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Standard Guide for Assessing the Environmental and Human Health Impacts of New Compounds for Military Use¹

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INTRODUCTION

Sustaining training operations while maintaining force health is vital to national security. Research efforts are underway to identify new substances that have negligible environmental impacts and implement them in military weapon systems and applications. This guide is intended to provide a standardized method to evaluate the potential human health and environmental impacts of prospective candidate substances. This guide is intended for use by technical persons with a broad knowledge of risk assessment, fate and transport processes, and toxicology to provide recommendations to the research chemist or systems engineer regarding the environmental consequences of use.

1. Scope

1.1 This guide is intended to determine the relative environmental influence of new substances, consistent with the research and development (R&D) level of effort and is intended to be applied in a logical, tiered manner that parallels both the available funding and the stage of research, development, testing, and evaluation. Specifically, conservative assumptions, relationships, and models are recommended early in the research stage, and as the technology is matured, empirical data will be developed and used. Munition constituents are included and may include propellants, oxidizers, explosives, binders, stabilizers, metals, dyes, and other compounds used in the formulation to produce a desired effect. Munition systems range from projectiles, grenades, rockets/missiles, training simulators, to smokes and obscurants. Given the complexity of issues involved in the assessment of environmental fate and effects and the diversity of the systems used, this guide is broad in scope and not intended to address every factor that may be important in an environmental context. Rather, it is intended to reduce uncertainty at minimal cost by considering the most important factors related to human health and environmental impacts of energetic materials. This guide provides an outline for collecting data useful in a relative ranking procedure to provide the systems scientist with a sound basis for prospectively determining a selection of candidates based on environmental and human health criteria.

¹ This guide is under the jurisdiction of ASTM Committee E50 on Environmental Assessment, Risk Management and Corrective Action and is the direct responsibility of Subcommittee E50.47 on Biological Effects and Environmental Fate.

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The general principles in this guide are applicable to substances other than energetics if intended to be used in a similar manner with similar exposure profiles.

1.2 The scope of this guide includes:

1.2.1 Energetic and other new/novel materials and compositions in all stages of research, development, test and evaluation.

1.2.2 Environmental assessment, including:

1.2.2.1 Human and ecological effects of the unexploded energetics and compositions on the environment.

1.2.2.2 Environmental transport mechanisms of the unexploded energetics and composition.

1.2.2.3 Degradation and bioaccumulation properties.

1.2.3 Occupational health impacts from manufacture and use of the energetic substances and compositions to include load, assembly, and packing of the related munitions.

1.3 Given the wide array of applications, the methods in this guide are not prescriptive. They are intended to provide flexible, general methods that can be used to evaluate factors important in determining environmental consequences from use of new substances in weapon systems and platforms.

1.4 Factors that affect the health of humans as well as the environment are considered early in the development process. Since some of these data are valuable in determining health effects from generalized exposure, effects from occupational exposures are also included.

1.5 This guide does not address all processes and factors important to the fate, transport, and potential for effects in every system. It is intended to be balanced effort between scientific and practical means to evaluate the relative environmental effects of munition compounds resulting from intended

use. It is the responsibility of the user to assess data quality as well as sufficiently characterize the scope and magnitude of uncertainty associated with any application of this standard.

1.6 Integration of disparate information and data streams developed from using the methods described in this guide is challenging and may not be straight-forward. Professional assistance from subject matter experts familiar with the fields of toxicology and risk assessment is advised.

1.7 *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.*

1.8 *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

- D5660 Test Method for Assessing the Microbial Detoxification of Chemically Contaminated Water and Soil Using a Toxicity Test with a Luminescent Marine Bacterium (Withdrawn 2014)³
- E729 Guide for Conducting Acute Toxicity Tests on Test Materials with Fishes, Macroinvertebrates, and Amphibians
- E857 Practice for Conducting Subacute Dietary Toxicity Tests with Avian Species
- E943 Terminology Relating to Biological Effects and Environmental Fate
- E1023 Guide for Assessing the Hazard of a Material to Aquatic Organisms and Their Uses
- E1147 Test Method for Partition Coefficient (N-Octanol/Water) Estimation by Liquid Chromatography (Withdrawn 2013)³
- E1148 Test Method for Measurements of Aqueous Solubility (Withdrawn 2013)³
- E1163 Test Method for Estimating Acute Oral Toxicity in Rats
- E1193 Guide for Conducting *Daphnia magna* Life-Cycle Toxicity Tests
- E1194 Test Method for Vapor Pressure
- E1195 Test Method for Determining a Sorption Constant (K_{oc}) for an Organic Chemical in Soil and Sediments (Withdrawn 2013)³
- E1241 Guide for Conducting Early Life-Stage Toxicity Tests with Fishes
- E1279 Test Method for Biodegradation By a Shake-Flask

- Die-Away Method (Withdrawn 2013)³
- E1372 Test Method for Conducting a 90-Day Oral Toxicity Study in Rats (Withdrawn 2010)³
- E1415 Guide for Conducting Static Toxicity Tests With *Lemna gibba* G3
- E1525 Guide for Designing Biological Tests with Sediments
- E1624 Guide for Chemical Fate in Site-Specific Sediment/Water Microcosms (Withdrawn 2013)³
- E1676 Guide for Conducting Laboratory Soil Toxicity or Bioaccumulation Tests with the Lumbricid Earthworm *Eisenia Fetida* and the Enchytraeid Potworm *Enchytraeus albidus*
- E1689 Guide for Developing Conceptual Site Models for Contaminated Sites
- E1706 Test Method for Measuring the Toxicity of Sediment-Associated Contaminants with Freshwater Invertebrates

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

3.1.1 *conception, n*—refers to part of the munition development process whereby molecules are designed through software and modeling efforts though not yet synthesized.

3.1.2 *demonstration, n*—refers to testing munition compounds in specific configurations that may use other substances to maintain performance specifications.

3.1.3 *engineering and manufacturing development, n*—involves the process of refining manufacturing techniques and adjusting formulations to meet production specifications.

3.1.4 *environmental, adj*—used to describe the aggregate of a receptor's surroundings that influence exposure, used in the holistic sense that may include human exposures in a variety of conditions.

3.1.5 *energetic materials, n*—chemical compounds or compositions that contain both fuel, binder, and potentially oxidizer and rapidly react to release energy and other products of combustion. Examples of energetic materials are substances used in high explosives, gun propellants, rocket & missile propellants, igniters, primers, initiators, and pyrotechnics (for example, illuminants, smoke, delay, decoy, flare and incendiary) and compositions. Energetic materials may be thermally, mechanically, and electrostatically initiated and do not require atmospheric oxygen to sustain the reaction.

3.1.6 *munition, n*—refers to weapon systems or parts of platforms that have a military application. Includes the use of energetic substances in addition to stabilizers, plasticizers, and other substances to the final combined formulation referred to as energetic material.

3.1.7 *production, n*—includes activities involved in the finalized manufacturing and use of the munition compound and accompanying system.

3.1.8 *synthesis, n*—process in which minute (gram) quantities of the energetic material are made, often using laboratory desktop equipment.

3.1.9 *testing and refinement, n*—includes preliminary small-scale tests to large-scale testing and range operations that require refined synthesis techniques within the research and

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 The last approved version of this historical standard is referenced on www.astm.org.