EUROPEAN SPALLATION SOURCE

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Target Wheel Global Tolerances, runout and alignment

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DOCUMENT REVISION HISTORY

Revision	Reason for revision	Date
1	New Document	2015-07-20
2	Increased distance to pedestal	2016-05-31
3	New flanges and new tolerance allocation drawing	2017-05-11
4	Updated vessel deformation, cleanup, pedestal tolerance	2017-10-09

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1. SUMMARY

Operation temperature

Minimum Helium inlet temperature is 10°C.

Maximum Helium inlet temperature is 60°C.

Shaft operation temperature

Maximum shaft temperature is 200°C. This is defined as an average temperature between the hot outlet and the cold inlet part of the shaft. The shaft will reach this temperature in the case of a trip of the helium cooling system.

Safety distance

There shall be a minimum distance between Target Wheel and other structures which will be defined on Interface Control Drawings.

Tolerance drawing

Allocated tolerances have been stated according to ISO 1101 on attached tolerance control drawing ESS-0110316.2

2. PRELIMINARY TOLERANCE ALLOCATION- SUMMARIZED. (MM)

Part	Dimension	Base dimension	Tolerance
Shaft	Length	7815	+/- 1
Shaft	Angular deviation shaft at shaft top position resulting from shaft misalignment from its bottom surface, misalignment in flange connections, shaft curvature	7815	+/- 1
Pedestal	Angular deviation at shaft top position resulting from pedestal misalignment	7815	+/- 0,3
Shaft and wheel	Total horizontal displacement when positioned in bottom of vessel	7815	+/- 3,6
Shaft and wheel	Relative angular misalignment of shaft when positioned in bottom of monolith	7815	0,5 mm/m
Pedestal	Distance to Target Coordinate System	1122	+/- 1
Wheel	Outer diameter including Beam Entrance Window	2616	+/- 2
Wheel	Thickness	118	+/- 0,15
Wheel	Flatness	-	+/- 0,2
Wheel	Rib angular position	10 degrees between each rib	+/- 1
Wheel	Misalignment between wheel and shaft	2616	+/- 0,5
Cassettes	Distance between ribs and cassettes	-	+/- 0,4

Table 1 Tolerances- summary

Allocated tolerances have been stated according to ISO 1101 on attached tolerance control drawing ESS-0110316.2

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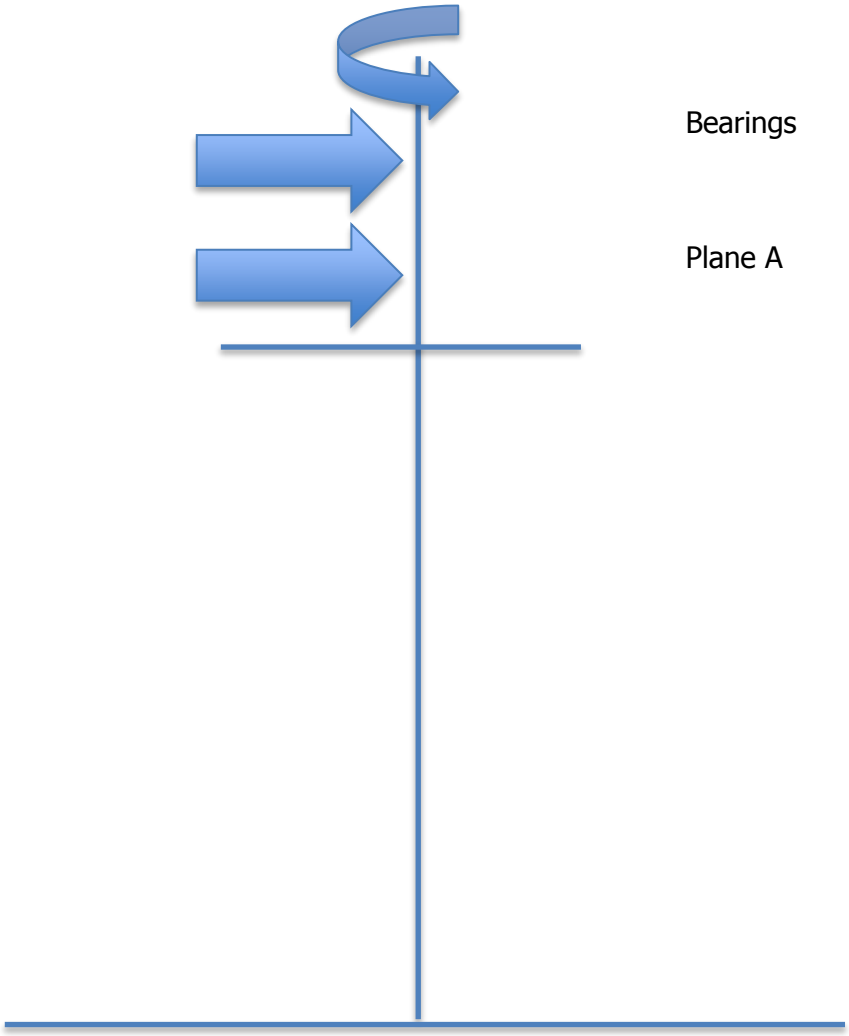
3. ALIGNMENT PROCEDURE

Operation	Assembly item	Alignment activities	Precision (mm)
1	New Wheel	Aligned by Pedestal in bottom of Monolith	+/- 3,6 Horizontally
2	Placement of Shielding blocks		Placement tolerance
3	Placement of cover		Placement tolerance
4	Ferrofluidic seal and bellow		
5	XY-table	Alignment of XY table in relation to shaft	+/- 0,1 Vertically
6	Drive unit assembly	Alignment of drive unit in relation to shaft	Drive unit requirements
7	Clamping of shaft to Drive Unit		Drive unit requirements
9	Lifting of Wheel and Shaft assembly	Vertical Alignment in level for operation	+/- 0,1 Vertically
10	XY- positioning	Horizontal Alignment	+/- 0,1 Horizontally
11	Target Wheel pressurized		
12	Vacuum in Monolith	Vertical Alignment	+/- 0,1 Vertically

Table 2 Alignment

4. ALLOCATION OF TOLERANCES



Generally, Target Wheel is suspended in a bearing structure which will be aligned, based on the exact position of the Spallation material hotspot in relation to Moderator- reflector structure and Beam Guides.

Other conditions

Vertical alignment resolution and accuracy is assumed to be better than 0,1 mm.

4.1 Summary Tolerances and results in Vertical direction

4.1.1 Geometrical tolerances

Geometrical tolerances Resulting displacement of wheel disc in vertical direction		
Tolerance	Base dimension	Resulting tolerance for wheel disc
Shaft length *1)	7815	+/- 1
Misalignment plane B	2616	+/- 0,5
Misalignment Plane A *2)	1200	+/- 0,25
Shaft straightness	7815	+/- 0,2
Parallellity	2616	+/- 0,2
Thickness	118	+/- 0,15
Sum		+/- 2,3
Sum excluding shaft tolerances		+/- 1,3

Table 3 vertical displacement

*1) The reason to exclude shaft length tolerances is the alignment procedure, where the shaft is fastened through a clamp to the Drive Unit. The position of the clamp on the shaft, and the lifting of the Target Wheel in correct position is not affected by shaft length tolerances.

*2) Misalignment after adjustment.

4.1.2 Operational effects

Operational effects	Moderator position	Pedestal position	Reference
Heating of shaft from 10 to 60 C	- 3,7	-3,7	[1]
Deformation caused by heating of vessel	-	-2,5	[2]
Movement caused by Vacuum	-2	-2	Preliminary numbers
Sum before adjustment	- 5,7	-8,2	

Table 4 Vertical displacement due to operational effects

4.1.3 Distance to lower moderator and pedestal before height adjustment

Vertical sum	Pedestal position	Moderator position
Geometrical 4.1.1	-	+/- 1,3
Displacement due to thermal elongation from start 4.1.2	-8,2	-5,7
Lowest position	- 8,2	-7,0

Table 5 Summary vertical displacement

4.1.4 Vertical runout

This deviation is included in 4.1.3 and should be seen as the part of the deviation that is synchronous to the rotation.

Runout	Moderator position	Pedestal position
Misalignment plane B	+/- 0,5	-
Shaft straightness effect, approximate	+/- 0,2	-
Sum	+/- 0,7	-

Table 6 Vertical runout

4.2 Accidents- vertical distance

4.2.1 Vertical distance to lower moderator at accident

Accident	Initial position tolerance	Geometrical variations 4.1.1	Thermal elongation from 40 to 200 [1]	Lowest position pedestal	Lowest position moderator
Loss of cooling	+/- 0,1	+/- 1,3	- 15,0	-15,0	- 16,4
Bearing failure	+/- 0,1	+/- 1,3	-	- 15,0	- 16,4

Table 7 Vertical movement in accidents

4.3 Summary Tolerances and results in Horizontal direction

4.3.1 Horizontal alignment procedure- deviations in top position

Distance	Base dimension	Allocated tolerances
Displacement Pedestal- Target Coordinate system	1122	+/- 1 mm
Clearance shaft- pedestal after Crane positioning		+/- 1 mm
Angular deviation at shaft top position resulting from pedestal misalignment	7815	+/- 0,3 mm
Angular deviation shaft at shaft top position resulting from shaft misalignment from its bottom surface, misalignment in flange connections, shaft curvature	7815	+/- 1,3 mm
Sum of above: Maximum resulting deviation shaft- shielding when shaft is positioned in bottom of monolith		+/- 3,6 mm
Informative: Relative angular misalignment of shaft when positioned in bottom of monolith	7,815 m	0,5 mm/m

Table 8 Horizontal deviation in top position

4.3.2 Horizontal- normal operation- geometrical tolerances

		Moderator position	Pedestal position
Shaft straightness	7815	+/- 1	+/- 1
BEW Diameter	2616	+/- 2	-
Sum		+/- 3	+/- 1

Table 9 Horizontal geometrical tolerances

4.3.3 Horizontal- operational effects

Operational effects	Moderator	Pedestal	Reference
Vacuum	+/- 2	+/- 2	Preliminary figure
Misalignment plane (A)	+/- 1	+/- 1	Based on adjustment precision +/- 0,1 mm
Sum before adjustment	+/- 3	+/- 3	
Sum after adjustment for vacuum	+/- 1	+/- 1	

Table 10 Horizontal deviation due to operational effects

Note- adjustment in this case means that the rotor can be adjusted to hang straight as a part of adjustment after vacuum pumping in monolith.

4.3.4 Total horizontal deviation after adjustment

Horizontal sum	Moderator	Pedestal
Geometrical 4.3.2	+/- 3	+/- 1
Process after adjustment 4.3.3	+/- 1	+/- 1
Most misaligned position	+/- 4	+/- 2
Informative: relative misalignment	-	0,25 mm/m

Table 11 Total horizontal deviation

4.3.5 Horizontal runout affecting Beam Footprint *1)

Runout	Base dimension	Tolerance
Placement of cassettes between shroud ribs	-	+/- 0,2
Angular misalignment of shroud ribs	1308	+/- 1
Horizontal runout affecting the beam footprint		+/- 1,2

Table 12 Horizontal deviation affecting beam footprint

*1) This deviation, summed up with the allowable deviation of speed measurement system, determines horizontal variations of beam footprint on Target.

4.3.6 Accidents/ Failures/ Horizontal

Moderator assembly

Accident	Initial misalignment at pedestal position 4.3.4	Initial misalignment at moderator position 4.3.4	Drop/ distance to Piedestal	Most misaligned horizontal position at moderator position
Bearing failure	+/- 2,7	+/- 4,7	7,3	**12,0**

5. TOLERANCE STANDARDS

5.1 ISO 2768- Tolerances for machined designs

Permissible angular deviations

Tabell 3 – Tillåtna avvikelser för vinkelmått
Table 3 – Permissible deviations of angular dimensions

Toleransklass *Tolerance class*		Tillåtna avvikelser för nedanstående längdområden i mm på den kortare sidan av den aktuella vinkeln *Permissible deviations for ranges of lengths in millimetres of the shorter side of the angle concerned*				
Beteckning *Designation*	Beskrivning *Description*	t o m 10 *up to 10*	över 10 t o m 50 *over 10 up to 50*	över 50 t o m 120 *over 50 up to 120*	över 120 t o m 400 *over 120 up to 400*	över 400 *over 400*
f	fin *fine*	± 1°	± 0°30′	± 0°20′	± 0°10′	± 0°5′
m	medel *medium*					
c	grov *coarse*	± 1°30′	± 1°	± 0°30′	± 0°15′	± 0°10′
v	mycket grov *very coarse*	± 3°	± 2°	± 1°	± 0°30′	± 0°20′

Permissible linear deviations

Värden i mm
Values in millimetres

Toleransklass *Tolerance class*		Tillåtna avvikelser för basmåttsområde *Permissible deviations for basic size range*							
Beteckning *Designation*	Beskrivning *Description*	0,5[1)] t o m *up to* 3	över *over* 3 t o m *up to* 6	över *over* 6 t o m *up to* 30	över *over* 30 t o m *up to* 120	över *over* 120 t o m *up to* 400	över *over* 400 t o m *up to* 1 000	över *over* 1 000 t o m *up to* 2 000	över *over* 2 000 t o m *up to* 4 000
f	fin *fine*	± 0,05	± 0,05	± 0,1	± 0,15	± 0,2	± 0,3	± 0,5	—
m	medel *medium*	± 0,1	± 0,1	± 0,2	± 0,3	± 0,5	± 0,8	± 1,2	± 2
c	grov *coarse*	± 0,2	± 0,3	± 0,5	± 0,8	± 1,2	± 2	± 3	± 4
v	mycket grov *very coarse*	—	± 0,5	± 1	± 1,5	± 2,5	± 4	± 6	± 8

1) För basmått under 0,5 mm skall avvikelserna anges vid aktuellt basmått.
For nominal sizes below 0,5 mm, the deviations shall be indicated adjacent to the relevant nominal size(s).

Straightness and flatness

Tabell 1 — Generella toleranser för rakhet och planhet
Table 1 — General tolerances on straightness and flatness

Toleransklass *Tolerance class*	Rakhets- och planhetstoleranser för nominella längdområden *Straightness and flatness tolerances for ranges of nominal lenghts*					
	t o m 10 *up to 10*	över 10 *over 10* t o m 30 *up to 30*	över 30 *over 30* t o m 100 *up to 100*	över 100 *over 100* t o m 300 *up to 300*	över 300 *over 300* t o m 1000 *up to 1000*	över 1000 *over 1000* t o m 3000 *up to 3000*
H	0,02	0,05	0,1	0,2	0,3	0,4
K	0,05	0,1	0,2	0,4	0,6	0,8
L	0,1	0,2	0,4	0,8	1,2	1,6

5.2 ISO 13920 Tolerances for welded designs

Linear dimensions

See table 1.

Table 1: Tolerances for linear dimensions

Tolerance class	Range of nominal sizes l in mm									
	2 to 30	Over 30 up to 120	Over 120 up to 400	Over 400 up to 1000	Over 1000 up to 2000	Over 2000 up to 4000	Over 4000 up to 8000	Over 8000 up to 12000	Over 12000 up to 16000	Over 16000 up to 20000	Over 20000
	Tolerances t in mm										
A	± 1	± 1	± 1	± 2	± 3	± 4	± 5	± 6	± 7	± 8	± 9
B		± 2	± 2	± 3	± 4	± 6	± 8	± 10	± 12	± 14	± 16
C		± 3	± 4	± 6	± 8	± 11	± 14	± 18	± 21	± 24	± 27

Table 2: Tolerances for angular dimensions

Tolerance class	Range of nominal sizes l in mm (length or shorter leg)		
	Up to 400	Over 400 up to 1000	Over 1000
	Tolerances Δα (in degrees and minutes)		
A	± 20'	± 15'	± 10'
B	± 45'	± 30'	± 20'
C	± 1°	± 45'	± 30'
D	± 1°30'	± 1°15'	± 1°
	Calculated and rounded tolerances t, in mm/m[1])		
A	± 6	± 4,5	± 3
B	± 13	± 9	± 6
C	± 18	± 13	± 9
D	± 26	± 22	± 18

[1]) The value indicated in mm/m corresponds to the tangent value of the general tolerance. It is to be multiplied by the length, in m, of the shorter leg.

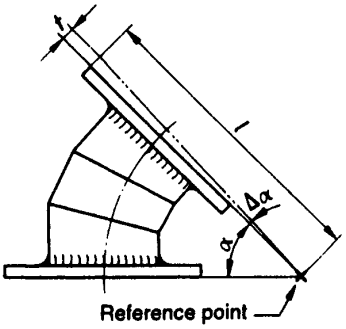


Figure 4

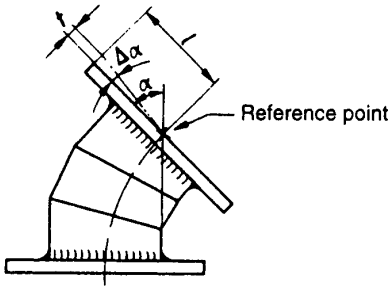
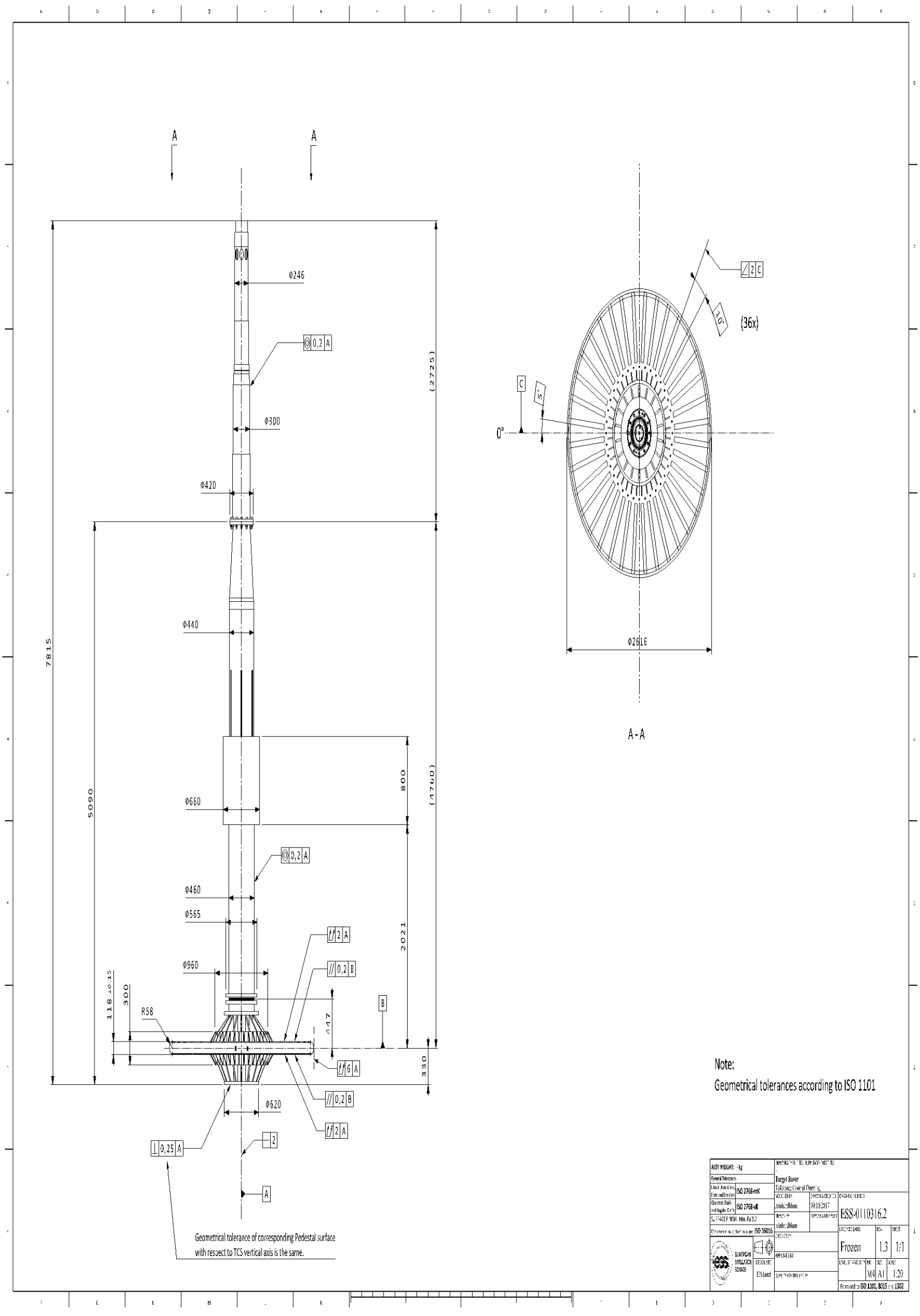


Figure 5.

6. TOLERANCE SKETCH



7. REFERENCES

[1] ESS-0028465 Target materials handbook
[2] ESS-0109614 Design Report Target vessel