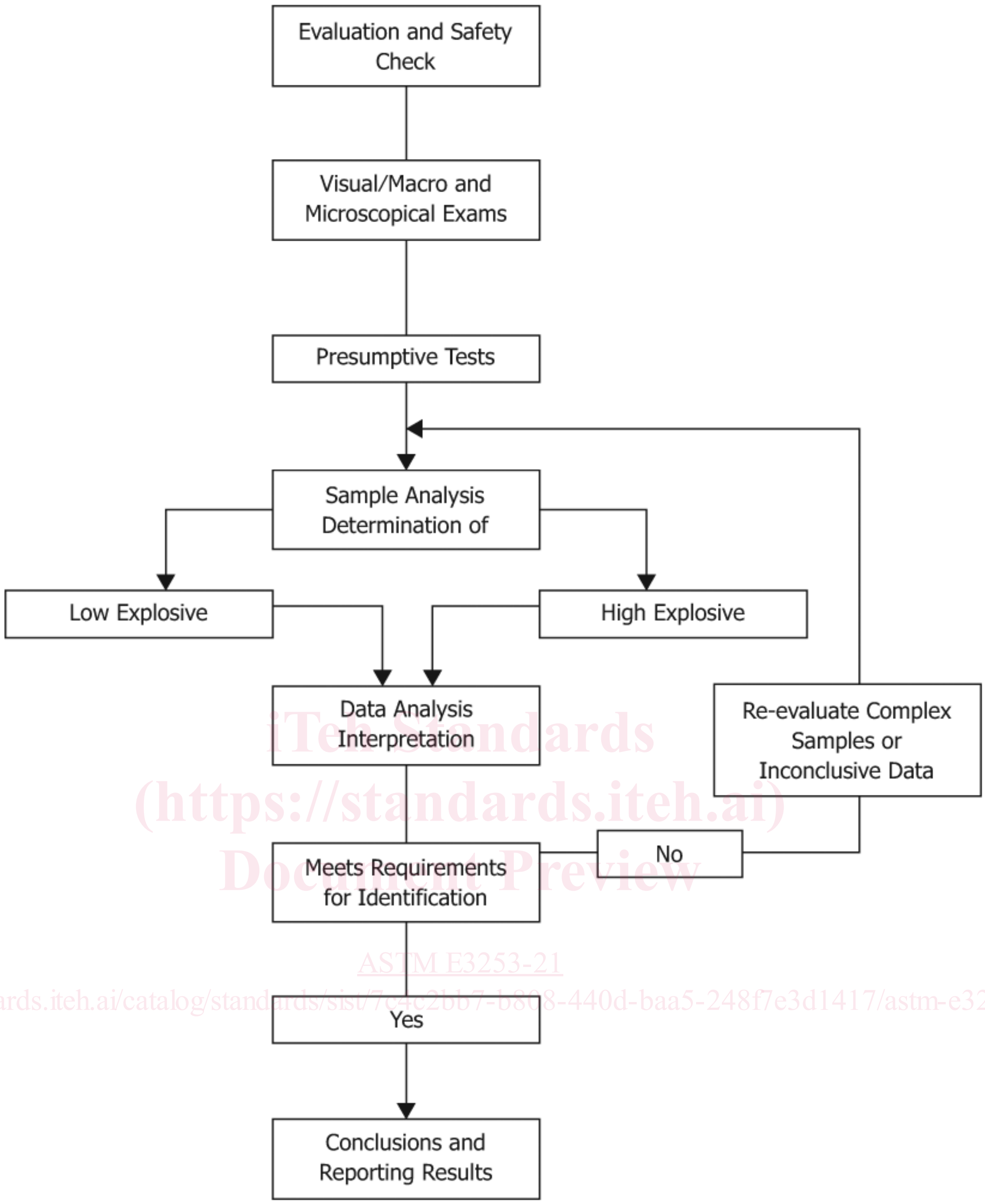




**FIG. 1 General Scheme for Intact Explosives Examination**

6.5 *Sample Preparation:*

6.5.1 Use sample preparation techniques, such as manual separation, sieving, grinding, or extraction (**2**), for powders and powder mixtures.

6.5.1.1 These preparation techniques result in separation and isolation of individual particles or explosive components for instrumental analysis.

6.6 *Ignition Susceptibility Test (IST):*

6.6.1 Use an IST to determine if an unknown sample will ignite easily. Conduct the test on a safe and suitable sample portion and away from other hazardous materials.

6.6.1.1 Notable IST results for explosives include ease of ignition, deflagration, flame color, smoke color or absence, and sounds.

6.7 *Chemical Spot (color) Tests:*

6.7.1 Use chemical spot tests to screen for the presence of explosives or explosive components (**4, 14**).

6.7.1.1 Conduct chemical spot tests contemporaneously with the appropriate positive and negative controls.

6.8 *Polarized Light Microscopy (PLM):*

6.8.1 Determine optical crystallographic properties to identify explosive compounds and components from low explosive mixtures such as black powder, flash powder and black powder substitutes, and high explosives such as ANFO and Composition C-4. Crystals are characterized by mounting intact material in refractive index liquids (**15, 16**); by recrystallizing from a solvent (**17, 18**) or melt, that is, recrystallization occurring when a melted compound is cooled (**19-24**).

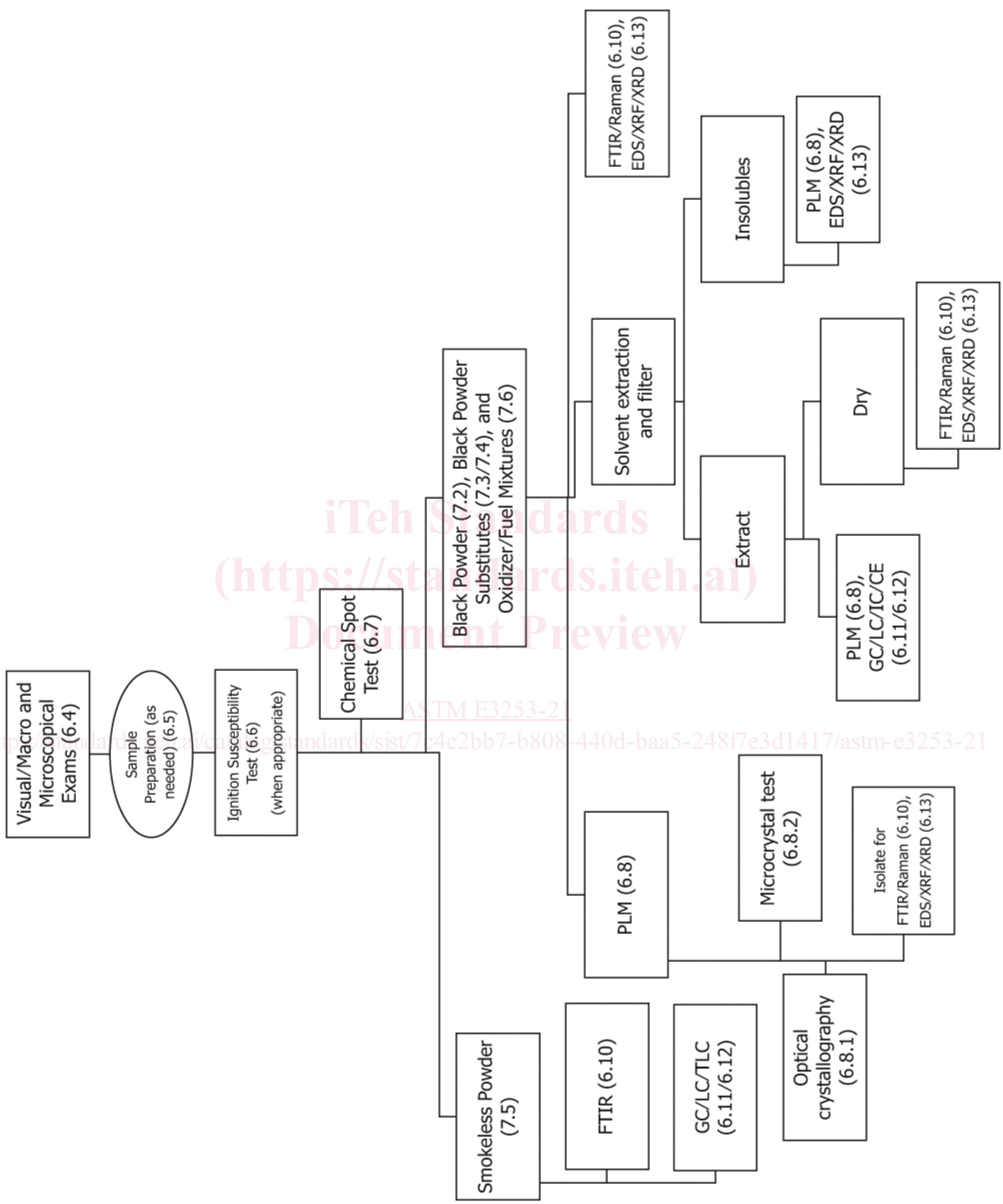


**FIG. 2 Scheme for Intact Low Explosive Examinations**

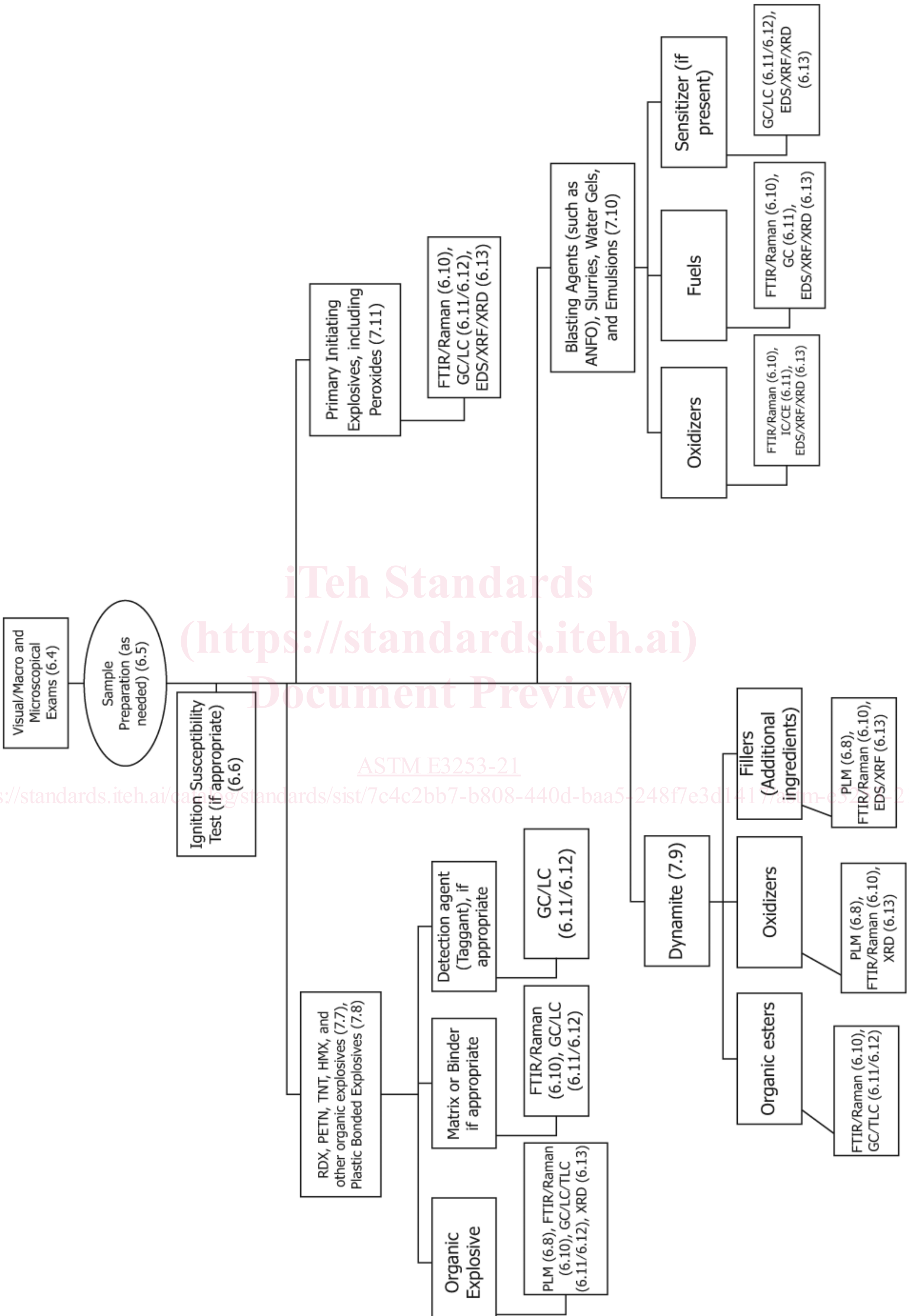


**FIG. 3 Scheme for Intact High Explosive Examinations**