DRAFT AMENDMENT
ISO 10791-7:2014/DAM 1

ISO/TC **39**/SC **2** Secretariat: **ASI**

Voting begins on: **2016-09-23** Voting terminates on: **2016-12-15**

Test conditions for machining centres —

Part 7: Accuracy of finished test pieces

AMENDMENT 1

Conditions d'essai pour centres d'usinage —

Partie 7: Exactitude des pièces d'essai usinées

AMENDEMENT 1

ICS: 25.040.10

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Foreword

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The committee responsible for this Amendment 1 is ISO/TC 39, Machine Tools, Subcommittee SC 02, Test conditions for metal cutting machine tools.

This second/third/... edition cancels and replaces the first/second/... edition (), [clause(s) / subclause(s) / table(s) / figure(s) / annex(es)] of which [has / have] been technically revised.

ISO 10791 consists of the following parts, under the general title Test conditions for machining centres:

— Part 1: Geometric tests for machines with horizontal spindle (horizontal Z-axis)

— Part 2: Geometric tests for machines with vertical spindle or universal heads with vertical primary rotary axis (vertical Z-axis)

— Part 3: Geometric tests for machines with integral indexable or continuous universal heads (vertical Z-axis)

— Part 4: Accuracy and repeatability of positioning of linear and rotary axes

— Part 5: Accuracy and repeatability of positioning of work-holding pallets

— Part 6: Accuracy of speeds and interpolations

— Part 7: Accuracy of a finished test pieces

— Part 8: Evaluation of contouring performance in the three coordinate planes

— Part 9: Evaluation of the operating times of tool change and pallet change

— Part 10: Evaluation of the thermal distortions

Test conditions for machining centres —

Part 7:
Accuracy of finished test pieces

AMENDMENT 1

Annex A
(informative)

Accuracy of a finished free form test piece

A.1 Scope

This annex introduces a free form test piece for five-axis machining centres. This machining test could be applied to machine centres used for five-axis flank milling of free-form surfaces.

This test is only used to check the performance of machining centre. It cannot be used to error identification. The test result mainly affected by geometric error of machining centre and performance of NC controller.

It is an optional test, which can be used according to the agreement between machining centre supplier/manufacturer and user.

A.2 Terms and definitions

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

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A.2.1

ruled surface

a surface containing a family of straight lines

Note 1 to entry A ruled surface is shown in Figure A.1, where each isoparametric line (parameter u constant), is a rule. The parametric equation for the ruled surface in Figure A.1 is given as:

$$S\left(u,v\right)=\left(1-v\right)\times C_0\left(u\right)+v\times C_1\left(u\right)\left(u\in\left[0,1\right],v\in\left[0,1\right]\right)$$

where

S(u, v)	surface generated by the movement of a rule moving over two curves C0(u) and C1(u) that provide its direction
u, v	are the parameters in u-direction and v-direction
C0(u), C1(u)	curves in space both defined on the same parametric interval u(0, 1)

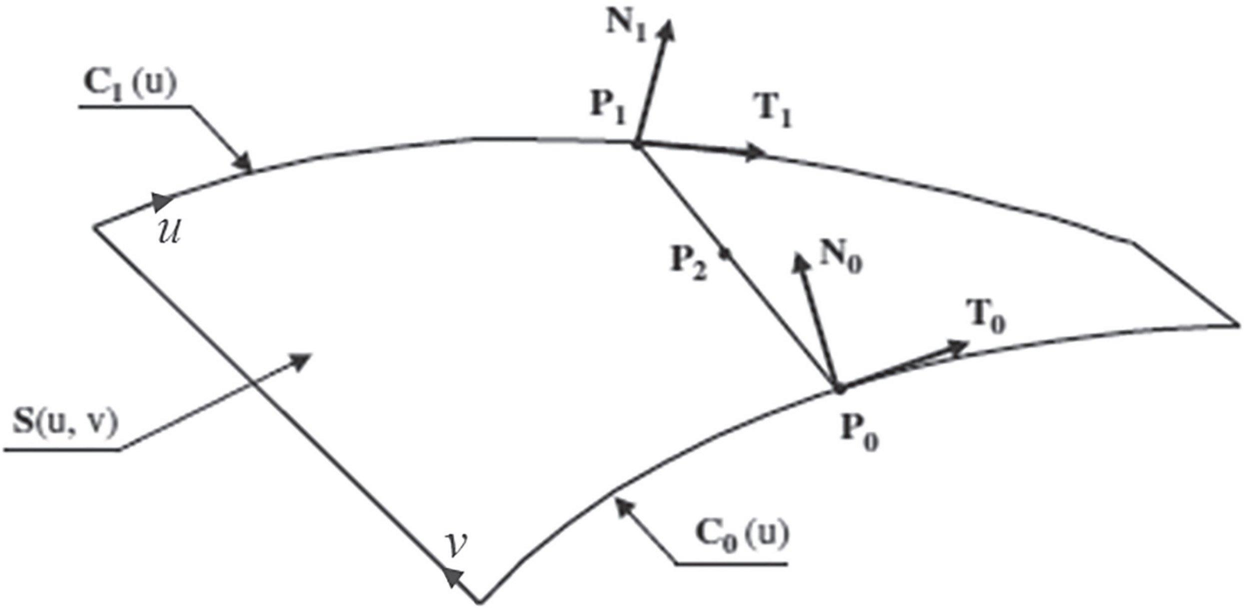


Figure A.1 — Ruled surface

A.2.2

non-uniform rational B-spline (NURBS)

standard definition method of complex surfaces and supported by most CAD/CAM systems

Note 1 to entry See ISO 10303-242:2014.

A.2.3

quasi-uniform rational B-spline

a special kind of non-uniform rational B-spline

Different from uniform rational B-spline, it has duplication k in two endpoint nodes. If the order of the spline is n, then k=n+1. The node vectors are evenly distributed, excepting the first and the end nodes. Assuming control points is m, the spline order is n, then the node vector is

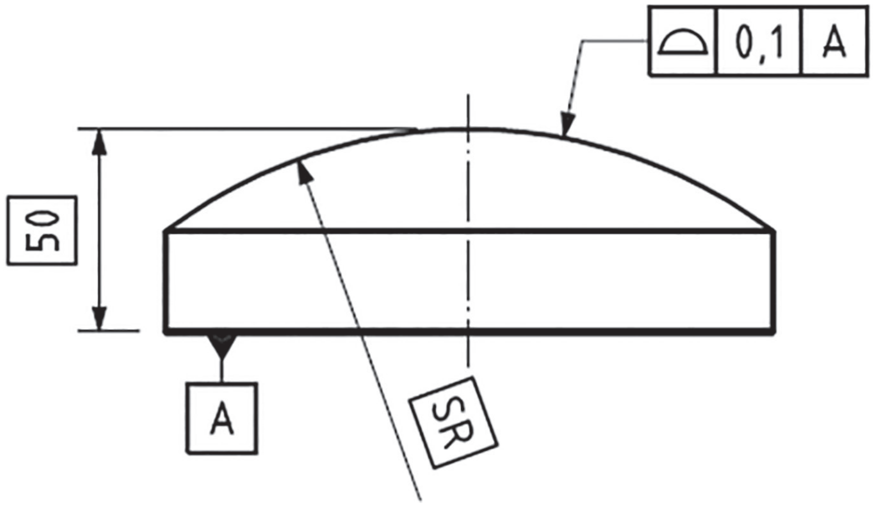
$$\left(\underbrace{\underbrace{0,0,..,0}_{k\ nodes}, \underbrace{\frac{1}{m-n}, \frac{2}{m-n}, \ldots,}_{(m-n-1)\,\text{nodes}} \underbrace{1,1,\ldots,1}_{k\ nodes}}_{(m+n+1)\,\text{nodes}} \right)$$

Once the coordinates of the control points and the order of the spline are known, the bijective curve can be obtained according to the definition of non-uniform rational B-spline.

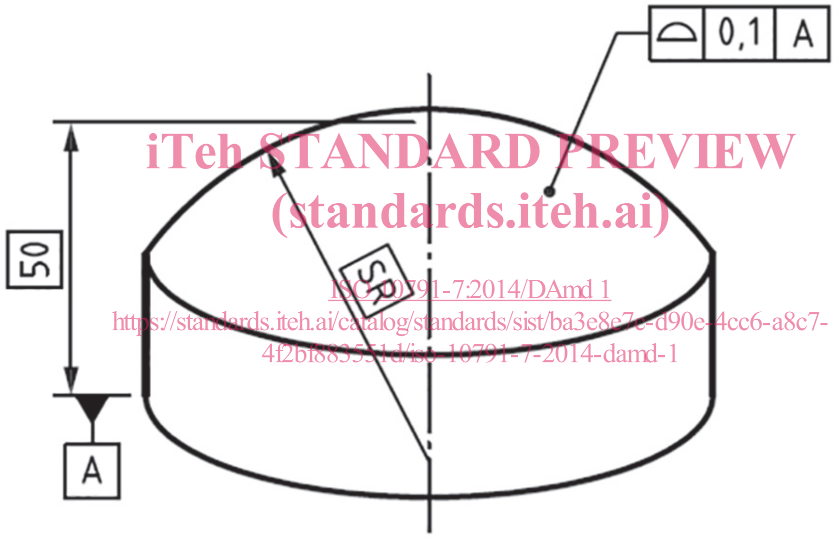
A.2.4

profile tolerance of a surface related to a datum

property of a surface



a) 2D



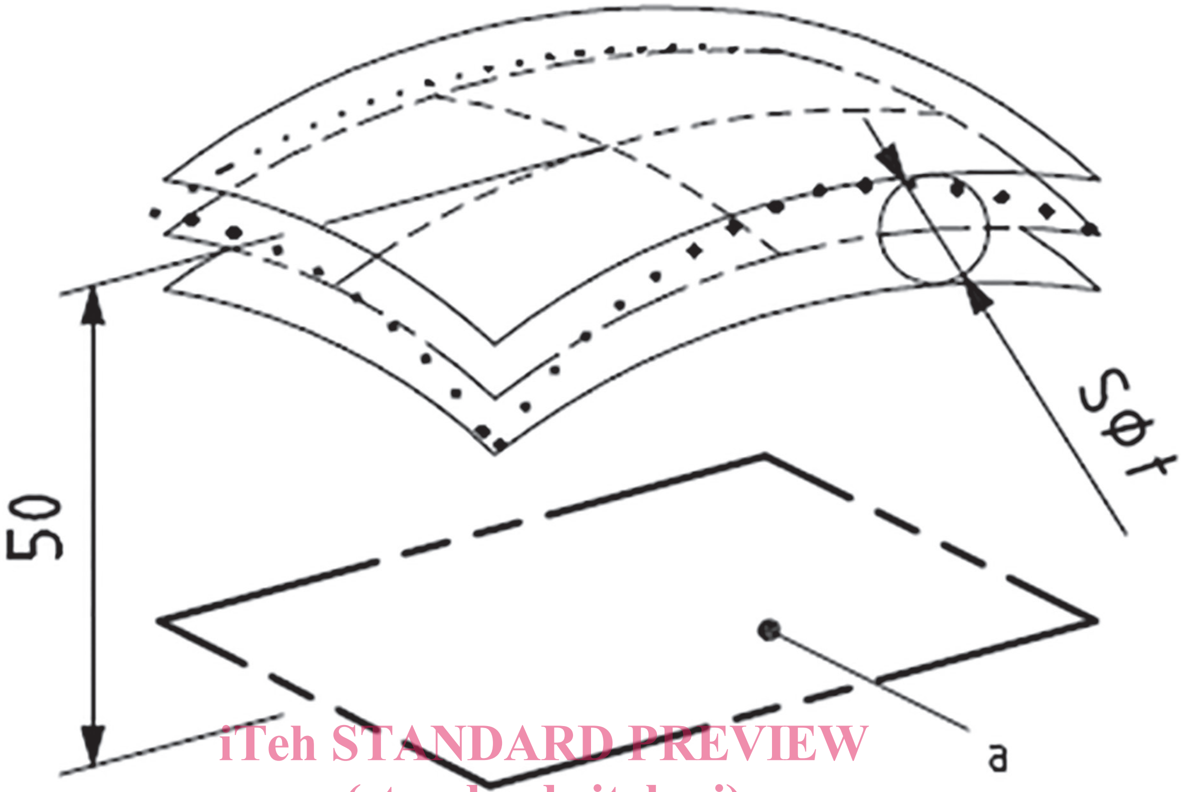
b) 3D

Note 1 to entry See ISO 1101:2012, clause 18.8 and ISO/DIS 1660:2013.

Note 2 to entry As shown in Figure A.2. The extracted (actual) surface shall be contained between two equidistant surfaces enveloping spheres of diameter 0,1, the centres of which are situated on a surface having the theoretically exact geometrical form with respect to datum plane A.

Figure A.2 — Indication and explanation of profile tolerance of a surface related to a datum

Note 3 to entry As shown in Figure A.3. The tolerance zone is limited by two surfaces enveloping spheres of diameter t, the centres of which are situated on a surface having the theoretically exact geometrical form with respect to datum plane A.



Key

a Datum A

Figure A.3 — Definition of the tolerance zone

A.2.5

straightness

property of a straight line

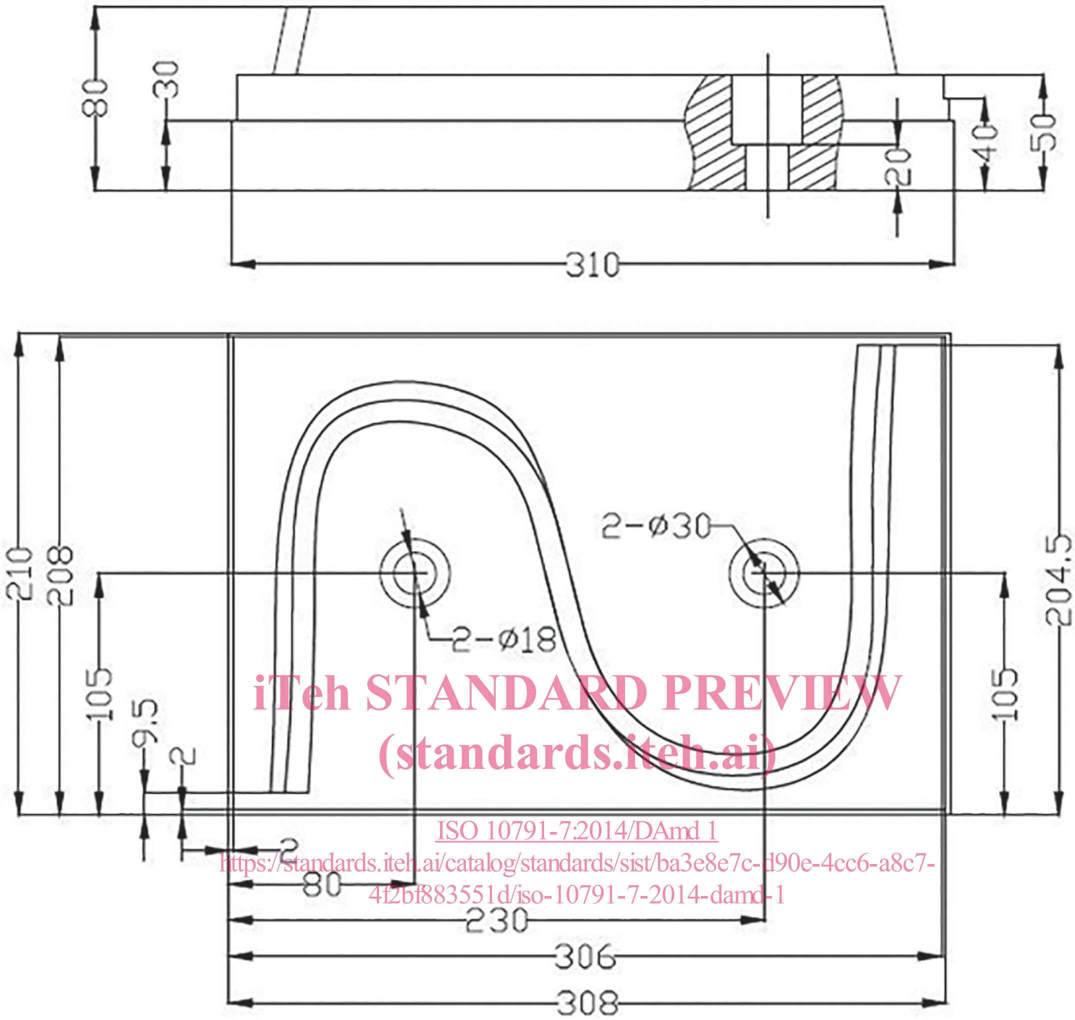
Note 1 to entry see ISO 12780-1:2011, definition 3.1.1

A.3 Geometric definition of the test piece

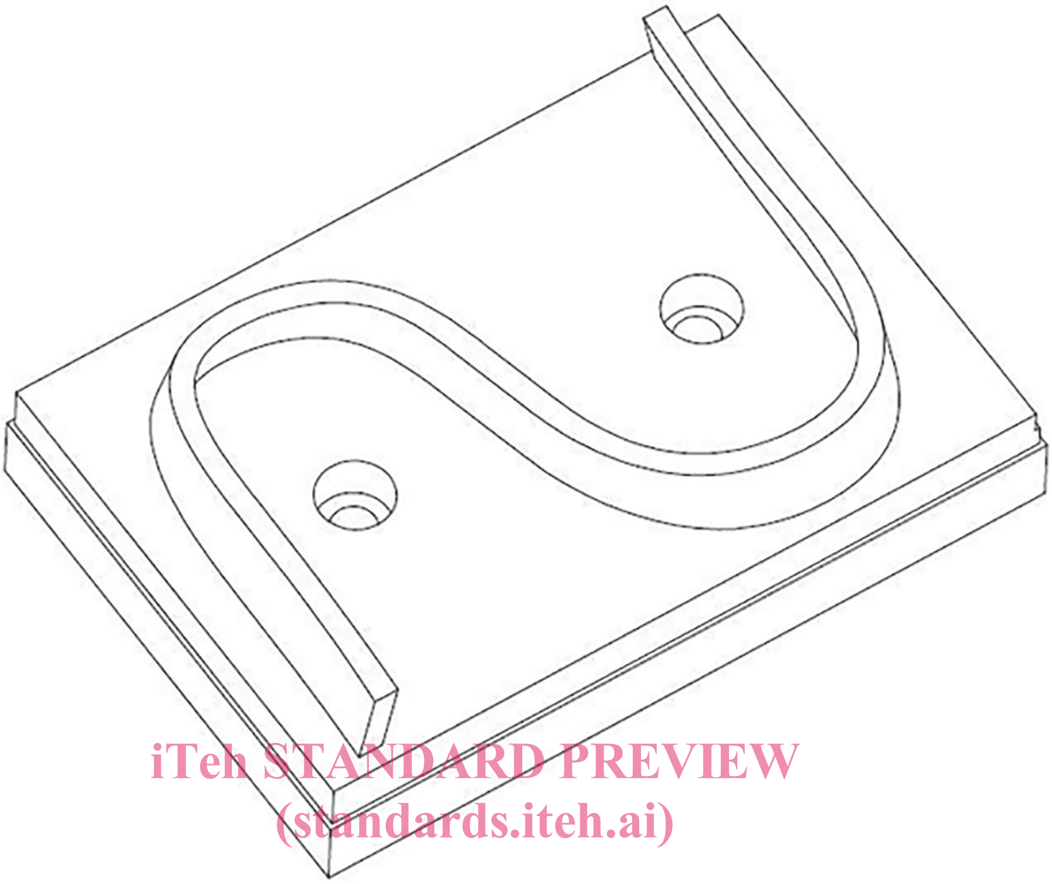
The test piece is formed of an S-shape fillet and a rectangular base, the final shape is shown in Figure A.4. The S-shape fillet is defined with two ruled surfaces. As shown in Figure A.5(a), ruled surface A is generated according to Formula in A.2.1 and two quasi-uniform cubic rational B-splines which are defined by two sets of control points Pi and Qi. Similarly, as shown in Figure A.5(b), ruled surface B is generated by two quasi-uniform cubic rational B-Splines which are defined by two sets of control points Mi and Ni.

During flank milling of a non-developable ruled surface, the existence of twist angle implies that it is impossible to machine the workpiece perfectly using a non-null diameter cutter, with the cutter positioning on the surface leading to inevitable interference. The twist angle corresponds to the angle between surface normal computed for points on the same rule.

Overcut and undercut on the ruled surfaces due to the interference may be as large as 20 µm. To minimize the overcut and undercut, the measuring lines (achieved by intersecting the horizontal plane through measuring points in Table A.2 with the ruled surfaces) can be used as guide lines when generating tool path. Then the overcut and undercut could be below 10μm.

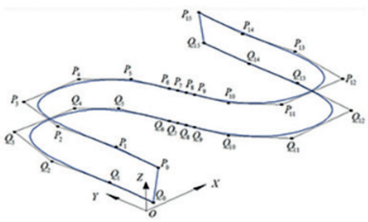


a) 2D



b) 3D

Figure A.4 — Geometry of the test part



Pi	POS_X	POS_Y	POS_Z	Qi	POS_X	POS_Y	POS_Z
P0	22	7,5	30	Q0	16	7,5	0
P1	27	62	30	Q1	19	62	0
P2	22	126	30	Q2	15	126	0
P3	37	181	30	Q3	35	190	0
P4	102	180	30	Q4	104	187	0
P5	133	149	30	Q5	130	161	0
P6	142	113	30	Q6	142	113	0
P7	144	105	30	Q7	144	105	0
P8	146	97	30	Q8	146	97	0
P9	148	89	30	Q9	148	89	0
P10	156	57	30	Q10	156	57	0
P11	185	23	30	Q11	189	15	0
P12	256	22	30	Q12	264	19	0
P13	269	90	30	Q13	272	90	0
P14	263	146	30	Q14	271	146	0
P15	268	202,5	30	Q15	274	202,5	0

a) Ruled surface A