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Standard Test Method for Crash Testing of Vehicle Security Barriers[1]

This standard is issued under the fixed designation F2656/F2656M; 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

Original perimeter barrier test methods were first published in 1985 by the Bureau of Diplomatic Security to assess the crash performance of perimeter barriers and gates. Since that time, the frequency and scale of attacks using vehicles with or without an explosive payload have increased both internationally and domestically. Therefore, there is a need to address a broad spectrum of possible incident conditions such as credible threat vehicle types for the locale, attack velocities of the different vehicles, and different acceptable penetration limitations. Also, there are different evaluation criteria for different agencies that fulfill their unique access control operations, aesthetics, and other organizational requirements. This test method was originally developed to expand the previous Department of State, Bureau of Diplomatic Security's crash testing standard to meet the broader needs of multiple organizations responsible for the protection of U.S. assets domestically and abroad.

Published test standards for vehicle perimeter security devices have previously been maintained by the U.S. State Department, Bureau of Diplomatic Security. The Specification for Vehicle Crash Test of Perimeter Barriers and Gates was first published in 1985 as SD-STD-02.01. In that standard, the test vehicle was specified as a medium-duty truck weighing 6800 kg [15 000 lb]. The payload was to be securely attached to the frame and nominal impact velocities were 50, 65, and 80 km/h [30, 40, and 50 mph]. Penetration limits were 1, 6, and 15 m [3, 20, and 50 ft] and were measured from the attack face of the perimeter security device to the final resting position of the front of the frame rails of the test vehicle.

In 2003, the U.S. State Department, Bureau of Diplomatic Security issued an updated standard (SD-STD-02.01, Revision A) for the testing of perimeter barriers. This update was done for several reasons. The foremost reason for change was limited setback distances precluded the use of any devices at their facilities or compounds that did not meet the highest test level, that is, those allowing more than 1-m [3-ft] penetration distance. Therefore, the revised standard only uses a 1-m [3-ft] penetration distance. Secondly, the method of rigid attachment of the ballast to the test vehicle was not simulating likely payload configurations and was altering the structural integrity of the test vehicle. Consequently, the updated standard requires a payload consisting of 208-L [55-gal] steel drums strapped together that have been filled with soil. This assembly is then strapped to the vehicle load platform. The third reason for change was based on the observation that the cargo bed of trucks could effectively penetrate certain types of barriers. Accordingly, the penetration distance is now measured from the inside face or non-impact surface of the barrier to the front of the cargo bed when the vehicle has reached its final position. Lastly, it was determined that the trucks used different platforms within a given class affecting result consistency. The revised test standard required the use of very specific diesel-powered medium-duty trucks.

In 2007, ASTM first published Test Method F2656 for Vehicle Crash Testing of Perimeter Barriers. It included the same test vehicle as specified in the 2003 SD-STD-02.01, Revision A, but additional test vehicles were added. They were the small passenger car, a ½-ton regular cab pickup, and a tandem axle dump truck. In addition, penetration ratings were reestablished and included the highest rating established by the 2003 SD-STD-02.01. Occupant risk values as established in NCHRP Report 350 were also added.

The previous version of Test Method F2656/F2656M incorporated two additional vehicles, the large passenger sedan and a Class 7 cab-over with a single rear axle. Additionally, the small car and pickup have been updated to match the latest AASHTO *Manual for Assessing Safety Hardware* (MASH), the update to NCHRP Report 350. Class 7 cab-over is compatible with European standards and is designated C7. Additional definitions and recommendations have also been added and the word "perimeter" has been deleted from the title to reflect more accurately all barriers tested under this test method. Since it was determined that the P4 rating did not have substantial relevance, this rating has been eliminated. To keep up with current terminology, the term "reduced risk" is discussed in that version of Test Method F2656/F2656M.

Test Method F2656/F2656M-20 has incorporated two major changes from F2656-15. The first and most significant change is all penetration ratings are referenced to the leading impact edge of the barrier being tested. This serves to remove any ambiguity relating to barrier size or footprint and the previous determination of reference points on trailing edges. It also serves to harmonize with the international standard ISO IWA14-1. Secondly, because the previous bed attachment requirement is inadequate demonstrated by loss of bed attachment, the number of shear plates has been increased to a minimum of three on each frame rail.

[1] This test method is under the jurisdiction of ASTM Committee F12 on Security Systems and Equipment and is the direct responsibility of Subcommittee F12.10 on Systems Products and Services.

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1. Scope

1.1 This test method provides a range of vehicle impact conditions, designations, and penetration performance levels. This will allow an agency to select passive perimeter barriers and active entry point barriers appropriate for use at facilities with a defined moving vehicle threat. Agencies may adopt and specify those condition designations and performance levels in this test method that satisfy their specific needs. Agencies may also assign certification ratings for active and passive perimeter barriers based on the tests and test methodologies described herein. Many test parameters are standardized to arrive at a common vehicle type and mass, and replication, and produce uniform rating designations.

1.2 Compliance with these test procedures establishes a measure of performance but does not render any vehicle perimeter barrier invulnerable to vehicle penetration. Caution should be exercised in interpreting test findings and in extrapolating results to other than test conditions and to user site conditions. This standard does not confirm the performance of the test barrier in the user site conditions. While computer simulations are powerful tools that are useful in the development of new and improved barriers or in estimating performance under differing conditions, the analytical models and methods must be validated against physical test data. When performing a test, developers and users are encouraged to address specific or unusual user site conditions as needed.

1.2.1 Often local terrain features, soil conditions, climate, or other items will dictate special needs at specific locations. Therefore, if user site conditions are likely to degrade a barrier's performance, the agency in need of a vehicle perimeter barrier should require testing with the specific user site conditions replicated for full-scale crash testing or numerical simulations that explicitly represent the user site conditions and have demonstrated connection to the "as-tested" soil configuration. For example, if the user site conditions are expansive clays, one could obtain user site materials and provide those to the test lab for the full-scale crash test.

1.3 Product/design certification under this test method only addresses the ability of the barrier to withstand the impact of the test vehicle. It does not represent an endorsement of the product/design or address its operational suitability.

1.4 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.5 This test method is intended to replace all previous versions of the test method for current and future testing.

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 to 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]

C39 Test Method for Compressive Strength of Cylindrical

[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.

Concrete Specimens
D1556 Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method
D4429 Test Method for CBR (California Bearing Ratio) of Soils in Place (Withdrawn 2018)[3]
D6938 Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

2.2 *AASHTO Standards* [4]
M147-65 Standard Specifications for Transportation Materials and Methods of Sampling and Testing, Table 1 Grading Requirements for Soil-Aggregate Materials, Grading B
T099 Standard Method of Test for Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop

2.3 *ISO Standard* [5]
ISO/IEC 17025 General requirements for the competence of testing and calibration laboratories

2.4 *SAE Standard* [6]
J211-1 Instrumentation for Impact Test – Part 1: Electronic Instrumentation
J211-2 Instrumentation for Impact Test – Part 2: Photographic Instrumentation

2.5 *U.S. Army Corps of Engineers – PDC Standard* [7]
List of DOD Certified Anti-Ram Vehicle Barriers[8]

2.6 *U.S. Department of State – DS* [9]
SD-STD-02.01 Specification for Vehicle Crash Test of Perimeter Barriers and Gates, April 1985
SD-STD-02.01, Revision A Test Method for Vehicle Crash Testing of Perimeter Barriers and Gates, March 2003

3. Terminology

3.1 *Definitions:*

3.1.1 *"A" pillar, n*—structural member forming the forward corner of the cab or passenger compartment.

3.1.2 *accredited independent testing laboratory, n*—testing laboratory accredited to perform the referenced testing procedures by a nationally recognized accrediting agency in accordance with ISO/IEC 17025 and led by a test director.

3.1.2.1 *Discussion*—Accredited independent testing laboratories may have no financial interest in or otherwise be affiliated with companies or individuals for which they perform accreditation testing. Hereinafter, accredited independent testing laboratories are referred to as either accredited facilities or testing laboratories. Other independent testing agencies actively pursuing accreditation and whose testing protocols are accepted by a federal agency may also conduct tests for a period of one year after performing the first test using this test method.

3.1.3 *agency, n*—specifier, responsible party, or owner.

3.1.4 *barrier, n—also referred to as a vehicle security barrier,* gate, bollard, wedges, drop arms, walls, wire ropes, net, planter, other structure, or topographic feature (that is, berms, rocks, ha-has, ditches, trenches or steep inclines) that provides protection against a vehicle trying to gain access overtly to a compound or facility.

3.1.4.1 *Discussion*—Active barriers can be deployed to serve as a security device and can be stored to allow traffic passage while passive barriers are generally permanent. Sometimes barriers are also portable; these can be active or passive. The perimeter is typically the outermost boundary over which the facility has control and is normally defined by the property line

3.1.5 *barrier reference point, n*—the leading impact edge of the barrier as shown in Annex A1 which, in conjunction with the vehicle reference point, determines the dynamic penetration distance.

3.1.5.1 *Discussion*—For barrier types not shown, the barrier reference point shall be determined by using same 'leading impact edge of the barrier methodology' portrayed by barrier reference points in Annex A1.

3.1.6 *berm, n*—mounded section of available material such as soil, gravel, rock, and so forth.

3.1.7 *bollard, n*—hollow or solid section posts or series of posts, usually metal, concrete, wood, or combinations of same, used to channel or restrict vehicular traffic which includes fixed, removable, and operable/retractable posts.

3.1.8 *condition designation, n*—relates vehicle type and vehicle velocity to the kinetic energy for which testing is conducted.

3.1.9 *continuous barrier, n*—any barrier that relies on a continuous foundation or a continuous structural element to resist penetration by vehicles.

3.1.10 *debris, n*—post-impact barrier, ballast, and vehicle components dispersed as a result of impact.

3.1.11 *disabled, adj*—used in conjunction with the vehicle and barrier description after impact.

3.1.11.1 *Discussion*—Disabled barrier pertains to an active barrier that is not operable after impact as a result of damage caused by the test impact. Disabled barrier also pertains to the post-test barrier conditions if it is no longer in a deployed position. Disabled vehicle pertains to the vehicle being unable to proceed under its own power immediately after impact as a result of damage caused by the test impact. It is appropriate and necessary to discuss the level of damage to the vehicle in determining what extent the vehicle is disabled, for example, the radiator or the oil pan or both may be ruptured that would

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

[4] Available from American Association of State Highway and Transportation Officials (AASHTO), 444 N. Capitol St., NW, Suite 249, Washington, DC 20001, http://www.transportation.org.

[5] Available from International Organization for Standardization (ISO), 1 rue de Varembé, Case postale 56, CH-1211, Geneva 20, Switzerland, http://www.iso.ch.

[6] Available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001, http://www.sae.org.

[7] Available from the U.S. Army Corps of Engineers, Protective Design Center, 12565 W. Center Rd., Omaha, NE 68144-3869, https://pdc.usace.army.mil/library/BarrierCertification. Maintains 1985 list for penetration purposes.

[8] Available from the U.S. Army Corps of Engineers, Protective Design Center, 1616 Capital Avenue, Ste 9000, ATTN: CENWO ED S. Omaha, NE 68102-9000, https://pdc.usace.army.mil/library/BarrierCertification.

[9] Available from U.S. Department of State, Bureau of Diplomatic Security, Office of Physical Security Programs, Physical Security Division, Washington, D.C. 20520-1403