Designation: E2068 – 00(Reapproved 2008)

Standard Test Method for Determination of Operating Force of Sliding Windows and Doors[1]

This standard is issued under the fixed designation E2068; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method determines the operating forces for opening and closing horizontal and vertical sliding windows and horizontal sliding door systems. It does not address the forces required for opening pivoting, projecting, or other fenestration systems. This test method does not address the use or performance of add-on devices or mechanical operators that might be installed to reduce operating forces of sliding windows or doors. It deals only with the forces necessary to open and close a sash or panel through the direct application of force to the operable sash or panel.

1.2 This test method is suitable for laboratory product comparisons or for qualifying products, or both, as meeting window or door operating force specifications. This test method is also suitable for use in the field to determine the operating forces required to open and close installed sliding windows and doors.

1.3 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are SI units provided for information only and are not considered standard.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For specific precautionary statements, see Section 7.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E631 Terminology of Building Constructions

3. Terminology

3.1 Definitions are in accordance with Terminology E631 unless otherwise specified.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *breakaway force*—the force required to start a sash (panel) in motion from a fully closed or fully open position.

3.2.2 *fully open position*—the point at the limits of the operating hardware (if applicable) or the point at which the sash or panel contacts a limiting device.

3.2.3 *fully closed position*—the position of the sash or panel after being closed, latched, and unlatched, or where the sash or panel is closed to its maximum engagement within a frame or pocket if no latching mechanism is provided.

3.2.4 *in-motion operating force*—the force required to maintain a sash or panel in motion while moving the sash or panel between 1 in. from fully open to 1 in. from fully closed positions, or 1 in. from fully closed to 1 in. from fully open position.

4. Summary of Test Method

4.1 Two equivalent test methods for determining operating force are described. Test Method A uses dead weights and a cable and pulley system to apply force to operate a sash or panel. Test Method B uses a force gage and hand-applied pressure to operate a sash or panel. The test specimen is mounted in a rigid support frame. After attaching the loading system to the operating sash or panel, the weight or force is applied and increased until the sash or panel is put into motion. This determines breakaway force. Starting from one inch (25 mm) from a closed or open position the minimum amount of weight or force required to keep a sash in motion, once it is started moving, is measured. This determines the in-motion operating force. Forces required to operate a sliding window or patio door in both opening and closing directions are determined by this test method.

5. Significance and Use

5.1 This test method determines the operational forces of sliding windows and doors by simulating force applied by hand directly to movable sash or panels. Breakaway and in-motion operating forces are measures of the ease of operation of

[1] This test method is under the jurisdiction of ASTM Committee E06 on Performance of Buildings and is the direct responsibility of Subcommittee E06.51 on Performance of Windows, Doors, Skylights and Curtain Walls.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

fenestration products. Product specifications, building codes, and building specifications establish operating force limits as measures of product performance or limits for handicapped accessibility, or both.

5.2 Window and door performance standards for air infiltration and water penetration in some cases require operating force measurements to be made and reported as an indication of the operability of the test specimen.

5.3 Operating forces can vary significantly from unit to unit due to factors such as installation parameters, wearing of sliding or rolling parts, lubrication, stiffening or softening of weather-strip, and environmental factors (for example, humidity, temperature, accumulation of dirt, and so forth). Therefore, when applied to new product designs, this test method requires that units be tested in a laboratory under controlled conditions including accurate mounting (plumb, square, and level) following the manufacturer's instructions. Use of this test method in the field does not necessarily indicate the operating forces that are inherent in the particular window design, but rather, provides a measurement of the forces required for operation of the particular unit at the particular time. The user is cautioned that installation defects such as bowed jambs, racked frames, or inadequate anchoring can result in binding or sticking of movable components and increased operating forces.

5.4 This test method requires measurement of both breakaway and in-motion operating forces. Generally, breakaway force is higher than in-motion operating force due to the difference between static and dynamic friction coefficients or the presence of weather-stripping and sash pockets, or both. Traditional fenestration product standards have required determination of in-motion operating force in the opening direction only and referred to this simply as operating force.

5.5 This test method is intended to determine the forces required to operate a window or sliding door which is properly installed and which is operated by hand application of force to a handle, pull bar, or sash member. Application of force through jerking or impact motion is not measured or evaluated by this test method. Operating forces can be significantly different between the opening and closing directions of movement; therefore, this test method involves measurements in both directions of movement.

5.6 This test method provides for two procedures which include a dead weight test method (Test Method A) and a force gage test method (Test Method B) of applying and measuring forces required to operate a sliding window or sliding door. When properly applied, both test methods are deemed to produce equivalent results. The dead weight test method is considered to be less likely to be affected by the operator's skill in applying loads in a steady and properly timed manner. The force gage test method is considered simpler to apply and more applicable to field testing where the installation of pulleys and cabling is often impractical. Both test methods are subject to a similar uncertainty.

6. Apparatus

6.1 This description of apparatus is general in nature and any arrangement of equipment capable of performing the test method, within allowable tolerances, is permitted.

6.2 *Test Method A*—The primary equipment used in Test Method A consists of a set of weights capable of being suspended and applied in 1-lb (0.5-kg) increments, a platen, lightweight flexible cable or cord, ball-bearing sheave(s), and a framework capable of supporting the sheaves and cable system in the appropriate location. Sheaves used to transmit the deadweight load to the specimen under test shall be a minimum of 3 in. (75 mm) in diameter. Weights used are to be Class F or better. In addition, a force gage in accordance with 7.3.1shall be used to verify that the load applied is transmitted to the unit under test when two or more sheaves are used to direct the load. (See Fig. 1.)

6.3 *Test Method B*—For Test Method B, a calibrated force gage with an accuracy of ±0.5 lbf (2.0 N) and with a peak hold and continuous reading capability is required.

6.4 Hardware such as hooks, cable, cord, small pulleys, and screw-eyes are to be used as necessary to provide for attachment of the loading system to the sash or panel.

7. Safety Precautions

7.1 When using Test Method A, be prepared for sudden movement of the sash or panel and potentially rapid dropping of the weights. The weights are to be suspended in such a manner that their fall will be stopped before the sash moves to the full limit of its travel to reduce impact between components. When using Test Method B, be prepared for sudden movement of the sash or panel.

7.2 There can be considerable energy and momentum in moving sash or panels that can cause a significant impact when the sash or panel hits the frame or limiting stops. Care must be taken to avoid injury and potential breakage of the specimen.

7.3 Glass breakage will not normally occur at the forces applied in these test methods; however, sudden breakaway or motion can occur. Take precautions to prevent injury from the moving sash.

8. Test Specimen

8.1 The test specimen shall consist of the entire unit as supplied by the manufacturer or as set forth in a referenced specification if applicable. When testing a unit in the field, the unit's location and description shall be detailed in the test report.

9. Procedure

9.1 Mount the test specimen to the support framework in accordance with the manufacturer's installation instructions. The supporting structure shall have a strength and rigidity at least equivalent to a nominal 2 by 4 stud wall with studs 16 in. (406 mm) on center and faced on one surface with nominal ½ in. (12 mm) plywood.

9.2 For laboratory tests, allow sufficient time for the test unit to fully equilibrate to the laboratory conditions prior to testing.

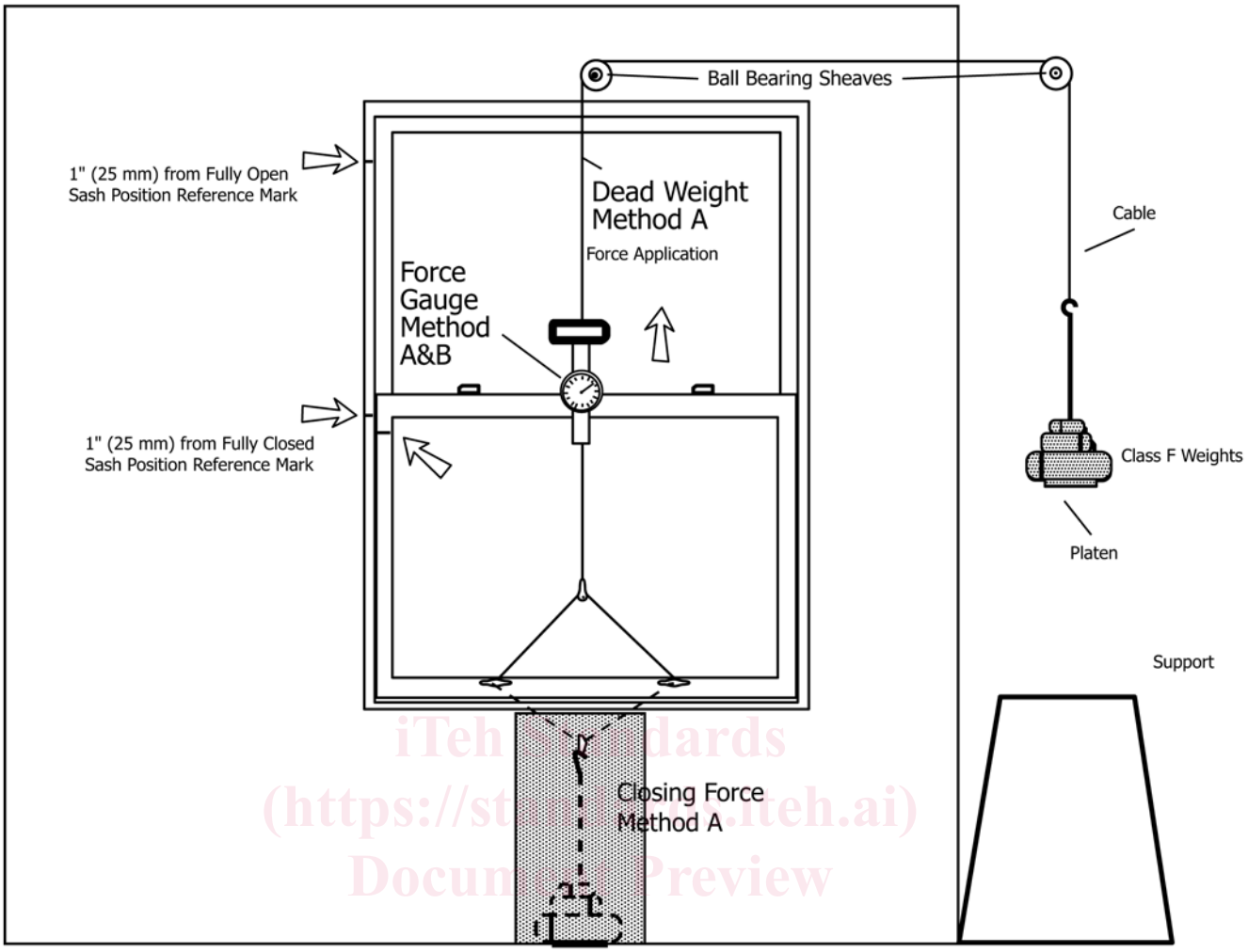

FIG. 1 Vertically Sliding Window Typical Arrangements

Fully open and close the test specimen five times, fully engaging the locks or latches on each closure.

9.3 Identify the location of normal opening or closing force application. This will normally be one or two handles or finger grip areas. For units with no clearly identified handle or grip area use the following locations: (*1*) *vertical sliding windows (single or double-hung)*, two points spaced 18 in. (460 mm) apart centered on either the sash top rail or bottom rail; or (*2*) *horizontal sliding windows*, one point at the vertical center of the pull bar (if present) or meeting edge vertical sash member.

9.3.1 Attach the loading system to the center of the indoor handle of sliding door assemblies. If none of these locations are clearly appropriate, the specifying authority shall determine the location of force application. (See Fig. 1 and Fig. 2.)

9.4 Attach the loading system to the position identified in 9.3. When two locations are identified, connect these locations with a cable or cord and apply force using a pulley strung on the cable or cord so that the force is evenly distributed between the two locations. All forces applied are to be in the direction parallel to the sash or panel surface that will cause the panel to move in the desired direction. Force is to be applied as close to the direction and plane of travel as possible.

9.5 *Number of Trials*—For each test method conduct a minimum of three trials. If the results of three trials are all within 10 % or 1 lb (0.5 kg), whichever is greater, of the average of the three trials, no additional trials are required. If any of the results of the three trials deviates by more than 10 % or 1 lb, whichever is greater, from the average, conduct seven additional trials (for a total of ten). When ten trials are required, calculate the average value by eliminating the highest and lowest values recorded and averaging the remaining eight values.

9.6 *Breakaway Force—Test Method A, Dead Weight:*

9.6.1 Close, lock, and unlock the sash or panel. Support the platen so that no load is applied, and place a 1-lb (0.5-kg) weight on it. While holding the platen, remove the support and gradually lower the weight so that the cable suspends it. This process is to take from 3 to 5 s. Repeat this process, including opening, closing, locking, and unlocking the latching mechanism, increasing the weight on the platen by 1 lb for each trial until the weight is sufficient to cause the sash or panel to fully disengage from the frame and any weather-strip or frame pocket. Record the total weight applied in this process as the breakaway force. Repeat this entire process twice for a total

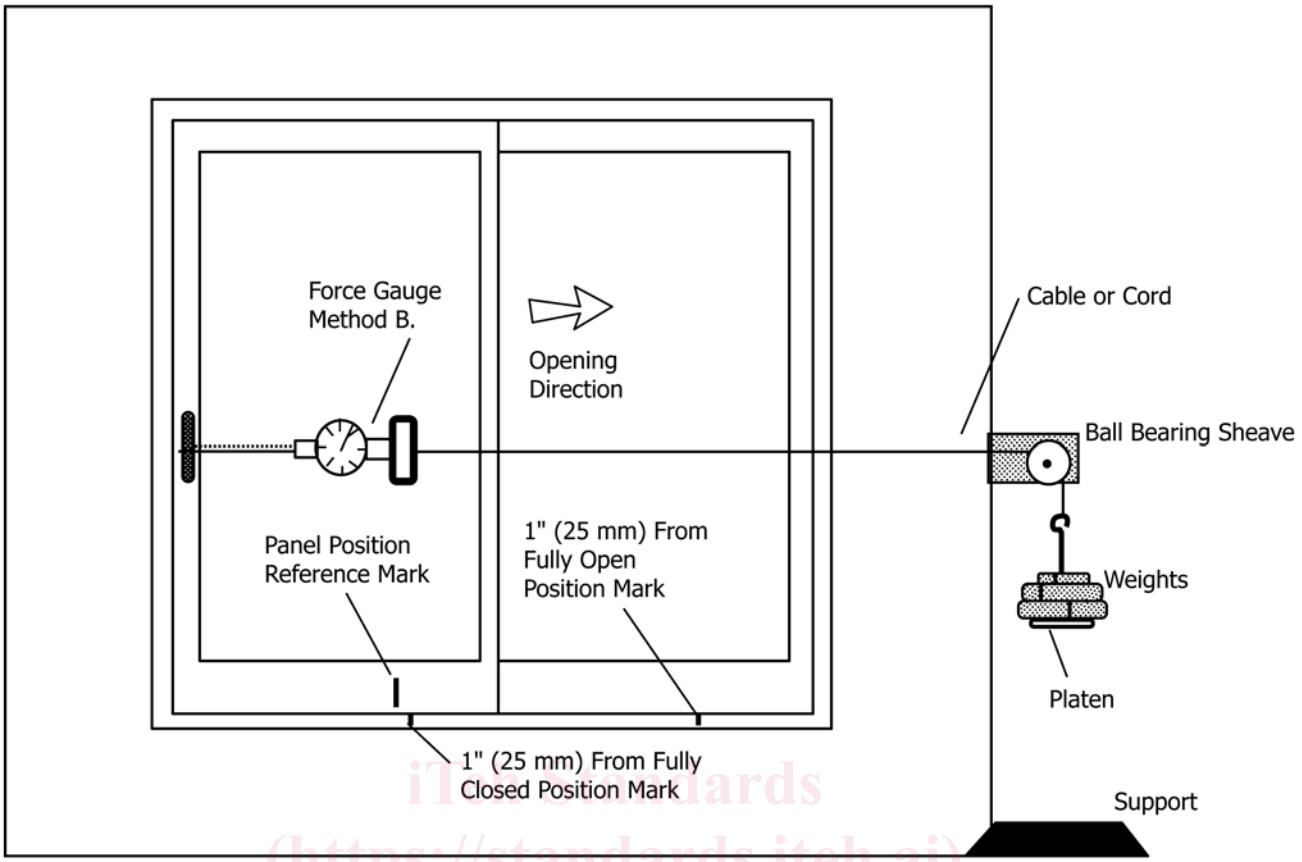

FIG. 2 Patio Door or Sliding Window Assembly

of three trials. Determine if additional trials are required as specified in 9.5 and perform if necessary. If the sash movement required to disengage from weather strip or a frame pocket is greater than 1 in. (25 mm), mark the sash position at the point of disengagement as the "end point" for this test.

9.6.2 If the sash or panel moves on its own when the latch(s) is disengaged, record the breakaway force as the weight required to initiate motion of the panel from the position the sash or panel moves to. This position is the "end point" for the purposes of the in-motion operating force test.

9.7 *In-Motion Operating Force—Test Method A, Dead Weight:*

9.7.1 From the fully closed position, open the sash or panel 1 in. (25 mm) or to the position identified as the end point in 9.6.2 and make a reference mark, using tape or a marking pen, indicating the relative frame/sash position. Open the sash to 1 in. from fully open and make a second mark on the frame.

9.7.2 Starting from the fully closed position, place a 1-lb (0.5-kg) weight on the platen. Manually open the sash to the 1-in. (25-mm) mark and release. If the sash continues to move, allow it to move until it stops or reaches the 1 in. from fully open mark. If it does not open to the 1-in. from fully open mark repeat the process adding 1 lb of weight to the platen. Continue this process until the weight applied is sufficient to open the sash or panel to or beyond the 1-in. from fully open mark. Record the total applied weight including the weight of the platen. If two or more sheaves are included in the loading system, verify that the force gage reads the correct value for the applied weight. Repeat this procedure at least two additional times (minimum of three trials) in the opening direction and record the required load for each trial. Determine if additional trials are required as specified in 9.5 and perform them if necessary. It is permissible to start the additional trials with a mass of 5 lb (2.5 kg) below that determined in the first trial provided that this mass does not cause the unit to open as described in this procedure.

9.8 Repeat the procedures in 9.6 and 9.7 for the closing direction. For vertically sliding windows, hang the weights directly from the operating handle or bridle if possible. This eliminates the need to use sheaves and a force gage. Measure breakaway force starting with the unit in the fully open position.

9.9 *Breakaway Force—Test Method B, Force Gage:*

9.9.1 Close, lock, and unlock the sash or panel. Using a force gage with a "peak load hold" feature gradually apply an increasing force at a rate of 1 lbf (4.5 N) every 2 to 3 s until either the sash or panel begins moving and the load applied is felt to decrease or until the sash or panel is clearly disengaged from the frame and any weather strip or frame pocket. Record the maximum force applied in this process as the breakaway force. Repeat this process twice more for a total of three trials. Determine if additional trials are required as specified in 9.5 and perform if necessary. If the sash movement required to