CERTIFICATE
ON CERTIFICATION OF EXPERTISE GIVEN BY THE EXPERT IN THE FIELD OF:

SPECIALIZED SPECIALIZATION OF LOCK AND SECURITY EQUIPMENT

No.:

MISCELLANEOUS TECHNICAL FIELDS

METHODOLOGY

OF LOCK CYLINDER TESTING BY THE „BUMPING“ NON-DESTRUCTIVE METHOD

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Day: Month: Year:

Appointing Certificate 1749/94 issued by the presiding judge of the Municipal Court in Prague

Contents:

1. NORMATIVE REFERENCES:

Resistance class according to EN 1303 of 2005

Security classes according to ČSN P EN 1627 of 2000

2. ANALYSIS

2.1. ANALYSIS OF LOCK CYLINDER SYSTEM

Based on manufacturer's declaration that the lock cylinder structure fails to allow application of non-destructive dynamic method of bumping (hereinafter referred to as the BK method), the accredited testing laboratory shall make an analysis of the locking system.

For this, the submitter has to provide a functional sample of a lock cylinder and primary documentation of the locking system. Ii is necessary to distinguish elements of serial additional variations and active additional variations.

If it results from the analysis that the BK method can be used for the locking system, samples according to following articles will be requested. If the analysis and a checking test find out that the BK method cannot be used for the locking system, no other tests will be performed. The testing laboratory shall show the analysis result in the test report and give technical reasons why the BK method cannot be used. Then it will issue a certificate with such wording, for which the testing laboratory is responsible.

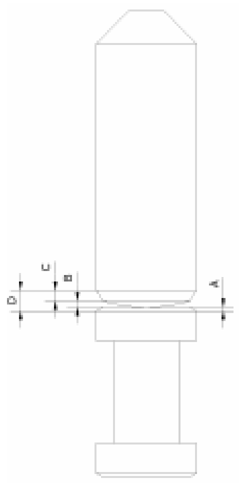
2.2. COMPULSORY DOCUMENTATION

The necessary (compulsory) documentation consists of schematic representations of the locking system cross-sections and essential documents, requested by the testing laboratory from the submitter - catalogue sheets and descriptions of operations of additional external and active blocking elements with various key cut depths, sprung blocking elements provided with cuts for the side blocking longitudinal bar, unsprung blocking elements, which are controlled by a path on the key surface, as well as of the locking systems, consisting of unsprung plates controlled by a path on the key surface. These documents should contain all basic parameters of a key and a key cut as well as basic parameters of movable elements of the locking system (if this is a system with accessory side mechanisms, then also dimensional parameters of these mechanisms). Data should be filled in to the table and the key parameters should be processed according to patterns as shown in Annex 2 of the "Methodology". These documents can be presented either in a form of dimensional drawings or as a chart (see Annex 2). Also 3D drawing is acceptable. It is necessary to specify an angle and a fitting strip of the production tool and to show the deepest variation used by the manufacturer in production for more than 95%.

2.3. INSPECTION OF LOCKING SYSTEM COMPONENT PARAMETERS

Before commencing the tests, within the analysis of the lock cylinder locking system, the testing laboratory shall measure individual locking system components and compare them with the drawing documentation. If the real product dimensions match with the drawing documentation, the inspection of samples can be considered completed. This analysis will be stored as a sample to evidence the tested lock type and will be archived in the testing laboratory premises.

The measurement procedure of the locking system components also includes measurement of the “locking system clearance“ in the dividing plane. The locking system clearance is measured by inserting an uncut blank key into the lock cylinder barrel and applying a twisting moment to one or the other side. This will turn the barrel from the zero position. The clearance parameter is then defined by the rate of turning. This parameter is always different for each manufacturer and it is measured in the testing jig on the extended indicator. This barrel turning value can be indicated either by measuring an angle on both sides or by a mark on the dial. This barrel turning value is limiting and corresponds to the locked state of the lock cylinder (tumblers are 100% locked and inserted to the lock cylinder body – incline of the indicator is directly proportional to the clearance between the lock cylinder body bores and tumbler diameters). The extreme deviations (twisting moment applied to the left side and twisting moment applied to the right side) define boundaries of the lock cylinder clearance. Thus, the lock cylinder clearance is both-sided angular deviation and forms a so-called “zero zone”. The zero zone does not have to be side symmetrical, and its center does not have to be parallel with the vertical axis of the system of coordinates. Each deflection above this value indicates that any of the tumblers became unblocked – i.e. that the applicator operation was effective.



The locking system clearance (measured as well as designed) should be smaller than the declared step of the code variation. If the clearance is larger, it is assumed that the locking system was opened by the BK method or by a secondary variation.

Photo-documentation included in the test report is a part of the analysis of the lock cylinder locking system.

Filing of the information is a part of documenting the test report of the testing laboratory, by which the tests were performed and the technical information are considered confidential. The shredding period is in accordance with the Filling and Shredding Code of the National Security Authority (at present the shredding period is 15 years).

3. TEST SAMPLE SELECTION AND APPLICATOR PRODUCTION

3.1. TESTING LABORATORY REQUIREMENTS FOR MANUFACTURERS

On the basis of manufacturer's (importer's) request the testing laboratory requires necessary number of lock cylinder samples in defined range of variations and necessary number of blank keys. The variation range on the key shall be assessed from the drawing documentation and this value is divided by three. The testing laboratory defines these variation code values for each group (i.e. variation ranges divided to thirds) also in compliance with manufacturer's internal regulations.

Analogical procedure is for single-row lock cylinders, whose locking system is completed with additional active and passive blocking elements (usually unsprung elements, pins, profiled segments, balls etc., used for profiled protection, and/or completed with elements of various sizes, i.e. various key cut depths, sprung blocking elements provided with cuts for the side blocking longitudinal bar, unsprung blocking elements, which are controlled by a path on the key surface, as well as of the locking systems, consisting of unsprung plates only, controlled by a path on the key surface).

The testing laboratory will require blank keys from the manufacturer. If the lock cylinder locking system includes additional passive or active blocking elements, the testing laboratory will require blank keys after prior consultation with the manufacturer. If the testing laboratory fails to have the applicable equipment for cutting the key cuts on additional blocking elements, the testing laboratory will request preparation of blank keys with these key cuts from the manufacturer.

Analogical procedure is also for multi-row lock cylinders. If the testing laboratory is not able to manufacture basic applicators with regards to the key cut structure on the key, the testing laboratory will request production of these applicators from the manufacturer and shall make an inspection by measuring on the basis of the documentation provided.

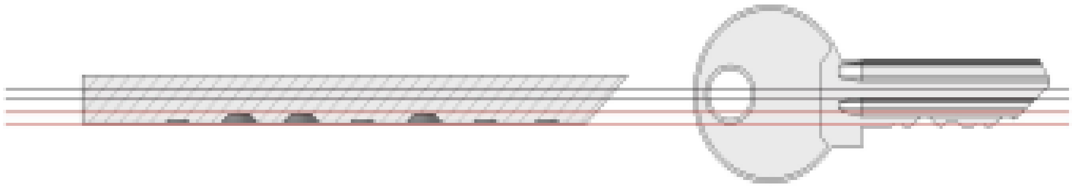
If the manufacturer provides the testing laboratory with documentation, from which it results that the lock cylinder locking system fails to enable creation of groups of lock cylinders according to following requirements due to the number of the effective combinations, the testing laboratory, after consultation with the manufacturer, shall either re-divide the groups or lower their number so that the entire variation range of the effective numbers is represented.

The testing groups should contain really produced key cuts only and should respect all technical and tactical production limitations.

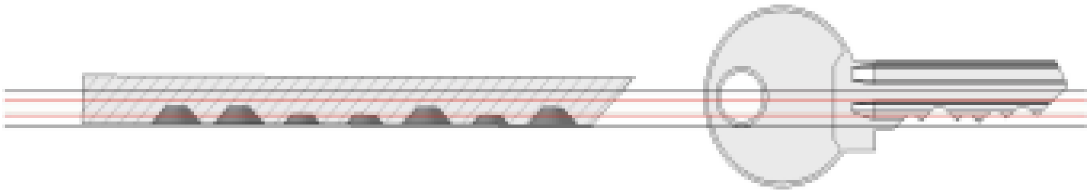
All samples of lock cylinders should have individual key cut with one original key in a sealed envelope.

Basic classification of tested lock cylinders into variation groups

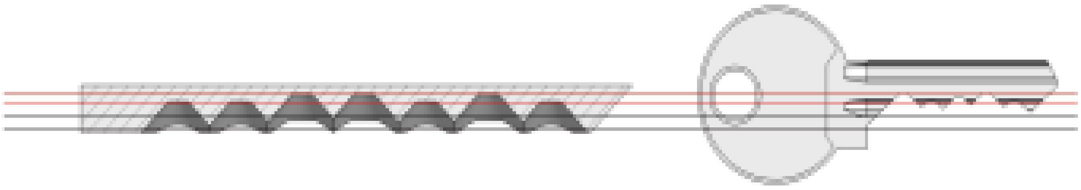
Group 1 *5X LOCK CYLINDER WITH VARIATIONS IN THE LOWER THIRD OF THE KEY CUT DEPTH (the lowest values)*



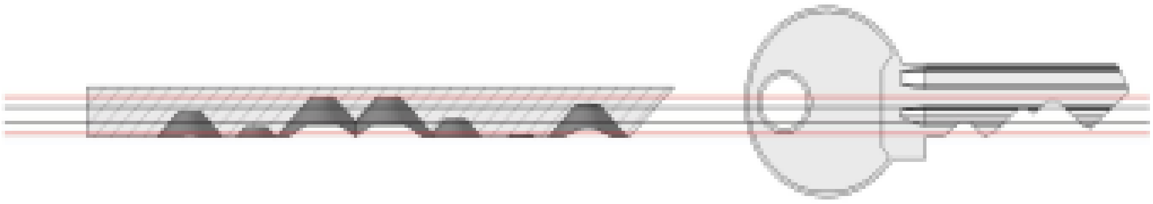
Group 2 *5X LOCK CYLINDER WITH VARIATIONS IN THE MIDDLE THIRD OF THE KEY CUT DEPTH (middle values)*



Group 3 *5X LOCK CYLINDER WITH VARIATIONS IN THE UPPER (EDGE) THIRD OF THE KEY CUT DEPTH (the highest values)*



Group 4 *5X LOCK CYLINDER WITH FULL EXTENT OF THE VARIATION FIELD (arbitrary key cuts from the number of effective combinations as considered by the manufacturer appropriate)*



Group 5 *1X LOCK CYLINDER WITH FULL EXTENT OF THE VARIATION FIELD FOR ANALYSIS OF THE LOCKING SYSTEM (arbitrary key cuts from the number of effective combinations)*

1X LOCK CYLINDER WITH FULL EXTENT OF THE VARIATION FIELD FOR CYCLING according to ČSN EN 1303:2005 (arbitrary key cuts from the number of effective combinations as considered by the manufacturer appropriate)

35X BLANK KEY OF ADEQUATE PROFILE

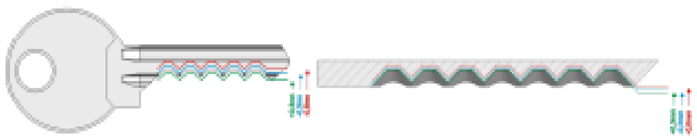
When selecting lock cylinders for the tests, do not select the lock cylinders, which use the deepest variation – more than 95%.

4. APPLICATOR MANUFACTURING

Applicator manufacturing should conform with the principle that a lock cylinder shall operate within the whole complex of its function and over the entire variation range. This means that when selecting lock cylinders of all groups, one lock cylinder sample shall be selected from each group and production of an optimal applicator is started. The procedure is selected so that the applicator is selected with maximum objectivity.

If the testing laboratory is not able to manufacture basic applicators with regards to the key cut structure on the key, the testing laboratory will request production of these applicators from the manufacturer (or other producer) and shall make a dimensional inspection on the basis of the drawing documentation provided.

Applicator sets shall be produced according to a specified procedure (see below) and on the basis of tested lock cylinder security classes as required by the submitter. The basis is a key cut equal to the deepest key cut, which is used by the manufacturer on more than 95 % of the total number of effective combinations. This is a specific variation for production and use of the applicator for the BK tests.

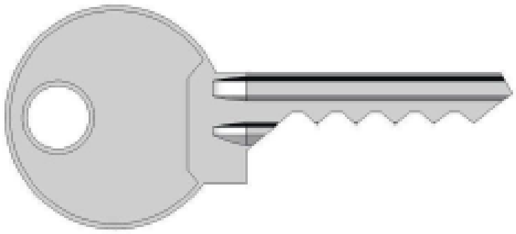


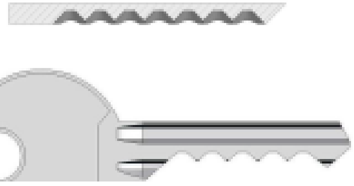
Design of basic and derived applicators.

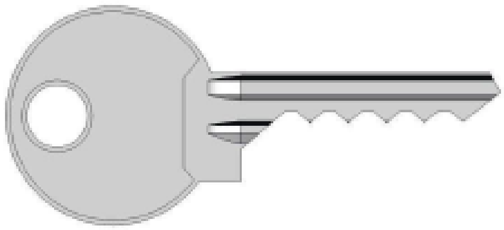
4.1. APPLICATOR SET

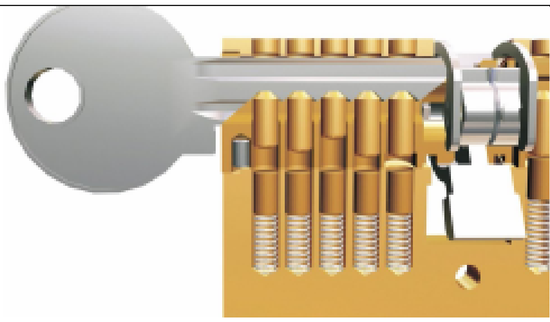
The set of applicators is manufactured by cutting on a milling machine (or by other producer). It is also produced by copying etalons for copy milling machines (or by a code cut). Blank keys provided by the manufacturer or a catalogue equivalent of the blank key shall be used for production. The basis for this is an applicator with the deepest key cut depth – more than 95 % of the actual production (this is based on analysis of the lock cylinder locking system). Then another two applicators are based on this basic applicator size, when one applicator's key cut depth is deepened by 0.3 mm (AP S -0.3) and the other one's key cut depth is deepened by 0.6 mm (AP S -0.6). In case that applicator fails to bear on the system, another applicator with key cut depth increased by 0.3 mm (AP S +0.3) shall be produced.

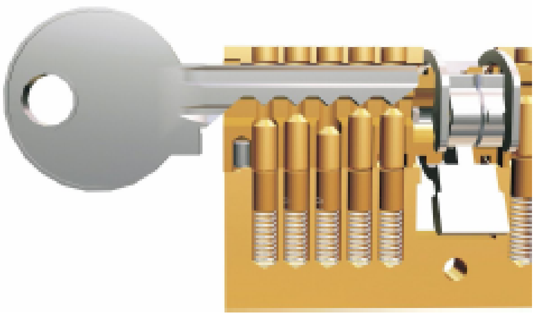
<table>
<tr><th colspan="3">Applicators</th><th>Security classes</th><th>Quantity</th></tr>
<tr><td rowspan="4">with uniform tip heights (standard)

AP S</td><td>AP S -0.6</td><td rowspan="4"></td><td>2</td><td>2</td></tr>
<tr><td>AP S -0.3</td><td>3</td><td>2</td></tr>
<tr><td>AP S Z</td><td rowspan="2">4</td><td rowspan="2">2</td></tr>
<tr><td>AP S +0.3</td></tr>
<tr><td rowspan="4">with increased front tip

AP V</td><td>AP V -0.6</td><td rowspan="4"></td><td>-</td><td>2</td></tr>
<tr><td>AP V -0.3</td><td>3</td><td>2</td></tr>
<tr><td>AP V Z</td><td rowspan="2">4</td><td rowspan="2">2</td></tr>
<tr><td>AP V +0.3</td></tr>
<tr><td rowspan="4">with the lowered key cut

AP SS</td><td>AP SS -0.9</td><td rowspan="4"></td><td>-</td><td>2</td></tr>
<tr><td>AP SS -0.6</td><td>3</td><td>2</td></tr>
<tr><td>AP SS -0.3</td><td rowspan="2">4</td><td rowspan="2">2</td></tr>
<tr><td>AP SS +0.3</td></tr>
<tr><td rowspan="4">with a lost stopper

AP SZD</td><td>AP SZD -0.6</td><td rowspan="4"></td><td>-</td><td>2</td></tr>
<tr><td>AP SZD -0.3</td><td>-</td><td>2</td></tr>
<tr><td>AP SZD Z</td><td rowspan="2">4</td><td rowspan="2">2</td></tr>
<tr><td>AP SZD +0.3</td></tr>
<tr><td rowspan="4">with the extra lowered key cut enabling ejection of applicator during application

AP SZS</td><td>AP SZS -1,2</td><td rowspan="4"></td><td>-</td><td>-</td></tr>
<tr><td>AP SZS -0.9</td><td>-</td><td>2</td></tr>
<tr><td>AP SZS -0.6</td><td rowspan="2">4</td><td rowspan="2">2</td></tr>
<tr><td>AP SZS +0.3</td></tr>
</table>

Basic applicators will be produced according to the table, out of which optimal applicators will be selected by a test. For the tests to determine optimal applicators (O AP) a set of one piece is needed, for the lock cylinder tests themselves two sets of optimal applicators needs to be produced.

4.2. OPTIMAL APPLICATOR DETERMINATION PROCEDURE

Select one lock cylinder from each group of lock cylinders (groups 1 – 4). Fix the lock cylinders into the testing jig so that they can be tested. Use double-sided adhesive tape (or contact adhesive) to stick the incline indicator on the lock cylinder barrel face.

The lock cylinder shall be securely fixed in the jig to prevent it from moving within all three planes of the XYZ system of coordinates.

On the basis of the locking system analysis, especially with regard to the detected locking system clearance (the locking system clearance is a value of indicator deflection to both sides by inserted blank key without cut variation), a technician shall select a basic twisting moment (value B), which shall be used during the test.

Twisting moment A (its value will be increased by 30 %) and twisting moment C (its value will be increased by 30 %) will be derived from this basic twisting moment.

The basic twisting moment is selected from the range between 0.01 Nm (a twisting moment, which is necessary to turn the barrel with the original key – it is different for separate types of lock cylinders) and 1.5 Nm (a twisting moment determined for the security mechanism operation test according to ČSN EN 1303:2005). The testing laboratory will determine the twisting moment to be applied from the analysis and on the basis of the procedure in the beginning of the tests.

1. When the lock cylinder is secured in the jig, insert a **basic applicator with uniform tip heights** (**AP S Z**) into the keyhole. Insert a preloading tool (spring Bowden, flexible drift etc.) into a hole in the key head. Deflection from the dial zero position will be displayed on the incline indicator dial. Insert an adjusting device (or a torque wrench) on the key head and set the zero position on the incline indicator dial by shifting a defined weight along a fulcrum. This defines the **basic twisting moment B**. (If the torque wrench is used, you will get the value in Nm).

When the zero position is set on the incline indicator dial, remove the adjusting device (the torque wrench) and read the value of deflection from the zero position on the dial.

2. Set the dial zero position to this value (by turning the dial) and commence the tests to determine an optimal applicator. Move the applicator out of the keyhole by one position and hit with the impact tool (the impact tool shall be selected by the testing technician at his own discretion and on the basis of his experience). If the incline indicator deflects above the zero position, then record this value to a table. Make 30 applications (hits) in this way. If the applicator causes different deflections at separate applications, record number and size of these deflections. During the test use the widest possible range of impact forces with the effort to overcome the locking system of the lock cylinder.

3. Perform the second test using the **twisting moment A** (30% higher than B) and make another 30 applications, while recording number and size of deflections.
4. Perform the third test using the **twisting moment C** (30 % lower than B).
5. Repeat the whole cycle of tests described in steps 1 – 4 using the applicator with a key cut, which is deeper by 0.3 mm. (AP S3)
6. Repeat the whole cycle of tests described in steps 1 – 4 using the applicator with a key cut, which is deeper by 0.6 mm. (AP S6)
7. If the applicator fails to have any influence on the system, repeat the whole cycle of tests described in steps 1 – 4 using the applicator with a key cut, with the key cut depth increased by 0.3 mm (AP Z3).
8. When all these four tests are finished, assess, which of the applicators caused the highest number of the largest deflections or lesser number of the largest deflections and this applicator will become the **optimal applicator with uniform tip heights** (**O AP S**).

Repeat the whole cycle of tests described in steps 1 – 7 for the **applicator with increased front tip** (**AP V)** with all three types (basic, with decrease of 0.3 mm and with decrease of 0.6 mm, and/or with increase of 0.3 mm) and select the optimal **applicator with increased front tip** (**O AP V**).

Repeat the whole cycle of tests described in steps 1 – 7 for the **applicator with the lowered key cut** (**AP SS**) with all three types (basic, with decrease of 0.6 mm a with decrease of 0.9 mm, and/or with increase of 0.3 mm) and select the **optimal applicator with the lowered key cut** (**O AP SS**).

Repeat the whole cycle of tests described in steps 1 – 7 for the **applicator with a lost stopper** (**AP SZD)** with all three types (basic, with decrease of 0.3 mm a with decrease of 0.6 mm, and/or with increase of 0.3 mm) and select the **optimal applicator with a lost stopper** (**O AP SZD**).

Repeat the whole cycle of tests described in steps 1 – 5 for the **applicator with the lowered key cut enabling ejection of applicator during application** (**AP SZS)** with all three types (basic, with decrease of 0.9 mm, with decrease of 1,2 mm, and/or with increase of 0.3 mm) and select the **optimal applicator with the lowered key cut enabling ejection of applicator during application** (**O AP SZS**).

If the incline indicator shows no deflection during applications for none of the three applicators of the same type (for the lock cylinder groups 1 and 2), it will be assessed as ineffective. Then select a basic applicator with the key cut depth corresponding to the highest tumbler (the deepest variation in more than 95 %) of the given lock cylinder group. In such case repeat the whole cycle of tests described in steps 1 – 7 and on the basis of their results select the optimal applicator for the given lock cylinder group.

If a lock cylinder locking system gets open during a test to select an optimal applicator, this will not be included to the main test assessment. Manufacture two duplicates for each optimal applicator type and thus create two sets of optimal applicators for the lock cylinder tests.

4.3. COMBINED APPLICATORS WITH ADDITIONAL VARIATION ON A KEY

Applicators for combined lock systems are divided into main systems and secondary variations.

The lock cylinders with multiple variation rows, which do not exclude application of the BK method, shall be tested identically as the single-row systems.

An combined applicator with serial additional variation, which is cut in series on the key profile for a limited production batch and does not change, is selected according to a standard procedure.

As a blank key you need such a blank key with this additional variation already cut and the applicator is made for the main variation row of tumblers.

Tested lock cylinders of this type should contain identical blank keys for the tested series, which ensures unblocking the additional variation when performing the BK test on the main variation. The applicator is selected identical on three levels is in case of single-row systems but they always have an identical additional variation corresponding to the tested series of lock cylinders. These are variations extending the combinatorics of the key variations after several production batches.

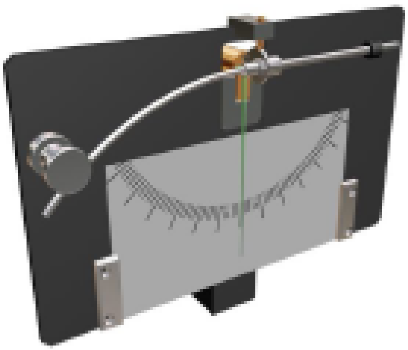
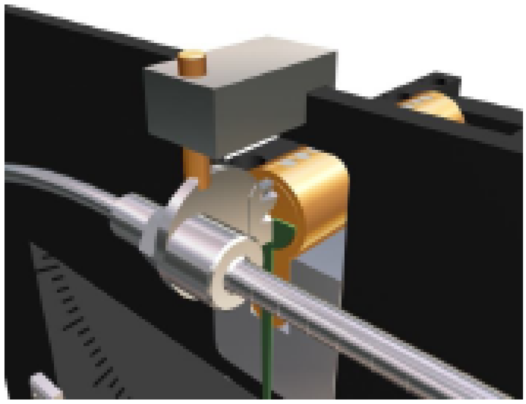
Combined applicators with active additional variation.

These are lock systems, where a change is made always on both (or more) variations at the same time and variation value of the combinatorics is multiplying.

These applicators are produced in the same way as single-row applicators, on other variations at the same time. On the basis of the lock cylinder analysis and the variations drawing documentation, the variation range will be again divided into three variation levels and the applicators will be manufactured analogically and identically by the ascending method of cut depths. Testing and testing applicator selection are performed identically as for the single-row systems.

If the tested lock cylinder resists to all applicators, when selecting the testing applicator, then select the applicator with the deepest variation on both and more tumble rows. Then, the depth of the applicator deepest cuts in all rows should match with maximum depths of the production process used by the manufacturer for 95% of production.

5. TESTING JIG

5.1. TIGHT FIT OF LOCK CYLINDER TO THE JIG

Tight fit of a lock cylinder to the jig means that the lock cylinder to be tested is fixed with the use of a main fastening bolt so that the lock cylinder is prevented from sliding or rotating against the XYZ coordinate system center. The testing jig design ensures full functionality of the lock cylinder, easy fixing and sufficient space for the testing technician to work during the test. Technician's access to the lock cylinder is not limited so he can do all and any operations on the lock cylinder, including applications under selected angles.

Secure fixation of the lock cylinder is a guarantee of the test objectiveness with constant rigidity and weight of the testing jig.

All preparatory work on the testing jig as well as when adjusting the twisting moment is not limited by technician's time. It is limited only by the number of impacts as specified in tables.

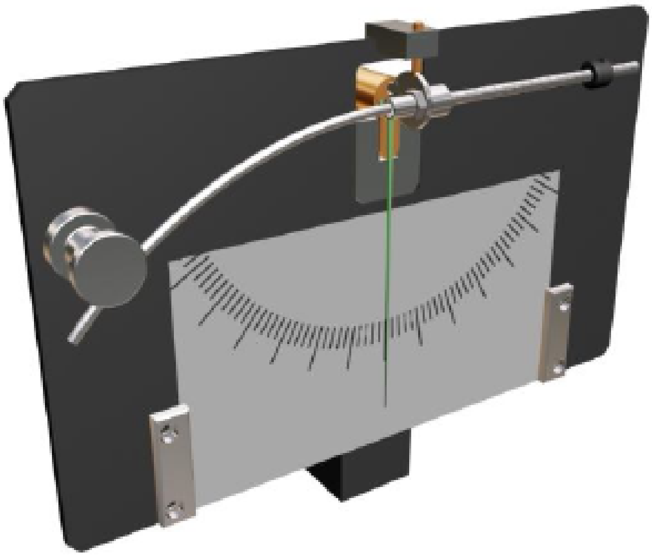
In case of tests of lock cylinders of non-standard sizes, padlocks with unblocked position and special locks, the testing jig trolley should be designed so that it corresponds with installation as described in 4.1.

5.2. TWISTING MOMENT DEVELOPMENT

Twisting moment during tests for determination of the optimal applicator is developed by a flexible preloading tool without the use of a human factor (spring Bowden, flexible drift with tension spring etc.).

The twisting moment will be developed by the preloading tool, which will be inserted into the hole in the applicator head and securely connected to an applicator head. The preloading tool must not substantially increase the applicator weight. End part of the preloading tool is anchored to a movable draw bolt, whose move will change the twisting moment value on the applicator. After setting to the required twisting moment, the movable draw bolt will be secured to a face plate of the testing jig either mechanically or magnetically.

Connect the movable draw bolt to the testing jig face plate so that it is possible to preload both rightwards and leftwards. The required twisting moment value shall be calibrated to one of the A, B, C values by an accessory linkage mechanism (or by moving a small weight of a known weight along a lever arm respectively). A torque wrench with the Nm indicator can be used for such calibration. New calibration should be performed in case of change of preload direction.



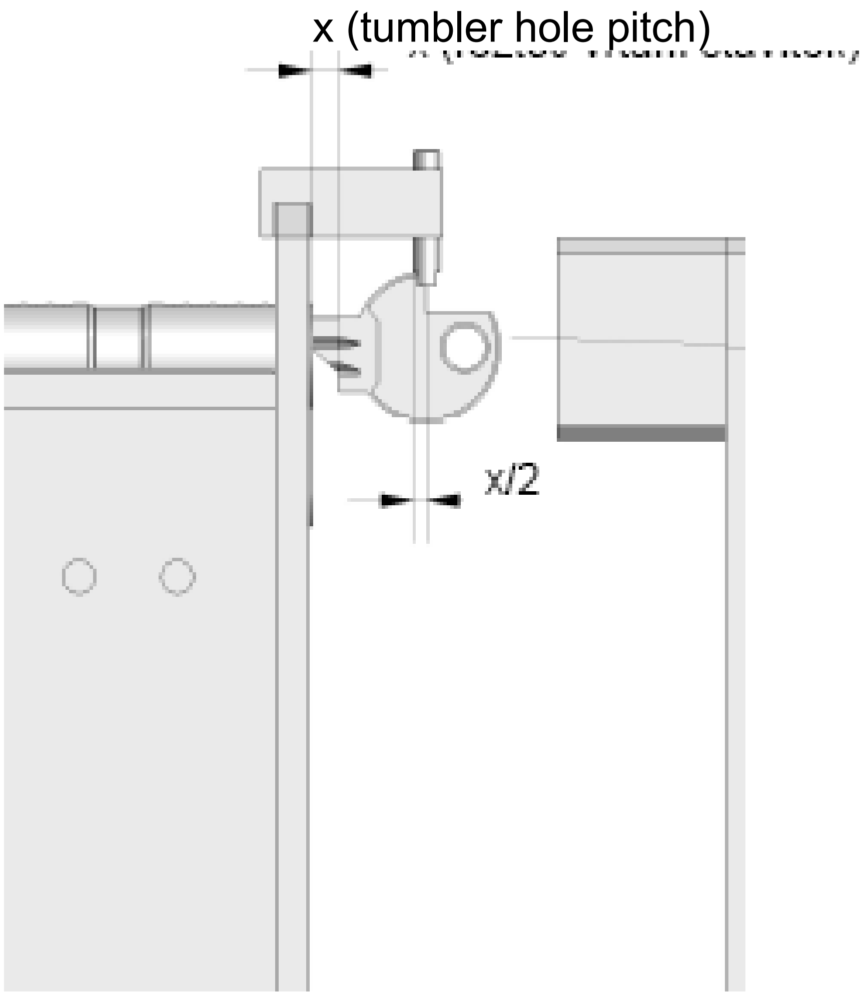
The twisting moment can be applied on the applicator and consequently on the locking system in three ways.

a) Application is performed **manually by the technician with the use of manual preloading**, or with the use of the preloading tool as selected by the technician (in such case it is not possible to define the preload value – for test of lock cylinders by manually performed application).

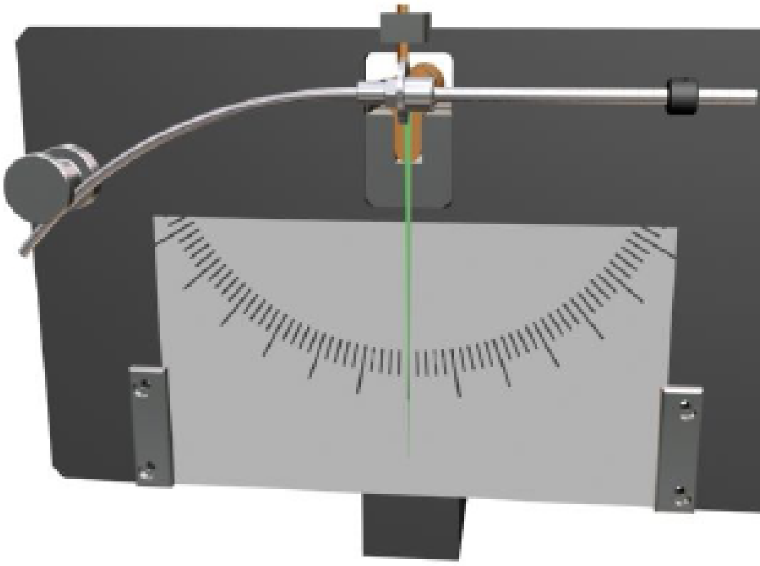
b) Application is performed on the applicator by a flexible element, which is securely fixed to the key head. The twisting moment is applied directly on the applicator, which causes partial turn of the applicator and deflection corresponding to the locking system clearance when a blank key without variation is inserted. The locking system is under specified draw for the whole period of application – for tests of lock cylinders of the security classes 2 to 4.

c) The twisting moment is applied from the applicator zero position. The twisting moment is applied by a jig, which secures the applicator – or the applicator head respectively, in zero position of the locking system clearance (see figure).

The fixation jig will provide immediate start of the twisting moment, while the applicator is inserted to the keyhole. Length of the longitudinal step of the retarding jig must not exceed a half of the tumbler pitch. The locking system is free of preload in the preliminary stage – for tests of lock cylinders of the security classes 3 and 4.



5.3. MEASURING FIXTURE - CYLINDER INCLINE ANGLE MEASURING



The incline indicator is made of a light material (glue-coated carton, plastic pad from an exercise book, thin strap of metal sheet) and it is fixed to the lock cylinder barrel by both-sided sticky tape so that it is prevented from touching the key stopper. An optical measuring fixture thus provides the technician with direct feedback with information on the applicator efficiency, correctness of twisting moment setting and correctness of force of a hit applied by the impact tool. Informative measurement of deflection is read on a dial, which is located in the lower part of the front plate of the testing jig. The reading can be determined from deflections on the standard dial of the jig (in degrees) or by indicating maximum deflections with a mark.

6. MAIN TEST PROCEDURE

As required by the submitter, the main test is performed on a set of lock cylinders divided into groups 1 to 4 (there are four lock cylinders = eight samples in each group) for the required resistance class. The main test is performed on both sides (if single-sided lock cylinders are used, 8 pieces of lock cylinders = 16 samples are required for each group of lock cylinders). The test is performed by a testing team consisting of a test manager and two technicians. The reason for two technicians is to ensure objectivity of the test. Technician No. 1 shall test the first half of the samples to be tested, technician No. 2 the other half of the samples.

By passing the main test of the BK method the tested lock cylinders should meet the following requirements:

6.1. REQUIREMENTS FOR THE TEST ITSELF

Table 1

	Table 1		Security classes		
			2	3	4
Applicators	AP S		x	x	x
	AP V		-	x	-
	AP SZD		-	-	x
	AP SZS		-	-	x
Number of cycles according to ČSN EN 1303 Art. 4.3			25 000	50 000	100 000
Total number of applications - sample after durability test			90	160	300
Total number of applications - sample without durability test			90	160	300
Number of opened lock cylinders after durability test (1/2 of lock cylinder = sample)			0	0	0
Number of opened lock cylinders without durability test (1/2 of lock cylinder = sample is enough)			2	1	0
Tight fit of lock cylinder in the jig			YES	YES	YES
Test		AP S (L) R	45	20	30
		AP S (P) R	45	20	30
		AP S (L) DP	0	20	30
		AP S (P) DP	0	20	30
		AP S (L) VDP	0	20	30
		AP S (P) VDP	0	20	30
		AP V (L) R	0	20	0
		AP V (P) R	0	20	0
		AP SZD (L) DP	0	0	30
		AP SZD (P) DP	0	0	30
		AP SZS (L) DP	0	0	30
		AP SZS (P) DP	0	0	30
	K - Total		90	160	300
	Legend				
	(L) R	Leftward twisting - manually			
	(P) R	Rightward twisting - manually			
	(L) DP	Leftward twisting - defined pre-springing			
	(P) DP	Rightward twisting - defined pre-springing			
	(L) VDP	Leftward twisting - defined pre-springing + leading			
	(P) VDP	Rightward twisting - defined pre-springing + leading			

Security class 2

- Each lock cylinder in all four groups will undergo a test BK, i.e. 90 applications by the optimal applicator with uniform tip heights (standard) O AP S on each side of the lock cylinder
- 50 % of them to the right side and 50 % to the left side,
- Twisting moment of the locking system preload is developed either by a technician's hand or manually by a preloading tool, as decided by the technician,
- Also, one lock cylinder sample, which underwent a durability test, will be tested in the same way.

On half of the total number of applications the team manager checks functionality of the tested samples by inserting an original key and trying to turn it by 360 degrees to the right side, then by 360 degrees to the left side.

Methodology of work with APS, APV applicators

1. Secure a sample in the testing jig
2. Apply a twisting moment according to table 1
3. Insert the applicator into the keyhole
4. Move the applicator out by one tumbler-to-tumbler distance
5. Hit by the impact system
6. Record the value

Repeat the steps 4 to 5 until the total number of applications is reached.

Security class 3

- Each lock cylinder in all four groups will undergo a test BK, i.e. 120 applications by the optimal applicator with uniform tip heights (standard) O AP S on each side of the lock cylinder
- 40 applications of them shall be performed with defined pre-springing,
- 50 % of them to the right side and 50 % to the left side,
- 40 applications performed with defined pre-springing with leading,
- 50 % of them to the right side and 50 % to the left side,
- 40 applications performed manually,
- 50 % of them to the right side and 50 % to the left side,
- Each lock cylinder in all four groups will undergo a test BK, i.e. 40 applications by the optimal applicator with increased front tip O AP V on each side of the lock cylinder
- 50 % of them to the right side and 50 % to the left side,

- Also, one lock cylinder sample, which underwent a durability test according to manufacturer’s declaration (on 25 000 cycles, on 50 000 cycles or on 100 000 cycles), will be tested in the same way.

On half of the total number of applications the team manager checks functionality of the tested samples by inserting an original key and trying to turn it by 360 degrees to the right side, then by 360 degrees to the left side.

Security class 4

- Each lock cylinder in all four groups will undergo a test BK, i.e. 180 applications by the optimal applicator with uniform tip heights (standard) O AP S on each side of the lock cylinder
- 60 applications of them performed with defined pre-springing,
- 50 % of them to the right side and 50 % to the left side,
- 60 applications performed with defined pre-springing with leading,
- 50 % of them to the right side and 50 % to the left side,
- 60 applications performed with manual pre-springing,
- 50 % of them to the right side and 50 % to the left side,
- Each lock cylinder in all four groups will undergo a test BK, i.e. 60 applications by the optimal applicator with a lost stopper O AP SZD on each side of the lock cylinder
- Performed with defined pre-springing,
- 50 % of them to the right side and 50 % to the left side,
- Each lock cylinder in all four groups will undergo a test BK, i.e. 60 applications by the optimal applicator with extra lowered stopper O AP SZS on each side of the lock cylinder
- Performed with defined pre-springing,
- 50 % of them to the right side and 50 % to the left side,
- Also, one lock cylinder sample, which underwent a durability test according to manufacturer’s declaration, will be tested in the same way.

On half of the total number of applications the team manager checks functionality of the tested samples by inserting an original key and trying to turn it by 360 degrees to the right side, then by 360 degrees to the left side. Then the key is removed.

Methodology of work with APSZD, APSZS applicators

1. Secure a sample in the testing jig
2. Apply a twisting moment according to table 1
3. Insert the applicator into the keyhole

4. Hit by the impact system

Repeat the step 4 until the total number of applications is reached.

6.2. EVALUATING RESULTS DURING THE TEST ITSELF

Security class 2

- Maximum of two samples without the durability test is allowed to be opened,
- No sample after the durability test is allowed to be opened,
- If multiple samples are overcome, a new set of samples should be provided (with new variation selection in levels) and the test should be repeated, while no sample is allowed to be overcome,
- If a sample after the durability test is overcome, two new lock cylinders after the durability test should be provided and none of them is allowed to be overcome.

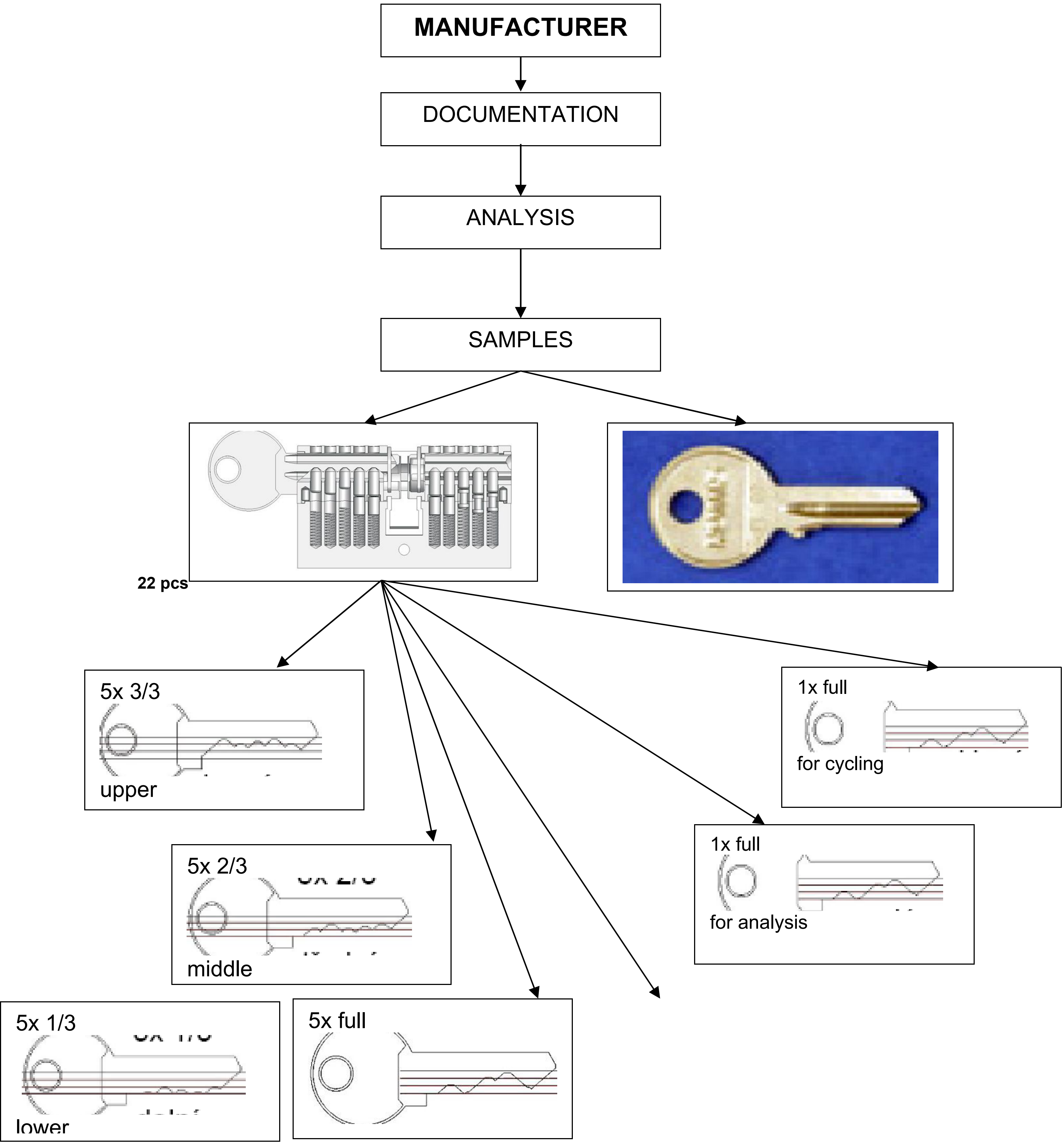
Security class 3

- Maximum of one sample without the durability test is allowed to be opened,
- No sample after the durability test is allowed to be opened,
- If multiple samples are overcome, a new set of samples should be provided (with new variation selection in levels) and the test should be repeated, while no sample is allowed to be overcome,
- If a sample after the durability test is overcome, two new lock cylinders after the durability test should be provided and the test should be repeated, while no sample is allowed to be overcome.

Security class 4

- No sample without the durability test is allowed to be overcome,
- If any sample without the durability test is overcome, a new set of samples should be provided (with new variation selection in levels) and the test should be repeated, while no sample is allowed to be overcome,
- No sample after the durability test is allowed to be overcome,
- If any sample from the replacement set and/or a sample after the durability test is overcome, the lock cylinder will be assessed as unsatisfactory.

7. GRAPHIC REPRESENTATION OF TEST PROCEDURES



8. DIAGRAM OF SELECTING AN OPTIMAL APPLICATOR IN ONE GROUP

Security class 2

4 cylinders = 8 samples
160 applications
Optimal applicator with uniform tips

1 cylinder after durability
Optimal applicator
90 applications
Left side
90 applications
Right side

90 applications
after durability

45 applications to the right side
45 applications to the left side
45 applications to the right side
45 applications to the left side
45 applications to the right side
45 applications to the left side

Twisting moment of the locking system preload is developed either by a technician's hand or manually by a preloading tool, as decided by the technician

Security class 3

1 cylinder after lifetime

Optimal applicator with uniform tips
120 applications
40 applications manually
50% of applications to the right side
50% of applications to the left side

40 applications with pre-springing
50% of applications to the right side
50% of applications to the left side

40 applications with leading
50% of applications to the right side
50% of applications to the left side

Applicator with increased tip
40 applications

20 with pre-springing
50% of applications to the right side
50% of applications to the left side

20 with leading
50% of applications to the right side
50% of applications to the left side

Optimal applicator with uniform tips
120 applications

40 applications with pre-springing
50% of applications to the right side
50% of applications to the left side

40 applications with leading
50% of applications to the right side
50% of applications to the left side

40 applications manually
50% of applications to the right side
50% of applications to the left side

Applicator with increased tip
40 applications

20 with pre-springing
50% of applications to the right side
50% of applications to the left side

20 with leading
50% of applications to the right side
50% of applications to the left side

Security class 4

Optimal applicator with uniform tips
180 applications
60 applications with pre-springing
50% of applications to the right side
50% of applications to the left side

60 applications with leading
50% of applications to the right side
50% of applications to the left side

60 applications manually
50% of applications to the right side
50% of applications to the left side

Optimal applicator with lost stopper
60 applications
30 applications with pre-springing
50% of applications to the right side
50% of applications to the left side

30 applications with leading
50% of applications to the right side
50% of applications to the left side

Optimal applicator with extra lowered key cut
60 applications
30 applications with pre-springing
50% of applications to the right side
50% of applications to the left side

30 applications with leading
50% of applications to the right side
50% of applications to the left side

1 cylinder after lifetime

Optimal applicator with uniform tips
180 applications
60 applications with pre-springing
50% of applications to the right side
50% of applications to the left side

60 applications with leading
50% of applications to the right side
50% of applications to the left side

60 applications manually
50% of applications to the right side
50% of applications to the left side

Optimal applicator with lost stopper
60 applications
30 applications with pre-springing
50% of applications to the right side
50% of applications to the left side

30 applications with leading
50% of applications to the right side
50% of applications to the left side

Optimal applicator with extra lowered key cut
60 applications
30 applications with pre-springing
50% of applications to the right side
50% of applications to the left side

30 applications with leading
50% of applications to the right side
50% of applications to the left side

9. TERMINOLOGY AND DEFINITIONS

Active blocking elements - elements contained in the locking system, to allow increasing the number of effective combinations, are usually in several sizes and they join the defined key cuts on the side of the key. They are either sprung or provided with cuts for the side blocking bar.

Active additional variations – This is an independent variation row of a lock system, which locks independently on other systems, while the key is removed and has its own variation heights.

Applicator with uniform tip heights (standard) AP S Z - it is manufactured by copying from etalons requested from the manufacturer on the basic variation of the deepest key cut used in a number of effective combinations; this is a basis for AP S -0.3 with the key cut lowered by 0.3 mm and AP S -0.6 with the key cut lowered by 0.6 mm, also AP S +0.3 applicator with the key cut depth increased by 0.3 mm. All tips between key cuts are identical (the front tip should be cut away from the etalon during copying).

Applicator with increased front tip AP V - this is a basis for AP V -0.3 with the key cut lowered by 0.3 mm and AP V -0.6 with the key cut lowered by 0.6 mm, also AP V +0.3 applicator with the key cut depth increased by 0.3 mm.

Applicator with the lowered key cut AP SS - it is manufactured by copying from etalons or according to documentation requested from the manufacturer on the basic variation of the deepest key cut used in a number of effective combinations. Basic applicator key cut, whose key cut is deepened by 0.3 mm; this is a basis for AP SS -0.6 with the key cut lowered by 0.6 mm, AP SS – 0.9 with the key cut lowered by 0.9 mm and AP SS +0.3 with the key cut raised by 0.3 mm.

Applicator with a lost stopper AP SZD - production of this kind of applicator is subject to proper knowledge of design of both the lock cylinder and the key. Its operation differs from other applicators by the fact that this applicator does not need to be moved out by one step after each impact of the impact tool, as its key tip and stopper are shortened. At is produced similarly as the applicator with uniform tip heights.

Applicator with the extra lowered key cut AP SZS - allowing the applicator to be moved out after application - a distance between the tip of the applicator leading edge and the back edge must be smaller than the value of the highest variation contained in a given key cut. It is manufactured by copying from etalons or according to documentation requested from the manufacturer on the basic variation of the deepest key cut used in a number of effective combinations. Basic applicator key cut, whose key cut is deepened by 0.3 mm; this is a basis for AP SS -0.6 with the key cut lowered by 0.6 mm, AP SS -0.9 with the key cut lowered by 0.9 mm, AP SS -1,2 with the key cut lowered by 1,2 mm and A P SS +0.3 with the key cut raised by 0.3 mm.

Defined range of variations - range of variations in individual groups of lock cylinder samples.

Optimal applicator O AP S - optimal applicator with uniform key cut depth and with uniform tip heights.

Optimal applicator O AP V - optimal applicator with increased tip on the last position.

Optimal applicator O AP SS - optimal applicator with lowered key cut depths.

Optimal applicator O AP SZD - optimal applicator with a lost stopper.

Optimal applicator O AP SZS - optimal applicator with extra lowered key cut depths.

Twisting moment A - selected twisting moment increased by 30 %.

Twisting moment B - selected twisting moment (from 0.01 Nm to 1.5 Nm).

Twisting moment C - selected twisting moment lowered by 30 %.

Passive blocking elements - elements contained in the locking system, which allow increase of the number of effective combinations; they are usually bound to a hole key cut on the side of the key, whose positions are not always occupied.

Preloading tool (spring Bowden, flexible drift etc.) - a tool to develop a twisting moment.

Combined applicator with active additional variation - This is an applicator for a lock design with one and more rows of independent active tumblers and sub-tumblers. This means that all rows of active tumblers have their own system of variation mode of a lock and their combinations are always changing independently on other rows. The tumbler rows can differ from each other by their designs, positions or variation ranges. They do not have to always show the compulsory value of repetition of compulsory values defined by a norm, as for these structures the variation range is in product of all rows. In this case the applicator is combined and it is made for each row to be active according to 3.2. It is cut by steps, on each side separately. Combined applicator then consists of all such verified and functional variations, cut on one applicator.

Combined applicator with serial additional variation - This is an applicator for a lock design with one and more rows of the main variation row and with the additional variation. The additional variation changes after using the whole variation range of the main variation. For this lock design the main and additional variations are added together. The applicator is made according to 3.2 for the main variation, and the additional variation is cut on the applicator in unlocked state for all tested locks.

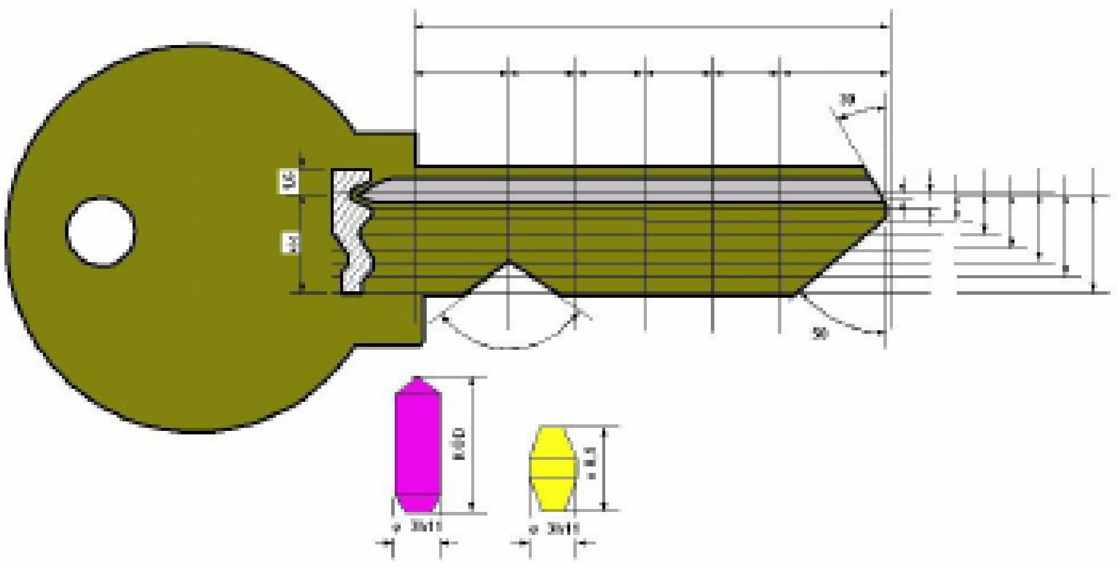
Impact tool - a tool, which is used to perform individual applications by the applicator. It is usually shaped as a "hammer"; the tool head can be made of plastic, aluminum, wood etc.

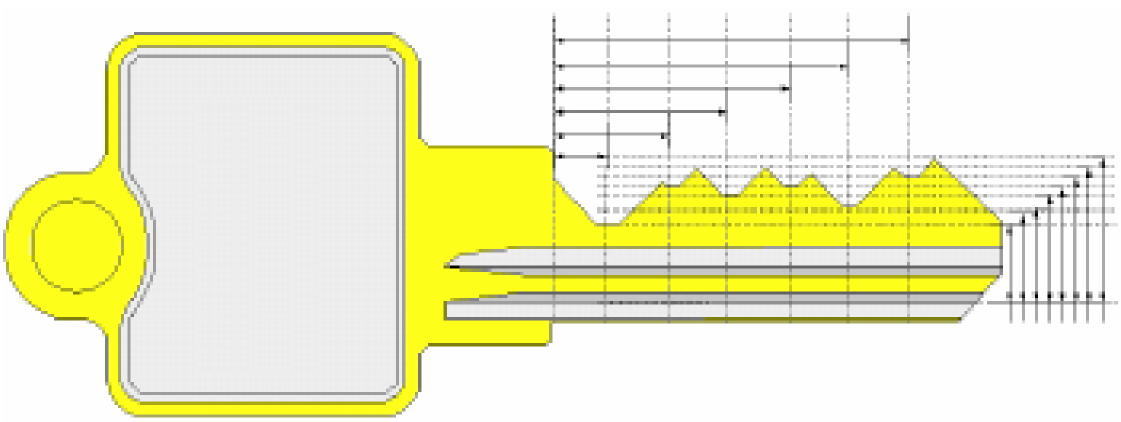
"Locking system clearance" in the dividing plane - clearance, whose value must not exceed height of one variation step.

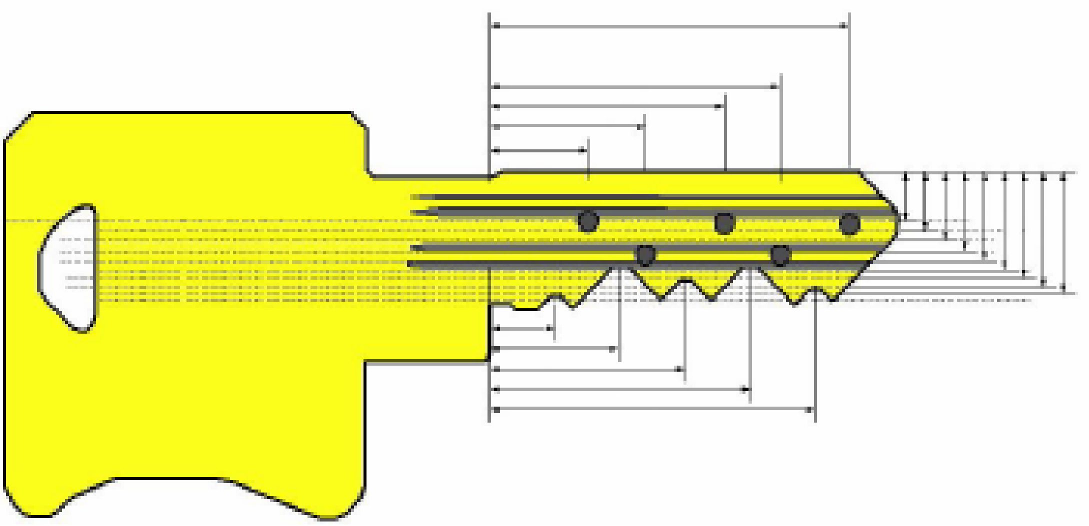
Table of requirements for information on lock cylinder locking systems – to be filled in by the test orderer

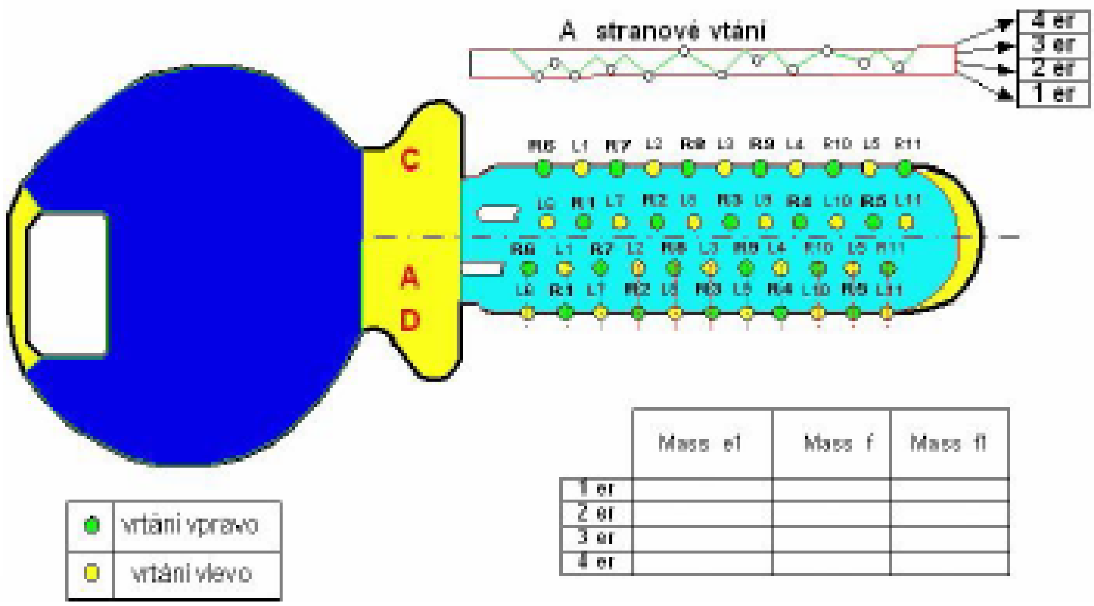
Group	*DESCRIPTION*	*USED VARIATIONS*
1	*5x LOCK CYLINDER WITH VARIATIONS V LOWER THIRD OF THE KEY CUT DEPTH (the lowest values)*	
2	*5x LOCK CYLINDER WITH VARIATIONS V MIDDLE THIRD OF THE KEY CUT DEPTH (middle values)*	
3	*5x LOCK CYLINDER WITH VARIATIONS IN THE UPPER THIRD OF THE KEY CUT DEPTH (the highest values)*	
4	*5X LOCK CYLINDER WITH FULL EXTENT OF THE VARIATION FIELD (arbitrary key cuts from the number of effective combinations as considered by the manufacturer appropriate)*	
5	*1X LOCK CYLINDER WITH FULL EXTENT OF THE VARIATION FIELD PRO ANALYSIS OF THE LOCKING SYSTEM (arbitrary key cuts from the number of effective combinations)* *1X LOCK CYLINDER WITH FULL EXTENT OF THE VARIATION FIELD PRO CYCLING according to ČSN EN 1303:2005 (arbitrary key cuts from the number of effective combinations as considered by the manufacturer appropriate)*	

Types of dimensional sketches of keys

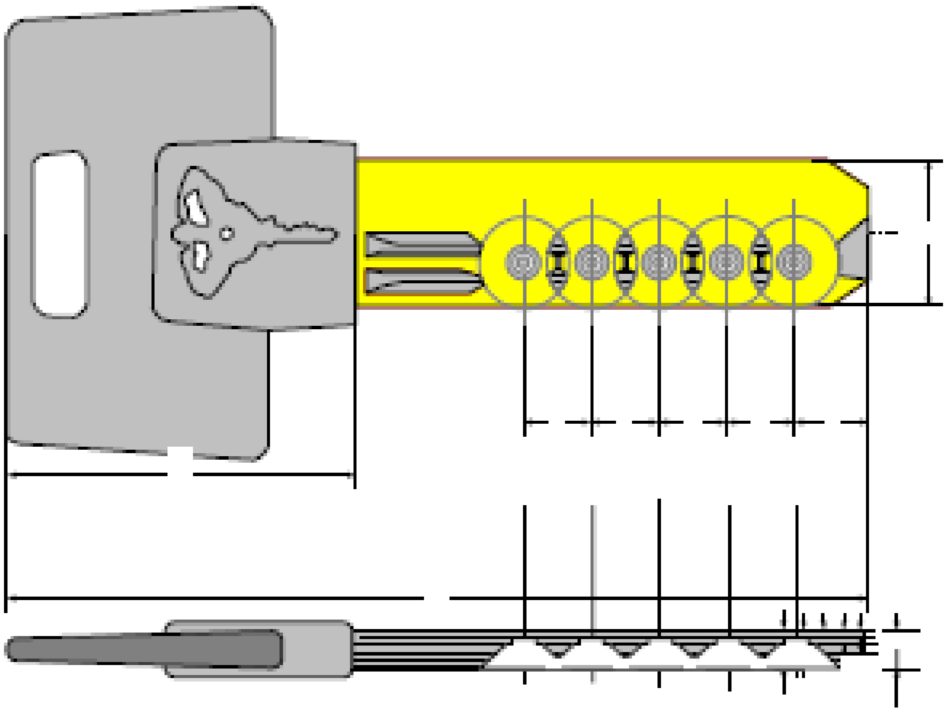


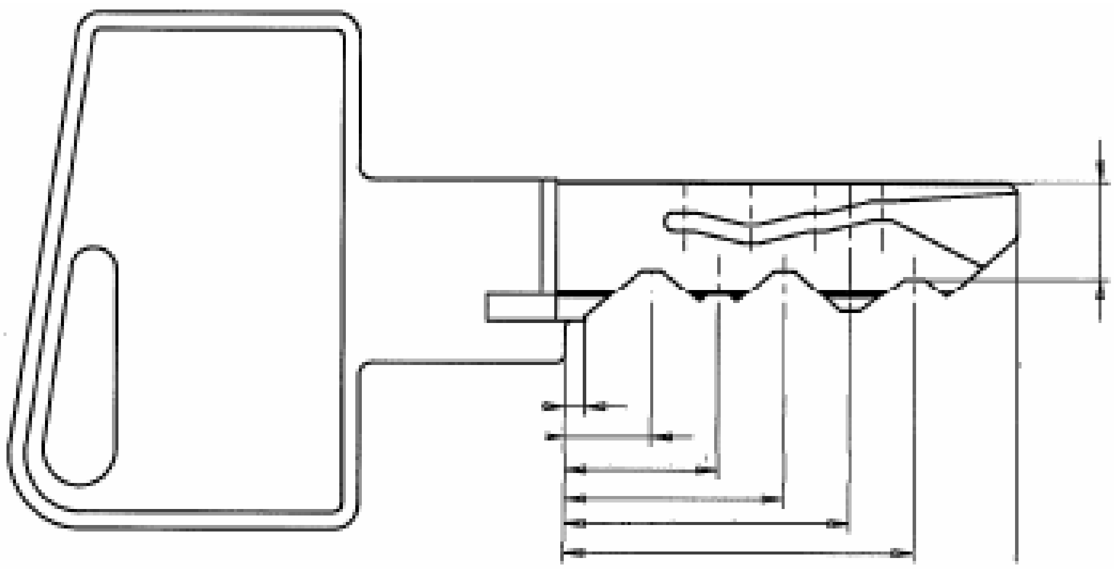




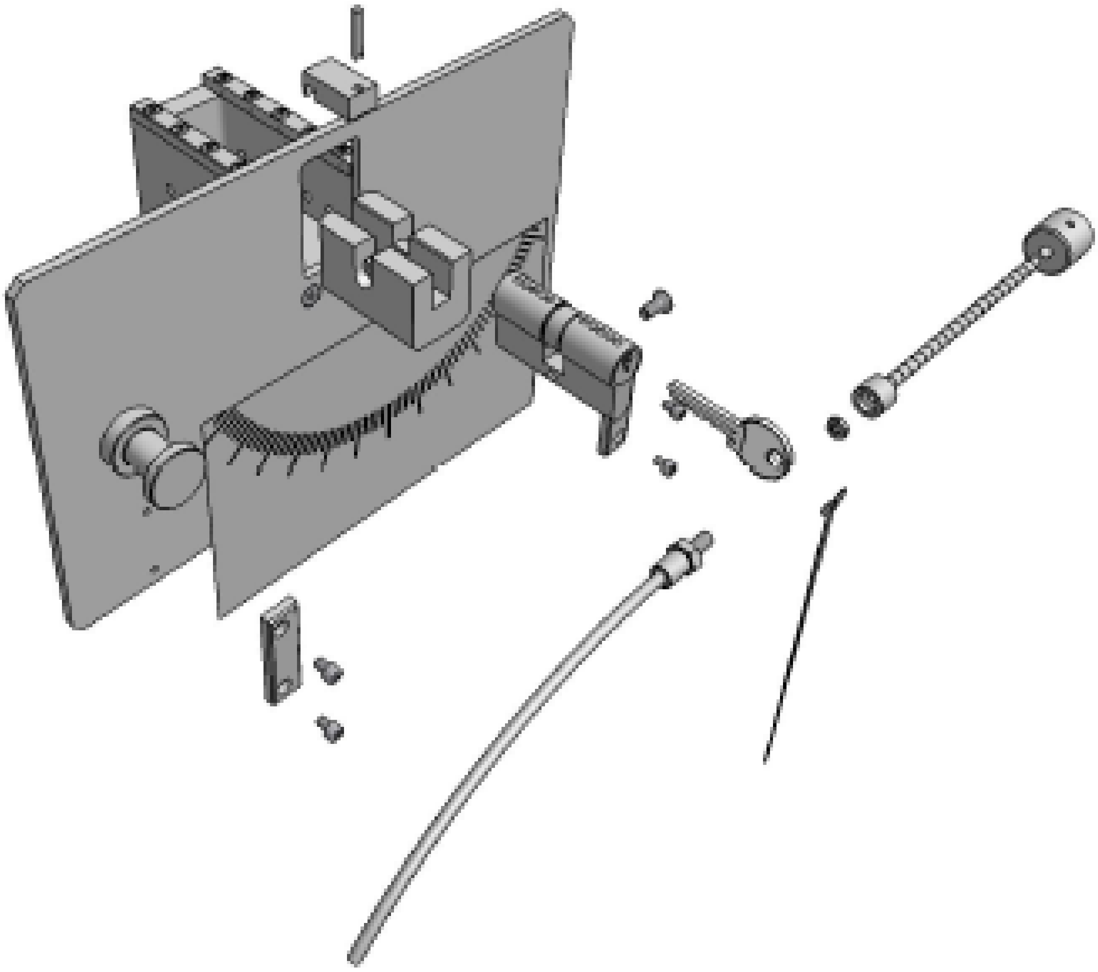


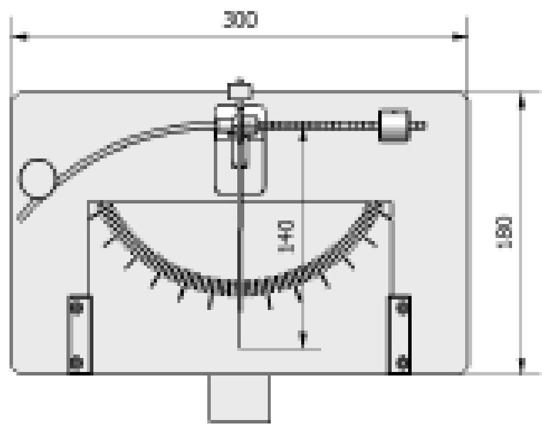
	Mass e1	Mass f	Mass f1
1 er			
2 er			
3 er			
4 er			

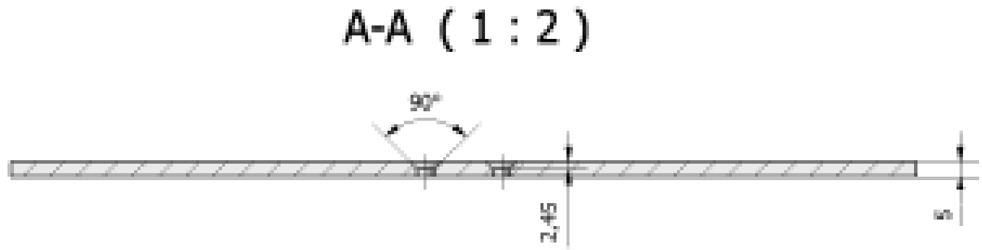


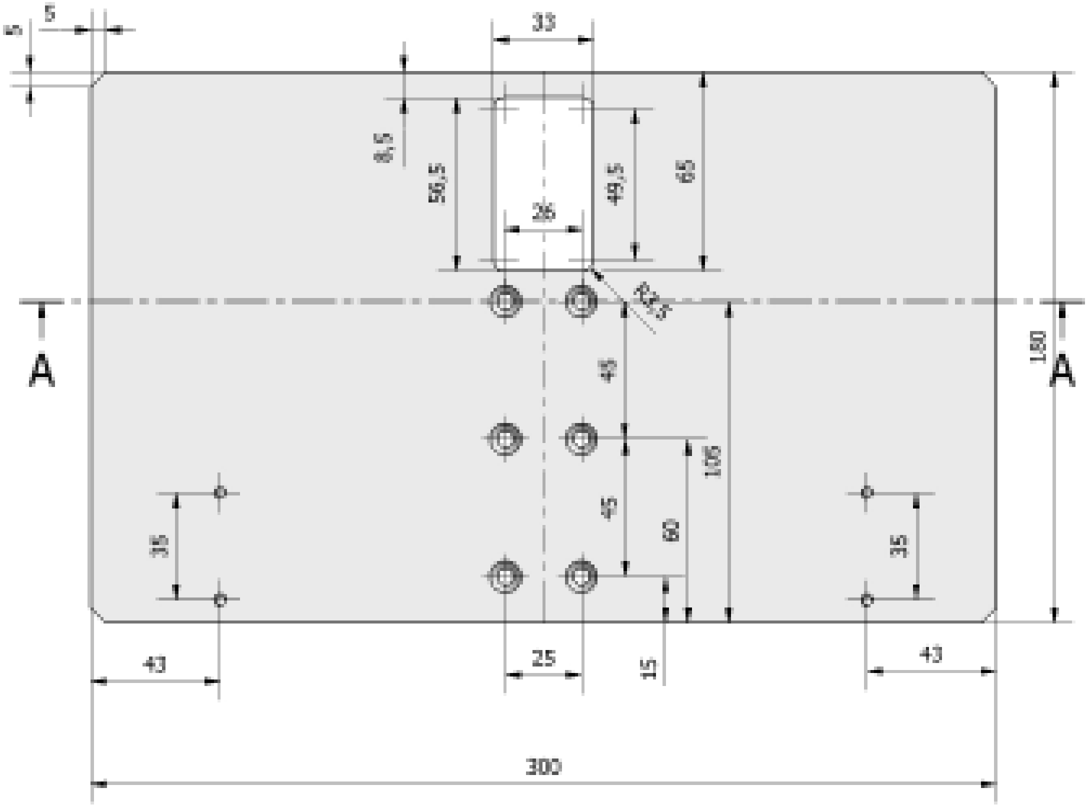


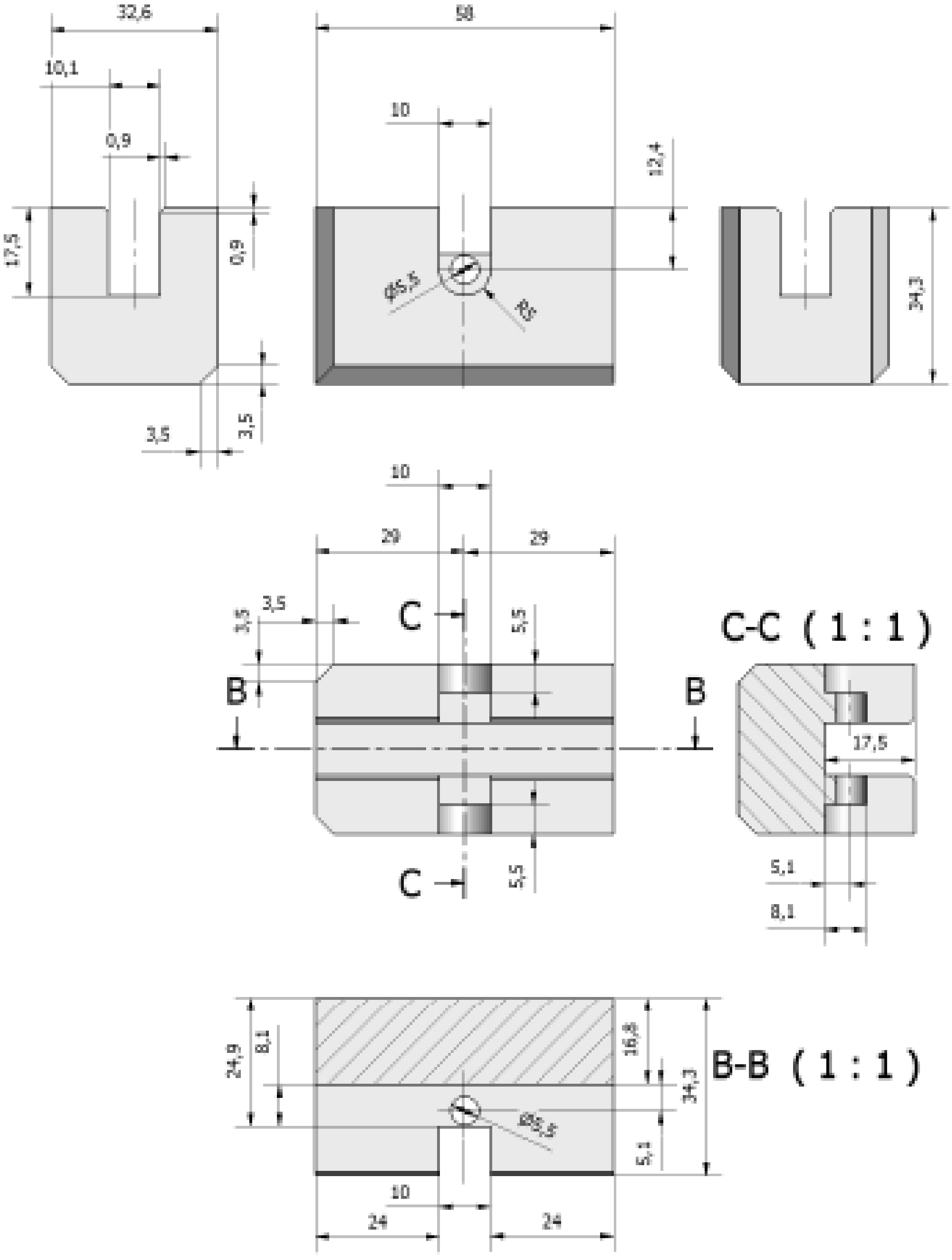
Testing Jig

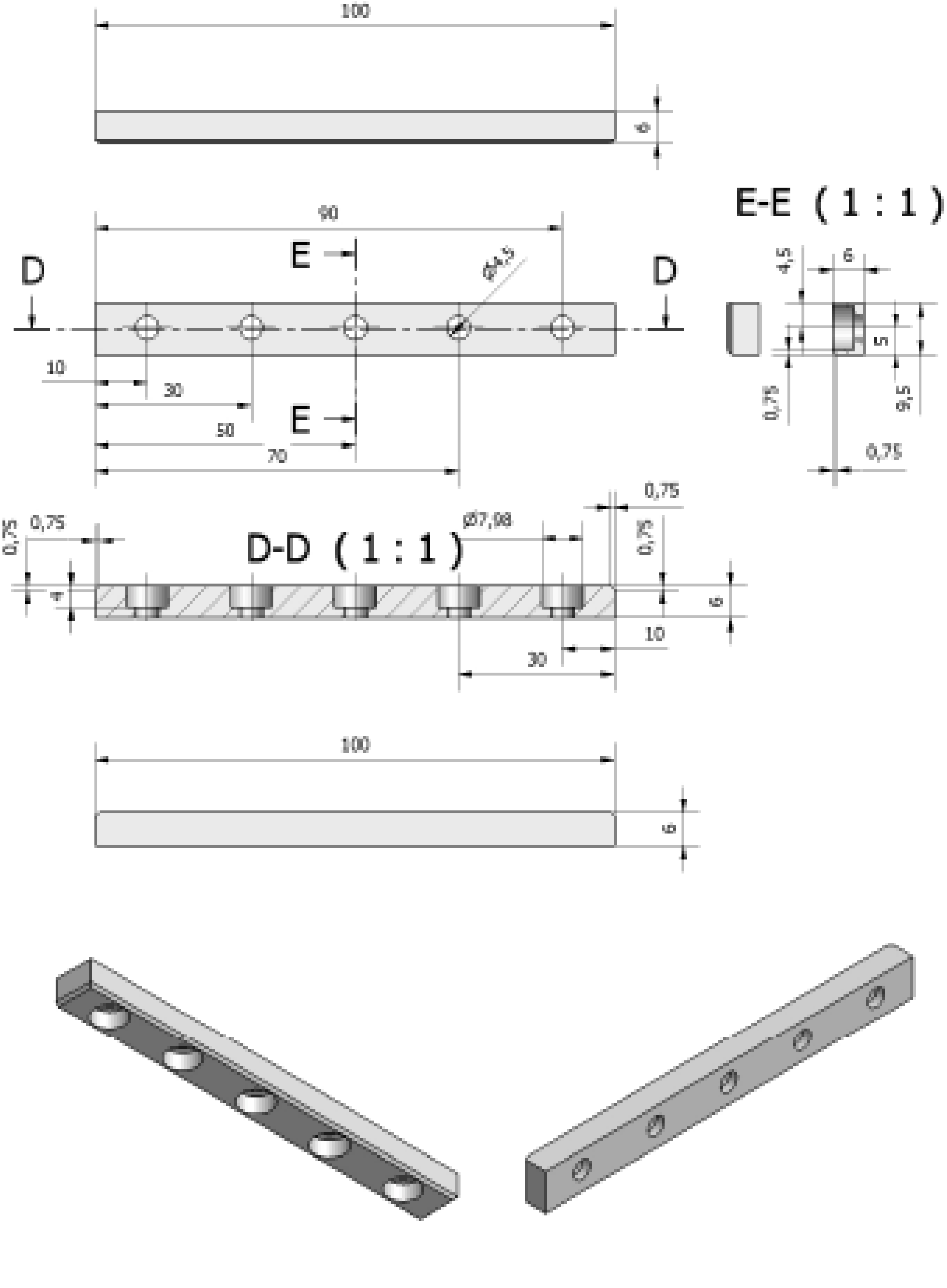


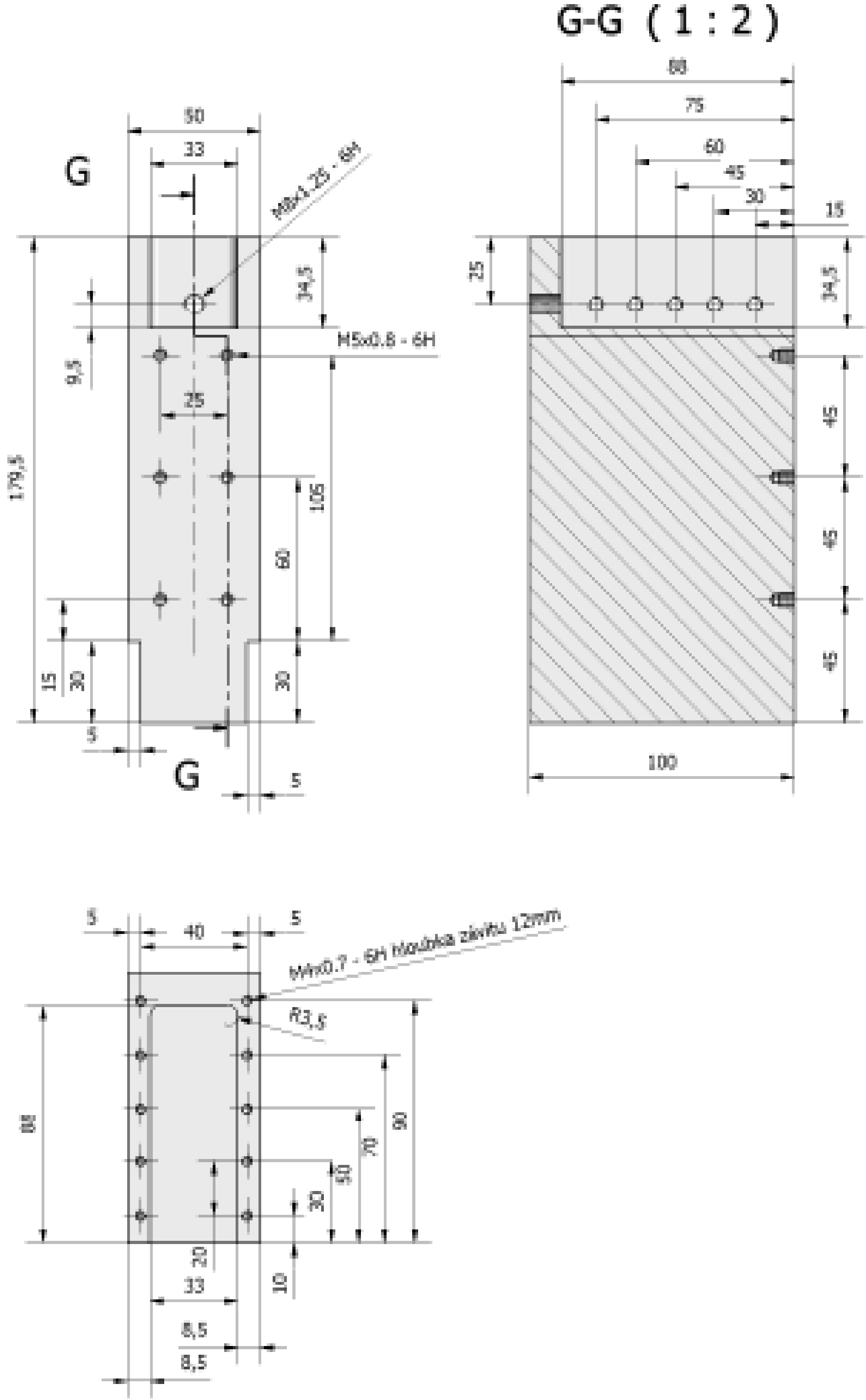


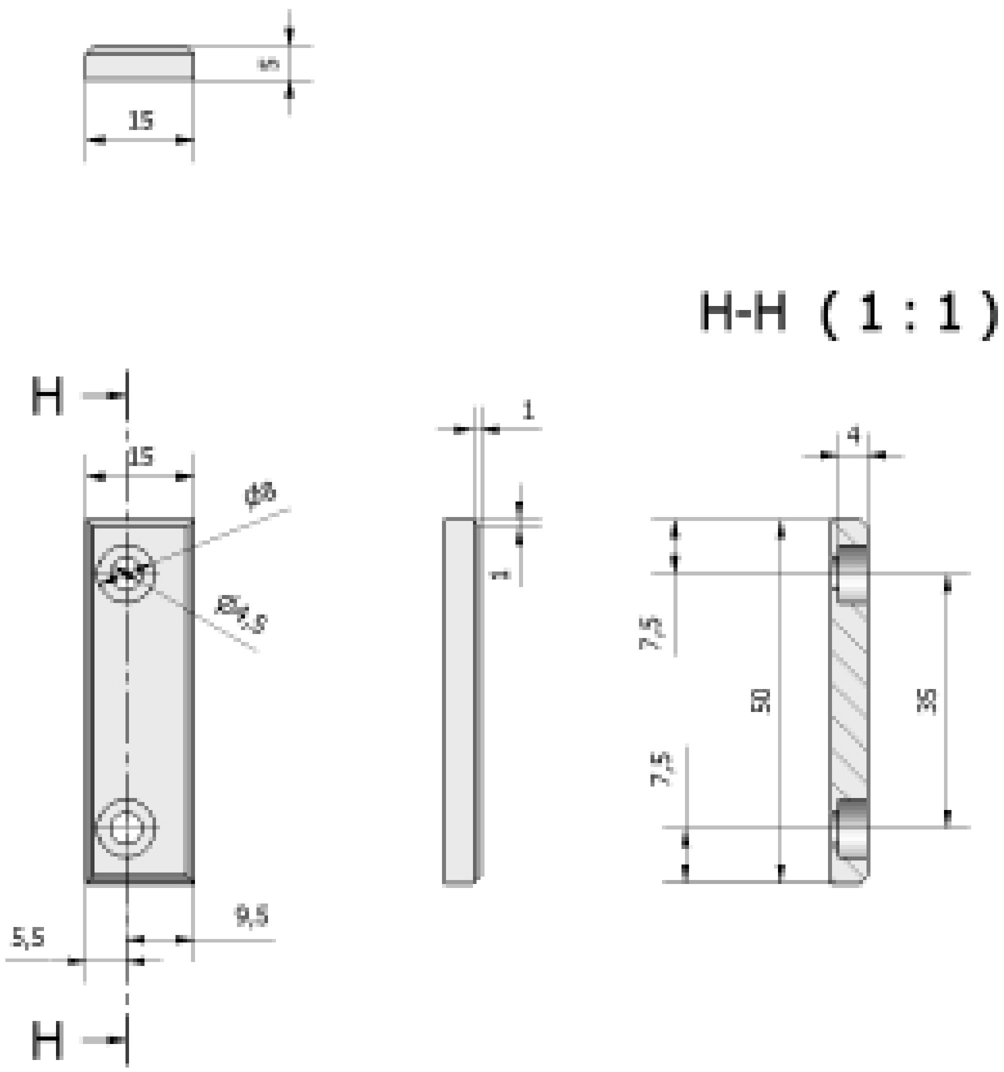

A-A (1 : 2)
90°
2,45
5

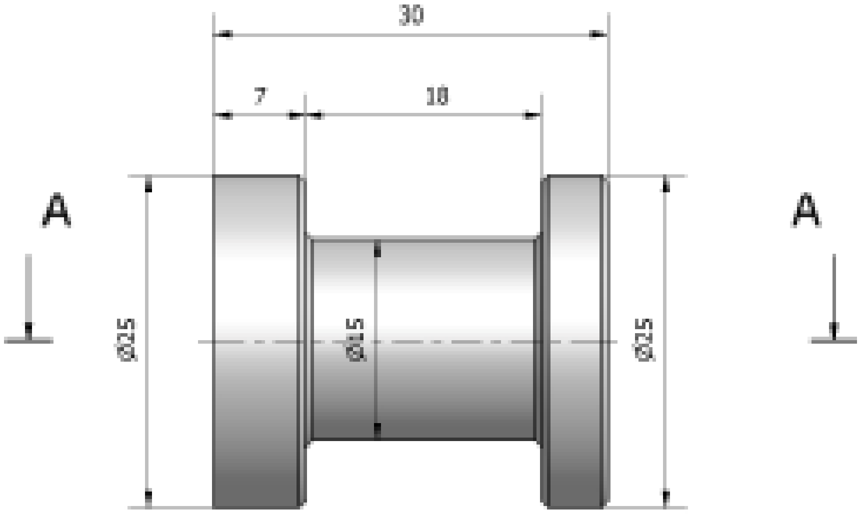

5
5
33
8,5
56,5
49,5
65
26
R2,5
A
A
180
45
105
45
60
35
35
43
25
15
43
300

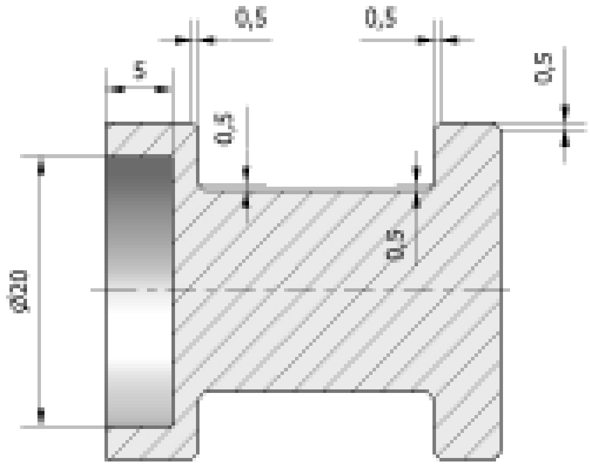

32,6
10,1
0,9
17,5
0,9
3,5
3,5
58
10
12,4
Ø5,5
R5
34,3
10
29
29
3,5
3,5
C
5,5
B
B
C-C (1 : 1)
17,5
5,5
C
5,1
8,1
24,9
8,1
16,8
34,3
B-B (1 : 1)
Ø5,5
5,1
10
24
24


100
6
90
E
D
D
ø4,5
E-E (1 : 1)
4,5
6
5
9,5
0,75
0,75
10
30
50
70
E
D-D (1 : 1)
0,75
0,75
4
ø7,98
0,75
0,75
6
10
30
100
6

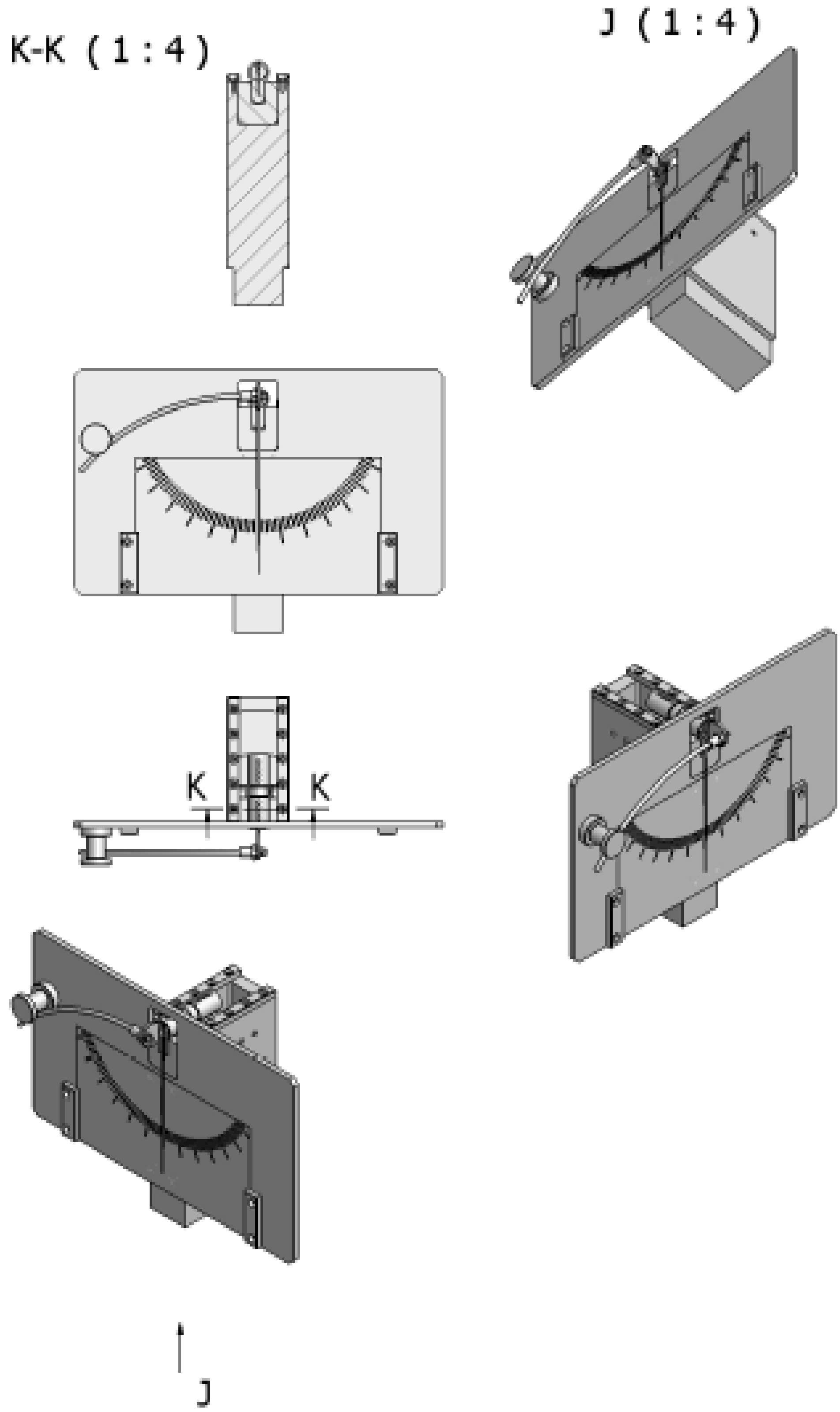

G-G (1 : 2)
G
G
M8x1.25 - 6H
M5x0.8 - 6H
M4x0.7 - 6H hloubka závitu 12mm
R3,5
50
33
34,5
9,5
25
179,5
105
60
15
30
30
5
5
88
75
60
45
30
15
25
34,5
45
45
45
100
5
40
5
88
90
70
50
30
20
10
33
8,5
8,5


15
5
H-H (1 : 1)
H
15
ϕ8
ϕ4,5
1
1
4
7,5
50
35
7,5
5,5
9,5
H





A-A (2 : 1)


K-K (1 : 4)
J (1 : 4)
K
K
J

IMPACT MODE OF THE TESTED LOCK CYLINDERS

A lock cylinder secured to the jig and prepared for the test with the use of the applicator is tested by an impact hammer. The impact hammer to be used is standard, bought from a network of producers of these products or made by the testing laboratory itself.

The hammer is shown in the Annex 1. This is a basic version of this type just for reference regarding to materials and basic dimensions.

Hammer head material is equal to umaplex or hardened silon. Other materials can be selected with weight and hardness similar to molded bakelite.

The hammer handle is made of flexible material with elastic memory of straightening rigidity in comparison with rule steel. Also, it is possible to use plastic or carbonic materials, preserving flexibility when testing by impacts.

APPLICATION OF IMPACTS ON TESTED LOCK CYLINDER

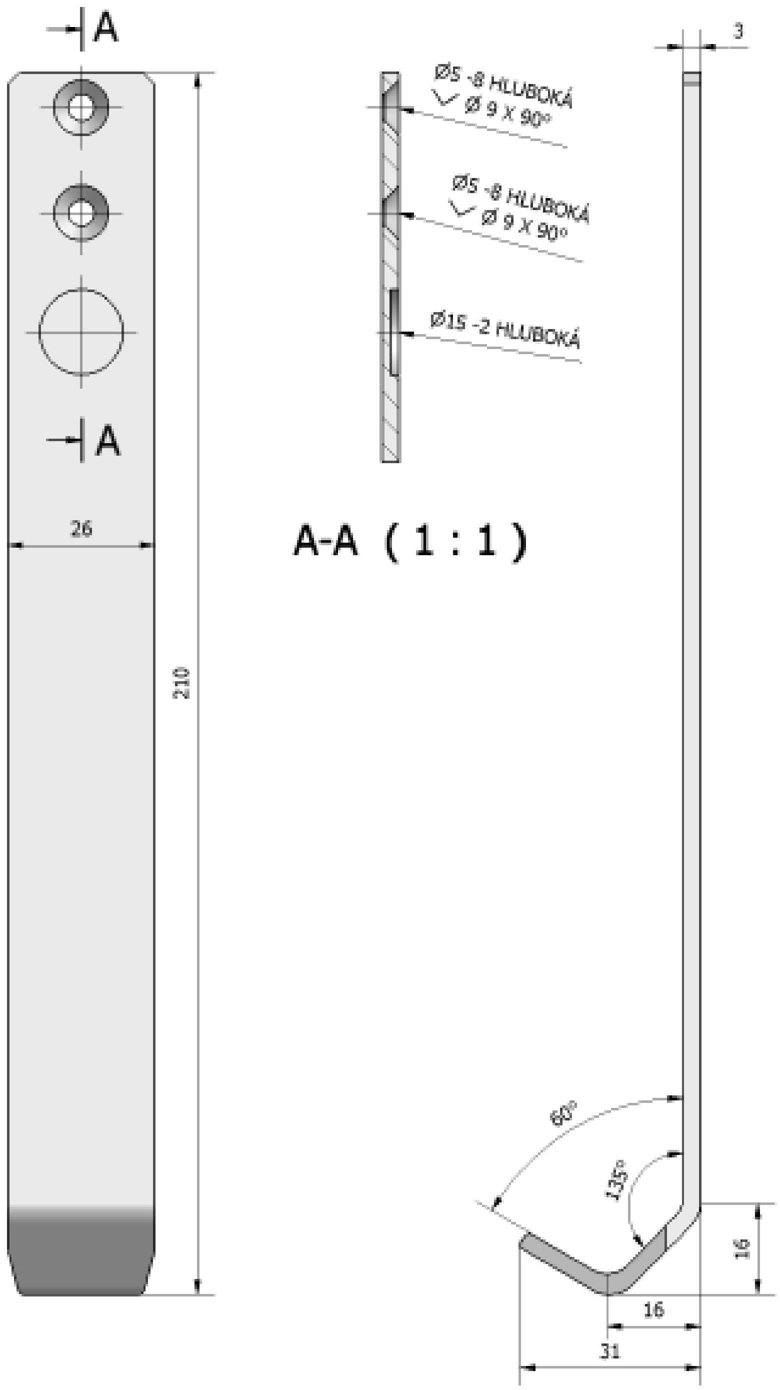
After setting the applicator to correct position, the technician will use the impact hammer to hit the applicator head in direction in which a key is inserted into the lock cylinder.

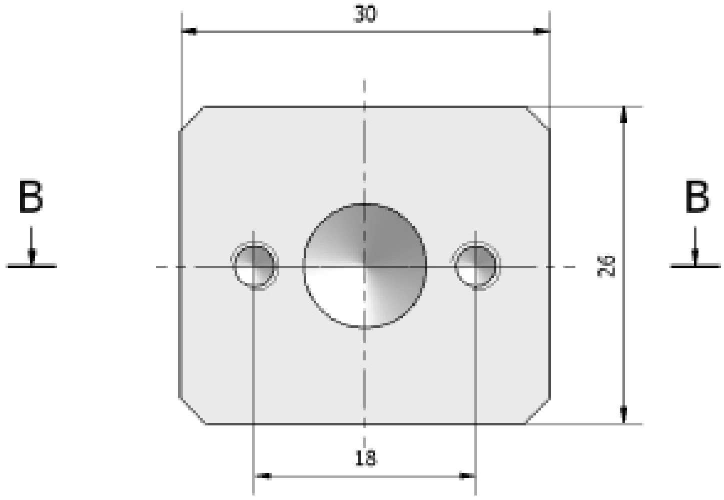
It is suitable to change force as well as direction of hammer impacts on the head within the range of 15 degrees. The applied striking energy of each impact should always insert the applicator into the tested lock cylinder.

Technician’s selection of the force and direction of hammer impacts is not limited, if the lock cylinder is tested by dynamic impact on the applicator head and if this creates the BK effect on the tumbler system of the lock.

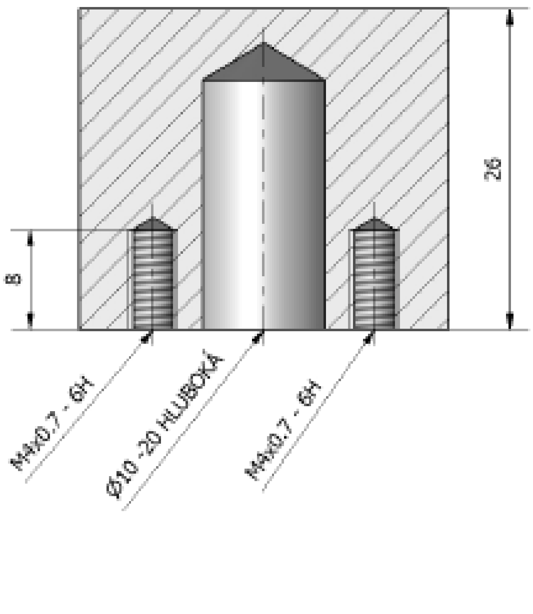
The identical system of impacts is used for the lost stopper method, when the applicator is not moved by the tumbler pitch.

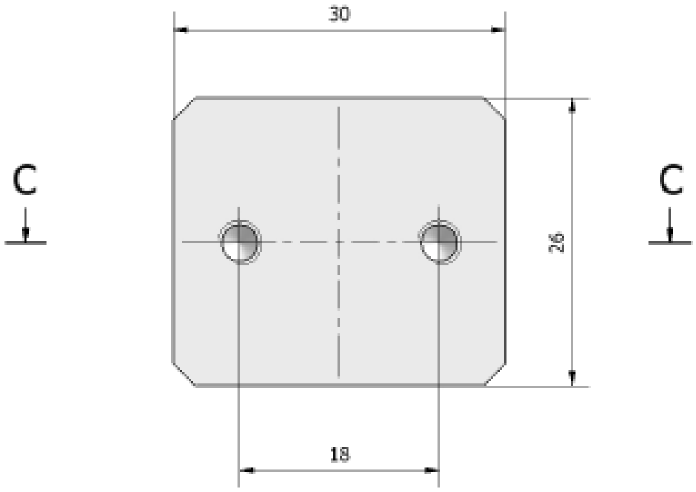
10. ANNEX 1 - IMPACT HAMMER



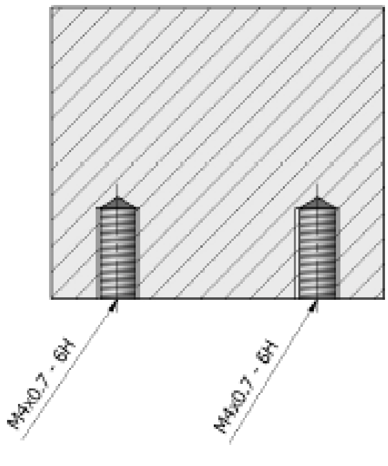


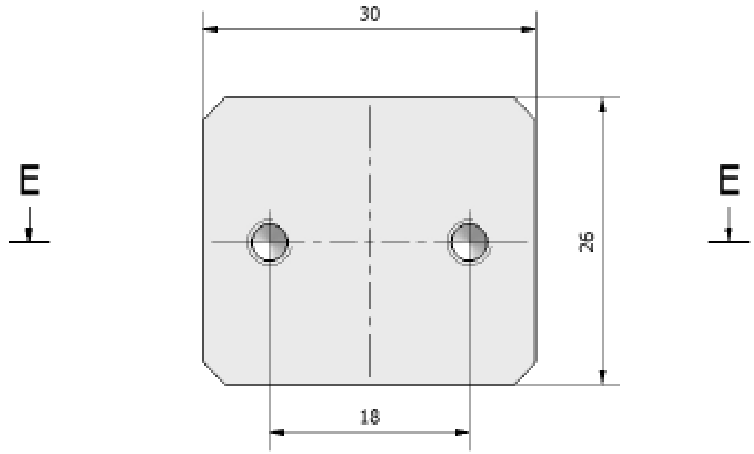
B-B (2 : 1)



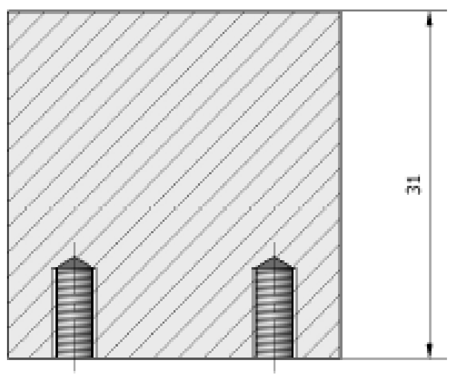


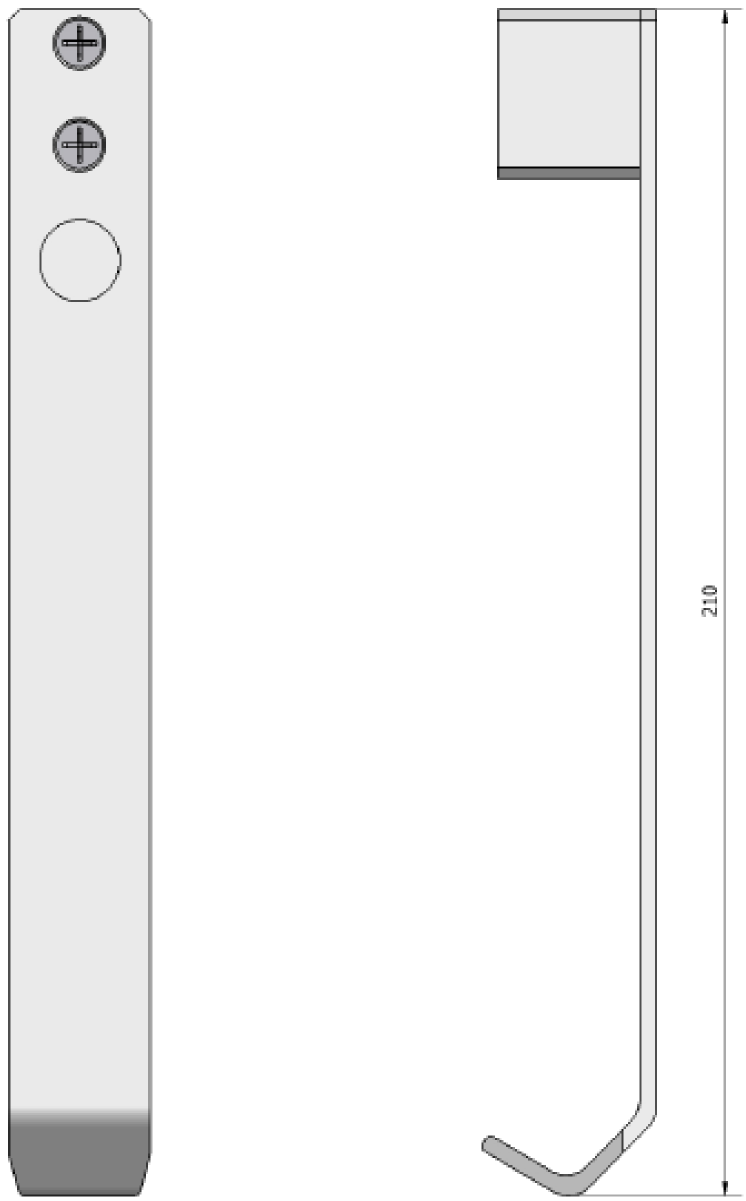
C-C (2 : 1)





E-E (2 : 1)




210

11. ANNEX 2 - TABLE WITH DATA REQUIRED FROM LOCK CYLINDER MANUFACTURERS

Table with requirements for information on lock cylinder locking systems											
Tumblers	**Tumblers (tolerance ± 0,0x)**										**Note**
Type	0	1	2	3	4	5	6	7	8	9	or another
Size [mm]											
Angle of a point [°]											
Diameter of tumblers											
Diameter of contact surface of a point											
Key cut	**Key cut (tolerance ± 0,0x)**										
Type	0	1	2	3	4	5	6	7	8	9	or another
Size [mm]											
Distance from key stopper [mm]											
Key cut pitch [mm]											
Depth of cylinder chamber [mm]											
Shape difference of tumblers - indication											dimen´l dwg
Pins	**Pins (tolerance ± 0,0x)**										
Type - Indication	A	B	C	D	E	F	G	H			or another
Size [mm]											
Diameter [mm]											
Narrowing of the center [mm]											drawing
Other narrowing [mm]											drawing
Link to tumbler size											regulation
Upper radius											
Lower radius											
Side pins	**Side pins (tolerance ± 0,0x)**										
Type	A	B	C	D	E	F	G	H	C		or another
Size [mm]											
Diameter [mm]											
Angle of point [°]											
Other narrowing [mm]											drawing
Side key cut pitch [mm]											
Plates	**Plates for SGHK (tolerance ± 0,0x)**										if any
Type	1	2	3	4	5	6	7				or another
Size [mm]											
Diameter [mm]											
Upper radius											
Lower radius											
Distance of axes of chambers	0	1	2	3	4	5	6	7	8	9	or another
from the lock cylinder face [mm]											drawing
Number of effective combinations of the main key cut											
Number of effective combinations of blocking subsystem											