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Glass in building — Forced-entry security glazing —

Part 3: Test and classification by manual attack

Verre dans la construction — Vitrages de sécurité contre infractions —

Partie 3: Essai et classification par assaut manuel

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 16936-3 was prepared by Technical Committee ISO/TC 160, *Glass in building*, Subcommittee SC 2, *Use considerations*.

ISO 16936 consists of the following parts, under the general title *Glass in building — Forced-entry security glazing*:

— *Part 1: Test and classification by repetitive ball drop*

— *Part 2: Test and classification by repetitive impact of a hammer and axe at room temperature*

— *Part 3: Test and classification by manual attack*

— *Part 4: Test and classification by pendulum impact under thermally and fire stressed conditions*

Introduction

ISO 16936 assesses security-glazing products that are more familiarly known as “anti-vandal”, “anti-bandit”, and detention glazing products. Because there is no single test that will cover such a wide range of resistance to attack, four separate test methods are provided to assess the forced-entry resistant properties of security glazing. It is not intended that any particular test method be associated with the terms “anti-vandal” or “anti-bandit”, since these terms can be only loosely defined and there is considerable overlap in their definition.

The test method specified in this part of ISO 16936 is a physical test using personnel and equipment and does not reproduce the conditions of real human attack. The test relies heavily on the competence and experience of personnel performing the test. The classification determined may not necessarily be reproducible and is therefore considered as comparative of various glazing constructions.

The selection of tools to be used for the simulated attack is based on an attack which can be carried out without regard to noise, smoke, vibration, etc. generated during the attack.

Glass in building — Forced-entry security glazing —

Part 3: Test and classification by manual attack

1 Scope

This part of ISO 16936 sets forth a physical test method for security-glazing designed to resist actions of manual attack by delaying access of objects and/or persons to a protected space for a short period of time. Its application is limited to the evaluation and the classification of the resistance of forced-entry security glazing against the following threats:

— blunt tool impacts;

— sharp tool impacts;

— thermal stress;

— chemical stress (optional).

It is not applicable to the use of power (motor- or engine-driven) tools or devices, explosives, military ordnance and tools, and processes or devices requiring more than two persons to transport and operate.

NOTE Classifications have not been assigned to specific applications and glazing classification must be specified on an individual basis for every application.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 48:1994, *Rubber, vulcanized or thermoplastic — Determination of hardness (hardness between 10 IRHD and 100 IRHD)*

ASTM A 53, *Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless*

EN 3:2004, *Portable Fire Extinguishers*

UL 154, *Standard for Carbon Dioxide Fire Extinguishers*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
action of force
deliberate action on the part of a person made with the intention of creating a hole in the security-glazing product by the use of manually held implements or by the use of thrown objects

3.2
attack face
face of a test piece marked by the manufacturer and/or supplier that is designed to face the attack

3.3
category of resistance
classification of the capability of a security-glazing product to resist actions of force

3.4
protected space
space protected against access by the completed installation

3.5
sample
specified number of test pieces which together are representative of the security-glazing product intended to comply with a particular category of resistance in this part of ISO 16936

3.6
security-glazing composition
specific construction of a glazing product

NOTE A product is deemed to be of the same or superior security-glazing composition if individual plies are exchanged with others of a different colour, but without significant effect on the resistance to actions of force, and/or additional glazing products are installed on either face of the security-glazing product, laminated to it or with an air space, and/or additional equipment such as alarm wires, heating wires, printing, or surface coatings (on part or all of the surface) are incorporated into the security-glazing product, provided that this does not significantly affect the resistance to actions of force.

3.7
security-glazing product
product based on glass with or without plastics with a single or multiple ply construction, where the individual plies are of uniform thickness over the whole area of the product

NOTE A security-glazing product is usually transparent or translucent, and provides a specific resistance to the actions of force.

3.8
test piece
specified piece of security-glazing product submitted to a specified test procedure

3.9
tool set
set of tools allocated for use for a particular resistance class

4 Sampling

The sample submitted for testing shall consist of one test piece. To ensure against invalid test results because of errors during the test, it is advisable to submit at least one extra test piece. Replicate testing is recommended. Cut-outs and holes in security-glazing products should be avoided where possible, as these can affect the resistance of the product.

The test piece shall be (1 100 ± 5) mm long × (900 ± 5) mm wide. The edges shall be free from visible chips, cracks and flaws. Glass samples should be lightly arrissed for ease of handling.

The surface to be impacted shall be marked on each test piece.

Each test piece shall be conditioned vertically and be self-supporting at (18 ± 3) °C, for at least 12 h immediately prior to the test.

5 Test piece support apparatus

Security-glazing products should be installed in a frame which can give appropriate resistance to impact and which also provides a suitable support for the security-glazing product. See Figure 1.

The test piece support apparatus shall

— be inherently rigid,

— have an unyielding connection to a solid base and/or sturdy wall,

— ensure plane and parallel clamping of the test piece in a vertical position,

— be designed in such a way that the test piece touches only the clamping frame during the test,

— ensure clamping of the test piece on all four edges with an edge cover of (30 ± 5) mm,

— have the clamping frame, i.e. the fixed stop and adjustable stop, covered on the contact area of the test piece with rubber strips 30 mm wide and 4 mm thick of hardness 40 IHRD to 60 IHRD according to method N of ISO 48:1994,

— ensure that the edges of the test piece are clamped with a uniform pressure of (140 ± 20) kN/m^2,

— allow mounting of the test piece in such a way that the bottom edge of the exposed faces (protected and assaulted) of the test piece shall be no higher than 80 cm nor lower than 70 cm from the horizontal surface supporting the operators.

6 Tool set

The tool set shall be stored at the test temperature for at least 12 h immediately prior to the test.

6.1 Blunt impacting tools

6.1.1 **Sledgehammer**, 3,0 kg, double-faced, drop forged steel head with a 910 mm handle.

6.1.2 **Pipe**, steel, 100 mm, in accordance with ASTM A 53, 90° cut-off.

6.1.3 **Ram**, two-man, 54 kg steel with a 100 mm square strike face and two 25 mm round handles mounted perpendicular to the longitudinal centreline extending 305 mm beyond the extremity of two opposing sides.

6.1.4 **Ball-peen hammer**, 0,5 kg, drop-forged steel head with a 410 mm handle.

6.2 Sharp impacting tools

6.2.1 **Ripping bar**, forged steel bar with slotted claw and chisel ends, 610 mm long.

6.2.2 **Cold chisel**, 200 mm long and a blade width of 22 mm, to be struck with a 0,25 kg claw hammer.

6.2.3 **Structural steel angle**, 510 mm × 50 mm, 6 mm thick, AISI-M1020, 90° cut-off.

6.2.4 **Pipe**, steel, 40 mm, Schedule 80 in accordance with ASTM A 53, 90° cut-off.

6.2.5 **Fireman's pickaxe**, head drop-forged steel, 3 kg, 910 mm long.

6.2.6 **Wood splitting maul**, 3,5 kg heat-treated steel head with 75 mm cutting edge and 910 mm handle.

6.3 Thermal stress tools

6.3.1 **CO_2 fire extinguisher**, steel cylinder conforming to EN 3 or UL 10BC or equivalent filled with 9 kg CO_2.

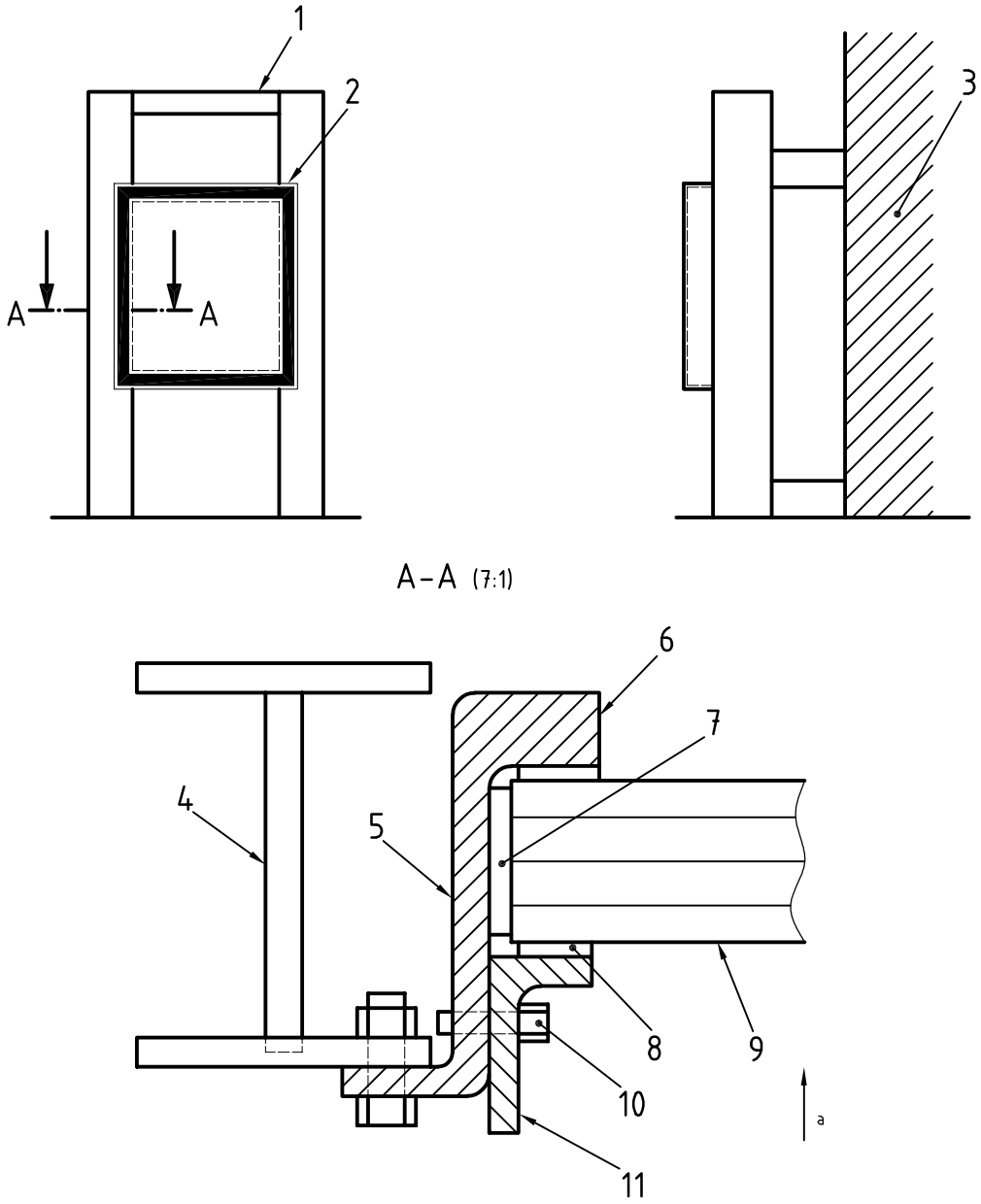
6.3.2 **Propane torch**, 5,5 kg to 7 kg cylinder with general purpose tip No. HT-880-2.9 or equivalent.

6.4 Chemically deteriorating materials (optional)

6.4.1 **Gasoline**, unleaded premium, 93 octane or equivalent.

6.4.2 **Solvent** containing acetone (minimum of 95 % concentration — technical grade).

6.4.3 **Atomising dispenser**, hand-operated pump-type similar to those used for dispensing window cleaning products (polypropylene or polyethylene).



Key

1 150 mm wide, steel
2 900 × 1 100 mm test piece
3 concrete wall
4 support structure
5 150 × 90 × 16 mm steel angle-iron
6 32 mm square steel block
7 neoprane setting block
8 glazing tape
9 glazing
10 socket head cap screw
11 loose stop

[a] Direction of attack.

Figure 1 — Test piece support apparatus and glazing test frame (detail)

7 Test team

The test team shall be employees of the testing laboratory and be comprised of

a) a test team leader or test director whose function is to direct and control the test work together with the subsequent production of a test report,

b) a timekeeper whose function is confined to timekeeping and compiling the record of the test work, and

c) two operators who carry out the manual attack.

8 Test method

8.1 Test environment

The test room temperature shall be (18 ± 5) °C.

The area immediately adjacent to the test sample, extending 1,8 m to the left and right of either of the sample's vertical edges, 3 m from its assault face and 2,4 m over the horizontal surface supporting the test team (operators), shall be free of all obstructions and appurtenances.

8.2 Installation of test piece

Place the test piece vertically, the attack face facing the operators, into the clamping frame of the test piece support apparatus. Hereby shall the test piece rest at the bottom on two neoprene setting blocks at least 50 mm long, 6 mm thick and as wide as the thickness of the test piece. The hardness of the setting blocks shall be 60 to 80 shore A according to ISO 48. Place the setting blocks at the quarter points. Then fix the test piece fixed in accordance with the requirements of Clause 6.

8.3 Test procedure

8.3.1 Test sequence and general requirements

The glazing test sample shall be tested in the sequence according to Table 1 until entry is forced.

The attack should be focused near the centre of the test piece rather than at the edge. However, the team leader or test director may at any time during the test direct the operator(s) to attack at any specific place in the area under attack.

The team leader or test director shall note the vigour of the operators so that a maximum impact force is produced on the impact face of the test piece.

All personnel actively engaged in forced-entry testing shall be equipped with appropriate items of personal protection which will include, but not necessarily be limited to, full-face shields, dust masks, sound-deadening ear protection, heavy gloves and, if necessary, appropriate chemical respirators.

Table 1 — Forced-entry sequence of testing

Test implements	Sequence				
	Class I	Class II	Class III	Class IV	Class V
Blunt impacting tool (no. of impacts)					
Sledgehammer (25)	N/A	5	10, 16	19, 22, 27	30, 33, 36, 39
10 cm diameter pipe/sledge (25)	N/A	N/A	9	18	29
Ram (10)	N/A	N/A	8	17	28
Ball-peen hammer (10)	1	2	N/A	N/A	N/A
Sharp tool (no. of impacts)					
Ripping bar (10)	N/A	7	12	23	N/A
Chisel/hammer (25)	N/A	N/A	13	25	35, 40
Angle-iron/sledge (25)	N/A	N/A	15	N/A	N/A
4 cm diameter pipe/sledge (25)	N/A	3	N/A	N/A	N/A
Fire axe (25)	N/A	N/A	N/A	24	32,38
Wood-splitting maul (25)	N/A	N/A	N/A	21	34,41
Thermal stress (min)					
Extinguisher, CO_2 (1)	N/A	4	N/A	N/A	N/A
Propane torch (5)	N/A	6 [a]	11 [b]	20 [b]	31 [b]
Chemical deterioration (amount) [c]					
Gasoline (0,25 l)	N/A	N/A	14	N/A	N/A
Acetone (0,25 l)	N/A	N/A	N/A	26	37
Total forced-entry sequences	1	7	16	27	41

N/A Not applicable.

[a] For Class II, the flame shall be extinguished with a fine mist of water immediately after the propane torch application.

[b] For Classes III, IV, and V, if the sample continues to burn after removal of the flame (self-sustaining), it shall be allowed to burn an additional 10 min and then extinguished with a fine mist of water.

[c] Chemical deterioration testing is optional, and may be eliminated.

8.3.2 Blunt impacting tools testing

8.3.2.1 General

The blunt impacting tools testing shall be directed whenever applicable according to the established sequence of testing (see Table 2), at locations pre-weakened by other phases of the test such as sharp impacting tools testing, heating and cooling.

8.3.2.2 Sledgehammer test

The operators shall deliver 25 impacts in total to the attack face of the test sample.

8.3.2.3 Pipe/sledgehammer test

One of the operators shall position the pipe with either end bearing on the attack face of the test piece while the other operator impacts 25 times the other end with the 5,5 kg sledgehammer. Conduct the test by repeated impacting at one location; the plane of the surface of the impacted area should be varied to examine the resistance of the test piece to both puncture (90°) and gouging (45° to 60°).

8.3.2.4 Ram test

Apply ten blows to the attack face of the test piece midway between the vertical edge of the test piece and at that height which is most accommodating to the physical make-up of the operators.

8.3.2.5 Ball-peen hammer test

The operators shall deliver 10 impacts in total to the attack face of the test sample.

8.3.3 Sharp impacting tools testing

8.3.3.1 Ripping bar test

The operators shall deliver 10 impacts in total to the attack face of the test sample.

8.3.3.2 Chisel/hammer test

The operator shall deliver 25 impacts using a cold chisel and a ball-peen hammer on areas of the test piece pre-weakened by previous phases of the test, and when applicable, against portions of any plastic materials which have been exposed by removal of glass layer(s) on the attack face.

8.3.3.3 Angle iron/sledgehammer test

One of the operators positions the angle iron against the attack face of the test piece while the second operator impacts 25 times the other end of the angle iron with a 5,5 kg sledgehammer.

8.3.3.4 Pipe/sledgehammer test

One of the operators positions the pipe against the attack face of the test piece while the second operator impacts 25 times the other end of the pipe with a 5,5 kg sledgehammer.

8.3.3.5 Fire-axe test

Two operators who are equipped with pick-head fire axes carry out this test. One impacts the test piece with the pick-end of the head and the other with the blade of the head. The total of impacts shall be 25.

8.3.3.6 Wood splitting maul test

Carry out this test as per 8.3.3.5, but substituting wood-splitting mauls for the fire axes.

8.3.4 Thermal stress testing

8.3.4.1 CO_2 extinguisher test

The CO_2 extinguisher test is to be carried out by two men, one of whom shall be equipped with a sufficient number of CO_2 extinguishers to provide for a total discharge time of 1 min (up to 4 fully charged extinguishers), and the other one of whom shall be equipped with a 5,5 kg sledgehammer, required sequentially following the thermal (CO_2 extinguisher) phase. Unless otherwise directed, the extinguishers shall be sequentially and fully discharged onto the attack face of the test piece. Immediately after each extinguisher has been discharged

the impact procedure of the next sequence of the test (see Table 1) — for example, 5 impacts with the sledgehammer — will be partially applied to the same location of the test piece. After the total discharge time of 1 min has been reached, all of the remaining blunt instrument impacts shall be applied to the test piece.

The team leader or test director shall ensure that the entire test sequence is conducted as rapidly as possible to optimise the cumulative effects of the thermal conditioning. He shall ensure that the last impact of the sledgehammer impact test is no longer than 7 min from the initiation of the first extinguisher discharging.

8.3.4.2 Propane torch test

The propane torch test is to be carried out by one person who will continually apply the flame of the propane torch to the test piece surface in an effort to create an opening, to enlarge an opening that might have been previously created, or to exploit any apparent weakness in the test piece to facilitate penetration in a later step of the attack sequence. Any ash or char that is developed during the course of this portion of the test may not be removed until the beginning of the next step in the attack sequence. Throughout this portion of the test, the blue tip of the torch flame shall be held no further than 25 mm from the surface of sample or ash.

The team leader or test director shall further ensure that the propane torch test is initiated immediately after the last impact test of the CO_2 extinguisher test, and that both thermal phases and the blunt and sharp impact test associated with the thermal tests are completed within a total elapsed time of 15 min.

8.3.5 Chemical deterioration testing (optional)

A minimum of 0,25 l of gasoline/acetone is to be dispensed from a spray device onto the surface of the glazing. Direct the dispensing of the gasoline/acetone at a single location which, as a result of previous impact testing has had the non-plastic attack face removed, fractured, or cracked exposing the plastic inner or rear laminates to direct impingement of the gasoline. The application of the gasoline/acetone will be at sufficient intervals to fully dispense the required quantity in no less than 5 min and not more than 8 min.

8.4 Evaluation of test results

After each sequence, the test piece shall be checked for penetration.

— A test piece has failed for the passage of contraband by forcible entry when a 3 mm diameter rod can be passed through the test piece.

— A test piece has failed for passage of a body by forcible entry when any opening in the test piece is sufficient to freely pass a solid uncompressible rectangular object measuring 130 mm × 200 mm.

9 Classification and designation

The security-glazing product shall be classified in a particular category of resistance when the test piece has resisted penetration by passage of a body by forcible entry after completing the total forced-entry sequences required for that category of resistance. The point at which failure has occurred for the passage of contraband is for information only, and is unrelated to classification.

Table 2 gives the code designations for the categories of resistance.

Table 2 — Classification for resistance of security-glazing products

Category of resistance	Total forced-entry sequences	Code designation for category of resistance
P1C	1	ISO … I C
P2C	7	ISO … II C
P3C	16	ISO … III C
P4C	27	ISO … IV C
P5C	41	ISO … V C

10 Test report

The following items shall be included in the test report:

— name of the testing laboratory;

— test number;

— date of test;

— reference to this part of ISO 16936;

— name of the company or authority submitting the sample for test;

— name (trade name or descriptive name) of the security-glazing product;

— description of the composition of the security-glazing product;

— the category of resistance against which the sample was tested according to Table 1;

— the code designation of the category of resistance, if obtained, according to Table 2;

— whether or not optional chemical deterioration testing was performed as part of this test;

— total time needed to carry out the test;

— if penetrated, the forced-entry sequence number for each mode of penetration, passage of contraband and body passage (see 8.4);

— test room temperature;

— test piece conditioning temperature;

— videotape of the entire test.

11 Marking

Products which satisfy the requirements of this part of ISO 16936 shall be accompanied by a delivery note, which includes the code designation as given in Table 2 and which identifies the attack face of the product. The same code designation can be marked on the product itself or, for reasons of security, the code designation on the product can be omitted.

Annex A
(informative)

Protection level ratings

A.1 General

Although the test method described in this part of ISO 16936 should not be used to establish or confirm the absolute prevention of forcible entries, some guidance based upon ASTM F 1233-98 is given here for different defined threat and asset levels.

A.2 Threat levels

A threat level is a perception of the capability, motivation and skill level of an intruder. Four threat levels are identified.

— Threat level 1: one or more unskilled individuals who have little knowledge of security systems or protective measures, who attack with little or no advanced planning, usually on target assets with little or no security measures. Motivation is usually money or vandalistic.

— Threat level 2: one or more semi-skilled individuals with some knowledge of and ability to defeat or compromise low-level security measures. Motivation is usually profit.

— Threat level 3: a group of skilled individuals with strong motivation, capability, knowledge and funding. Motivated by profit, public attention or disruption of services.

— Threat level 4: a group of high-skilled individuals with strong motivation, substantial technological support, knowledge and funding. Motivated by profit, public attention, sabotage or acts of war.

A.3 Asset levels

Four asset levels are categorised so that an assigned category is intended to convey the principal characteristics of that asset level and classify relative risk.

— Residential: an average-to-above-average home containing normal valuable assets.

— Commercial: offices, retail stores, small business with moderate value assets. Residential areas with high-value assets should be included in this category.

— Industrial: manufacturing facilities, high-value retail or wholesale stores and where higher-risk commodities such as firearms or narcotics are stored.

— Very high-risk facilities: utility facilities for which security requirements are not regulated, detention and correctional facilities and installations, which are attractive to threat level 4.

A.4 Possible solutions

Table A.1 gives possible security-glazing categories of resistance for different threat and asset levels as a protective measure against forced entry.

Table A.1 — Possible security-glazing classes for different threat and asset levels

Asset	Threat level 1	Threat level 2	Threat level 3	Threat level 4
Residential	I [a]	II	III	III
Commercial	II	III	III	IV
Industrial	III	III	IV	V
High-risk	III	IV	V	V

[a] Class of security glazing (see Table 2).

Bibliography

[1] ISO 6508, *Metallic materials — Hardness test — Rockwell test (scales A-B-C-D-E-F-G-H-K)*

[2] ASTM F 1233-98, *Standard Test Method for Security Glazing Materials and Systems*

[3] AS 3555:1988, *Building Elements — Testing and rating for intruder resistance*

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