DM--DT-TBSI------Baseline-Geometry of Monolith and A2T Supporting Structure.docx

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1. INTRODUCTION

This document describes the governing measurements needed from stakeholder perspective for the supporting concrete structure around the Monolith, Bunker area and A2T. The information will fix the geometry and therefore also the model of D02 concrete structure regarding heights, dimensions, angles and tolerances for the building elements such as the slab, Monolith foundation, supporting walls, shield wall, A2T area, structural shielding and the Hatches above the Monolith and A2T needed. The hatches in the triangular part of Utility area are not included in this document.

2. GENERAL

Tolerances

In-situ cast concrete walls tolerance shall be in accordance with AMA 27.C/11 Klass A
In-situ cast concrete horizontal surface tolerance shall be in accordance with AMA 43.DB/11

Surface Smoothness

The concrete surface smoothness shall be in accordance with AMA ESE.2/1 or ESE. 24/2 Class A.

Penetrations and Embedment's

Some of the penetrations and embedment's for installations through the structure are mentioned and others are not. All penetrations and embedment's need to be specified during Detailed Design.

Surface Treatment

The areas around the Monolith will have surface treatment in accordance with TBY (Technical Regulations for Surface treatment edition 3). A compilation of concrete additives and shuttering panel restrictions, the primary treatment in terms of eventual covings, blasting, grinding, vacuum-cleaning and the painting program for different areas and building elements shall be put together.
The A2T will have the same surface treatment as the rest of the Accelerator tunnel G01.

Shielding

The Heavy concrete used is:

Recept C30/37 Malmbetong

Material		Quantities [kg/m3]	Density [kg/m3]	Volume [liter]	
Cement	Degerhamn Anläggning	335	3,200	104,7	
Water	Malmö	164	1,000	164,0	
Superplasticiser	Sikament EVO 26	2,84	1,060	2,7	0,85 [%]
Ore	Magnetit Magnadense 8s	1750	4,760	367,6	
	Magnetit Magnadense 20s	1713	4,740	361,4	
Air				0,0	
		3965		1000	

Total water:	165,70	[kg/m3]
Effective water:	165,70	[kg/m3]
Vct (water cement quotient):	0,495	
Dry density:	3799,136	

3. MONOLITH SLAB

The Monolith slab lower edge is situated at level +73.90. The slab is 2000 mm thick and the upper edge of the floor is situated at +75.90.

The slab structure footprint is the rectangular shaped area formed by the rooms and the monolith at the centre in basement;

- Utility 091 SW, (D02.091.4003)
- Utility 091 NW, (D02.091.4002)
- Utility 091 NE, (D02.091.4005)
- Utility 091 SE, (D02.091.4004)

The slab shall contain a circular recess for the Echir beam dump. The recess shall be performed by a steel pipe with an inner diameter of 1297 mm.

The floor in each room shall contain a 500 mm deep sump 600 x 600 equipped with a demountable grating. The floor shall be performed sloping 1:50 with in a meter from the edges of the sump downwards to the sump. The purpose of the sumps is to allow water to be pumped from the floor in to a tank.

The openings for doors in the basement shall be 2220 x 2610 (W x H)

(See Appendix 1)

4. MONOLITH PUCK

The Monolith puck is the circular shaped concrete structure that constitute the base for the monolith. The outer radius of the puck is 5275 mm on the two sides of the monolith puck that facing the two experimental halls respectively in the basement.

In order to create enough service and manoeuvre area for shutters and trolley between the shelf and the columns in the basement the clear distance between the shelf and the columns need to be ≥ 1650 mm.
(See Appendix 1 and 3)

5. MONOLITH FOUNDATION INTERFACE

The interface between CF and TD regarding the Monolith bottom, is the circular shaped concrete surface with a radius of 5275 mm on level +80.64 together with the circular stepped recess in the centre of the same surface.

The concrete between the above described surface and down to the shelf at level +77.40 contain an embedded stepped pipe for Echir. (Echir pipe configuration and dimensions to be decided.)
(Location, size, interface and angles see Appendix 1, 2, 3 and 4).

6. MONOLITH SUPPORTING WALLS

The monolith supporting walls are the two curved walls on each side of the monolith with the base on the monolith slab and the top in High bay floor structure. The walls face the triangular part of A2T and the triangular part of Utility area respectively.

The two supporting walls around the monolith will be performed so the gap between the monolith outer surface curvature and the concrete inner surface curvature will be ≥20 mm and ≤100 mm. The 20 mm secure that the monolith do not interact with the supporting walls during an H4 earthquake (Reference still missing?) The 100 mm together with the 500 mm monolith step secure that there will be no radiological streaming path "line of sight" upwards between the monolith outer side and the concrete inner side of the walls.

The design measurement for the concrete inner surface curvature shall be the monolith radius plus 60 mm. This together with the tolerance mentioned in chapter 2 will secure that the final measurements will be kept within the tolerance.

The wall between Monolith and A2T (D02.113.4013) shall contain steel block shielding and a recess 1000 x 1000 mm for the proton beam pipe towards the A2T area.
(See Appendix 2 and 5, Section E-E)

The wall between Connection cell (D02.115.4001) and A2T access area (D02.115.4005) shall contain a rectangular hole with measurements of 1500 x 2500 mm (width x height) for a door frame and a steel shielding door.

The wall will also contain penetrations for cryogenic hydrogen cooling pipes and beam diagnostics. Location, number size and performance to be developed during DD.
The wall facing A2T shall be straight and not curved in this section.
(See Appendix 2 and 5, Section G-G)

The wall between Connection cell (D02.115.401) and Utility 115 (D03.115.4003) will contain penetrations for cooling pipes and electrical cables. Location, number size and performance to be developed during DD.

In order to reduce radiation levels in Utility 103 (D02.103.4023), the wall between the Monolith and Utility 103 shall have additional 500 mm of concrete thickness to a total thickness of 1500 mm.
(See Appendix 2)

7. MONOLITH SHIELD WALLS

The shield walls are the two hanging curved walls around the upper part of the Monolith and Connection cell (D02.115.4001) that face Experimental hall 1 and 2 Bunker areas respectively.

The shield walls will be performed so the gap between the monolith outer surface curvature and the concrete inner surface curvature will be ≥20 mm and ≤100 mm. The 20 mm shall secure that the monolith does not interact with the shield wall during an H4 earthquake event. The 100 mm together with the 500 mm monolith step secure that there will be no radiological streaming path “line of sight” upwards between the monolith outer side and the concrete inner side.

The design measurement for the concrete inner surface curvature shall be the monolith radius plus 60 mm. This together with the tolerance mentioned in chapter 2 will secure that the final measurements will be kept within the tolerance.

In order to reduce background radiation, the thickness of the shield wall shall be ≥ 500 mm but will be made 800 mm thick for structural reasons.

The measurement between TC and the lower edge of the shield wall shall be 2960 mm.

The outer side of the shield wall shall be performed facetted/Angular. The plane surfaces shall be perpendicular to 21 pcs. 6° separated beams that originates from TC on both side of the monolith.
(See Appendix 3 and 5, Section G-G)

8. BUNKER BASE AREA

The bunker base is the four sectors of thicker concrete slab around the Monolith that constitute the footprint of the bunker. The purpose of the bunker base is as permanent shielding reduce radiation levels from inside the bunker out to the experimental halls, reduce background radiation (noise) to the instruments and to act as a support structure for the bunker walls and the columns that support the bunker roof.

The South and the West bunker base sectors stretch from the curved line 6.0 meter from TC near the monolith out to a 28.1 meter radius from TC in to the experimental hall floors and include a 250 mm step from level +80.15 at radius 24.5 meter down to level+79.90.

The North and the East bunker base sectors stretch from the curved line 6.0 meter from TC near the monolith out to a 15.1 meter radius from TC in to the experimental hall floors and include a 250 mm step from level +80.15 at radius 11.5 meter down to level+79.90.

The 250 mm step that divide the two levels and the step between bunker base and the Experimental hall floor shall be performed facetted/Angular. The vertical plane surfaces shall be perpendicular to 21 pcs. 6° separated beams that originates from TC on both side of the monolith in a way that correspond to the facetted shielding wall.

(See Appendix 4 and 5, Section G-G)

9. BUNKER AREA ANGLED WALLS

The bunker area angled walls are the walls that creates the bunker area outside the monolith and below High bay floor structure facing the Experimental Hall 1 and 2 respectively. The walls shall be parallel to;

- For the North sector wall, the 30° theoretical beamline that origin in target centre.
- For the West sector wall the 150° theoretical beamline that origin in target centre.
- For the East sector wall the -30° theoretical beamline that origin in target centre.
- For the South sector wall the -150° theoretical beamline that origin in target centre.

(Angles are related to Proton beam)

The distance between the walls and those beamlines shall be 800 mm.

To prevent radiological streaming path “line of sight” between the walls and the Bunker shielding roof in Bunker area, the walls shall be performed with a horizontal shelf sticking out 250 mm from the wall in to the bunker area. The “Shelf” shall be 500 mm high in order to take some part of the Bunker shielding roof weight. For the North and East sector walls the shelf shall stretch all the way from the Monolith supporting walls out to R=12000 mm. For the west and south sector angled walls the shelf shall stretch along the whole length of the walls and around the angled corner. Where the shelfs ends there

shall be a vertical contreforte to prevent radiological streaming between the angular wall and the bunker shielding wall and roof.
(See Appendix 12)

10. MONOLITH HATCHES

The High bay floor structure above Connection cell (D02.115.4001) shall be performed with an opening and removable lids.

In order to reduce the radiation levels in High bay CF have received preliminary estimations for shielding materials and material thickness. Up to this date there are no official reference document/calculations made by TD. The total thickness of the lids shall be 2000 mm and the lids shall be made of normal concrete.

The configuration of the lids shall allow a possibility to open up only the middle section of the opening and when needed the whole area. The maximum weight of each lid in the middle shall not exceed 45 tons and the outer blocks shall not exceed 95 tons. The lids shall not be designed for additional load bearing capacity than the dead weight of the lids themselves according to Target Station Logistic [1].
When all the lids are removed the clear opening shall be circular and aligned with the inner side of the monolith supporting wall and the monolith shield wall inside Connection Cell. The lids will rest on two shifted bearing shelfs with a width of 300 mm each to prevent radiological streaming path "line of sight" between the lids and the opening.

The lids shall be performed as T-beams or plates with overlapping joints to prevent radiological streaming path "line of sight" between the lids.
(See Appendix 2, 3 and 5, Section H-H)

11. A2T SHIELDING CONFIGURATION

In order to reduce the radiation levels from the proton beam in the triangular part of A2T (D02.103.4007) to the surrounding areas CF have received preliminary estimations for shielding materials and material thickness. Up to this date there are no official reference document/calculations made by TD.

The shielding in the triangular part of the A2T area consist of, on each side of the proton beam; a 700 mm thick wall of heavy concrete, 2600 mm wide cavity filled with shielding material (Heavy Concrete or Magna Dense) and a 700 mm thick additional wall of heavy concrete.

The floor below proton beam in D02.102.4007 together with the walls and the cavity mentioned above shall be performed as a 1000 mm thick heavy concrete structure. The heavy concrete shall have a density of ≥ 3.6 tons/m^3. The heavy concrete shall be delivered by CF.

Above the proton beam there shall be 1800 mm of scrap steel slabs and on top of that additional 1500 mm of concrete. The steel and the concrete shall as much as possible be performed as removable lids.
(See Appendix 2, 6, and 10)

In corners outside the A2T shielding additional steel shielding is needed.
(See Appendix 4)

12. A2T HATCHES

The lids between A2T triangular part (D02.103.4007) and A2T Access area (D02.115.4005), shall consist of a lower layer of steel lids and an upper layer of concrete lids. The steel lids shall be performed by a number of layers of steel slabs with overlapping joints to prevent radiological streaming path “line of sight” between the lids. The total thickness of the steel shall be 1800 mm. The maximum weight of each lid shall be adjusted to the crane hook print capacity for each lid. 90 or 45 metric ton depending on the crane hook coverage area. The lids will rest on two shifted load bearing shelfs in the innermost walls to prevent radiological streaming path “line of sight” between the lids. Steel blocks will be performed with a 15 mm gap on each side.

The concrete lids shall be performed by a number of layers of concrete slabs with overlapping joints to prevent radiological streaming path “line of sight” between the lids. The total thickness of the concrete shall be 1500 mm. The lids will rest on two shifted load bearing shelfs in the innermost walls above the steel lids to prevent radiological streaming path “line of sight” between the lids and the wall. The maximum weight of each concrete lid shall be adjusted to the crane hook print capacity for each lid. 90 or 45 metric ton. The lids shall be designed for additional load bearing capacity according to Target Station Logistics [1] and Target Station Live- and Payloads [2].
(See Appendix 2, 6 and 10)

13. A2T ACCESS AREA

The High bay floor structure above A2T Access area (D02.115.4005) shall be performed with an opening and removable concrete lids. The maximum weight of each lid shall be adjusted to the crane hook print capacity for each lid. The maximum weight of each lid shall be (90 or 45) metric ton. The lids shall be designed for additional load bearing capacity according to ESS-0011043 ESS-0011043-3, Target Station Logistics [1] and ESS-0029970 [2].
(See Appendix 2, 6 and 10)

14. A2T TUNNEL

A2T tunnel (D02.103.4013) is the extended accelerator tunnel between the accelerator dogleg outside the foot print of D02 and the triangular part of A2T (D02.103.4007). The inside width is 6000 mm and the room height is 3500 mm and the floor is located on +79.90.

The document ESS-0013575 [3] describes the estimated structural shielding requirements.

In order to achieve radiation levels <3 µSv/h (Supervised area) in the Experimental halls on both sides of the A2T Tunnel and in the HVAC area above, the walls on each side of the tunnel shall consist of 4400 mm normal concrete and the roof structure shall consist of 3900 mm normal concrete and additional 400 mm of normal concrete in the floor structure between Technical Supply Routing (D02.120.4014) and HVAC area (D02.125.4014) at +91.40 level above.

The 4400 mm thick wall between A2T tunnel (D02.103.4013) and Experimental hall 1 (D01.100.5001) will contain conduits for electrical cables. Location, number, size and performance to be developed during DD (See ESS-0030412, Cable Penetration Chicane Design between the A2T and GSA for Normal Operations [4]).

The 3900 mm thick roof structure between A2T tunnel (D02.103.4013) and Technical Supply Routing (D02.120.4014) will contain ventilation ducts. Location, number, size and performance to be developed during DD (See ESS-0048116, ESS tunnel HVAC exhaust duct chicane design for normal operations [5]).

15. INSTALLATION GALLERY WALL

In order to achieve radiation levels <3 µSv/h (equivalent to Supervised) in the Installation gallery D02.090.4024 and ~0.3 µSv/h (equivalent to Public Area) in the staircase D04.090.201 behind the Installation Gallery the wall in the gallery towards Accelerator beam dump and dogleg need to be 630 mm thick and made of Heavy Concrete for shielding according to ESS-0036637 [6] and ESS-0042828 [7].
The wall need to be made of Heavy concrete all the way from the upper level of the floor structure up to the upper level of the roof structure. For that reason, CF will have the roof structure in this section made of Heavy concrete as well.
(See Appendix 11)

16. DILATATION JOINT

The whole monolith part of the building (all building elements on top of the Monolith slab foot print up to the upper edge of High bay) shall be performed as one structure separated with a dilatation joint. The purpose of the dilatation joint is to minimize the

interaction of surrounding loads and masses with the Monolith part of the building during an H4 earthquake event.

The dilatation joint shall allow a horizontal movement of 130 - 65 mm. (Reference is missing)

The joint shall be performed water tight and in a way that the joint not cause any radiological steaming path.
(See appendix 3, 4, 6, 7, 8, 9, 10 and 12).

17. GLOSSARY

Term	Definition
A2T	Accelerator to Target
TC	Target Center (Target coordinate system)
TD	Target Division
NSS	Neutron Scattering System Division
AD	Accelerator Division
CF	Conventional Facilities
Echir	Future instrument located in D02.091.4002
DD	Detailed Design, the third phase in CF design process (Feasibility Study, Preliminary Design, Detailed Design, For Construction)
A2T	Accelerator to Target
TC	Target Center (Target coordinate system)
TD	Target Division
NSS	Neutron Scattering System Division
AD	Accelerator Division
CF	Conventional Facilities
Echir	Future instrument located in D02.091.4002
DD	Detailed Design, the third phase in CF design process (Feasibility Study, Preliminary Design, Detailed Design, For Construction)

18. REFERENCES

[1] Target Station Logistics, ESS-0011043-3.

[2] Target Station Live- and Payloads, ESS-0029970.

[3] Shield Thickness Estimate for the A2T Region for normal operation, ESS-0013575.

[4] Cable Penetration Chicane Design between the A2T and GSA for Normal Operations, ESS-0030412.

[5] ESS tunnel HVAC exhaust duct chicane design for normal operations, ESS-0048116.

[6] Preliminary Radiation Shielding Assessment Close to A2T Area for ESS Linac Operations, ESS-0036637.

[7] Addendum: Preliminary Radiation Shielding Assessment Close to A2T Area for ESS Linac Operations, ESS-0042828.

DOCUMENT REVISION HISTORY

Revision	Reason for and description of change	Author	Date
1	First issue	Fredrik Bergstedt	2015-10-30