ANSI/BHMA A156.5-2014
Revision of ANSI/BHMA A156.5-2010

AMERICAN NATIONAL STANDARD

FOR

CYLINDERS AND INPUT DEVICES FOR LOCKS

SPONSOR

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION, INC

Revision A 12/7/2018

AMERICAN NATIONAL STANDARD

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FOREWORD (This Foreword is not a part of ANSI/BHMA A156.5)

This Standard is the result of the collective efforts of members of the Builders Hardware Manufacturers Association, Inc. who manufacturer cylinders and input devices for locks.. The total Product Standards effort is a collection of standards , each covering a specific category of items.

Performance tests, and, where necessary, dimensional requirements, have been established to ensure safety, security and stability to which the public is entitled. There are no restrictions on design, except for those dimensional requirements imposed for the reasons given above. It is also required that locks fit certain cutout dimensions.

This Standard is not intended to obstruct, but rather to encourage, the development of improved products, methods, and materials. The BHMA recognizes that errors will be found, items will become obsolete, and new products, methods, and materials will be developed. With this in mind, the Association plans to update, correct, and revise these Standards on a regular basis. It shall also be the responsibility of manufacturers to request such appropriate revisions.

In most cases, products have been described in grade levels related to performance and security. Choice of grade and specific product is made on the basis of utility, aesthetics, security objectives and end use desired.

The BHMA numbers, which indicate types of hardware do not identify grade, finish, or design and are not intended to be used without necessary supplementary information. Individual manufacturers' catalogs are consulted.

Users of this Standard consult applicable local building codes as to requirements affecting the functions of locks used on fire doors and doors within a means of egress. Some communities require the use of exterior door locks having a dead bolt with a 1 in. (25.4 mm) projection for the purpose of providing greater security. Only functions compatible with the requirements of the applicable building codes are used.

In 2008, the BHMA subcommittee revising A156.5 amended the standard to recognize the increased application of electrical input products with analogous functions to the traditional mechanical cylinders. At the same time, the auxiliary locking products were removed and placed in a new dedicated standard, A156.36.

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1. SCOPE

1.1 ANSI/BHMA A156.5 establishes requirements for mechanical cylinders, electrified input devices, and push button mechanisms, which include operational and strength tests.

1.2 Related products are covered in additional BHMA Publications: A156.25 ANSI/BHMA A156.28 for Master Keying Systems, and ANSI/BHMA A156.30 for High Security Cylinders and Input Devices.1.3 Auxiliary Locks previously included in this Standard are now found in ANSI/BHMA A156.36 for Auxiliary Locks.

1.4 Tests described in this Standard are performed under laboratory conditions. In actual usage, results vary because of installation, maintenance and environmental conditions.

1.5 The intent of this standard is to provide fair, uniform and repeatable testing of locking cylinders and input devices used in commercially available door hardware. Each testing section of the standard identifies the tools and/or fixtures applicable to that particular test. We recognize that any cylinder can be compromised or destroyed by excessive force or extended time or by the use of custom designed tools or techniques. For cylinders and input devices to be used beyond the scope of this standard, we recommend the guidance of or consultation with an independent physical security specialist.

1.6 No lock can provide complete security by itself. Locks may be defeated by forcible or technical means, or evaded by entry elsewhere on the property. No lock can substitute for caution, awareness of your environment, and common sense. Builders hardware is available in multiple performance grades to suit the application. In order to enhance security and reduce risk, you should consult a qualified locksmith or other security professional. For applications where pick resistance and other higher security protections are required consider locks meeting UL 437-2013 Key Locks, or ANSI/BHMA A156.30-2010 for High Security Cylinders.

1.7 **Grade Qualifications** Two classifications of tests are described in this Standard, Operational and Security. Manufacturers shall indicate the Grade level. A Grade 1 product shall meet all Grade 1 criteria, a Grade 2 product shall meet all Grade 2 criteria, and a Grade 3 product shall meet all Grade 3 criteria in each classification.

2. DEFINITIONS

2.1 **Bitting** 1. the number(s) which represent(s) the dimensions of the key, 2. the actual cut(s) or combination of a key

2.3 **Cam** 1. a lock or cylinder component which transfers the rotational motion of a key or cylinder plug to the bolt works of a lock, 2. the bolt of a cam lock.

2.4 **Card Readers** Insertion or swipe credit-card readers decode magnetic stripes and smart cards (memory cards and chip cards).

2.5 **Contact Memory Readers** Electrical contact readers decode embedded EEROM chips and “touch memory” modules.

2.6 **Credential** A key, keycard, electronic key fob, PIN (personal identification number), biometric attribute, or other device, used in contact or proximity of the input device to transfer a code required for unlocking the locking device, or communicating with it for other access control purposes.

2.7 **Cylinder** The subassembly of a mechanical lock containing a plug with keyway and a body with movable detainers.

2.8 **Cylinder Body** The portion of a cylinder that surrounds the plug and contains the tumbler mechanism. The cylinder body is sometimes called a cylinder shell.

2.9 **Cylinder Guard** That portion that surrounds the otherwise exposed portion of a cylinder to protect the cylinder from wrenching, cutting, pulling or prying.

2.10 **Cylinder Housing** The portion of a mechanical lock that surrounds and retains the cylinder body. It is often part of a lock itself.

2.11 **Cylinder Plug** A component of the cylinder within the body, which is actuated when the correct key is used.

2.12 **Electrified Input Devices** The electrified locks equivalent to a cylinder for reading a credential and transmitting the "key code" to the controlling device. Examples include card readers, keypads, contact memory key readers, radio frequency (proximity) readers, optical readers, and biometric readers.

2.13 **Input Devices** electrified input devices and push button mechanism

2.14 **Interchangeable Core (IC)** A cylinder that is removed from the lock with a designated key.

2.15 **Interchangeable Core (IC) Mortise Cylinder** The combination of a mortise IC housing, integrated with a corresponding interchangeable core cylinder.

2.16 **Interchangeable Core (IC) Rim Cylinder** The combination of a rim cylinder IC housing, integrated with a corresponding interchangeable core cylinder.

2.17 **Key** A properly combinated device specifically intended to operate a corresponding cylinder.

2.18 **Keypads** Membrane or switch input readers decode digital pin codes mechanically entered.

2.19 **Keyway** The slot or hole in a cylinder plug within which a key is fully inserted to operate the cylinder.

2.20 **Mechanical Pushbutton Mechanism** Decodes the input and releases a control shaft to activate the lock drive mechanism.

2.21 **Mortise Cylinder** A threaded cylinder, regularly supplied with a cam to actuate the lock mechanism.

2.22 **Movable Detainer** Part of the mechanism of the cylinder which first should be moved by the key into a predetermined position before the key or plug can release. Examples include components known as pins, side bars, discs, and the like.

2.23 **Optical Readers** Single or bi-directional readers employing optical sensors for decoding visible credentials (bar codes and diagrams) or infrared serial transmissions.

2.24 **Push Button Mechanism** A mechanical coding device used in place of a key and cylinder.

2.25 **Radio Frequency Readers** Single or bi-directional readers employing antennas for decoding contactless RFID tags and proximity badges.

2.26 **Recessed Cylinder** A cylinder where the cylinder head is flush with, or recessed below, the outside surf9ace of the trim to protect the cylinder from wrenching, cutting, pulling or prying.

2.27 **Rim Cylinder** A cylinder typically used with surface applied locks and attached with a back plate and machine screws. It has a tailpiece to actuate the lock mechanism.

2.28 **Tailpiece** A bar projecting from the back of a rim, bored lock cylinder or a push button mechanism engaging the lock mechanism and when rotated by the key or turn either locks or unlocks the lock.

2.29 **Turn** The component that projects or retracts a dead bolt or latch bolt by turning. Sometimes called a turn piece or thumb turn.

3. GENERAL

3.1 **Tolerances** Where only minus tolerances are given, the dimensions are permitted to be exceeded at the option of the manufacturers.

3.2 **Reference to other Standards** Referenced standards are available from www.astm.org, www.ansi.org, www.buildershardware.com, , and www.ul.com.

3.3 **Values** Required values in this Standard are given in US units. The SI (metric) equivalents are approximate.

3.4 **All mechanical cylinders** shall have five or more movable detainers to qualify for this standard. Modifications of these requirements to provide greater security are permitted.

3.5 **Where manipulation of the lock with a screwdriver** is required, a maximum of five minutes testing time shall be allowed. The screwdriver shall be a commercially available type with a blade not exceeding 6 in. (150 mm) in length or 10 in. (250 mm) overall length. It is not intended that the screwdriver be used to attack the lock mount or fixture or cause further damage to the lock.

4. EXPLANATION OF IDENTIFYING NUMBERS

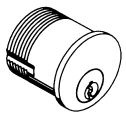
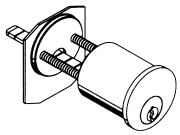
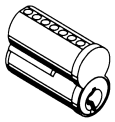
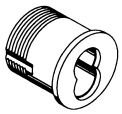
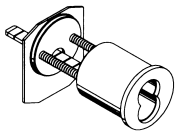
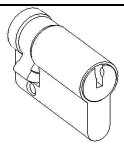
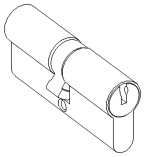
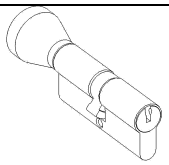
4.1 First letter denotes BHMA Product section E.

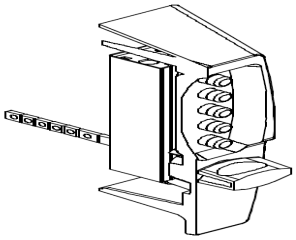
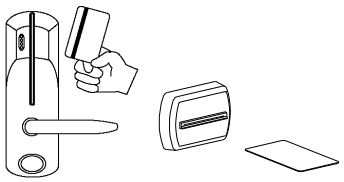
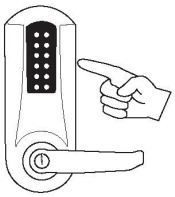
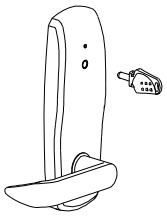
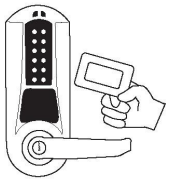
4.2 First numeral indicates general material used

Numeral	Description	Numeral	Description
0	Optional material	5	Stainless steel, 300 series
1	Cast, forged or extruded brass or bronze	6	Malleable iron
2	Wrought brass or bronze	7	Cast iron
3	Cast, forged or extruded aluminum	8	Wrought steel
4	Wrought aluminum	9	Zinc alloys

4.3 Second numeral identifies the type of product: 9 – Cylinders and Input Devices

4.4 Third and fourth numerals identify the function of the products. Note: these are arbitrary numbers assigned so that each type number shall be different per the following table:

Cylinder Type		Function Number
Mortise Cylinder		21
Rim Cylinder		22
Bored Lock Cylinders		23
Interchangeable Core (IC) Cylinder		24
Mortise IC Housing		25
Rim IC Housing		26
Single Cylinder European Profile		27
Double Cylinder European Profile		28
Single Cylinder European Profile with Thumbturn		29

Mechanical Pushbutton Mechanism		40
Insertion Or Swipe Credit-Card Readers		50
Keypads – Membrane Or Switch Input Readers		51
Electrical Contact Readers		52
Single Or Bi-Directional Readers Employing Antennas		53
Contactless Card Readers		54

4.5 Fifth numeral designates the operation and security grade classification of the item:

1 - Grade 1 2 - Grade 2 3 - Grade 3

Suffix "A" refers to cylinders of pick and drill resistance - see paragraph 6.6.6.

Suffix "L" designates cylinders to be used with Bored Locks only – see Cylinder Plug Pull Test paragraph 6.6.3.

Suffix "M" designates cylinders which are dedicated to the lock with which they are supplied, and not qualified for interchanging in other locksets or applications – see Cycle Test paragraph 6.4.

Suffix "D" designates cylinders which comply with 6.6.1, Cylinder Body or Housing Tension Test, or 6.6.2 Cylinder Body or Housing Torque Test, or 6.6.3 Cylinder Plug Pulling Test or 6.6.4 Cylinder Plug Torque Test. Exception: this test is not applicable if unable to drill to the required depth.

Designate multiple suffix numbers as applicable.

4.6 **Example** E09231AL

E	Section E
0	Optional material
9	Cylinders and input devices
23	Bored lock cylinder
1	Grade 1
A	Drill and pick resistant
L	Bored locks only

5. TEST METHODS AND EQUIPMENT

5.1 Where a function or design does not allow a specific test, the test is not required.

5.2 Failure of the fixture does not constitute pass or failure of the tests. It is permissible to use a mating lockset as an equivalent *holding* fixture; when performed in this manner, the lockset may be modified as necessary to perform the test as specified.

5.3 **Test Sample Quantities**

5.3.1 **For Mechanical Cylinders** A total of twelve cylinders and keys will be needed for three sections of tests; three each for the operational/cycle tests, three for the cylinder plug pulling test, three for the cylinder plug torque test, and three for the key strength test. Failure of the cylinder or key constitutes failure of that specific section only. Five additional cylinders are required for testing to UL 437, Cylinder Drilling and Picking Test, 6.6.5. The cylinder shall be fully loaded as designed, with bittings randomly scrambled within the manufacturers normal parameters.

5.3.2 **For Pushbutton and Electrified Input Devices** The test lab and the manufacturer shall determine the appropriate number of samples required to properly evaluate the particular product.

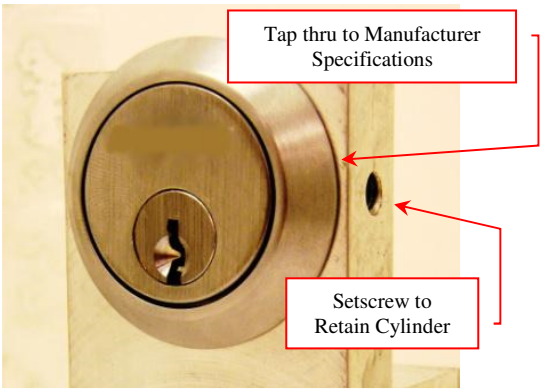
5.4 Test Equipment

5.4.1 Cylinder Holding Fixtures for Cycle, Pull, and Torque Cylinder Tests

NOTES: All Dimensions and Tolerances to be based on Manufacturer Requirements.
For Mortise Cylinders, typical thread size is 1.150 in. – 32 UNS-2A

Bored Lock Cylinder

Interchangeable Core Cylinder



Mortise Cylinder

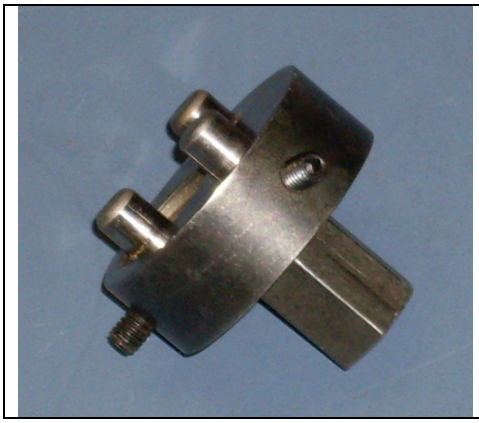
Rim Cylinder
Install using manufacturer's specified hardware

Euro-style Cylinder

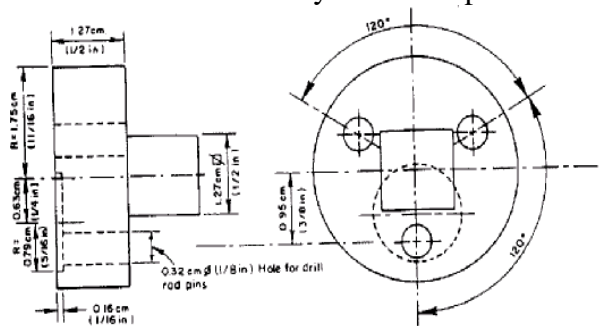
Mortise Cylinder with Interchangeable Core

5.4.3 **Cylinder Pulling Device** capable of delivering and measuring tensile forces exceeding 3600 lbf (16013 N)

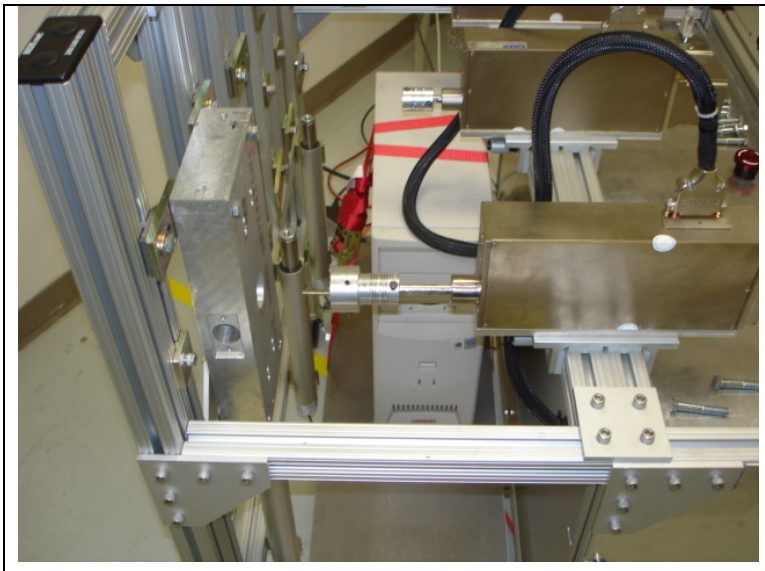
5.4.4 **Torque Applicators** Examples of torque loading adapters required to grip the components are shown below.

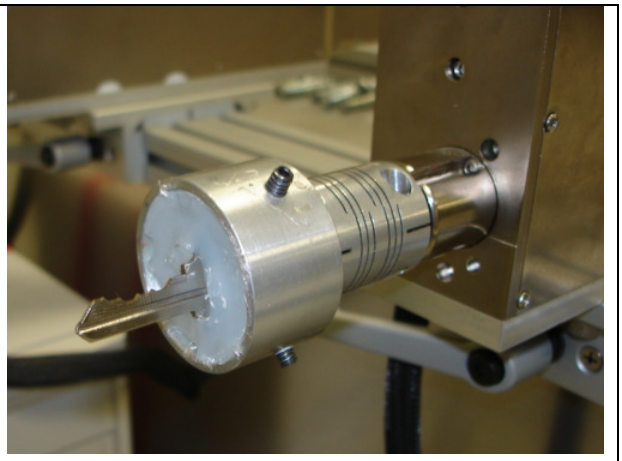


ASTM F476 X1.10 Cylinder Adaptor



5.4.5 **Cycle Test Fixture**





5.4.6 **Measuring Equipment**

Measuring equipment shall consist of commercial torque measuring devices, force meters and load dynamometers capable of a combined calibration and reading accuracy within 5% to obtain test data as specified in the applicable performance tests. Provide a linear measuring device accurate to reading within ±0.005 in. (0.13 mm) to obtain test data as specified.

6. TESTS FOR MECHANICAL CYLINDERS

6.1 **Cylinder Lubrication** is limited to manufacturer's normal factory application. No additional lubrication is allowed to be applied prior to, or during testing.

6.2 **Break-in** Prior to testing, insert key into each test cylinder 25 times and manually rotate clockwise and counterclockwise after each insertion.

6.3 **Operational Tests**

6.3.1 **Force to Insert Key into Keyway** A force meter shall be applied to the key of a cylinder unit in such a manner that the axial force required to insert the key fully into the keyway of the cylinder plug can be measured. Average three readings for each specimen. The force required to fully insert the key into the keyway shall not exceed the maximum specified.

Requirements Maximum All Grades

Five or six movable detainers	Seven or more movable detainers
3 lbf (13 N)	5 lbf (22 N)

6.3.2 **Force to Extract Key from Keyway** A force meter shall be applied to the key of a cylinder unit in such a manner that the axial force required to completely extract the key from its fully inserted position is measured. Average three readings for each specimen. The force required to completely extract the key from the keyway shall not exceed the maximum specified.

Requirements Maximum All Grades

Five or six movable detainers	Seven or more movable detainers
3 lbf (13 N)	5 lbf (22 N)

6.3.3 **Torque to Rotate Cylinder Plug** A torque measuring device shall be attached to the key of a cylinder unit in such a manner that the torque required to rotate the cylinder plug within the cylinder body is measured. For this test, there is no additional load applied to the tailpiece or cam. The torque required to rotate the cylinder plug the maximum rotation allowable within the cylinder body shall not exceed the maximum specified.

Requirements Maximum

Grades 1 & 1A	Grade 2	Grade 3
18 ozf-in. (0.14 Nm)	27 ozf-in. (0.19 Nm)	36 ozf-in. (0.25 Nm)

6.4 **Cycle Test** The test cylinder shall be installed in mechanically operated device which simulates normal operation of a cylinder. A constant torque load of 3 in.-lbf (.34 Nm) shall be applied at the "cam" end, releasing the load at the key extraction position. (Exception: Suffix "M" designated cylinders shall be tested in the dedicated lockset, with no additional preload).

6.4.1 The cycle shall be as follows:

a) Fully inserting the key into the cylinder plug keyway, and

b) Rotating the key and cylinder plug to a minimum of 180 degrees, or less than 180 degrees to the maximum rotation limited by the design, , and

c) Returning the key and cylinder plug to the home position, and

d) Extracting the key from the cylinder plug keyway until the tip no longer touches the front pin

6.4.2 Complete half of the cycles in a clockwise direction, and half of the cycles counterclockwise alternating the sequence as specified by the manufacturer

6.4.3 The test fixture shall operate the cylinder unit at a rate of not more than 30 cycles per minute.

6.4.4 The test cylinder shall be subjected to operational tests 6.1 through 6.3 before starting the cycle test and shall meet the requirements specified.

6.4.5 Complete the cycle test to the required number of cycles specified for the grade of cylinder being tested.

Requirements Minimum

Grades 1 & 1A	Grade 2	Grade 3
40,000	20,000	10,000

6.5 **Operational Tests After Cycle Test** At the completion of the cycle test, cylinders shall operate in both directions and meet the following:

6.5.1 **Force to Insert Key into Keyway** A force meter shall be applied to the key of a cylinder unit in such a manner that the axial force required to insert the key fully into the keyway of the cylinder plug can be measured. Average three readings for each specimen. The force required to fully insert the key into the keyway shall not exceed the maximum specified.

Requirements Maximum

Five or six movable detainers	Seven or more movable detainers
6 lbf (26 N)	10 lbf (42 N)

6.5.2 **Force to Extract Key from Keyway** A force meter shall be applied to the key of a cylinder unit in such a manner that the axial force required to completely extract the key from its fully inserted position is measured. Average three readings for each specimen. The force required to completely extract the key from the keyway shall not exceed the maximum specified.

Requirements Maximum

Five or six movable detainers	Seven or more movable detainers
6 lbf (26 N)	10 lbf (42 N)

6.5.3 **Torque to Rotate Cylinder Plug** A torque measuring device shall be attached to the key of a cylinder unit in such a manner that the torque required to rotate the cylinder plug within the cylinder body is measured. For this test, there is no additional load applied to the tailpiece or cam. The torque required to rotate the cylinder plug the maximum rotation allowable within the cylinder body shall not exceed the maximum specified.

Requirements Maximum

Grades 1 & 1A	Grade 2	Grade 3
13 in.-lb.	13 in.-lb.	13 in.-lb.

6.6 **Strength Tests**

6.6.1 Cylinder Body or Housing Tension Test Applies to mortise, rim, and interchangeable core housings for mortise and rim cylinders. Install test specimen in the applicable fixture in 5.4.1. Attempt to drill two holes using one ~~a~~ number 21 standard HS drill bit in the cylinder body or housing on a center line of the cylinder body or housing (see figure below) to a minimum depth of 1/2 in. (13 mm). Tap the holes using a number 10-32 thread standard tap and attach a suitable pulling adapter to the cylinder body or housing with two number 10-32 hardened cap screws fully threaded into the cylinder body or housing. Connect the adapter to the tensile pulling device and apply the tension load specified. Failure occurs if the body or housing pulls out of the fixture. Exception: this test is not applicable if unable to drill to the ½ inch depth. Cylinders which meet 6.6.1 due to the exception above shall be designated with a Suffix "D" (See Paragraph 4 Explanation of Type Numbers).

Requirements Minimum

Grade 1	Grade 2	Grade 3
3,600 lbf (16,000 N)	2,500 lbf (11,000 N)	1,000 lbf (4,400 N)

6.6.2 **Cylinder Body or Housing Torque Test** Applies to mortise, rim, and interchangeable core housings for mortise and rim cylinders. Install in a certified lockset of the same grade. Apply specified torque rapidly in both directions without stopping, using a suitable device that tranfers the force to the centerline of the cylinder assembly and does not weaken the cylinder. Failure results if the cylinder is removable or the latchbolt is withdrawn, by hand or with the aid of commercially available screwdriver with a blade not exceeding 6 in. (150 mm) in length or 10 in. (250 mm) overall length for five minutes duration maximum. Also, test the bolt by hand for end pressure resistance to assure that it is deadlocked or dead latched. Exception: this test is not applicable if unable to drill to the ¼ inch depth.

Cylinders which meet 6.6.2 due to the drilling exception above shall be designated with a Suffix "D" (See Paragraph 4 Explanation of Type Numbers).

Requirements Minimum

Grade 1	Grade 2	Grade 3

120 lbf-ft (160 Nm)	80 lbf-ft (110 Nm)	40 lbf-ft (50 Nm)

6.6.3 **Cylinder Plug Pulling Test** Applies to all cylinders. Install test specimen in the applicable fixture in 5.4.1. Drill a hole on the centerline of the cylinder plug adjacent to the keyway using a No. 21 drill to a minimum depth of 1/2 in. (13 mm). Tap this hole with a 10-32 thread. Attach a suitable tensile loading device to the cylinder plug in such a manner that an axial tensile load is applied to a 10-32 hardened cap screw fully threaded into the tapped hole of the cylinder plug in such a manner that an axial load is applied to the cylinder plug in the direction of pulling it out of its companion cylinder body or fixture. The cylinder plug shall be loaded to the proof load specified for the grade of cylinder being tested. Failure shall occur if the cylinder plug is removed from the body, or the cylinder is removed from the fixture. Exception: this test is not applicable if unable to drill to the ½ inch depth.

Requirements Minimum
Cylinders which meet 6.6.3 due to the exception above shall be designated with a Suffix "D" (See Paragraph 4 Explanation of Type Numbers).

Cylinders designated to bored lock application only, designate with Suffix "L" (See Paragraph 4 Explanation of Type Numbers)

Grade 1 & 1A	Grade 2	Grade 3
500 lbf (2200 N)	300 lbf (1350 N)	250 lbf (1100 N)

Requirements Minimum
Cylinders housed in all other applications

Grade 1 & 1A	Grade 2	Grade 3
2,500 lbf (11000 N)	1,000 lbf (4400 N)	500 lbf (2200 N)

6.6.4 **Cylinder Plug Torque Test** Applies to all cylinders.

Install test specimen in the applicable fixture in 5.4.1. Prepare the plug face with a slot 3/32 in. ± 0.005 (2.4 mm ± 0.13) at 90 degrees to the keyway to a depth not to penetrate the first pinhole. Insert a blade the width of the plug body -1/32 in. +0 (-0.8 mm +0). The cylinder plug shall be loaded to the torque specified. Failure occurs if the plug rotates more than 45 degrees.

Cylinders which meet 6.6.4 due to the exception above shall be designated with a Suffix "D" (See Paragraph 4 Explanation of Type Numbers).

Requirements Minimum

Grades 1 & 1A	Grade 2	Grade 3
300 lbf-in. (34 Nm)	150 lbf-in. (17 Nm)	120 lbf-in. (14 Nm)

6.6.5 **Key Strength Test** With the key fully inserted into the cylinder and the cylinder driving element blocked against rotation, gradually apply the required torque to the key and hold for a period of 5 seconds. The key shall then be removed and reinserted and shall operate the cylinder with maximum torque of 13 in.-lb (1.3 Nm).

Requirements Minimum All Grades

23 in.-lb (2.6 Nm)

6.6.6 **Cylinder Drilling and Picking Test** Cylinders meeting all the drilling and picking requirements of UL 437-2013 shall be designated with the applicable type number including the suffix A. The cylinder

shall also meet Grade 1 requirements of this standard. Cylinders which are listed to UL 437 do not need to be retested for drill and pick resistance.

7. REQUIREMENTS FOR ELECTRIFIED INPUT DEVICES

7.1 Operational Tests

7.1.1 **Force to Insert Key (credential) into Keyway** A force meter shall be applied to the key (credential) of an electrified input device in such a manner that the axial force required to insert the key (credential) fully into the keyway of the input device can be measured. Average three readings for each specimen. The force required to fully insert the key (credential) into the keyway shall not exceed the maximum specified.

Requirements Maximum All Grades

3 lbf (13 N)

7.1.2 **Force to Extract Key (credential) from Keyway** A force meter shall be applied to the key (credential) of an electrified input device in such a manner that the axial force required to completely extract the key (credential) from its fully inserted position is measured. Average three readings for each specimen. The force required to completely extract the key (credential) from the keyway shall not exceed the maximum specified.

Requirements Maximum All Grades

3 lbf (13 N)

7.1.3 **Torque to Rotate Cylinder** When a physical input device key (credential) rotates to operate the lock mechanism, a torque-measuring device shall be attached to the key (credential) of the input device in such a manner that the torque required to rotate the cylinder plug (rotating member) within the cylinder body (fixed member) is measured. For this test, there is no additional load applied to the tailpiece or cam. The torque required to rotate the cylinder plug the maximum rotation allowable within the cylinder body shall not exceed the maximum specified.

Requirements Maximum

Grades 1 & 1A	Grade 2	Grade 3
18 ozf-in. (0.14 Nm)	27 ozf-in. (0.19 Nm)	36 ozf-in. (0.25 Nm)

7.2 Cycle Tests For Rotating Input Devices

7.2.1 Electronic lock input devices shall withstand rotational cycle testing when rotation of the key (credential) is required in normal operation of the lock assembly The test input device shall be installed in mechanically operated locking device provided by the manufacturer. If rotation of the key is required in the normal operation, a constant torque load of 3 in.-lbf shall be applied; at the “cam” end, releasing the load at the credential extraction position,.

The cycle shall be as follows:

a) Fully inserting the credential into the electrified input device keyway, and

b) Rotating the key and input device rotating member to a minimum of 180 degrees, or less than 180 degrees to the maximum rotation limited by the design, , and

c) Returning the credential and cylinder plug to the home position, and

d) Extracting the credential from the electrified input device until the tip no longer contacts the device.

7.2.3 The test fixture shall operate the input device at a rate of not more than 30 cycles per minute. Replacement of the key (credential) shall be permitted every 2,000 cycles for frictional contact types; e.g., mag stripe keycards, and contact smart cards.

7.2.4 Complete the cycle test to the required number of cycles specified for the grade of cylinder being tested. When credentials are powered by batteries, replacement of batteries is permitted.

Requirements Minimum

Grades 1 & 1A	Grade 2	Grade 3
40,000	20,000	10,000

7.2.5 **Performance After Cycle Test** At the completion of the cycle test, electrified input devices shall operate and shall be subjected to operational tests for torque to rotate cylinder and shall meet the requirements specified.

7.3 **Cycle Test For Insertion Input Devices**

7.3.1 Electronic lock input devices shall withstand insertion cycle testing when rotation of the key (credential) is not required in normal operation of the lock assembly.

7.3.2 The test input device shall be installed in mechanically operated locking device provided by the manufacturer and tested through a cycle consisting of:

A) Fully inserting the key (credential) into the electrified input device keyway, and

B) Retracting the key (credential) from the electrified input device until the tip no longer contacts the electrified input device.

7.3.3 The test fixture shall operate the cylinder unit at a rate of not more than 30 cycles per minute.

7.3.4 Complete the cycle test to the required number of cycles specified for the grade of cylinder being tested. When credentials are powered by batteries, replacement of batteries is permitted.

Requirements Minimum

Grades 1 & 1A	Grade 2	Grade 3
80,000	40,000	20,000

7.3.5 **Performance After Insertion Cycle Test** At the completion of the cycle test, electrified input devices shall operate and shall meet the operational tests for force to insert paragraph 8.1.1, and force to extract key (credential), paragraph 7.1.2, from keyway.

7.4 **Tests For Keypad Input Devices**

7.4.1 **Force to Compress Key (credential) to Initiate Signal** A force meter shall be applied to three keypad keys of an electrified input device in such a manner that the axial force required to compress the key fully to initiate a signal can be measured. Average the three readings for value. The force required to fully initiate a signal shall not exceed the maximum specified.

Requirements

Maximum All Grades	3 lbf (1.4Kg)

7.4.2 Electronic lock keypad input devices shall withstand cycle test requirements consisting of inputting a code to the keypad and verifying that the signal is sent to activate the lock. This can be done by assembling the input device on a lock or by connecting a wire harness to the device and verifying the code

allows operation of the lock.

7.4.3 The cycle shall be as follows:

a) Use a minimum of 3 digit code to the input device to active the lock.

b) Verify that the code activates the device or test fixture to allow the lock to be opened.

c) Repeat the cycle until the total amount of cycles are reached.

7.4.4 The test fixture shall operate the input device at a rate of not more than 30 cycles per minute.

7.4.5 Complete the cycle test to the required number of cycles specified for the grade of input device being tested. When credentials are powered by batteries, replacement of batteries is permitted.

Requirements Minimum

Grades 1 & 1A	Grade 2	Grade 3
80,000	40,000	20,000

7.5 Cycle Tests For Prox and Smart Card Input Devices

7.5.1 Electronic lock Prox and Smart Card Input Devices shall withstand cycle test requirements by presenting the card to the reader to activate the input to the lcok. This can be done by assembling the input device on a lock or by connecting a wire harness to the device and verifying the code allows operation of the lock.

7.5.2 The cycle shall be as follows:

a) Presenting the card to the input device to activate the input to the lock.

b) Verify that the card activates the device or test fixture.

c) Repeat the cycle until the total amount of cycles are reached.

7.5.3 The test fixture shall operate the input device at a rate of not more than 30 cycles per minute.

7.5.4 Complete the cycle test to the required number of cycles specified for the grade of input device being tested. When credentials are powered by batteries, replacement of batteries is permitted.

Requirements Minimum

Grades 1 & 1A	Grade 2	Grade 3
80,000	40,000	20,000

7.6 Strength Tests

7.6.1 **Input Device Pulling Test** The pulling test shall be performed when removal of the input device would allow access to parts that would allow opening of the lock or expose wires or conductors that would allow operation of the output device by application or removal of electrical current. Attach a suitable tensile loading device to the electrified input device in such a manner that an axial tensile load is applied to the input device in the direction of pulling it out of its companion cylinder body or escutcheon mounting while installed and restrained. The input device shall be loaded to the proof load specified for the grade of input device being tested. If the Input Device is removed before the value is reached, failure occurs if the lock can be unlocked within five minutes, by a) manipulating exposed mechanical parts using a screwdriver, or, b) performing 7.7.1 and 7.7.2 to the exposed wires or conductors, or, c) by using a jumper wire or stripping exposed wires to cause a short in the electrical system.

Requirements Minimum

Grade 1 & 1A	Grade 2	Grade 3
2,500 lbf (11000 N)	1,000 lbf (4400 N)	500 lbf (2200 N)

7.6.2 **Input Device Torque Test** The torque test shall be performed when removal of the input device would allow access to parts that would allow opening of the lock or expose wires or conductors that would allow operation of the output device by application or removal of electrical current. Install the input device in its companion cylinder body or escutcheon mounting while installed and restrained in the locked position. Attach a suitable torque loading device to the electrified input device in such a manner that a torque load is applied to the input device in the direction the key (credential) rotation while installed and restrained. The input device shall be loaded to the proof load specified for the grade of input device being tested. If the Input Device is removed before the value is reached, failure occurs if the lock can be unlocked within five minutes, by a) manipulating exposed mechanical parts using a screwdriver, or, b) performing 7.7.1 and 7.7.2 to the exposed wires or conductors, or, c) by using a jumper wire or stripping exposed wires to cause a short in the electrical system.

Requirements Minimum

Grades 1 & 1A	Grade 2	Grade 3
300 lbf-in. (34 Nm)	150 lbf-in. (17 Nm)	120 lbf-in. (14 Nm)

7.6.3 **Key (Credential) Strength Test** Electronic lock input devices credentials shall withstand a key (credential) strength test when rotation of the key (credential) causes bolts to retract in normal operation of the lock assembly. Install the input device in its companion cylinder body or escutcheon mounting while installed with the lock-driving element blocked against rotation. Perform key strength test 6.6.5. Repeat 7.1.1, 7.1.2, and 7.1.3.

7.6.4 **"Key" Freefall Strength Test** Applies only to physical credentials that are supplied with the manufacturer's input device. When a locking device is operated by a physical credential, ten credentials shall be slowly pushed off a horizontal surface from a height of 4.9 feet (1.5 M) and allowed to land randomly on a flat concrete surface. Repeat the test for all ten keys three times each. Failure shall occur if any credential is broken, or requires reassembly to operate, or, if after the test, more than one key fails to operate a lock it is intended to operate.

7.6.5 **"Key" Water Resistance Test** Applies only to physical credentials that are supplied with the manufacturer's input device. Submerge a properly combinated electronic credential in water four inches deep (10.2 cm) for ten seconds. Remove credential and wipe dry. Failure shall occur if the credential fails to operate the lock. When the credential is rotated to operate a cylinder plug, the force to operate the cylinder shall not exceed 27 ozf-in (0.19 Nm).

7.7 Security Tests

Electronic lock input devices shall withstand an over-voltage attack test and an ESD attack test to the I/O conducting terminals without allowing an entry. The over-voltage and ESD attack shall not cause the locking device to unlock, but unlike the ANSI/BHMA A156.25 tests, could cause the device to also fail to unlock for subsequent key (credential) operations without constituting failure of the test.

7.7.1 **A Over-voltage Test** Each combination of conducting terminals, for the purpose of interface to the key (credential), or other exposed sockets or surfaces on an installed device for interface to other external devices, shall be subjected to over-voltage test. The power supply shall be capable of 500 ma at twice the

normal operating voltage. The power shall be applied both positively and negatively biased to each possible pair of conducting pins. Application of the voltage to these pins shall not cause the lock to unlock at any time.

7.7.2 **Immunity Requirements (ESD)** All system components which are subject to contact during normal operation shall meet the requirements of IEC 61000-4-2, level 4". The ESD source shall be discharged through a 150 pico-farad capacitor (the ISO human body model) with the case ground connected to earth ground and the ESD device referenced to earth ground. Application of the voltage to these pins shall not cause the locking device to unlock at any time.

7.7.3 **Wrong Electronic Code on Mechanical/Electronic "Key"** When a cylinder with a rotating plug uses a credential with both an electrical combination and mechanical bitting, an incorrectly combinated electrically but properly bitted mechanically credential shall not operate the cylinder that is properly bitted mechanically for that credential, and shall resist gradual application of torque up to 30 in-lb (3.5 Nm) for five seconds. Failure shall occur if the key breaks at a torque less than 23 in-lb (2.6 Nm), or if the cylinder fails to operate with a properly combinated and bitted key after the test.

8. REQUIREMENTS FOR MECHANICAL PUSHBUTTON DEVICES

8.1 **Operational Test** Insert new code into device. Enter the correct code into device and rotate the control shaft, shaft will rotate. Insert incorrect code into device and rotate the control shaft, shaft will not rotate. Rotational Torque to operate control shaft with correct code. Select 3 pushbutton units from the manufacturers stock from the regular production for each grade of mechanical pushbutton mechanism being tested.

Requirements Maximum

12 in.-lbs (1.4 Nm)

8.1.2 **Force to Depress Pushbuttons** A force meter shall be applied to three pushbuttons in such a manner that the axial force required to compress the key fully to initiate a signal can be measured. Average the three readings for value. The force required to fully initiate a signal shall not exceed the maximum specified.

Requirements Maximum All Grades

Lock actuator buttons	9 lbf (4.1Kg)
Code buttons	5 lbf (2.3Kg)

8.2 **Cycle Test** The test push button mechanism shall be installed in a mechanically operated device which simulates normal operation of a cylinder. A constant torque load of 3 in.-lbf shall be applied at the "cam" end. Enter the correct code to place the mechanism into an unlocked mode. Cycle the mechanism by rotating the turn or pushing the paddle to rotate the tailpiece.

8.2.1 The test cylinder shall be subjected to operational test 8.1 before starting the cycle test and shall meet the requirements specified.

8.2.2 Complete half of the cycles in a clockwise direction, and half of the cycles counterclockwise alternating the sequence as specified by the manufacturer.

8.2.3 Complete the cycle test to the required number of cycles specified for the grade of push button mechanism being tested.

Requirements Minimum

Grades 1 & 1A	Grade 2
250,000	150,000

8.2.4 Performance After Cycle Test. At the completion of the cycle test, the test pushbutton mechanism shall be subjected to operational tests 8.1 and shall meet the requirements specified.

8.3 **Strength Tests**

8.3.1 **Pushbutton Device Pull Test** The pulling test shall be performed when removal of the pushbutton device would allow access to parts that would allow opening of the lock. Attach a suitable tensile loading device to the pushbutton device in such a manner that an axial tensile load is applied to the pushbutton device in the direction of pulling it out of its companion cylinder body or escutcheon mounting while installed and restrained. The pushbutton device shall be loaded to the proof load specified for the grade of input device being tested. Failure shall occur if the pushbutton device is removed from the body or escutcheon.

Requirements Minimum

Grade 1 & 1A	Grade 2	Grade 3
2,500 lbf (11000 N)	1,000 lbf (4400 N)	500 lbf (2200 N)

8.3.2 **Pushbutton Device Torque Test** The torque test shall be performed when removal of the pushbutton device would allow access to parts that would allow opening of the lock or expose wires or conductors that would allow operation of the output device by application or removal of electrical current. Install the pushbutton device in its companion cylinder body or escutcheon mounting while installed and restrained in the locked position. Attach a suitable torque loading device to the pushbutton device in such a manner that a torque load is applied to the pushbutton device in the direction the key (credential) rotation while installed and restrained. The pushbutton device shall be loaded to the proof load specified for the grade of pushbutton device being tested. Failure shall occur if the pushbutton device is removed from the body or escutcheon.

Requirements Minimum

Grades 1 & 1A	Grade 2	Grade 3
300 lbf-in. (34 Nm)	150 lbf-in. (17 Nm)	120 lbf-in. (14 Nm)

APPENDIX

A-3.1 If cylinders with pick and drill resistance are desired, so specify. The cylinder number to specify is E09221A or E09231A as applicable. These cylinders are the ones meeting the performance requirements for Grade 1 cylinders as listed in this Standard, and, in addition, shall have been tested for pick and drill resistance requirements of the Underwriters Laboratories, Inc. Standard UL 437, be listed or labeled by a nationally recognized independent testing laboratory and be under an in-plant follow-up inspection service.

A-3.2 All cylinders resist picking but to varying degrees. Measuring pick resistance is difficult and there are many variables, such as:

A-3.2.1 Inconsistencies in keying requirements as to master keying and grand master keying.

A-3.2.2 Variations among manufacturers concerning pin lengths, hole drilling, plug to housing fit and key cuts.

A-3.2.3 The experience of the picker, location of the cylinder to be picked and the type of lock function used.

A-3.3 Because of the diversity and varying grades of cylinders in this Standard and because cylinder picking ranks low statistically in unauthorized entry, picking is only included for cylinder Grades 1A.

MORTISE CYLINDERS

Threads are typically 1.150 in.-32 UNS-2A. Thread lengths vary by manufacturer.

Appendix Continued

Applicable Tests by Type Numbers

Function Number	Cylinder Type	Paragraph										
		6.3.1	6.3.2	6.3.3	6.4.5	6.5.1	6.5.2	6.5.3	6.6.1	6.6.2	6.6.3	6.6.4
E09211	Mortise Cylinder	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
E09221	Rim Cylinder	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
E09231	Bored Lock Cylinder	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y
E09241	Interchangeable Core (IC) Cylinder	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y
E09251	Mortise IC Housing	N	N	N	N	N	N	N	Y	Y	N	N
E09261	Rim IC Housing	N	N	N	N	N	N	N	Y	Y	N	N
E09271	Single Cylinder European Profile	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y
E09281	Double Cylinder European Profile	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y
E09291	Single Cylinder European Profile With Thumb turn	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y

		7.1.1	7.1.2	7.1.3	7.2.4	7.3.4	7.3.5	7.4.1	7.4.2	7.4.3	7.4.4	7.5.1	7.5.2	8.1 8.2.3 8.2.4	8.3.1 8.3.2
E09401	Mechanical Pushbutton Mechanism	N	N	N	N	N	N	N	N	N	N	N	N	Y	Y
E09501	Insertion Or Swipe Credit-Card Readers	Y	Y	N	N	Y	Y	N[2]	N[2]	N	N	N[3]	N[3]	N	N
E09511	Keypads - Membrane Or Switch Input Readers	N	N	N	N	Y	Y	N[2]	N[2]	N	N	N[3]	N[3]	N	N
E09521	Electrical Contact Readers	Y	Y	N[1]	N[1]	Y	Y	N[2]	N[2]	N[1]	N[1]	Y	Y	N	N
E09531	Single Or Bi-Directional Readers Employing Antennas	N	N	N[1]	N[1]	N	N	N[2]	N[2]	N[1]	N[1]	N[3]	N[3]	N	N
E09541	Optical Readers	N	N	Y[1]	N[1]	N	N	N[2]	N[2]	N	N	N[3]	N[3]	N	N
E09551	Biometric Readers	N	N	N	N	N	N	N[2]	N[2]	N	N	N[3]	N[3]	N	N

Y = Yes N = No * Only Grade 1 Type Numbers are listed. All Grades are subjected to the tests as shown

1 Yes, when credential rotates to operate the lock mechanism. See standard.

2 Yes, when forced removal exposes parts or wires that can be manipulated to open lock mechanism. See standard.

3 Yes, when exposed sockets or conducting surfaces interface with external devices. See standard.