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Standard Guide for General Principles of Resilience[1]

This standard is issued under the fixed designation E3341; 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 guide ~~describes~~covers general principles related to the resilience of systems, including natural and anthropological systems.

1.2 Resilience is defined by four general principles: planning and preparation, adaptation, withstanding and limiting impacts, and recovery of operations and function. This guide covers the fundamentals for each of the general principles.

1.3 This guide recognizes that, in applying principles of resilience, decision makers often balance opportunities and challenges, as well as the safety and risk associated with each of the general principles and their interdependence.

1.4 This guide recognizes that improved resilience may result from a variety of sources and potential solutions. Solutions and their associated impacts can span economic, physical, environmental, health and wellness, ecological, and other human aspects related to individuals, organizations, social systems, physical systems, and natural systems.

1.5 The general principles identified in this guide are applicable to all types of systems, the boundaries of which are defined by the user based upon the system functions, uses, and impacts, as well as other natural, social, economic, or physical constraints for the specific situation.

1.6 Applying the principles in this guide will require informed assessment and practical experience to determine if system resilience goals are advanced or achieved through application of the four principles and meeting project requirements.

1.7 This guide acknowledges that the various contexts in which a system is used or operates directly affects its resilience.

1.8 This guide recognizes that one or more components make up systems, requiring evaluation of each component individually, as well as being part of the relevant system, and in relationship to relevant externalities.

1.9 This guide recommends four general principles to inform planning and design processes; it does not recommend a specific course of action. This guide cannot replace education or experience and should be used in conjunction with informed judgment.

1.10 *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] This guide is under the jurisdiction of ASTM Committee E60 on Sustainability and is the direct responsibility of Subcommittee E60.80 on General Sustainability Standards.

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1.11 *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]
C1145 Terminology of Advanced Ceramics
E2114 Terminology for Sustainability
E2135 Terminology for Property and Asset Management
E2432 Guide for General Principles of Sustainability Relative to the Built Environment
E2921 Practice for Minimum Criteria for Comparing Whole Building Life Cycle Assessments for Use with Building Codes, Standards, and Rating Systems
E3027 Guide for Making Sustainability-Related Chemical Selection Decisions in the Life-Cycle of Products

3. Terminology

3.1 *Definitions*—For terminology where the definition is defined in another standard:

3.1.1 *built environment, n*—refer to Guide E2432.

3.1.2 *durability, n*—refer to Terminology C1145.

3.1.3 *repairable, n*—refer to Terminology E2135.

3.1.4 *risk, n*—refer to Guide E3027.

3.1.5 *risk assessment, n*—refer to Terminology E2135.

3.1.6 *service life, n*—refer to Practice E2921.

3.1.7 *sustainability, n*—refer to Terminology E2114.

3.2 *Definitions of Terms Specific to This Standard:*

~~3.2.1 *adaptation, n*—the adjustment to stressors.~~

3.2.1 *disruptive event, n*—an event over a short timeframe that may impact a system to a degree that the system is unable to perform its intended function or service.

3.2.1.1 *Discussion*—
Disruptive events may be caused by natural hazards (for example, an earthquake, fire, floods, or pandemic), technological hazards (for example, oil spill), or human-caused hazards (for example, an attack).

~~3.2.3 *recovery, n*—the resumption of intended functions or services within a specified timeframe.~~

~~3.2.3.1 *Discussion*—~~
~~Recovery may occur in stages, depending on the level of damage or disruption and role of the system in supporting the recovery of other systems. Operational recovery is the resumption of a minimal level of function or services that may require temporary solutions (for example, a portable generator for electric power) as repairs/construction are completed. Functional recovery is the resumption of full system operations/functions following the completion of system repairs and restoration.~~

3.2.2 *resilience, n*—the ability to prepare for anticipated hazards, adapt to changing conditions, to withstand and limit negative impacts due to events, and to return to intended functions/services within a specified time after a disruptive event.

3.2.2.1 *Discussion*—
Resilience is not durability nor sustainability but may include those concepts.

[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.

3.2.3 *resilient, adj*—able to withstand or recover from disruptive events or stressors.

3.2.4 *stressor, n*—a changing condition that negatively affects system performance over time.

3.2.4.1 *Discussion*—
Slowly changing conditions may be environmental (for example, the effects of climate), physical (for example, degradation of transportation or water systems or increased demands on existing systems), or social (for example, lack of training or educated workforce or chronic food or water shortages).

3.2.5 *system, n*—an assembly of interconnected natural and anthropological components that serve a function or provide a service at or within defined boundaries.

3.2.5.1 *Discussion*—
An anthropological system can be physical (for example, building, utility network) or social (for example, education, financial). Both anthropological and natural (for example, wetland, forest) systems can be composed of an interdependent set of systems.

4. Significance and Use

4.1 Every system is subject to disruptive events and stressors. Events and stressors can occur at all life-cycle stages and affect systems in multiple ways and on a range of scales. It is imperative to define and understand the nature of the events and stressors that may affect a system in order to address the opportunities and challenges presented.

4.2 A resilient system is better able to withstand an anticipated disruptive event or stressor.

4.3 Knowledge from historic disruptive events can aid in the design of system resilience. However, assumptions based on historical events may not be indicative of future conditions or future system operations, or they may not be consistent with design criteria in codes and standards. Systems can be designed to withstand and limit damage and support health and safety; stressors and recovery of function can often be more robustly addressed in initial system design practice. Advancing resilience requires addressing all principles of resilience for applicable events and stressors during the design process and life of the system.

NOTE 1—Design practice is influenced by codes, standards, federal regulations, and other applicable industry best practices. Both resilience, particularly recovery of function and services, and stressors, are new concepts for design practice of many systems, and guidance is evolving.

4.4 This guide provides general guidance but does not prescribe a specific course of action.

4.5 This guide is intended to inform those associated with creating or managing a system when considering its resilience. This could be product development teams, designers, or assessment teams.

4.6 The general principles of resilience are interrelated. However, to facilitate clarity, they are discussed individually as much as possible.

4.7 The general principles in this guide are intended to identify the required performance of more resilient systems and to assist users in making decisions that advance resilience.

4.8 The general principles identified in this guide are intended to inform the development and refinement of tools and standards that qualify and quantify resilience.

4.9 This guide, in covering general principles, is intended to be a basis for the creation of more specific documents on more specific topics.

5. The General Principles

5.1 The four principles are interdependent as shown in Fig. 1. A higher level of resilience can be achieved by addressing all four resilience principles, from planning through recovery, as decisions at each stage or phase of resilience have an influence or impact on the other stages or phases.

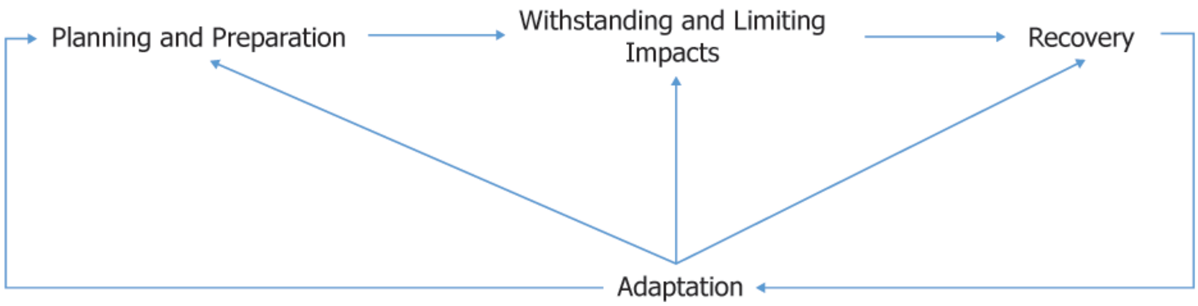

FIG. 1 Interdependency of Principles and How They Lead to Resilience

5.2 *Planning and Preparation*—Planning and preparation involve identifying measurable system performance requirements, goals for improved resilience, relevant hazards and stressors for the system(s) under consideration, interdependencies, and engagement of relevant stakeholders who have a role or an interest in the operation or function of the system.

5.3 *Adaptation:*

5.3.1 Adaptation addresses the performance of the system for future disruptive events or stressors.