Introduction:
The use of detectable warning systems at curb cuts and vehicular ways is mandated as part of the Americans with Disabilities Act. These detectable warning systems are subject to a variety of environmental conditions that can lead to material degradation and reduction in performance. In extreme cases, degradation may occur such that the detectable warning systems become a hazard to pedestrians—for example, by becoming a tripping or slip hazard.

Key Aspects of the Program:
The work plan provides a protocol for testing the durability of detectable warning systems in a repeatable manner. Laboratory exposures and evaluation tests were developed to simulate the types of damage and degradation anticipated in service. Exposures are conducted cyclically to allow for effects of combined interaction of the simulated environmental exposures. Nondestructive evaluation tests are conducted both before and after exposures to provide comparative values. Destructive evaluation tests are conducted after the exposures.

The primary objective of this test method is to provide a repeatable set of tests that can be conducted specifically to evaluate durability of detectable warning systems. Each test is suitable for use with any type of detectable warning system, regardless of the material composition or method of attachment. Specimens are attached to concrete slabs to provide a test of the detectable warning system/sidewalk system. Data produced following this method is anticipated to be used for purposes of determining product durability and product comparison. Users can use all or parts of the data, as applicable, for the user’s conditions.
Terminology:

*Cast-In-Place:* a detectable warning system device that is cast into plastic concrete (wet set) with or without mechanical anchors. DWS can be made of any material.

*Surface Applied, adhesive bonded:* a detectable warning system device that is applied onto the surface of cured concrete with only adhesive. DWS can be made of any material.

*Surface Applied, anchor bonded:* a detectable warning system device that is applied onto the surface of cured concrete with mechanical anchors, may be installed with or without adhesive. DWS can be made of any material.

*Dome:* the truncated dome on the detectable warning system.

*Field:* the space between the domes on the detectable warning system. The field is typically level with the surrounding concrete.

*Surface-Applied Single Dome or Array:* a single truncated dome that is adhered to a concrete substrate or the field as part of an array of separately applied domes composing a detectable warning system. Also, an array of truncated domes that are formed during installation using a stencil or other method. Domes can be made of any material and can be set in wet concrete or on cured concrete, and with or without mechanical anchors.

*Brick Paver:* a paving stone, tile, brick or brick-like piece that is set into a framed space or channel in wet or cured concrete

*Concrete:* Products that use a modified Portland cement-based binder (non-polymeric) and fine aggregates in addition to other additives such as polymers and fibers.

*Polymer Concrete:* Products that use a polymeric based binder and fine aggregates.

*Polymers and Composites:* Products that use a polymeric based binder and non-aggregate materials.

*Metal:* Metallic products made of cast iron, stainless steel, or other metal material.

**Review of Evaluations and Significance of Data Generated:**
**Visual and Microscopic Evaluation**

**Scope:**
This test method covers visual and microscopic evaluation of detectable warning systems. Visual and microscopic evaluation provide a method to determine the effects of laboratory-accelerated weathering on detectable warning system specimens that are not readily measured with other standard tests.

**Significance and Use:**
Visual and microscopic evaluation provide a method to determine the effects of laboratory-accelerated weathering on detectable warning system specimens that are not readily measured with other standard tests. Visual and microscopic evaluation provides a means to evaluate any degradation of a detectable warning system as a result of laboratory-accelerated weathering. Acceptable values depend on the environment of the installation. Any product that show significant deterioration after laboratory-accelerated weathering may not have a long service life. For a product specification, users could include a description of the allowable defects and features observed microscopically and location on the specimen and describe the allowable changes after High Temperature Thermal Cycling or Freeze/Thaw Durability testing from the initial evaluations of the same specimen.

**Domes and Spacing Dimensional Testing**

**Scope:**
This test method covers the measurement of dome shape and geometry of detectable warning systems. Reported values can be in millimeter (mm) or inches (in) units.

**Significance and Use:**
The Americans with Disabilities Act Accessibility Guidelines (ADAAG) provides geometric recommendations for the domes and dome spacing of detectable warning systems. This evaluation is intended to provide a basis for quantifying potential changes in dome shape and geometry as the result of laboratory-accelerated weathering. At a minimum the product should meet all the ADAAG geometric recommendations. For a product specification, users could include a describe the allowable changes after High Temperature Thermal Cycling or Freeze/Thaw Durability testing from the initial evaluations of the same specimen.

**Slip Resistance Testing**

**Scope:**
This test method covers the measurement of static coefficient of friction of detectable warning systems under both wet and dry conditions. In use, detectable warning systems are placed as outdoor walking surfaces, often on inclined planes. Consequently, the surface must be resistant to slip. This method is applicable for use in evaluating the dry and wet static coefficient of friction of detectable warning systems as part of a laboratory testing program. The testing program measure both the tops of the domes and the recessed areas between the domes.

**Significance and Use:**
In use, detectable warning systems are generally placed as outdoor walking surfaces, often on inclined planes. Consequently, the surface must be resistant to slip. Depending on location of the detectable warning system, different friction values may be necessary for wet and dry conditions. The unit is coefficient of friction. The coefficient of friction is typically between 0 and 1, but in some cases may exceed 1. For a product specification, users could include the wet and dry values on the specimen and the allowable changes after High Temperature Thermal Cycling or Freeze/Thaw Durability testing from the initial evaluations of the same specimen.
**Color Measurement Testing**

**Scope:**
This test method covers the measurement of color and color change of detectable warning systems. Exposure to environmental conditions, such as ultraviolet light and abrasion, may fade the color of the detectable warning system.

**Significance and Use:**
The *Americans with Disabilities Act Accessibility Guidelines* discuss the need for color contrast between the detectable warning system and the surrounding pavement. Certain materials may experience color fading or color change upon exposure to the environment. Measurement of color and evaluation of color change are used as tools to evaluate potential changes in color contrast of the detectable warning system and surrounding pavement. Depending on location of the detectable warning system, different colors with different values may be necessary. For a product specification, users could identify each color they will allowed and the measured or averaged \( L^* \), \( a^* \), and \( b^* \) values and the allowable difference in measured or averaged \( L^* \), \( a^* \), and \( b^* \) values after High Temperature Thermal Cycling or Freeze/Thaw Durability testing from the initial evaluations of the same specimen.

---

**Resistance to Impact from Falling Tup Testing**

**Scope:**
This test method covers the evaluation of impact resistance of detectable warning systems. In use, detectable warning systems are subject to impact from a wide variety of sources. Pedestrians carrying objects may drop them, and if a heavy object lands with a concentrated force on a dome, damage can result. Another potential source of impact damage is from wheeled carts and hand trucks being pushed over the surface of detectable warning system. This test involves impacts of predetermined energies on the domes of detectable warning systems cast into concrete. Impact is provided by a weighted falling tup. The test provides a description and classification of the testing damage.

**Significance and Use:**
In use, detectable warning systems are subject to impact from a wide variety of sources. Pedestrians carrying objects may drop them, and if a heavy object lands with a concentrated force on a dome, damage can result. Another potential source of impact damage is from wheeled carts and hand trucks being pushed over the surface of detectable warning system. Depending on location of the detectable warning system, different weight values may be necessary to approximate the conditions. For a product specification, users should identify the impact weight required and then could identify the Classification or Description in accordance to the testing criteria they will allow and the allowable Classification or Description after High Temperature Thermal Cycling or Freeze/Thaw Durability testing from the initial evaluations of the same specimen. Users can create separate requirements for each impact weight to be used.
Wear Resistance Testing

Scope:
This test method is intended to evaluate the response of detectable warning systems to an abrasive action. This response of the test samples to this action is expected to be indicative of performance of detectable warning systems when subjected to abrasion from foot traffic. The testing reports the change in the height of the domes. Reported values can be in millimeter (mm) or inches (in) units.

Significance and Use:
This response of the test samples to this action is expected to be indicative of performance of detectable warning systems when subjected to abrasion from foot traffic. Any product that shows significant height loss from Wear Resistance testing may not have a long service life. For a product specification, users could identify the change in height they will allow and the allowable difference in measured height values after High Temperature Thermal Cycling or Freeze/Thaw Durability testing from the initial evaluations of the same specimen.

Bond Strength Testing

Scope:
This test method covers testing of the bond strength of coatings on detectable warning systems, and the bond strength of single surface-applied domes and surface applied tiles to the concrete substrate. Bond strength of the coating to the field and the dome and tile to the concrete is tested. The coating bond and adhesive strength of surface-applied domes will be measured according to ASTM D4541, “Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers.” The coating bond and adhesive strength of surface-applied warning systems will be measured according to this Section.

Significance and Use:
Some detectable warning systems are coated to provide static coefficient of friction or color contrast with the surrounding sidewalk. If the coating becomes debonded from the substrate, the detectable warning system may no longer be slip-resistant and the system may not meet color contrast requirements for the system. Some detectable warning systems are adhesively bonded to the concrete substrate. If the adhesive becomes debonded from the substrate, the functionality of the detectable warning system could be reduced. Other detectable warning systems consist of an array of surface-applied single truncated domes adhesively bonded to the concrete substrate. If the domes become debonded, functionality of the detectable warning system could be reduced. The best performance of detectable warning system would be a bond failure within the concrete substrate. Depending on the user’s concrete mix design, a minimum value of 150 psi tensile adhesion strength would be acceptable because it meets or exceeds an average concrete tensile adhesion strength. For a product specification, users could identify the failure mode and the minimum Bond Strength in psi they will allow and the failure mode and allowable difference in psi values after High Temperature Thermal Cycling or Freeze/Thaw Durability testing from the initial evaluations of the same specimen.

High-Temperature Thermal Cycling Testing

Scope:
This thermal cycle includes cycles of temperature changes from 77°F to 200°F with cycles of wetting, passes of abrasion exposure, and hours ultraviolet testing to simulate several years of exposure and use. This method exposes detectable warning systems to cyclic ramped heating and sudden cooling to simulate daily thermal variations and rapid cooling events.

Significance and Use:
Thermal excursions have the potential to induce stresses between the detectable warning system and the substrate, which may have different coefficients of thermal expansion. This thermal cycling may be rapid, such as due to sudden rainfalls, or more gradual due to daily variations in ambient temperature. This response of the test samples to this action is expected to be indicative of performance of detectable warning systems when subjected to the environment and abrasion from foot traffic. For a specification, users will identify which Thermal Cycling Testing needs to be used for the testing.

Freeze-Thaw Durability Testing

Scope:
This thermal cycle includes cycles of cold temperature changes from -10°F to 85°F and cycles of hot temperature changes from 77°F to 170°F with cycles of wetting, passes of abrasion exposure, and hours ultraviolet testing to simulate several years of exposure and use.

Significance and Use:
Thermal excursions have the potential to induce stresses between the detectable warning system and the substrate, which may have different coefficients of thermal expansion. This thermal cycling may be rapid, such as due to freezing, sudden rainfalls, or more gradual due to daily variations in ambient temperature. This response of the test samples to this action is expected to be indicative of performance of detectable warning systems when subjected to the environment and abrasion from foot traffic. For a specification, users will identify which Thermal Cycling Testing needs to be used for the testing.