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Earthquake Actuated Automatic Gas Shutoff Devices

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STANDARDS

In 2003, the Board of Direction approved the revision to the ASCE Rules for Standards Committees to govern the writing and maintenance of standards developed by the Society. All such standards are developed by a consensus standards process managed by the Society's Codes and Standards Committee (CSC). The consensus process includes balloting by a balanced standards committee made up of Society members and nonmembers, balloting by the membership of the Society as a whole, and balloting by the public. All standards are updated or reaffirmed by the same process at intervals not exceeding five years.

The following Standards have been issued:

ANSI/ASCE 1-82 N-725 Guideline for Design and Analysis of Nuclear Safety Related Earth Structures
ANSI/ASCE 2-06 Measurement of Oxygen Transfer in Clean Water
ANSI/ASCE 3-91 Standard for the Structural Design of Composite Slabs and ANSI/ASCE 9-91 Standard Practice for the Construction and Inspection of Composite Slabs
ASCE 4-98 Seismic Analysis of Safety-Related Nuclear Structures
Building Code Requirements for Masonry Structures (ACI 530-02/ASCE 5-02/TMS 402-02) and Specifications for Masonry Structures (ACI 530.1-02/ASCE 6-02/TMS 602-02)
ASCE/SEI 7-05 Minimum Design Loads for Buildings and Other Structures
SEI/ASCE 8-02 Standard Specification for the Design of Cold-Formed Stainless Steel Structural Members
ANSI/ASCE 9-91 listed with ASCE 3-91
ASCE 10-97 Design of Latticed Steel Transmission Structures
SEI/ASCE 11-99 Guideline for Structural Condition Assessment of Existing Buildings
ASCE/EWRI 12-05 Guideline for the Design of Urban Subsurface Drainage
ASCE/EWRI 13-05 Standard Guidelines for Installation of Urban Subsurface Drainage
ASCE/EWRI 14-05 Standard Guidelines for Operation and Maintenance of Urban Subsurface Drainage
ASCE 15-98 Standard Practice for Direct Design of Buried Precast Concrete Pipe Using Standard Installations (SIDD)
ASCE 16-95 Standard for Load Resistance Factor Design (LRFD) of Engineered Wood Construction
ASCE 17-96 Air-Supported Structures
ASCE 18-96 Standard Guidelines for In-Process Oxygen Transfer Testing
ASCE 19-96 Structural Applications of Steel Cables for Buildings
ASCE 20-96 Standard Guidelines for the Design and Installation of Pile Foundations
ANSI/ASCE/T&DI 21-05 Automated People Mover Standards—Part 1
ASCE 21-98 Automated People Mover Standards—Part 2
ASCE 21-00 Automated People Mover Standards—Part 3
SEI/ASCE 23-97 Specification for Structural Steel Beams with Web Openings
ASCE/SEI 24-05 Flood Resistant Design and Construction
ANSI/ASCE/SEI 25-06 Earthquake-Actuated Automatic Gas Shutoff Devices
ASCE 26-97 Standard Practice for Design of Buried Precast Concrete Box Sections
ASCE 27-00 Standard Practice for Direct Design of Precast Concrete Pipe for Jacking in Trenchless Construction
ASCE 28-00 Standard Practice for Direct Design of Precast Concrete Box Sections for Jacking in Trenchless Construction
SEI/ASCE/SFPE 29-05 Standard Calculation Methods for Structural Fire Protection
SEI/ASCE 30-00 Guideline for Condition Assessment of the Building Envelope
SEI/ASCE 31-03 Seismic Evaluation of Existing Buildings
SEI/ASCE 32-01 Design and Construction of Frost-Protected Shallow Foundations
EWRI/ASCE 33-01 Comprehensive Transboundary International Water Quality Management Agreement
EWRI/ASCE 34-01 Standard Guidelines for Artificial Recharge of Ground Water
EWRI/ASCE 35-01 Guidelines for Quality Assurance of Installed Fine-Pore Aeration Equipment
CI/ASCE 36-01 Standard Construction Guidelines for Microtunneling
SEI/ASCE 37-02 Design Loads on Structures During Construction
CI/ASCE 38-02 Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data
EWRI/ASCE 39-03 Standard Practice for the Design and Operation of Hail Suppression Projects
ASCE/EWRI 40-03 Regulated Riparian Model Water Code
ASCE/EWRI 42-04 Standard Practice for the Design and Operation of Precipitation Enhancement Projects
ASCE/SEI 43-05 Seismic Design Criteria for Structures, Systems, and Components in Nuclear Facilities
ASCE/EWRI 44-05 Standard Practice for the Design and Operation of Supercooled Fog Dispersal Projects
ASCE/EWRI 45-05 Standard Guidelines for the Design of Urban Stormwater Systems
ASCE/EWRI 46-05 Standard Guidelines for the Installation of Urban Stormwater Systems
ASCE/EWRI 47-05 Standard Guidelines for the Operation and Maintenance of Urban Stormwater Systems
ASCE/SEI 48-05 Design of Steel Transmission Pole Structures

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FOREWORD

The material presented in this publication has been prepared in accordance with recognized engineering principles.

This standard and commentary should not be used without first securing competent advice with respect to their suitability for any given application. The publication of the material contained herein is not intended as a representation or warranty on the part of the American Society of Civil Engineers, or of any other person named herein, that this information is suitable for any general or particular use or promises freedom from infringement of any patent or patents. Anyone making use of this information assumes all liability from such use.

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HISTORY OF THE DEVELOPMENT OF THE STANDARD

Initiation of a standard for earthquake-actuated automatic gas shutoff devices began in 1977 with a request from the American National Standards Committee Z21 to the Automatic Gas Valve Working Committee of its Subcommittee on Standards for Gas Appliance Control Devices. In 1978, a working group was appointed to proceed with this task and a draft standard was prepared.

The draft standard was distributed for review and comment in mid-1979. A revised draft standard was adopted by the Z21 Committee by letter ballot in December 1979. The first edition of the Standard for Earthquake-Actuated Automatic Gas Shutoff Systems was approved as an American National Standard by the American National Standards Institute on April 16, 1981.

In 1981, the secretariat for this standard was transferred from the American Gas Association to the American Society of Mechanical Engineers (ASME). The ASME committee responsible for the standard did not initiate any changes. In 1991, a proposal was approved for the formation of a Pre-standards Committee within the Gas and Liquid Fuel Lifelines Committee of the American Society of Civil Engineers' (ASCE) Technical Council on Lifeline Earthquake Engineering to revise the shutoff valve standard.

A full Standards Committee was formed in late 1992 and met for the first time in early 1993. The Committee was formed of manufacturing, engineering, local and state government, and insurance representatives.

The aggressive data collection effort following the January 17, 1994, Northridge earthquake provided a unique opportunity to assess the risk posed to the public by natural gas–related post-earthquake fires and ground motions for which automatic gas shutoff would be beneficial. The ASCE Standards Committee met in the months following the Northridge earthquake and finalized the scope of research needed to support development of the revised standard.

Research focused on two key areas. It was decided that dynamic testing of current devices was needed to quantify performance characteristics. The other key area was in-depth examination of Northridge earthquake data on ground motions, structural damage, fire initiation, and actuation of existing earthquake shutoff devices.

A proposal to perform research in these two areas was prepared for ASCE by the Standards Committee and the project was jointly funded by the Federal Emergency Management Agency (FEMA), natural gas utilities, and shutoff device manufacturers. The research project was initiated in March of 1995 and completed in November of 1995.

Performance characteristics of the devices tested were determined and evaluated for both discrete dynamic loads and complex motions such as simulated earthquakes. The results of the dynamic testing of the devices currently on the market bracketed the ranges that were used in defining the actuation requirements in response to seismic disturbances.

The revised ASCE standard, ASCE 25, was first published in 1997.

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ACKNOWLEDGMENTS

The American Society of Civil Engineers (ASCE) acknowledges the work of the Earthquake-Actuated Automatic Gas Shutoff Devices Standards Committee of the Lifelines Standards Council, Codes and Standards Activities Council. This group comprises individuals from many backgrounds, including manufacturing, gas industry, consulting engineering, government, insurance industry, education, and private practice. This standard was prepared through the consensus standards process by balloting in compliance with procedures of ASCE's Codes and Standards Activities Council. Individuals serving on the Standards Committee are listed below.

Martin Asbra
Antonio Braga
Paul Brooks
Don Clyde
John Diehl, Chair (1999–2004)
Donald Dockray
Douglas Honegger, Chair (2004–2006)
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Eric Youngberg

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Earthquake-Actuated Automatic Gas Shutoff Devices

1.0 GENERAL

Except as modified by this standard, devices qualified to this standard shall conform to the applicable specifications of ANSI Z21.21b/CSA 6.5b.

1.1 SCOPE

This standard provides minimum functionality requirements for earthquake-actuated automatic gas shutoff devices and systems (hereafter referred to as *devices*) meant to include mechanical devices consisting of a sensing means and a means to shut off the flow of gas.

The components or parts of devices not covered by this standard or the applicable sections of ANSI Z21.21b/CSA 6.5b shall be in accordance with the applicable American National Standards Institute and industry standards.

1.2 APPLICABILITY

The typical configuration considered in this standard applies to a single-family or multi-family structure of three stories or less. This standard is applicable only to devices carrying gaseous fuels, such as natural gas and propane.

1.2.1 Pressure Rating

This standard applies to devices having maximum operating gas pressure ratings of 0.5 psi (3.4 kPa) up to and including 60 psi (414 kPa).

1.2.2 Mounting

This standard applies to devices that are to be mounted in strict accordance with manufacturers' specifications, and in a manner as to be sensitive to earthquake ground motions and not motions that might result from the dynamic response of structures, equipment, or other appurtenances.

1.3 OPERATION

1.3.1 Mode of Operation

The device shall be designed to operate automatically. Actuation of gas shutoff may be accomplished either directly or indirectly by mechanical or other means. The use of one or more permanent magnets as valve components is not permitted if their placement might cause iron oxides, iron sulfides, or similar ferrous materials to collect on valve seating surfaces.

1.3.2 Operating Conditions

Devices covered by this standard shall be capable of operating at ambient temperatures of –10 °F to 150 °F (–23 °C to 66 °C) unless manufacturers specify lower minimum or higher maximum operating temperature ranges.

1.3.3 Pressure Specification

All references to internal pressure throughout this standard are to be considered gage pressures unless otherwise noted.

1.4 MARKING

1.4.1 Permanent Label

In addition to the requirements of ANSI Z21.21b/CSA 6.5b, each device shall have a permanent labeling to identify this standard, as follows:

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1.4.2 Installation Warning

All devices shall have the following warning affixed to the device with a tag and on the device shipping carton:

WARNING! This device must be installed by a qualified installer in accordance with the manufacturer's installation instructions; if improperly installed, failure to function as intended or unwarranted interruption of gas service could result.

1.4.3 Resetting Warning

All devices shall bear the following warning:

Following actuation of this device, reset the device and restore service only after a qualified person has verified no gas leak exists.

1.5 WARRANTY

Manufacturers shall warrant the performance of devices for a specified time to meet this standard.

2.0 CONSTRUCTION

2.1 GENERAL

The construction of parts not covered by this standard shall employ reasonable concepts of safety and durability. General assembly shall be of a neat and workmanlike character with all parts and components well fitted.

All specifications as to construction set forth herein may be satisfied by the construction actually prescribed or such other construction as will provide at least equivalent performance.

2.1.1 Indication of Actuation

The device shall have an external means of indicating whether or not actuation has occurred without the use of tools or equipment.

2.1.2 Resetting

The device shall require manual resetting after having been actuated.

2.2 EQUIPMENT AND DATA TO BE FURNISHED BY THE MANUFACTURER

The manufacturer shall furnish the following equipment and data for the use of the testing agency in listing devices under this standard.

A. Representative devices, as specified by the testing agency
B. Drawings, blueprints, or photographs that describe each model of the device as specified by the testing agency
C. Minimum and maximum operating pressure
D. Operating ambient temperature range
E. Drawings, blueprints, or photographs that describe the mounting configurations and leveling tolerances
F. Operating instructions for the device that prescribe the steps necessary to reset the device
G. A plot of pressure drop versus flow rate
H. Capacity with 1,000 Btu/ft^3 (37.25 MJ/m^3), 0.64 specific gravity gas at 60 °F and the following conditions:

1. A pressure drop of 1.0 inch water column for a device with a maximum operating pressure of 0.5 psi (3.4 kPa)
2. A pressure drop of 10% of the maximum operating pressure for a device with a maximum operating pressure of more than 0.5 psi (3.4 kPa)

2.3 CORROSION AND CHEMICAL RESISTANCE OF EXTERNAL PARTS

Valve bodies, casings, and external parts shall be made of or protected by materials that are resistant to attack over the expected life of the device by the atmosphere, weather (sunlight, humidity, and temperature changes), and common cleaning and other agents to which it may be exposed. The device case and exterior parts shall be capable of meeting or exceeding the requirements of ANSI B109 for gas meters.

2.4 INSTRUCTIONS

Complete instructions covering installation and proper operation shall be furnished by the manufacturer. These instructions shall be reviewed by the testing agency for accuracy and compatibility with results of tests.

Included in these instructions shall be the following:

A. A statement that the system must be installed by a qualified installer as defined by this standard or the authority having jurisdiction
B. The necessity for compliance with local codes or, in the absence of local codes, with the National Fuel Gas Code, ANSI ASC Z223/NFPA 54, and, if applicable, the National Electrical Code, ANSI/NFPA 70
C. Step-by-step installation and inspection procedures
D. Step-by-step procedures for resetting the device, including information that a qualified person, as defined by this standard, must follow to verify that no gas leak exists
E. Instructions on how the device is to be located with respect to the related gas service and structures
F. Instructions on how the devices should be mounted to meet the requirements of Section 1.2.2
G. Clearances not less than those needed for testing and resetting, and provisions for access
H. A description of how the system operates
I. Instructions for examining the system for continued safe operation indicating the necessity and minimum frequency for these examinations
J. A plot of pressure drop versus flow rate
K. The equivalent length of pipe, of the same nominal size as the piping connection to the device, that would produce the same pressure drop indicated in the plot of pressure drop versus flow rate. Conditions used to determine the equivalent length of pipe must be specified

2.5 CONTINUED OPERATION

The continued operation requirements of ANSI Z21.21b/CSA 6.5b shall not apply to devices qualified under this standard.

3.0 PERFORMANCE

3.1 RIGIDITY OF MOUNTING

Rigidity of mounting specified by a manufacturer shall be considered to meet the minimum requirements of Section 1.2.2 if the mounting assembly, including the sensing means, has no resonant period greater than 0.06 seconds.

3.2 DEFLECTION LIMITS

One sample of the device shall be tested to confirm that after having closed, it will remain in the closed position with the device in any position up to a maximum deflection of 45 degrees from vertical at any azimuth.

3.3 TEST SPECIMENS

Tests other than those specified in Sections 3.4 and 3.5 shall be conducted on one sample of the device.

3.4 RUGGEDNESS OF DEVICE

Three samples of the device shall be tested at room temperature to confirm that after having closed, it will

not return to the open position after being subjected to horizontal sinusoidal oscillations.

These tests shall be performed with the device in a closed position and oriented in a 20 degree deflected position from vertical as described in Section 3.4.2 prior to the tests described in Section 3.4.1.

Two samples shall be tested at no more than 0.5 psi (3.4 kPa) and one sample at the maximum specified operating pressure of the device.

3.4.1 Ruggedness Test Requirements

The device, when in a closed position and a deflected position of 20 degrees from vertical, shall not be placed in an open position after being subjected to 20 seconds of horizontal sinusoidal oscillation having

A. a peak acceleration of 0.85 g (8.33 m/s^2) and a period of 0.13 second;
B. a peak acceleration of 1.00 g (9.8 m/s^2) and a period of 0.20 second;
C. a peak acceleration of 0.85 g (8.33 m/s^2) and a period of 0.40 second; and
D. a peak acceleration of 0.30 g (2.94 m/s^2) and a period of 0.90 second.

These conditions shall be met for horizontal axes of the sensing means.

3.4.2 Method of Test

Each test shall be conducted on three samples of the device. With the agreement of the manufacturer, all three samples may be tested simultaneously.

The device shall be rigidly attached to a table or platform capable of being adjusted to provide the horizontal or vertical, sinusoidal, unidirectional acceleration forces necessary to conduct the tests described herein.

Test motions shall be monitored by measuring the acceleration of the sensing means.

Pipe-mounted devices shall be mounted on pipe and shall be mounted within 6 inches (15 cm) of either the surface of the table or a rigid object rigidly fastened to the table. Rigidity of mounting may be demonstrated by resonance search testing as described in ANSI/IEEE 344.

The device shall be connected to a pneumatic system using inlet and outlet connectors that will not interfere with the motion of the platform. This pneumatic system shall be capable of being monitored to determine whether the device under test has remained in a closed position. At the discretion of the testing agency, alternate means of determining the status of the device may be used, provided such means are objective and measurable.

The device under test shall be positioned at 20 degrees from vertical relative to the specified position in the manufacturer's installation instructions with the sensing means in the manufacturer's specified operating position. The device shall be rotated about its vertical axis to correspond to the least favorable orientation of the device, with respect to the direction of acceleration of the table. At the discretion of the testing agency, additional tests may be conducted at other orientations about the vertical axis.

The table shall be adjusted to provide a horizontal oscillation at a period specified in Section 3.4.1. The acceleration levels shall be increased to the maximum acceleration level for a selected oscillating period as specified in Section 3.4.1. The oscillations shall be maintained at this level for 20 seconds.

If the shutoff means is open following this test, the device will be considered as not meeting the requirements of this standard.

3.5 RESPONSE TO SEISMIC DISTURBANCES

The range of motions defining the response of devices is illustrated in Figure 3-1. Tests are required to confirm that devices meet the seismic response requirements of Figure 3-1.

Three samples shall be tested for conformance to the seismic response performance requirements. All three samples must pass the seismic response requirements of this section.

Two samples shall be tested at no more than 0.5 psi (3.4 kPa). One sample shall be tested at the maximum specified operating pressure of the device.

The three samples shall be tested at the minimum and maximum operating temperature defined in Section 1.3.2.

3.5.1 Actuation Requirements

The sensing means of the device shall actuate the shutoff means within 5 seconds when subjected to horizontal sinusoidal oscillation having

A. a peak acceleration of 0.70 g (6.87 m/s^2) and a period of 0.13 second;
B. a peak acceleration of 0.40 g (3.92 m/s^2) and a period of 0.20 second;
C. a peak acceleration of 0.30 g (2.94 m/s^2) and a period of 0.40 second; and
D. a peak acceleration of 0.25 g (2.45 m/s^2) and a period of 1.00 second.

These conditions shall be met for horizontal axes of the sensing means.

3.5.2 Non-Actuation Requirements

The sensing means of a device shall not actuate the shutoff means when subjected for 5 seconds to sinusoidal oscillations having