



UL 555S

STANDARD FOR SAFETY

Smoke Dampers

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UL Standard for Safety for Smoke Dampers, UL 555S

Fifth Edition, Dated February 13, 2014

Summary of Topics

This revision of ANSI/UL 555S dated October 9, 2020 includes an additional option for Protection Against Corrosion; [5.1](#)

Text that has been changed in any manner or impacted by UL's electronic publishing system is marked with a vertical line in the margin.

The revised requirements are substantially in accordance with Proposal(s) on this subject dated August 14, 2020.

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UL 555S

Standard for Smoke Dampers

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Fifth Edition

February 13, 2014

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The most recent designation of ANSI/UL 555S as an American National Standard (ANSI) occurred on October 9, 2020. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

The Department of Defense (DoD) has adopted UL 555S on July 29, 1994. The publication of revised pages or a new edition of this Standard will not invalidate the DoD adoption.

Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at <https://csds.ul.com>.

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INTRODUCTION

1 Scope

1.1 These requirements cover smoke dampers intended for use in heating, ventilating, and air conditioning (HVAC) systems. Smoke dampers are intended:

- a) To restrict the spread of smoke in HVAC systems that are designed to be automatically shut down in the event of a fire, or
- b) To assist with the control of pressure differentials across smoke barriers when the HVAC system is part of an engineered smoke control system.

1.2 Dampers covered by these requirements are evaluated for use as either:

- a) Smoke Dampers – For use in HVAC systems where ducts pass through smoke barriers.
- b) Combination Fire and Smoke Dampers – For locations in HVAC systems where a fire damper and a smoke damper are required at a single location, or
- c) Corridor Dampers – For locations in HVAC Systems where air ducts penetrate or terminate at openings in the ceilings of interior corridors when permitted by authority having jurisdiction.

1.3 The smoke dampers covered by these requirements are intended for installation in accordance with the National Fire Protection Association Standard for Installation of Air Conditioning and Ventilating Systems, NFPA 90A, the International Mechanical Code and the Uniform Mechanical Code.

1.4 Combination fire and smoke dampers and corridor dampers shall also comply with the applicable requirements in the Standard for Fire Dampers, UL 555.

2 General

2.1 Components

2.1.1 Except as indicated in [2.1.2](#), a component of a product covered by this standard shall comply with the requirements for that component. See Appendix [A](#) for a list of standards covering components generally used in the products covered by this standard.

2.1.2 A component is not required to comply with a specific requirement that:

- a) Involves a feature or characteristic not required in the application of the component in the product covered by this standard, or
- b) Is superseded by a requirement in this standard.

2.1.3 A component shall be used in accordance with its rating established for the intended conditions of use.

2.1.4 Specific components are incomplete in construction features or restricted in performance capabilities. Such components are intended for use only under limited conditions, such as certain temperatures not exceeding specified limits, and shall be used only under those specific conditions.

2.2 Units of measurement

2.2.1 Values stated without parentheses are the requirement. Values in parentheses are explanatory or approximate information.

2.3 Undated references

2.3.1 Any undated reference to a code or standard appearing in the requirements of this standard shall be interpreted as referring to the latest edition of that code or standard.

3 Glossary

3.1 For the purpose of this standard the following definitions apply.

3.2 CONTROLLED CLOSURE – The closure of a damper by means of electric, pneumatic, hydraulic, or other similar device that inhibits the rate of closure.

3.3 DYNAMIC CLOSURE – The closure of a fire damper under conditions of airflow and heat upon activation of the heat responsive device.

3.4 HEATED AIR OPERATION – The operation of a smoke damper by means of the actuator when the damper is subjected to a condition of airflow and heat.

3.5 MULTIPLE SECTION DAMPER ASSEMBLY – Two or more dampers assembled together to function as a single smoke damper, or corridor damper or combination fire and smoke damper.

3.6 NON-CONTROLLED CLOSURE – The closure of a damper by means of spring operation, gravity or other similar device that does not inhibit the rate of closure. Non-controlled closure is also referred to as instantaneous closure, rapid closure or slam shut closure.

3.7 SAME DESIGN FAMILY – Actuators composed of the same gear train and motor but incorporates a transformer, among other features, for different input voltages and has nominally the same force/torque output.

3.8 SMOKE CONTROL SYSTEM – An engineered system that uses mechanical fans to produce airflows and pressure differences across smoke barriers to limit (see [Table 16.1](#), Leakage classifications) and direct smoke movement.

3.9 VOLUME CONTROL DAMPER – A fire damper employing position devices that enable the fire damper to remain in positions other than fully open or fully closed.

CONSTRUCTION

4 General

4.1 All electrical components, damper actuators, fusible links, and heat responsive devices shall be examined and tested, as required, for their intended function.

4.2 A heat responsive device provided with a corridor damper and combination fire and smoke damper shall have a temperature rating which is equal to or less than the temperature rating of the damper.

5 Protection Against Corrosion

5.1 A ferrous metal part used in the damper assembly shall be one of the 300 Series of stainless steel or shall have one of the following corrosion-protection systems:

a) A coating of hot-dipped mill galvanized sheet steel complying with the coating Designation G60 or A60 in the Weight (Mass) of Coating Requirements table in the Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process, ASTM A653, with not less than 40 percent of the zinc on any side, based on the minimum single spot test requirement in this ASTM Designation. The weight of the zinc coating is to be established in accordance with the Standard Test Method for Weight (Mass) of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings, ASTM A90. An A60 (alloyed) coating shall also comply with the requirements of [5.4](#).

b) A zinc coating, other than that provided on hot-dipped mill galvanized sheet steel, uniformly applied to an average thickness of not less than 0.00041 inch (0.01041 mm) on each surface with a minimum thickness of 0.00034 inch (0.00864 mm). The thickness of the coating is to be established in accordance with the test method in the Standard Guide for Measurement of Electrodeposited Metallic Coating Thicknesses by the Dropping Test, ASTM B555. An annealed coating shall also comply with the requirements of [5.4](#).

c) A cadmium coating not less than 0.0005 inch (0.0127 mm) thick on both surfaces. The thickness of coating is to be established in accordance with the test method in the Standard Guide for Measurement of Electrodeposited Metallic Coating Thicknesses by the Dropping Test, ASTM B555.

d) Two coats of an organic finish of the epoxy or alkyd-resin type or other outdoor paint on each surface. The acceptability of the paint is to be determined by its composition or by corrosion tests, as specified in the Standard for Organic Coatings for Steel Enclosures for Outdoor Use Electrical Equipment, UL 1332.

e) A coating consisting of aluminum, zinc and silicon applied by the continuous hot-dip process to a minimum thickness of not less than 0.02 mm on each side. The quality of aluminized-zinc coating is to be established in accordance with the Standard Specification for Steel Sheet, 55 % Aluminum-Zinc Alloy-Coated by the Hot-Dip Process, ASTM A792/A792M.

5.2 Coated or uncoated metals used in the assembly of dampers shall be galvanically compatible.

5.3 Component springs and bearings used in the assembly of dampers shall be of material having resistance to atmospheric corrosion equivalent to brass or bronze.

5.4 A hot-dipped mill galvanized A60 (alloyed) coating or an annealed zinc coating that is bent or similarly formed after annealing and that is not otherwise required to be painted shall be painted in the bent or formed area as specified in [5.1\(d\)](#) when the bending or forming process damages the zinc coating as described in [5.5](#).

5.5 When flaking or cracking of the zinc coating at the outside radius of the bent or formed section is visible at 25 power magnification, the zinc coating is to be identified as damaged. Simple sheared or cut edges and punched holes are not to be defined as formed. Extruded edges and rolled edges and holes shall comply with the requirements of [5.5](#).

6 Actuators

6.1 An actuator shall be formed and assembled to have the strength and rigidity required to resist the abuses to which it is subjected, without the loosening or displacement of any parts, or other serious defects.

6.2 Actuators shall be factory-mounted securely in position. Bolts, screws, or other parts used for mounting an actuator shall be independent of those used to secure components of the actuator to the frame, base, or panel.

6.3 A pneumatic actuator shall comply with the requirements of the Hydrostatic Pressure Test for Pneumatic Actuators, Section [15](#).

6.4 An electric actuator, position indicator switch, and similar materials, shall comply with the applicable requirements of the Standard for Temperature-Indicating and -Regulating Equipment, UL 873; or the Standard for Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements, UL 60730-1, and Standard for Automatic Electrical Controls for Household and Similar Use; Part 2: Particular Requirements for Electric Actuators, UL 60730-2-14, for their intended use.

6.5 An actuator shall comply with the requirements of the Performance Tests for Actuators, Section [15](#).

PERFORMANCE

7 General

7.1 Representative samples of each design or design variation, including all operational components, are to be subjected to the Cycling Test, Section [8](#); Temperature Degradation Test, Section [9](#); Leakage Tests, Section [10](#); and Operation Test, Section [11](#). Corridor dampers and combination fire and smoke dampers are also to be subjected to the Dynamic Closure Test in the Standard for Fire Dampers, UL 555. The testing sequence and representative samples required (which are intended to cover a range of damper sizes for one specific design) is to be as specified in [Table 7.1](#), except as noted in the following sentence. Representative samples, tested in accordance with the Exception to [10.4](#) (that is, using a correlation method) are to be test sequenced as specified in [Table 7.2](#) using the samples specified in [Table 7.2](#).

Table 7.1
Samples required and test sequence for dampers

Samples required	Test sequence
Square or rectangular dampers	
Max. Width-Max. Height	Cycling – Operation – Dynamic Closure ^a – Leakage
Max. Width-Min. Height	Cycling – Operation – Dynamic Closure ^a – Leakage
Min. Width-Max. Height	Cycling – Operation – Dynamic Closure ^a – Leakage
Round dampers	
Max. Diameter	Cycling – Operation – Dynamic Closure ^a – Leakage
Min. Diameter	Cycling – Operation – Dynamic Closure ^a – Leakage
Notes	
¹ This table applies to smoke dampers, corridor dampers and combination fire and smoke dampers; dampers tested using the correlation method specified in the Exception to 10.4 are to be tested as specified in Table 7.2 rather than as specified in Table 7.1 .	

Table 7.1 Continued on Next Page

Table 7.1 Continued

Samples required	Test sequence
Square or rectangular dampers	
² "Max." refers to maximum, and "Min." refers to minimum.	
^a The dynamic closure test applies only to corridor dampers and combination fire and smoke dampers, not to smoke dampers, and is specified in the Standard for Fire Dampers, UL 555.	

Table 7.2
Correlation method: samples required and test sequence

Sample number	Description	Test sequence
Square or rectangular dampers		
1	Max. Width-Max. Height	Cycling – Operation – Dynamic Closure ^a – Leakage
2	Max. Width-Max Height ^c	Cycling – Temp. Degradation – Operation ^b – Dynamic Closure ^{a, b} – Leakage ^b
3	Max. Width-Min. Height	Cycling – Temp. Degradation – Operation ^b – Dynamic Closure ^{a, b} – Leakage ^b
4	Min. Width-Max. Height	Cycling – Temp. Degradation – Operation ^b – Dynamic Closure ^{a, b} – Leakage ^b
Round dampers		
5	Max. Diameter	Cycling – Operation – Dynamic Closure ^a – Leakage
6	Max. Diameter ^d	Cycling – Temp. Degradation – Operation ^b – Dynamic Closure ^{a, b} – Leakage ^b
7	Min. Diameter	Cycling – Temp. Degradation – Operation ^b – Dynamic Closure ^{a, b} – Leakage ^b
Notes ¹ This table applies to smoke dampers, corridor dampers and combination fire and smoke dampers being tested using the correlation method of testing as specified in the Exception to 10.4 . See also 7.1 . ² "Max." refers to maximum, and "Min." refers to minimum. ^a The dynamic closure test applies only to corridor dampers and combination fire and smoke dampers, not to smoke dampers, and is specified in the Standard for Fire Dampers, UL 555. ^b This test is conducted at ambient temperature. ^c Sample Number 1, after required tests have been completed on Sample Number 1, is an acceptable sample for Sample Number 2. ^d Sample Number 5, after required tests have been completed on Sample Number 5, is an acceptable sample for Sample Number 6.		

7.2 In addition, two dampers, consisting of the largest (except as noted in the next sentence) and smallest sizes, are to be subjected to the salt-spray exposure tests. For the salt spray exposure testing, the overall size of the sample used including the actuator is not to exceed 42 inches high by 46 inches wide (1.07 m by 1.15 m) for vertical dampers and 46 inches long by 28 inches wide (1.15 m by 0.71 m) for horizontal dampers.

7.3 A damper incorporating nonmetallic or organic components such as gaskets, sealants, adhesives, blade position indicators, and similar materials which are exposed to the air stream, is to be subjected to the Fire Exposure Test, Section [13](#). The representative sample used is to be size 24 by 24 inches (610 by 610 mm), or 24 inches in diameter, or the maximum size damper produced when the maximum size damper is smaller. In addition, a representative sample of the nonmetallic or organic component such as a gasket, sealant, adhesive and similar material used in the damper is to be subjected to the Accelerated Aging Test, Section [14](#).

7.4 The Salt-Spray Exposure Test, Section 12, is intended to simulate debris that accumulates on a damper mounted in a duct within a building, and to investigate the performance of the damper while subjected to such accumulations.

7.5 Dampers to be identified and labeled as corridor dampers are required to comply with the requirements for combination fire and smoke dampers as specified in this standard.

8 Cycling Test

8.1 A damper intended for controlled closure with an actuator (that is, the electric, pneumatic, or hydraulic device used to operate the damper) shall function as intended after being mechanically operated for 20,000 full-stroke (that is, close and reopen) operations, or 100,000 full-stroke operations when the damper is also intended for use as a volume control damper, while using the specified damper actuator and while operating without duct system pressure. The closing time shall not exceed 75 seconds nor shall the reopening time of the damper exceed 75 seconds. All dampers are to be cycled while mounted in the position intended for installation.

8.2 Alternately when the damper is intended for use as a volume control damper it is permitted to be cycled 20,000 full-stroke cycles as described in 8.1 and then perform 100,000 repositioning cycles. A "repositioning cycle" is a minimum rotation of the damper actuator of 5 degrees (± 2 degrees) or 10% in one direction and in the reversed direction. The repositions shall be achieved in one of two ways:

a) The actuator on the damper shall be moved forward 10 degrees (± 2 degrees) and then move back 5 degrees (± 2 degrees). This sequence of movements shall be considered one reposition. Once the damper and actuator reach the full-open position the same series of movements shall be performed to move the damper and actuator back to the full close position. This shall be repeated until 100,000 repositions have been achieved.

b) The actuator on the damper shall be moved from the 0% position (full-closed) to the 10% position and then back to the 0% position. This sequence of movements shall be considered one reposition. That same series of movements shall be performed for 10,000 repositions. Another 10,000 repositions shall then be performed between the 10% and 20% positions, the 20% and 30% positions, the 30% and 40% positions, the 40% and 50% positions, the 50% and 60% positions, the 60% and 70% positions, the 70% and 80% positions, the 80% and 90% positions, and finally the 90% and 100% positions for a total of 100,000 repositions.

9 Temperature Degradation Test

9.1 When tested as specified in 9.2 and 9.3, each damper shall remain functional during the test.

9.2 The dampers used for this test are to be those previously subjected to the Cycling Test, Section 8, prior to subjecting them to the leakage test. The elevated temperatures are to be in increments of 100°F (56°C), and the minimum temperature is to be 250°F (121°C). The damper is to be exposed to the elevated temperature, ± 5 percent, for 30 minutes in the completely closed position.

9.3 After the 30-minute period and while at the elevated temperature, the damper shall function as intended while being operated through three complete operation cycles. The closing time shall not exceed 75 seconds nor shall the reopening time of the damper exceed 75 seconds. The damper is to be cycled by using the actuator that has also been subjected to the test temperature.

10 Leakage Tests

10.1 The amount of leakage measured during this test shall determine the leakage class of the damper, in accordance with the limitations in Table 16.1.

10.2 For smoke dampers the leakage test is a continuation of the operation test. For corridor dampers and combination fire and smoke dampers, the leakage test is a continuation of the dynamic closure test.

10.3 At the conclusion of the operation test or dynamic closure test, as appropriate (see [10.2](#)), while the damper is in the closed position, the duct section downstream of the damper is to be converted to the duct section with measuring plane. The pressure and test temperature are to be maintained against the closed damper. The resultant leakage through the damper, corrected to standard temperature and pressure conditions, is to be determined using the test procedures, airflow measuring equipment, instrument, apparatus and setup specified in the "Air flow leakage rate using ambient or heated air" section of the Air Movement and Control Association, Inc. (AMCA) Laboratory Methods of Testing Dampers for Rating, AMCA 500-D.

10.4 This test is to be conducted on the maximum width – maximum height, maximum width – minimum height, and minimum width – maximum height damper sizes for square and rectangular shaped dampers. The test is to be conducted on the maximum and minimum diameter sizes of round dampers. The leakage classification shall be determined by [Table 16.1](#) from the highest leakage value obtained from the specimens tested.

Exception: This test procedure is not required when the leakage classification is determined using the correlation method as specified in [10.5](#) – [10.10](#). The correlation method involves measuring the leakage through the largest size under heated air and comparing with leakage obtained on the largest size following the methods described in [10.5](#) – [10.10](#). The leakage measurement described in [10.7](#) is conducted at ambient temperature. The ambient leakage through the minimum-maximum and maximum-minimum sizes are determined. The required computations are specified in [10.10](#).

10.5 A sample of the maximum width – maximum height square or rectangular damper or maximum diameter round damper is to be subjected to the heated air leakage test as described in [10.1](#) – [10.3](#). The resultant heated air leakage is to be recorded.

10.6 The leakage of the maximum width – maximum height, maximum width – minimum height, and minimum width – maximum height damper sizes for square and rectangular shaped dampers and the maximum and minimum diameter sizes of round dampers is to be determined from the procedures specified in [10.7](#).

10.7 The dampers specified in [10.6](#) are to be subjected to the Cycling Test, Section [8](#), and to the Temperature Degradation Test, Section [9](#). After completion of the temperature degradation test, each damper is to be sealed against one face of an air flow measurement apparatus. For smoke dampers, the dampers are to be cycled open and close three times against the test airflow and damper closure pressure. For corridor dampers and combination fire and smoke dampers, the dampers are to be first cycled open and close three times at the test airflow and closure pressure conditions. For the third closure, the heat responsive device is to be manually released and the damper shall close by the fire response mechanism. The resultant air leakage through the damper, corrected to standard temperature and pressure conditions, is to be determined using the test procedures, air flow measuring equipment, instruments, apparatus and setups specified in the Air Movement and Control Association, Inc. (AMCA) Laboratory Methods of Testing Dampers for Rating, AMCA 500-D. The dampers shall be tested on both sides.

10.8 The minimum air velocity and closed damper pressure rating for dampers shall be 2000 fpm (10.2 m/s) and 4 inches of water (1.0 kPa). Air velocity and pressure ratings higher than the minimum are established in increments of 1000 fpm (5.1 m/s) and in increments of 2 inches of water (0.5 kPa). For the leakage test, first the test velocity is to be established at a minimum of 400 fpm (2.0 m/s) higher than the rated air velocity with the damper in the open position; secondly, the test pressure is to be established at a minimum 0.5 inch water column (0.12 kPa) higher than the rated pressure when the damper is in the closed position.

10.9 There shall be no extrapolations above the maximum test pressures.

10.10 When the leakage obtained on the maximum – maximum size under heated air test conditions is less than the leakage obtained on the maximum – maximum size under ambient conditions, the resultant leakage classification shall be the highest leakage rate of the three samples conducted at ambient conditions following the parameters described in [Table 16.1](#). When the leakage rate obtained on the maximum – maximum size under heated air conditions is higher than the leakage obtained on the maximum – maximum size under ambient conditions, the resultant leakage obtained on the minimum – maximum and maximum – minimum sizes shall be increased by the same percentage. The leakage classification is then to be determined from the highest computed leakage rate following the parameters of [Table 16.1](#). The values of all test results are to be corrected to standard air density.

10.11 The damper area is to be determined from the nominal outside frame dimensions of the damper for an internal mounted damper and from the nominal inside frame dimensions for a flange-mounted damper.

10.12 The damper under test is to be mounted in the plane in which it is intended to be used and in accordance with the manufacturer's installation instructions. A flange-mounted damper is to be either mounted to a short section of ductwork or flange-mounted directly to the test chamber wall. For an internal-mounting damper, the test chamber wall is to be fitted with a short section of ductwork for mounting the damper. Ductwork is not to extend more than 9 inches (229 mm) beyond the damper frame and is not to interfere with the test. A sealing means is to be used to resist air leakage around the ductwork or damper frame. Mounting holes on the damper that are not used are to be plugged when they provide a path for air leakage around the damper.

11 Operation Test

11.1 General

11.1.1 Under conditions of maximum specified air velocity, smoke dampers, corridor dampers, and combination fire and smoke dampers (including any actuators) shall function without damage to the dampers or their components and shall completely close and open under the conditions described herein. The test pressure difference created in the closed position is to be recorded and shall be not less than that specified in [Table 11.1](#) and [Table 16.1](#). The dampers are to be tested using the air flow measuring equipment, instruments, apparatus, and setups specified in the Air Movement and Control Association International, Inc. (AMCA) Laboratory Methods of Testing Dampers for Rating, AMCA 500-D. The tests are to be conducted at an ambient temperature between 32 – 120°F (0 – 49°C) prior to introduction of heat into the system.

11.1.2 Dampers are to be tested first in one direction. Another test sample is to be then mounted such that the airflow is in the opposite direction and tested.

11.1.3 The minimum air velocity and closed damper pressure rating for dampers shall be 2000 fpm (10.2 m/s) and 4 inches of water (1.0 kPa). Air velocity and pressure ratings higher than the minimum are established in increments of 1000 fpm (5.1 m/s) and in increments of 2 inches of water (0.5 kPa).

11.2 Method

11.2.1 When a damper is subjected to the heated air operation test, a representative damper sample is to be mounted, as intended, inside the duct connected to the test chamber. When the damper is subjected to the ambient air operation test, a representative damper sample is to be mounted, as intended, to the test chamber or inside the duct connected to the test chamber.

11.2.2 Dampers provided with electric actuators are to be connected to the intended power supply. The test voltage is to be the minimum specified on the electric motor actuator. Dampers provided with pneumatic actuators are to be connected to the intended air supply line. The supply line pressure is to be at the minimum pressure specified on the actuator manufacturer's pneumatic device.

11.2.3 All airflow measurements are to be taken at ambient conditions and the tests are to be conducted at an ambient temperature between 32°F (0°C) and 120°F (49°C) prior to introduction of heat into the system.

11.2.4 Dampers are to be tested using the airflow measuring equipment, instruments, apparatus, and setups specified in the Air Movement and Control Association International, Inc. (AMCA) Laboratory Methods of Testing Dampers for Rating, AMCA 500-D.

11.2.5 The airflow generating equipment is to be capable of producing the prescribed airflow and pressure conditions without the use of pressure relief devices.

11.2.6 With the damper in the open position, the airflow velocity is to be established at the rate indicated in [Table 11.1](#).

Table 11.1
Test airflow and pressure conditions

Rated air velocity and pressure		Minimum test air velocity and pressure	
Air velocity, fpm (m/s)	Pressure, inches of water (kPa)	Air velocity, fpm (m/s)	Pressure, inches of water (kPa)
2000 (10.2)	4 (1.0)	2400 (12.2)	4.5 (1.12)
3000 (15.2)	4 (1.0)	3400 (17.3)	4.5 (1.12)
4000 (20.3)	4 (1.0)	4400 (22.3)	4.5 (1.12)
2000 (10.2)	6 (1.5)	2400 (12.2)	6.5 (1.62)
3000 (15.2)	6 (1.5)	3400 (17.3)	6.5 (1.62)
4000 (20.3)	6 (1.5)	4400 (22.3)	6.5 (1.62)
2000 (10.2)	8 (2.0)	2400 (12.2)	8.5 (2.12)
3000 (15.2)	8 (2.0)	3400 (17.3)	8.5 (2.12)
4000 (20.3)	8 (2.0)	4400 (22.3)	8.5 (2.12)

11.2.7 For air velocity and closed damper pressure ratings higher than those indicated in [Table 11.1](#) the test air velocity is to be 400 fpm (2.0 m/s) higher than the rated air velocity and the test pressure is to be 0.5 inch water (0.12 kPa) higher than the rated pressure.

11.2.8 Dampers shall be fully-closed and fully-opened using the specified actuator. The closing time shall not exceed 75 seconds nor shall the reopening time of the damper exceed 75 seconds. The test pressure difference created in the closed position is to be recorded and shall not be less than the specified test pressure. This sequence is to be conducted for three complete cycles. For the ambient temperature rating the test is completed after the damper is cycled three times.

11.2.9 The test apparatus for the generation of airflow and heat is to be of the open loop construction. A natural gas flame is to be used as the heat source; or another heat source corrected such that the total mass flow rate across the damper is equivalent to that which occurs using a natural gas flame as the heat source.

11.2.10 After the conduct of three closing and opening cycles at ambient temperature, the test damper is to be returned to the full-open position and heat is to be introduced to the system at an average temperature rise rate of 30° to 50° F (17 to 28° C) per minute until the specified elevated temperature is attained. The system shall be maintained at the elevated temperature of up to a maximum 50° F (28° C) above the specified elevated temperature for a minimum of 15 minutes. At that time the damper is to be fully closed using the actuator. The closing time is to be recorded. The closing time shall not exceed 75 seconds. Once the damper fully-closes, the heat input into the system is to be discontinued. The test pressure difference created in the closed position is to be recorded and shall not be less than the specified test pressure. The damper is to then be fully opened using the actuator. The opening time is to be recorded. The reopening time of the damper shall not exceed 75 seconds.

11.2.11 A damper equipped with an external actuator is to be tested with an enclosure around the actuator. The enclosure containing the actuator is to be equipped with a heater which raises the temperature inside the enclosure to the same rated temperature and for the same duration as that to which the damper is subjected. There is to be no airflow through the enclosure containing the actuator. Dampers tested with an internal actuator shall be considered acceptable for either internal or external actuator mounting. Dampers that are only tested with an external actuator shall not be accepted for internal mounting.

11.2.12 The measured temperature is to be the average temperature obtained from the readings of not less than nine thermocouples. The thermocouples are to be 0.04 to 0.06 inch (1.0 to 1.6 mm) outside diameter sheathed-junction thermocouples symmetrically disposed and distributed. The distance of the thermocouple junctions from the damper blades, as measured with the damper in the closed position, is to be not greater than 12 inches (305 mm) upstream from the damper. The temperature is to be recorded at least as frequently as every 10 seconds from the time heat is introduced into the system until the damper fully closes.

11.2.13 As an alternative to the requirements of this section dampers greater than 12 ft² shall be permitted to be evaluated in accordance with Section [11.4](#), Torque Compensation Method – Alternate Operation Test. Only damper designs that have already had their largest single section up to 12 ft² tested per Section [11.2](#) shall be permitted to be evaluated in accordance with Section [11.4](#).

11.3 Multiple assembly – general

11.3.1 General

11.3.1.1 Multiple assemblies shall comply with the requirements of one of the items listed below. The requirements of items (b) and (c) shall not be used for dampers intended for non-controlled closure:

- a) The requirements of Sections [11.1.1](#) – [11.2.12](#),
- b) One single section is to be tested at the maximum specified volumetric airflow rate for the multiple assembly. Damper assemblies at least two sections wide and two sections high shall also be tested to the requirements of Section [11.3.2](#) to qualify the assembly.
- c) The requirements of Section [11.3.2](#). The damper section or sections driven by a single actuator that make up these multiple assemblies shall have already been tested to the requirements of Section [11.2](#) or [11.4](#). These multiple assemblies shall either be driven by a common drive mechanism, such as a jackshaft, or shall demonstrate that the assembly closes in unison. Corridor dampers and combination fire and smoke dampers tested to this option shall utilize a single heat responsive device.
- d) The requirements of Section [11.4](#).

Exception: Multiple section damper assemblies that are multiple sections wide and only one section high or that are multiple sections high and only one section wide utilizing a common drive

mechanism do not require any additional testing. Corridor dampers and combination fire and smoke dampers taking advantage of this exception shall utilize a single heat response device.

11.3.2 Structural integrity

11.3.2.1 Multiple damper assemblies shall be tested for structural integrity where required by the provisions of Section [11.3.1](#).

11.3.2.2 This test method uses the leakage rate of a multiple section damper assembly to determine if the structural integrity of a given damper design is compromised when single sections are assembled together. This test method shall not be used to test the structural integrity of a damper intended for non-controlled closure. The damper assembly shall be tested with the fastest closing actuator intended for use with the damper design being evaluated.

11.3.2.3 The multiple section damper assembly is to consist of at least four equal size dampers and shall be at least two sections wide and at least two sections high. The single section size tested shall be the largest size used in the classified assembly. The design of the single sections that make up the multiple section damper assembly shall have already been tested per the test sequence described in Section [7](#).

11.3.2.4 Each section of the multiple section damper assembly is to be cycled as required in Section [8](#) and subjected to the temperature degradation test described in Section [9](#). The temperature degradation test shall be permitted to be conducted on the entire assembly or on all of its individual sections.

11.3.2.5 After the temperature degradation test, the multiple section damper assembly is to be reassembled (if necessary) and subjected to the ambient air operation test on the chamber as described in Section [11](#). All of the actuators in the multiple assembly shall be operated in unison. For the purposes of this test, as an alternative to the minimum air velocity requirements of Section [11.1.3](#), the test velocity shall be set to the minimum test air velocity in [Table 11.1](#) multiplied by 0.25. To compensate for the reduced air velocity the full closed pressure shall be increased by the difference in velocity pressure between the minimum test air velocity of Section [11.2](#) and the test air velocity of this section. [Table 11.2](#) lists the increase in the full closed pressure that shall be applied to the minimum test pressure values of [Table 11.1](#).

Table 11.2
Air pressure compensation for testing per Section [11.3.2.5](#)

Rated air velocity, fpm (m/s)	Section 11.2 test air velocity, fpm (m/s)	Section 11.3.2 test air velocity, fpm (m/s)	Increase in test pressure, inches of water (kPa)
2000 (10.2)	2400 (12.2)	600 (3.1)	0.20 (0.05)
3000 (15.2)	3400 (17.3)	850 (4.3)	0.41 (0.10)
4000 (20.3)	4400 (22.3)	1100 (5.6)	0.68 (0.17)

11.3.2.6 At the conclusion of the operation test, with the airflow generating equipment still running, the multiple section damper assembly shall be closed and subjected to an ambient leakage test at the selected test pressure required per [Table 11.1](#). The resultant leakage through the damper, corrected to standard temperature and pressure conditions, is to be determined using the test procedures, airflow measuring equipment, instruments, apparatus and setup specified in the "Airflow leakage rate using ambient or heated air section" of the Air Movement and Control Association, Inc (AMCA) Laboratory Methods of Testing Dampers for Ratings, AMCA Standard 500D.

11.3.2.7 If the leakage tests performed per Section [10](#) for the original single section damper of the same design resulted in an increased leakage rate under heated air conditions compared to ambient conditions, the leakage through the multiple section damper assembly shall be increased by the same percentage.

11.3.2.8 The corrected leakage through the multiple section damper assembly must fall within the same leakage class, as described in [Table 16.1](#), which the single section damper design had been previously qualified to.

11.4 Torque compensation method - alternate operation test

11.4.1 General

11.4.1.1 This is an alternate test method to the heated air operation test method described in Section [11.2](#). It is also used where required by the provisions of Section [11.3.1](#). This alternate method shall only be used to evaluate dampers greater than 12 ft² for damper designs already tested per the heated air operation test method described in Section [11.2](#).

11.4.1.2 Under these requirements the required operation tests are conducted at ambient temperature rather than at elevated temperatures as required in Section [11.2](#). To compensate for the reduced temperature requirement the damper is subjected to an increased torque by increasing the velocity and/or static pressure or by adding mechanical resistance. The torque compensation value shall be determined by establishing a correlation between the damper torque requirement at elevated temperatures and ambient temperatures.

11.4.1.3 The torque requirements of the damper design being evaluated shall be determined by developing curves that describe the damper's torque requirement versus the operating shaft position or torque versus time curve. These curves shall be developed using the torque measurement equipment described in Section [11.4.2](#). Two curves shall be developed. The first curve shall be at elevated temperature conditions. The second curve shall be at ambient conditions where measures are then applied to adjust the torque requirements of the damper. The peak torque versus shaft position or time location shall match that of the elevated temperature curve.

11.4.2 Torque measurement equipment

11.4.2.1 The torque measurement equipment used to develop the torque versus position or time curves described in [11.4.1.3](#), shall meet the following minimum requirements:

a) Accuracy of Torque Reading – The torque measuring equipment shall demonstrate its ability to measure torque within +/-1% of full scale (i. e. the peak damper torque requirement). The equipment's accuracy shall be verified and, if necessary, calibrated before each test series.

b) Accuracy of Position Feedback – The torque measurement equipment shall generate feedback of the damper's shaft position within +/- 2 degrees of rotation or shall produce data such that the degree of rotation can easily be calculated. The equipment's accuracy shall be verified and, if necessary, calibrated before each test series.

c) Rotational Speed – One of the following two options shall be used to set the rotational speed of the torque measurement equipment. If option 1 is selected, actuators of any rotational speed may be tested using the torque data generated. If option 2 is selected, only actuators that rotate the damper at the rotational speed of the torque measurement equipment or faster may be tested using the torque data generated. If the opening and closing speeds of an actuator are different, the torque measurement equipment shall be adjusted to rotate at the slower of the two speeds in both directions.

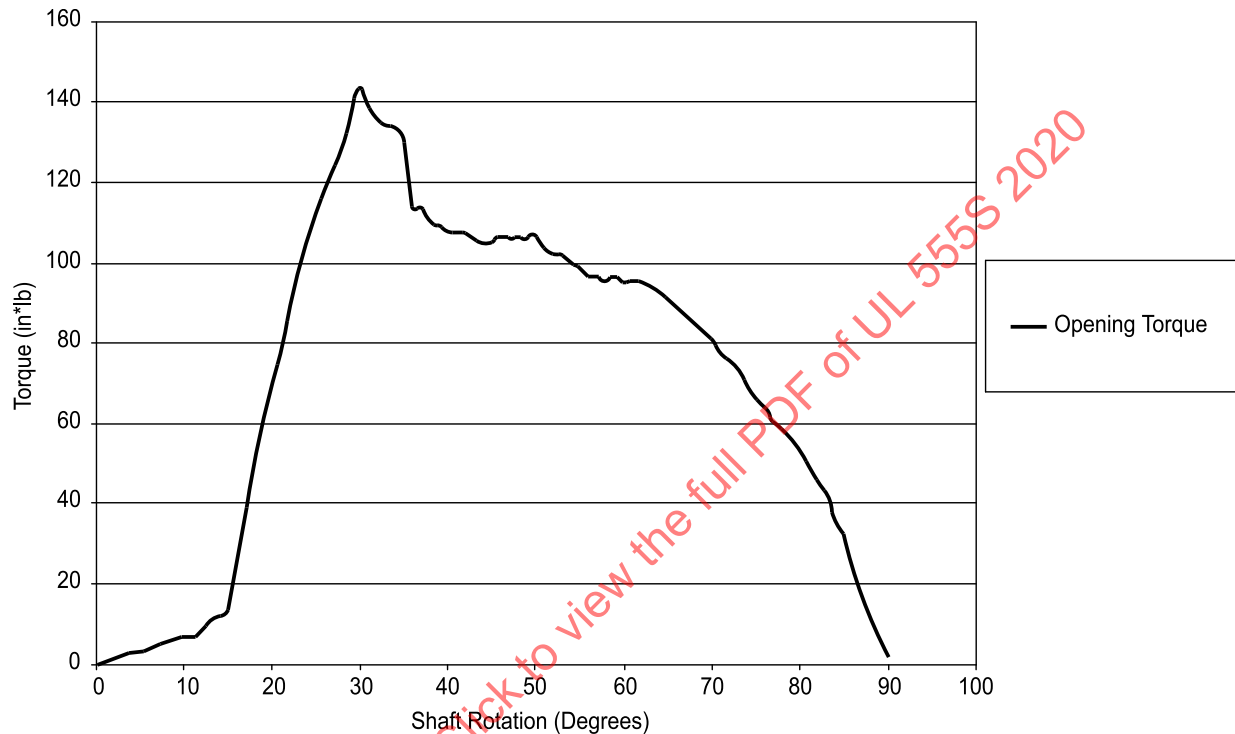
1) The torque measurement equipment shall operate the damper in 15 seconds or more; or

2) The torque measurement equipment shall not operate the damper any faster than the slowest actuator intended to be used on the damper model being tested.

d) Plotting Data – The output/feedback from the torque measurement equipment shall allow a torque versus position curve or torque versus time curve to be generated such that a point can be plotted at least every 2 degrees of rotation. The following is an example curve of a damper's opening torque versus shaft position:

Figure 11.1

Example torque versus position curve



su0255

11.4.3 Development of torque requirement data

11.4.3.1 For a single section damper larger than 12 ft² using this method the torque requirement data shall be developed using a 12 ft² sample.

11.4.3.2 For a multiple section damper larger than 12 ft² using this method, the torque requirement data shall be developed using one of the following:

- a) The largest single section size covered for the same damper model;
- b) A 12 ft² sample;
- c) The largest single section size that is part of the multiple section damper being evaluated.

11.4.3.3 The damper sample being used to generate the torque requirement data shall be first subjected to the cycle test requirements as described in Section [8](#).

11.4.3.4 The damper sample subjected to the cycling test shall then be subjected to a leakage test for smoke dampers at the rated temperature as required in Section [10](#).

11.4.3.5 The damper sample subjected to the cycling and leakage tests shall then be subjected to an ambient air operation test as described in Section 11.2. The test shall be conducted at the minimum test air velocity and pressure described in Table 11.1 corresponding to the rated air velocity and pressure desired. Instead of using an actuator to operate the damper, the damper shall be operated using the torque measurement equipment described in 11.4.2. The test shall be conducted three times to ensure consistent results. If any of the three cycles produce a peak torque that is more than +/-5% from the average of the three peak torque values the three ambient operation tests shall be repeated until consistent results are achieved.

11.4.4 Operation testing of damper greater than 12 ft²

11.4.4.1 Once the necessary heated air to ambient air torque compensation has been determined, the single section damper greater than 12 ft² or the multiple damper assembly greater than 12 ft² shall be preconditioned. This includes subjecting the damper or damper assembly to the cycling test requirements of Section 8 and the temperature degradation test requirements of Section 9.

11.4.4.2 The preconditioned sample shall then be subjected to an ambient air operation test with the damper mounted in accordance with the Air Movement and Control Association, Inc. (AMCA) Laboratory Methods of Testing Dampers for Ratings, AMCA Standard 500D's test figure describing a Test Damper Setup with Outlet Chamber or the test figure describing a Test Damper Setup with Inlet Chamber. If the torque compensation was accomplished by increasing the air velocity and/or full closed pressure, the operation test shall be conducted under those conditions. If the torque compensation was accomplished by adding mechanical resistance, then the following formula shall be used to determine the appropriate amount of torque to add to the sample being evaluated:

$$T_S = T_C(A_S/A_R)$$

where:

T_S is the total additional torque applied to the test assembly.

T_C is the torque compensation determined through torque profiling. The total compensation is to be applied and evenly distributed on a per square foot basis to all sections of the test sample.

A_R is the area of the reference damper used for torque profiling.

A_S is the area of the test sample.

11.4.4.3 The actuator shall be heated in an oven at an average temperature rise rate of 30° to 50°F (17° to 28°C) per minute until the rated temperature of the damper/actuator is reached. The oven temperature shall be maintained at the elevated temperature of up to a maximum 50°F (28°C) above the temperature rating of the damper for a minimum of 15 minutes. At that time with the determined airflow and closing pressure set and with mechanical resistance in place (if applicable), the damper is to be fully closed using the actuator. The closing time is to be recorded. The closing time shall not exceed 75 seconds. Once the damper fully-closes, the test pressure difference created in the closed position is to be recorded and shall not be less than the specified test pressure. If measures are necessary to compensate for the additional torque required during opening, they shall be taken at this time. The damper shall then be fully opened using the actuator. The opening time and velocity are to be recorded. The reopening time of the damper shall not exceed 75 seconds. The velocity shall not be less than the specified test velocity.

11.4.4.4 The damper shall be closed and leakage tests as specified in Section 10 shall be conducted.

11.4.4.5 The test method described in 11.4.4.1 through 11.4.4.4 shall be conducted in both directions of airflow on the damper assembly.

12 Salt-Spray Exposure Test

12.1 Representative samples of a damper shall automatically close and latch when a latch is provided following exposure to salt spray for a period of 5 days when tested as described in [12.2](#) – [12.4](#).

12.2 Prior to the test, all grease or oil is to be removed from the damper, using organic solvents. Also prior to the test in cases where the salt creates interfering buildup of zinc chloride, galvanized steel parts are to be painted.

12.3 The damper is to be installed in a test chamber with the damper open and supported in the position of intended use and then exposed to salt spray for 120 hours, in accordance with the Standard Practice for Operating Salt Spray (Fog) Apparatus, ASTM B117; except that the salt solution is to consist of 20 percent by weight of common salt (sodium chloride) and distilled water. The pH value of this solution as collected after spraying in the test apparatus is to be between 6.5 and 7.2 and the specific gravity between 1.126 and 1.157 at 95°F (35°C).

12.4 At the conclusion of the exposure, the damper is to be removed from the chamber and dried at a temperature of 75 ±10°F (23.9 ±5.5°C) for a minimum of 24 hours. It is then to be placed in its intended mounting position and tested for closing and latching (when a latch is provided).

13 Fire Exposure Test

13.1 When tested as specified in the fire test portion of the Fire Endurance and Hose Stream Test as specified in the Standard for Fire Dampers, UL 555, there shall be no flaming of the damper assembly materials on the unexposed side.

Exception No. 1: Flaming of nonmetallic or organic components used in a damper assembly is not prohibited on the unexposed side when the flames do not exceed 6 inches (152 mm) in length.

Exception No. 2: This requirement does not apply to nonmetallic or organic components used in a damper assembly when the total exposed surface area of the nonmetallic or organic components is 25 square inches (161 cm²) or less.

Exception No. 3: This requirement does not apply to materials used in a damper assembly which are classified as to surface burning characteristics and which have a flame spread value of 25 or less and a smoke developed value of 50 or less when tested as specified in the Standard for Test for Surface Burning Characteristics of Building Materials, UL 723.

Exception No. 4: This requirement does not apply to components of a fire damper assembly with nonmetallic enclosures which are classified when tested as specified in the Standard for Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces, UL 2043.

14 Accelerated Aging Test

14.1 Nonmetallic components such as gaskets and sealants made of silicone, rubber, neoprene, and other such materials except foamed materials shall have physical properties as specified in [Table 14.1](#) after accelerated aging under the conditions specified in [Table 14.2](#).