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An American National Standard

Standard Guide for Specifying and Evaluating Performance of Single Family Attached and Detached Dwellings—Durability[1]

This standard is issued under the fixed designation E 2136; 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.

INTRODUCTION

This standard guide is part of a set which together presents a complete performance standard guide for specifying and evaluating single family attached and detached dwellings. The complete set in the series, when finished, is to include the attributes given in Fig. 1.

The series provides a framework for specifying and evaluating qualities of building products and systems to meet user needs without limiting ways and means. The format for this standard guide includes performance statements that consist of four components (Objectives-Criteria-Evaluation-Commentary) which together provide a systematic performance based approach for the intended purpose. These performance statements are presented in Section 8 against a Hierarchy of Building Elements as tabulated in Fig. 2.

The purpose of these standard guides is to provide a standardized methodology for describing performance parameters of single-family attached or detached dwellings. This methodology standardizes the descriptions of performance of a single-family dwelling, attached or detached, that can be expressed as performance statements (O-C-E-C) for a particular attribute, degradation factor, and user need.

These standard guides are intended for use by those who need to prescribe required levels of performance and those who need to rate a product which forms a single-family dwelling or part thereof. The standard guides include examples of performance statements that may be used for the specification and evaluation of design, materials, products, components, subsystems, and systems.

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1. Scope

1.1 This guide gives examples of performance statements for durable in-place materials, products, components, subsystems, and systems for single family attached and detached dwellings, considering the effects of normal degradation factors to which they are anticipated to be subjected over their service lives. Table 1 provides a listing of the sections of this Guide that address durability including the performance statements.

1.2 Damage from extreme acts of nature, vandalism, or intentional destructive acts by dwelling inhabitants are not considered as normal degradation factors affecting durability in this guide.

NOTE 1—Performance statements regarding the performance of single family attached and detached dwellings under extreme acts of nature are addressed in the Guide on Structural Safety and Serviceability.

1.3 This document also addresses site planning in so far as it affects the durability of single family attached and detached dwellings.

1.4 The values stated in SI units are to be regarded as the standard. The values in parentheses are for information.

1.5 This guide is not intended to be used as a prescriptive regulatory document.

2. Referenced Documents

2.1 *ASTM Standards:*

B 117 Salt Spray (Fog) Testing
C 1036 Flat Glass
C 1048 Heat-Treated Flat Glass--Kind HS, Kind FT Coated and Uncoated Glass
C 1172 Laminated Architectural Flat Glass
C 1349 Architectural Flat Glass Clad Polycarbonate
D 225 Asphalt Shingles (Organic Felt) Surfaced With Mineral Granules
D 256 Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics

[1] This guide is under the jurisdiction of ASTM Committee E06 on Performance of Buildings and is the direct responsibility of Subcommittee E06.66 on Performance Standards for Dwellings.

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Attributes Addressed in the Series of Performance Standards for Single Family Attached and Detached Dwellings

A — Structural Safety and Serviceability
B — Fire Safety
C — Accident Safety
D — Health and Hygiene
E — Indoor Air Quality
F — Light
G — Acoustics
H — Durability
I — Accessibility
J — Security
K — Economics
L — Functionality
M — Aesthetics
N — Adaptability
O — Maintainability
P — Sustainability

FIG. 1 Attributes Addressed in the Series of Performance Standards

D 1729 Visual Evaluation of Color Differences of Opaque Materials
D 2444 Determination of the Impact Resistance of Thermoplastic Pipe and Fitting by Means of a Tup (Falling Weight)
D 2486 Scrub Resistance of Wall Paints
D 3363 Film Hardness by Pencil Test
D 3462 Asphalt Shingles Made from Glass Felt and Surfaced with Mineral Granules
D 3746 Test Method for Impact Resistance of Bituminous Roofing Systems
D 4226 Test Methods for Impact Resistance of Rigid Poly-(Vinyl Chloride) (PVC) Building Products
D 4449 Visual Evaluation of Gloss Differences Between Surfaces of Similar Appearance
D 4812 Test Method for Unnotched Cantilever Beam Impact Strength of Plastics
D 5178 Mar Resistance of Organic Coatings
D 5420 Test Method for Impact Resistance of Flat, Rigid Plastic Specimen by Means of a Striker Impacted by a Falling Weight (Gardner Impact)
D 6110 Test Methods for Determining the Charpy Impact Resistance of Notched Specimens of Plastics
E 632 Developing Accelerated Tests to Aid Prediction of the Service Life of Building Materials and Components
E 695 Method for Measuring Relative Resistance of Wall, Floor, and Roof Construction to Impact Loading
E 773 Accelerated Weathering of Sealed Insulating Glass Units
E 774 Specification for the Classification of the Durability of Sealed Insulating Glass Units
E 822 Practice for Determining Resistance of Solar Collector Covers to Hail by Impact With Propelled Ice Balls
E 917 Measuring Life-Cycle Costs of Buildings and Building Systems
E 997 Structural Performance of Glass in Windows, Curtain Walls, and Doors Under the Influence of Uniform Static Loads by Destructive Method
E 998 Structural Performance of Glass in Windows, Curtain Walls, and Doors Under the Influence of Uniform Static Loads by Non-destructive Method
E 1017 Generic Requirements for Exterior Residential Window Assemblies
E 1233 Structural Performance of Exterior Windows, Curtain Walls, and Doors by Cyclic Static Air Pressure Differential
E 1825 Evaluation of Exterior Building Wall Materials, Products, and Systems
E 2025 Test Method for Evaluating Fenestration Components and Assemblies for Resistance to Impact Energies
F 925 Resistance to Chemicals of Resilient Flooring
F 1265 Test Method for Resistance to Impact for Resilient Floor Tile
G 116 Conducting Wire-on Bolt Test for Atmospheric Galvanic Corrosion
G 149 Conducting the Washer Test for Atmospheric Galvanic Corrosion
G 151 Exposing Nonmetallic Materials in Accelerated Test Devices that Use Laboratory Light Sources
G 152 Operating Open-Flame Carbon Arc Light Apparatus for Exposure of Non-Metallic Materials
G 153 Operating Enclosed Carbon Arc Light Apparatus for Exposure of Non-Metallic Materials
G 154 Operating Fluorescent Light Apparatus for UV Exposure of Non-Metallic Materials
G 155 Operating Xenon Arc Light Apparatus for Exposure on Non-Metallic Materials

2.2 *American Architectural Manufacturers Association and Window and Door Manufacturers Association:*

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Hierarchy of Building Elements Included in the Series of Performance Standards for Single Family Attached and Detached Dwellings

0. Whole Building System
- 0.1 All Building Subsystems
- 0.2 Groups of Building Subsystems

1. Spaces
- 1.1 Entries
- 1.2 Living Spaces
- 1.3 Dining Spaces
- 1.4 Kitchens
- 1.5 Sleeping Spaces
- 1.6 Bathrooms
- 1.7 Water Closets
- 1.8 Outdoor Living Spaces
- 1.9 Storage Spaces
- 1.10 Other

2. Structure
- 2.1 Foundation
- 2.2 Superstructure

3. Exterior Enclosure
- 3.1 Grade Enclosure
  - 3.1.1 Floor on Grade
  - 3.1.2 Floor over Air Space
  - 3.1.3 Other
- 3.2 Vertical and Sloped Enclosure
  - 3.2.1 Walls
  - 3.2.2 Windows
  - 3.2.3 Doors
  - 3.2.4 Other (e.g., railings, louvers, screens, etc.)
- 3.3 Roofs
  - 3.3.1 Roof Coverings
  - 3.3.2 Skylights
  - 3.3.3 Other Roof Openings
- 3.4 Joint Sealants

4. Interior Space Division
- 4.1 Vertical Space Dividers
  - 4.1.1 Partitions
  - 4.1.2 Doors
  - 4.1.3 Other
- 4.2 Horizontal Space Dividers
  - 4.2.1 Floors
  - 4.2.2 Ceilings
  - 4.2.3 Floor/Ceiling Openings
  - 4.2.4 Other
- 4.3 Stairs and Ramps

5. Plumbing
- 5.1 Plumbing Fixtures
- 5.2 Domestic Water Distribution
- 5.3 Sanitary Waste
- 5.4 Rain Water Drainage

6. HVAC
- 6.1 Heating
  - 6.1.1 Heating Generation
  - 6.1.2 Heating Distribution
  - 6.1.3 Heating Terminal and Package Units
  - 6.1.4 Heating Controls and Instrumentation
- 6.2 Cooling

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FIG. 2 Hierarchy of Building Elements Included in the Series of Performance Standards

6.2.1 Cooling Generation
6.2.2 Cooling Distribution
6.2.3 Cooling Terminal and Package Units
6.2.4 Cooling Controls and Instrumentation
6.3 Ventilation
6.3.1 Ventilation Distribution
6.3.2 Ventilation Terminal and Package Units
6.3.4 Ventilation Controls and Instrumentation
7. Fire Protection Subsystems
7.1 Suppression
7.2 Detection
7.3 Notification
7.4 Fire Protection Specialties
8. Electrical Network
8.1 Electrical Service and Distribution
8.2 Lighting and Branch Wiring
9. Communication and Security Networks
9.1 Telephone
9.2 Intercom
9.3 Television
9.4 Security
9.5 Other
10. Fuel Networks
10.1 Gas
10.2 Oil
10.3 Other
11. Fittings, Furnishings and Equipment

FIG. 2 Hierarchy of Building Elements Included in the Series of Performance Standards *(continued)*

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ANSI/AAMA/NWWDA 101/I.S. 2-97 Voluntary Specifications for Aluminum, Vinyl (PVC) And Wood Windows and Glass Doors
AAMA/WDMA 1600/I.S. 7-2000 Voluntary Specifications for Skylights
AAMA 910–93 Voluntary "Life Cycle" Specifications and Test Methods for Architectural Grade Windows and Sliding Glass Doors
AAMA 2603.8 Voluntary Performance Requirements and Test Procedures for Pigmented Organic Coatings. on Extruded Aluminum
AAMA 2604.2 Voluntary Specification for Residential Color Anodic Finishes
AAMA 2605.2 Voluntary Specification for High Performance Organic Coatings on Architectural Extrusion and Panels
AAMA 2606.1 Voluntary Guide Specifications and Inspection Methods for Integral Color Anodic Finishes for Architectural Aluminum
AAMA 2607.1 Voluntary Guide Specification and Inspection Methods for Clear Anodic Finishes for Architectural Aluminum
AAMA 2608.1 Voluntary Guide Specification and Inspection Methods for Electrolytically Deposited Color Anodic Finishes for Architectural Aluminum
AAMA 2611 Voluntary Standards for Anodized Architectural Aluminum

2.3 *American Concrete Institute:*

ACI 318 Building Code Requirements for Reinforced Concrete, Part 3
ACI 530/ASCE 5/TMS 402 Building Code Requirements for Masonry Structures

2.4 *American Forest & Paper Association:*

AF&PA Technical Report No. 7 The Permanent Wood Foundation System

2.5 *Asphalt Roofing Manufacturers Association (ARMA):*

Residential Asphalt Roofing Manual

2.6 *Factory Mutual Research Corporation (FMRC):*

FMRC 4450 Approval Standard for Class 1 Insulated Steel Deck Roofs
FMRC 4470 Approval Standard for Class 1 Roof Covers

2.7 *International Council Code:*

International Residential Code for One- and Two-Family Dwellings

2.8 *Underwriters Laboratories (UL):*

UL 2218 Impact Resistance Testing of Prepared Roof Covering Material

3. Terminology

3.1 *Definitions*—For definitions of terms used in this Standard Guide refer to Terminology E 631.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *durability*—the capability of a building, assembly, component, product, or construction to maintain serviceability over at least a specified time.

TABLE 1 Sections of this Practice Addressing Durability

Section Title	Section
Parameters Affecting Durability	5
Degradation Factors and Service Life	5.1
Site Considerations Affecting Durability	6
Site Design	6.1
Site Investigation Report	6.2
Special Evaluation Methods Used in Durability	7
Performance Statements (O-C-E-C)	8
Example of Minimum Service Lives for Typical Building Elements	X1
Examples of Special Evaluation Methods Used in Durability	X2
EM-1: General Evaluation Method for Durability of Materials and Elements	X2.1
EM-2: Evaluation Method for Determination of Resistance to Light Exposure	X2.2
EM-3: Determination of Resistance to Point Impact	X2.3
EM-4: Determination of Wash and Scrub Resistance	X2.4
EM-5: Determination of Scratch Resistance Rating with Pencil Hardness Test	X2.5
Examples of Durability Performance Statements	X3
Whole Building	X3.1
Spaces	X3.2
Structure	X3.3
Exterior Enclosure	X3.4
Interior Space Division	X3.5
Plumbing	X3.6
HVAC	X3.7
Fire Protection Subsystems	X3.8
Electrical Network	X3.9
Communication and Security Networks	X3.10
Fuel Networks	X3.11
Fittings, Furnishings, and Equipment	X3.12

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3.2.2 *dwelling unit*—a unit providing complete independent living facilities for one or more persons, including permanent provisions for living, sleeping, eating, cooking, and sanitation.

3.2.2.1 *attached dwelling*—two or more dwelling units, each with an independent means of entry and means of egress, that are connected to each other at a common wall, but not by a common floor/ceiling.

3.2.2.2 *detached dwelling*—a dwelling unit standing by itself.

3.2.3 *performance statement*—an essential part of a performance standard that addresses a specific attribute in terms of an element in a hierarchy of built elements, and consists of four related parts: objective, criteria, evaluation, and commentary.

3.2.3.1 *objective*—the first part of a performance statement, consisting of a qualitative statement of the performance to be provided by the built element being addressed in order to satisfy a particular user need.

3.2.3.2 *criteria*—the second part of a performance statement, consisting of quantitative statements defining the level or range of performance necessary to meet an objective or, where such a level or range cannot be established, the units of measurement of the performance.

3.2.3.3 *evaluation*—the third part of a performance statement, consisting of the method(s) of assessing conformance of the element being addressed to the criteria.

Discussion—The evaluation states the standards, inspection methods, review procedures, historical documentation, test methods, in-use performance, engineering analyses, models, or other means to be used in assessing whether or not a criterion has been satisfied.

3.2.3.4 *commentary*—the fourth part of a performance statement, consisting of an informative narrative explaining aspects of the performance statement.

Discussion—A commentary may include one or more of the following: an explanation of how the objective relates to user needs in fields such as physiology, psychology, and culture or tradition; an explanation of how the criteria are established including guides for setting different levels of performance to

meet various user needs; a discussion of the reliability of the evaluation method; and example solutions that are deemed to comply with the performance statement.

3.2.4 *provider*—the individual or organization providing specific designs, materials, products, components, subsystems, or buildings for acceptance by the specifier.

3.2.5 *serviceability*—the capability of a building, assembly, component, product, or construction to perform the function(s) for which it is designed and used.

3.2.6 *service life (of a building component or material)*—the period of time after installation during which all properties meet or exceed the minimum acceptable values when routinely maintained.

3.2.7 *specifier*—the individual or organization using the standard guides to create specifications and ultimately accept dwelling designs, materials, products, components, subsystems, or buildings to be provided by providers.

3.2.8 *systems integrator*—the individual or organization within a provider who is responsible for responding to performance statements at the highest level of the hierarchy of built elements and for assigning the responsibility for responding to performance statements at lower levels to others, such as subcontractors, suppliers, or product manufacturers.

3.2.9 *user need*—a statement of the activities and behavior to be carried out in relation to the dwelling by its residents, or other users, defined in terms of motor, kinetic, physiological, psychological, emotional and other parameters of human behavior.

4. Significance and Use

4.1 This standard guide and the use of consensus performance standards for housing can significantly contribute to the removal of barriers to the acceptance of housing innovation in the global marketplace. This standard guide in conjunction with the balance of the set of standard guides, when complete, can also serve to improve communications between producers and consumers leading to enhanced quality and performance of housing.

4.2 This standard guide is not intended for use in specifying and evaluating residential construction other than single family attached and detached dwellings. Nevertheless, some performance statements may have application to assessing the durability of building materials, components, and systems used in other constructions.

4.3 Although this standard guide addresses site planning as it affects the durability of single family attached and detached dwellings, the site-planning issues considered are not to be construed as a comprehensive site specification.

4.4 This standard guide can be useful to managers of housing procurement projects, home builders, designers, product manufacturers, and evaluation services in addressing durability issues related to single family attached and detached dwellings. Such applications can require that the performance statement examples be written in mandatory language.

4.5 The performance statement examples given in this standard guide are intended to complement the durability requirements implied in prescriptive provisions of codes such as the International Residential Code for One- and Two-Family Dwellings (IRC).

4.6 *Limitations on Performance Prediction*:

4.6.1 The traditional approach to evaluating the durability in building materials, components, and systems has been related to specific materials, and their reaction over time to specific degradation factors. This is useful for establishing standards for the quality control and use of specific materials. However, it is not much help in making comparisons across a variety of traditional materials intended for the same use, in evaluating systems comprised of a number of specific materials (for example, walls), or in developing performance specifications and performance standards needed for innovative materials. Little research has considered the generic analysis of degradation factors acting upon building elements in residential application. Moreover, insufficient work has been done in the development of accelerated weathering tests in which the degradation processes simulate those occurring in practice. Also, much more material science studies of degradation mechanisms and rates are needed to form a strong foundation for performance prediction of building materials. For these reasons, the performance statements in this Guide are examples and initial steps of an evolving process in developing performance standards for single family attached and detached dwellings. It is anticipated that, as this Guide is applied to housing procurement projects and as more research into the subject of durability is carried out, the performance statement examples in this Guide will change. Both providers and specifiers should consider the basis for modifications as performance statements are established.

4.6.2 General conformance to this Guide is intended to provide reasonable assurance that the in-place materials, built elements, and service subsystems of attached and detached dwellings will be serviceable through their service lives. Conformance to the performance statement examples in Appendix X3 does not assure that the service-lives will be met. Many of the listed tests are empirical in nature, and often do not reflect the variety of exposure conditions to which a material may be subjected in different geographic locations. However, the tests can be useful in illustrating comparisons of the performance of competing materials and systems. Paragraph X2.1.2.3 suggests that Practice E 632 be followed in developing service-life prediction data when little performance history is available for a material or system.

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Table 2. Matrix of Typical Building Elements and Potential Degradation Factors

Element	Sub-element	User Factors	Operation/use	Point impact	Chemicals/Stains	Washing and Scrubbing	Abrasions	Thermal shock	Hot water exposure	Weather Factors	Sunlight	Wind	Moisture including rain	Sand storms	Hail impact	Temperature maximum	Temperature minimum	Thermal shock	Water freeze-thaw	Earth Factors	Moisture	Water	Chemicals	Vermin including termites	Bacteria and fungus	Frost (heaving)	Other Factors	Differential expansion	Corrosion	Chemical incompatibility	Physical incompatibility	Electrical current	Internal water/air pressure
1. SPACES																																	
Entries																												○		○	○		
Living spaces																												○		○	○		
Dining spaces																												○		○	○		
Kitchens																												○	○	○	○		
Sleeping spaces																												○		○	○		
Bathrooms																												○	○	○	○		
Water closet																												○	○	○	○		
Outdoor living spaces																												○	○	○	○		
Storage spaces																												○		○	○		
Other																												○		○	○		
2. STRUCTURE																																	
Foundation											○	○	○	○	○	○	○	○	○		○	○	○	○	○								
Superstructure											○	○	○	○	○	○	○	○	○		○	○	○	○									
3. EXTERIOR ENCLOSURE																																	
Grade Enclosure	Floor on grade		○	●	●	○	○		○		●										○	○	○	○	○	○		○	●	○	○		
	Floor over air space		○	●	●	○	○		○		●										○		○	○	○			○	●	○	○		
	Other		○	●	●	○	○		○		●										○	○	○	○	○	○		○	●	○	○		
Vertical and Sloped Enclosure	Walls		○	●	●	○	○		○		●	●	○	○	●	●	●	○	○		○	○	○	○	○	○		○	●	○	○		
	Windows		●	●	●	○	○		○		●	●	●	●	●	●	●	●	●		○	○	○	○	○	○		○	●	○	○		
	Doors		●	●	●	○	○		○		●	●	●	●	●	●	●	●	●		○	○	○	○	○	○		○	●	○	○		
	Other		○	●	●	○	○	○			●	●	○	○	●	●	●	○	○		○	○	○	○	○	○		○	●	○	○		
Roofs	Roof coverings		○	●			○	○			●	●	○	○	●	●	●	○	○						○			○	●	○	○		
	Skylights		○	●			○	○			●	●	○	○	●	●	●	○	○						○			○	●	○	○		
	Other roof openings		○	●			○	○			●	●	○	○	●	●	●	○	○						○			○	●	○	○		
Joint Sealants			○	○				○			○		○		○	○	○	○	○						○			○		○	○		
4. INTERIOR SPACE DIVISION																																	
Vertical Space Dividers	Partitions		○	●	●	●	○		○		●													○	○			○	○	○	○		
	Doors		○	●	●	●	○		○		●													○	○			○	○	○	○		
	Other		○	○	●	○	○		○		●													○	○			○	○	○	○		
Horizontal Space Dividers	Floors		○	●		●	○		○		●													○	○			○	○	○	○		
	Ceilings		○	○		○			○																			○		○	○		
	Floor/ceiling openings		○	○																					○								
	Other		○	○	●	○					●													○	○			○	○	○	○		
Stairs and Ramps																																	
5. PLUMBING																																	
Plumbing Fixtures			○	●	●	●	○		●										○										●				
Domestic Water Distribution			○	●	●	●	○		●		●								○									○	●	○	○		●
Sanitary Waste			○	●	●	●	○	○	●		●	○	○	○	○	○	○	●										○	●	○	○		●
Rain Water Drainage			○	○	○	○	○	○			●	○	○	○	○	○	○											○	○	○	○		○
6. HVAC																																	
Heating				●	●	●			●		●																						●
Cooling				●	●	●					●																						●
Ventilation				●	●	●					●																						●
7. FIRE PROTECTION SUBSYSTEMS																																	
				●	●	●	○	○			●								○									○	●	○	○		●

8. ELECTRICAL NETWORK																																	
Electrical Service and Distribution			●	●	●					●																							
Lighting and Branch Wiring		●		●																								●					
9. COMMUNICATION AND SECURITY NETWORKS																																	
Telephone		●	●	●	●					●																		●					
Intercom		●	●	●	●					●																		●					
Television		●	●	●	●					●																		●					
Security		●	●	●	●					●																		●					
Other		●	●	●	●					●																		●					
10. FUEL NETWORKS																																	
																																	●
11. FITTINGS, FURNISHINGS, AND EQUIPMENT																																	
									●																			●					

○ indicates that the illustrative performance statement includes general criteria and evaluation methods.

● indicates that the illustrative performance statement includes specific criteria and evaluation methods.

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5. Parameters Affecting Durability

5.1 *Degradation Factors and Service Life*:

5.1.1 *Interaction of Degradation Factors and Building Elements*. Table 2 is a matrix displaying the interaction of degradation factors affecting service life of building elements. The table is not all inclusive; the specifier can add other degradation factors (e.g., specific pollutants) as warranted. Also, the specifier can delete degradation factors that are not applicable (e.g., sandstorms, hail, and corrosion) in developing specific performance statements. In Table 2, every intercept with a "dot" has one or more examples of performance statements associated with it. An unfilled dot (designated by "o" in Table 2) indicates an example of a performance statement having general criteria and evaluation methods (EM-1 in Appendix X2) in terms of resistance to degradation factors over the service life. A filled dot (designated by "·" in Table 2) indicates a performance statement example having specific criteria and evaluation methods.

5.1.2 *Environmental Factors*. Durability requirements specify the resistance of building elements to the effects of a variety of user factors and environmental factors (that is, weather and earth factors) to which they may be subjected over their service-life. The environmental factors may vary as a function of geographic location and, in some cases, this variation may occur at the micro scale. For example, the effects of airborne salts and other chemicals on a dwelling depends on its location in relation to roads, airports, industrial sources of air pollution and local wind patterns. If such specific information on weather factors is available for a specific dwelling project, the specifier should make it available to providers.

5.2 *Anticipated Minimum Service Life*:

5.2.1 Specifiers of durability need, by definition, to consider the minimum acceptable, anticipated service lives of the products, components, assemblies, and subsystems for which performance specifications are developed. Information on the anticipated service life of the specific materials, products, components, assemblies, and subsystems proposed by providers in response to performance specifications is also needed. Table 3 is provided to assist specifiers in the consideration of minimum acceptable, anticipated service lives necessary for the development of performance specifications of durability. Table 3 includes a list of typical building elements that are organized by subsystems 2 through 11 of the Hierarchy of Building Elements presented in Figure 2. Specifiers should add to or select from this list of building elements depending on the scope of the performance specification they are developing, and then complete Table 3 with the minimum anticipated service lives that they will accept. These minimum anticipated service lives may be based on the specifiers' knowledge and needs for the housing, user expectations, and life-cycle cost analysis, where the relationship between first cost and cost of renewal provides the basis for establishment of minimum service life. Practice E 917 provides a protocol for measuring life-cycle costs of buildings and building systems.

5.2.2 Examples of anticipated minimum service lives for various building elements are given in Appendix X1. These examples are based on professional judgment of user expectations for minimal acceptable conventional construction in the U.S., which may be permanent or temporary, with normal maintenance activities. Note in Table X1.1 that a range of service lives is given for each building element. The ranges reflect experience that the service life of a given building element varies depending upon a number of factors including the type of material from which the product is manufactured, the manufacturing process, the service environment, and maintenance conducted over the service life.

6. Site Considerations Affecting Durability

6.1 *Site Design*:

6.1.1 There are many conditions specific to a building site that can have a significant effect on the durability of building materials, products, components, assemblies, and subsystems. This section addresses information that should be considered to protect a dwelling from surface and subsurface environmental degradation factors that can adversely affect the durability of the building materials, products, components, assemblies, and subsystems.

6.1.2 The specifier should provide information in the form of site design and site-building interface design of sufficient detail for providers to design the protection of the buildings against surface and subsurface environmental degradation factors such as water, chemicals and salts, and temperatures from the ground.

6.1.3 Alternatively the specifier may choose to make housing providers responsible for the design of site and building methods to protect buildings against water, chemicals and salts, and temperature from the ground. If so, each provider should determine, in the site design, the methods used on the site for protection. Additionally, each provider should determine, in the building design interfaces, the methods to be used in the buildings to protect them against surface and subsurface environmental degradation factors such as water, chemicals and salts, and temperature from the ground. In such cases, the specifier should provide site planning performance criteria.

6.2 *Site Investigation Report*:

6.2.1 A site investigation report for the protection of buildings against surface and subsurface environmental degradation factors such as water, chemicals and salts, and temperature from the ground should be prepared by the specifier or provider. The following information is generally included:

6.2.1.1 Maximum flood levels with a specified year recurrence interval.

6.2.1.2 Maximum precipitation with a specified year recurrence interval.

6.2.1.3 Maximum depth below grade of frost penetration with a specified year recurrence interval.

6.2.2 For the protection of buildings against water, chemicals and salts, and temperature the report generally correlates the site information of 6.2.1 in the following three areas of site and building design:

6.2.2.1 Site.

6.2.2.2 Site-building interface.

6.2.2.3 Building systems.

6.2.3 The presentation of information in both graphic and written form should be based on the proposed site design topography and elevations (provided by the specifier or the

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Table 3. Anticipated Minimum Service Life of Typical Building Elements

Building Element			Required Minimum Service Life years
STRUCTURE			
	Foundation	Single-family housing	
	Superstructure	Single-family housing	
EXTERIOR ENCLOSURE			
	Grade Enclosure	Floor on grade	
	Vertical and Sloped Enclosure	Walls	
		Wall finish — easily renewable	
		Wall finish — difficult to renew	
		Doors	
		Windows	
		Door and window finish — easily renewable	
	Roofs	Roof Covering	
		Skylights	
	Joint Sealants		
INTERIOR SPACE DIVISION			
	Vertical Space Dividers	Partitions	
		Partition surface finishes — easily renewable	
		Partition surface finishes — difficult to renew	
		Doors	
		Doors — easily renewable door paint	
	Horizontal Space Dividers	Floor surfaces — bath and w.c.	
		Floor surfaces — other	
		Ceiling surfaces — private spaces; easily renewable	
		Ceiling surfaces — private spaces; difficult to renew	
	Stairs and Ramps	Stair surfaces — private spaces	
PLUMBING			
	Piping	Accessible	
		Inaccessible	
	Fixtures		
	Fixture Trim		
	Hot Water Heater		
HVAC			
	Fuel pump		
	Pipes	Accessible	
		Inaccessible	
	Radiators		
	Fan Coil Units		
	Pumps		
	Boilers		
	Mechanical Refrigeration	Machines	
	Evaporative Coolers		
	Furnaces		
	Duct Work	Accessible	
		Inaccessible	
	Louvers		
	Thermostats		
	Exhaust Fans		
FIRE PROTECTION SUBSYSTEMS			
ELECTRICAL NETWOR			
	Conductors	Accessible	
		Inaccessible	
	Conduit		
	Exposed Raceways		
	Switches		
	Sockets		
	Overcurrent Protection	Circuit breaker	
	Panels		
	Switch Board		
	Light Fixtures		
COMMUNICATION AND SECURITY NETWORKS			
	Television Antenna		
FUEL NETWORKS			
	Fuel Storage	Above ground	
		Below ground	
	Fuel Supply Piping	Accessible	
		Inaccessible	
FITTINGS, FURNISHINGS AND EQUIPMENT			
	Furnishings	Built-in furnishings	
		Built-in furnishing surfaces — easily renewable	

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provider) and the proposed design locations, positions, configurations, and elevations of buildings near, at and below ground.

6.2.4 Site designs for the protection of buildings against surface and subsurface environmental degradation factors can be used to determine the performance required at the site-building interface. The site investigation report should show the effect of specific site design considerations that can have a significant effect on the durability of building materials and systems. The site investigation report should address the anticipated flood level, precipitation level, water table and frost penetration level adjacent to buildings. The site design might include:

6.2.4.1 The reduction by diversion, ponding or other means of surface water runoff entering ground adjacent to buildings.

6.2.4.2 The reduction of subsurface water entering ground adjacent to buildings by the provision of subsurface drainage, either by pumping or by gravity, at site structures, at paved areas and at other site areas where the ground is or may be water-logged.

6.2.5 Site-building interface designs for the protection of buildings against surface and subsurface environmental degradation factors can be used to determine the performance required of the building and building systems. The designs may show the effect of anticipated flood level, precipitation level, water table level and frost penetration level at buildings. The site design might include:

6.2.5.1 The reduction by diversion or other means of surface water run-off entering ground at and around the envelope or the foundation of buildings.

6.2.5.2 The reduction of subsurface water entering ground around the envelope or the foundation of buildings by the provision of subsurface drainage, either by pumping or gravity, at the envelope or the foundation, or by other approved means.

6.2.5.3 The reduction of subsurface water entering ground under the floors or the foundation of buildings by the provision of subsurface drainage, either by pumping or gravity, or other approved means, at floors and foundations.

6.3 Building designs for the protection of buildings against surface and subsurface environmental degradation factors such as water, chemicals and salts, and temperatures should clearly show the methods used to provide adequate protection from environmental conditions that can have a significant effect on the durability of building materials, products, components, assemblies, and subsystems.

7. Special Evaluation Methods Used in Durability

7.1 Conformance of building materials, products, components, assemblies, and subsystems to many of the durability criteria examples provided in this standard guide may be determined by common evaluation methods. Examples of such evaluation methods (designated EM-1 through EM-5) that may be used to evaluate durability are given in Appendix X2. These evaluation methods are based on considerations of the most common types of user and environmental degradation factors to be encountered in practice. These five special evaluation methods are cited in some of the performance statement examples given in Appendix X3. In some cases, the examples of special evaluation methods are simplified versions of published standard test methods. A reason for not specifying the standard test methods is that they were generally developed for specific materials and, consequently, their direct application to the variety of materials and products covered by this Guide is precluded. Additionally, the scope of these standard methods may limit their use to laboratory testing. In contrast, this Guide allows several evaluation methods to be performed in both the laboratory and field, enabling the specifier, if warranted, to require field testing for durability in providers' test plans. The specifier is cautioned to check the appropriateness of evaluation methods before adding them to specifications.

8. Performance Statements (O-C-E-C)

8.1 Examples of performance statements for building materials, products, components, assemblies, and subsystems are given in Appendix X3 in Objective, Criteria, Evaluation Method, and Commentary (O-C-E-C) format. The objectives are based on considerations of normally encountered user, weather, earth, and other degradation factors (Table 2) which may reduce service life. In many evaluation methods, it is necessary to use test conditions more severe than those normally encountered by the product or system in practice to obtain useful results in a reasonable period of time. The performance statement examples in Appendix X3 provide examples to specifiers and providers in the development of performance specifications for the durability of building materials, products, components, assemblies, and subsystems for single-family attached and detached dwellings.

8.2 While the resistance of particular degradation factor for a specified service life is a valid performance criterion, it is often difficult to evaluate when the factors affecting performance are complex and interactive, or when accelerated test methods have not been developed. Where examples of criteria and test methods are given in Appendix X3, professional judgment has been used in determining that the particular criteria and test methods adequately simulate the anticipated degradation factors and their effects over the specified service life. Providers may suggest modifications to the criteria and test methods, especially if they can give adequate historic documentation that the anticipated degradation factors can be resisted for the service life, or that different criteria and test methods provide a better simulation of these degradation factors and their effects over the service life.

8.3 *The Hierarchy of Building Elements*:

8.3.1 The example performance statements given in Appendix X3 are presented against the Hierarchy of Building Elements tabulated in Figure 2. The order of presentation begins with "0. Whole Building System" followed in order by each of the 11 subsystems. Within each subsystem, the example performance statements follow in order down to the lowest levels of the hierarchy as needed. For example, the performance statements for subsystem "3. Exterior Enclosure" are followed by "3.1 Grade Enclosure", followed by "3.1.1 Floor on Grade" and lower if necessary, then followed by "3.1.2 Floor over Air Space" and lower if necessary, "3.1.3 Other", "3.2 Vertical and Sloped Enclosure" and so forth.

8.3.2 To some extent the Hierarchy of Building Elements reflects the structure of the housing industry, and therefore, the

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organization of the provider teams. For example, a home-builder or developer is likely to be the systems integrator responsible for “0. Whole Building System”. The provider teams may include separate subcontractors for “2.1 Foundation,”“ 2.2 Superstructure,” “5. Plumbing,” “6. HVAC,” and the like, and separate suppliers for components such as “3.2.2 Windows,”“ 4.1.2 Doors,” “3.4 Joint Sealant,” “5.1 Plumbing Fixtures,” and the like.

8.3.3 The Evaluation part of the performance statements includes the identification of information (for example, drawings, samples, test reports, and so forth) to be submitted by providers to document compliance with the Criteria. The responsibility for making available this information rests with the provider. For performance statements at higher levels of the Hierarchy of Building Elements such as “0. Whole Building System,” the technical information documenting compliance must be provided by the systems integrator. The systems integrator may assemble portions of this information from other members of the provider’s team, such as subcontractors or suppliers. In some cases, the systems integrator may develop a performance specification for one or more products, components, or assemblies at lower levels of the Hierarchy of Building Elements in order to obtain this information.

8.3.4 For performance statements at lower levels of the Hierarchy of Building Elements, the information documenting compliance may be provided directly by a subcontractor or supplier member of the provider’s team. For example, tests that are part of a performance statement for “3.2.2 Windows” will likely be carried out and reported by the window manufacturer or supplier.

9. Keywords

9.1 building materials and systems; durability; dwelling; performance criteria; single-family

APPENDIXES

(Nonmandatory Information)

X1. EXAMPLE OF MINIMUM SERVICE LIVES FOR TYPICAL BUILDING ELEMENTS

X1.1 This Appendix provides examples of anticipated minimum service lives for typical building elements. See Table X1.1. The example complements Table 3 given in the main text of this standard guide.

X1.2 The examples are based on professional judgement of the members of ASTM Subcommittee E06.66 for minimal acceptable conventional construction in the U.S., which may be permanent or temporary, with normal maintenance activities.

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