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1 Revision table

Revision	Date and Author	Description
1	17/10/2013 – F. Forest	First release for review by Quality department
2	22/11/2013 - F. Forest	Full version for comments

2 Conductor consolidation

Paramètres	Valeurs acceptables	Moyens de contrôle	Documents d'enregistrement
Consolidation shims thickness	See magnet specification	1D measurement	Sigmaphi control report
Hydraulic pressure	See magnet specification	Manometer	Sigmaphi control report
Conductor thickness before and after consolidation	See magnet specification	1D measurement	Excel file record Sigmaphi control report
Conductor width before and after consolidation	See magnet specification	1D measurement	Excel file record Sigmaphi control report
Aspect	See magnet specification	Camera Visual inspection	Pictures Sigmaphi control report
Young modulus and Yyield strength at 20°C	See magnet specification	Lab mechanical testing	Sigmaphi measurement report Sigmaphi control report
Pulling test	See magnet specification	Pulling testing device Visual inspection	Sigmaphi control report
Reel good length	See magnet specification	Measurement wheel	Sigmaphi control report
Spool transition length	Middle of the good length	Visual inspection Excel file record analysis	Sigmaphi control report

3 Central spacers

Parameters	Values acceptable	Control Equipment	Record documents
Material	See drawings	Visual inspection	Supplier material certificate
Impact test - lateral expansion	See magnet specification	Charpy test	Lab control report
Magnetic permeability	See magnet specification	Permeability meter	Sigmaphi control report
Heat treatment	See magnet specification	Temperature/time recorder	Supplier control report
Geometry	See drawings and 3D cad files	3D measurement	Supplier control report
Aspect	No oil, no grease, no burrs, no sharp edges accepted	Visual inspection	Sigmaphi control report

4 Straight intermediate spacers

Parameters	Values acceptable	Control Equipment	Record documents
Material	See drawings	Visual inspection	Supplier material certificate
Impact test - lateral expansion	See magnet specification	Charpy test	Lab control report
Magnetic permeability	See magnet specification	Permeability meter	Sigmaphi control report
Heat treatment	See magnet specification	Temperature/time recorder	Supplier control report
Geometry	See drawings and 3D cad files	3D measurement	Supplier control report
Aspect	No oil, no grease, no burrs, no sharp edges accepted	Visual inspection	Sigmaphi control report

5 Curvated spacers

Parameters	Values acceptable	Control Equipment	Record documents
Material	See drawings	Visual inspection	Supplier material certificate
Impact test - lateral expansion	See magnet specification	Charpy test	Lab control report
Magnetic permeability	See magnet specification	Permeability meter	Sigmaphi control report

Heat treatment	See magnet specification	Temperature/time recorder	Supplier control report
Geometry	See drawings and 3D cad files	3D measurement	Supplier control report
Aspect	No oil, no grease, no burrs, no sharp edges accepted	Visual inspection	Sigmaphi control report

6 End spacers

Parameters	Values acceptable	Control Equipment	Record documents
Material	See drawings	Visual inspection	Supplier material certificate
Geometry	See drawings and 3D cad files	3D measurement	Supplier control report
Aspect	No oil, no grease, no burrs, no sharp edges accepted	Visual inspection	Sigmaphi control report

7 Shims

Parameters	Values acceptable	Control Equipment	Record documents
Material	See drawings	Visual inspection	Supplier material certificate
Geometry	See drawings and 3D cad files	1D measurement	Supplier control report
Aspect	No oil, no grease, no burrs, no sharp edges accepted	Visual inspection	Sigmaphi control report

8 Conductor insulation

Parameters	Values acceptable	Control Equipment	Record documents
Material	See magnet specification	Visual inspection	Supplier material certificate
Geometry	See magnet specification	1D measurement	Sigmaphi control report
Aspect	No oil, no grease, no tear accepted	Visual inspection	Sigmaphi control report

9 Double pancakes winding

Parameters	Values acceptable	Control Equipment	Record documents
Number of turns	See magnet specification	Visual inspection	Sigmaphi control

			report
Turns resistance at 20°C	See magnet specification	Ohm meter	Sigmaphi control report
Local insulation	Kapton and G10 sheet	Visual inspection	Sigmaphi control report
Insulation between layers	G10 sand blasted Drilled for resin impregnation No oil, no grease , no tear accepted	Visual inspection	Sigmaphi control report
Aspect	No oil, no grease , no tear accepted No turns sticking out No shims or spacers sticking out	Visual inspection	Pictures Sigmaphi control report

10 Soldering between pancakes

Parameters	Values acceptable	Control Equipment	Record documents
Solder composition	See magnet specification	Visual inspection	Supplier material certificate Sigmaphi control report
Soldering temperature	See magnet specification	Temperature recorder Thermal camera	Sigmaphi control report
Resistance at 20°C	See magnet specification	Micro Ohm meter	Sigmaphi control report
Pull resistance	See magnet specification Testing on samples	Visual inspection Pulling test device	Sigmaphi control report
Aspect	No oil, no grease, no burrs accepted	Visual inspection	Pictures Sigmaphi control report

11 Coil moulding

Parameters	Values acceptable	Control Equipment	Record documents
Resin composition	See magnet specification	Visual inspection Scales	Supplier material certificate Sigmaphi control report
Curing temperature	See magnet specification	Time/temperature recorder	Excel record file Sigmaphi control

			report
Turns resistance at 20°C	See magnet specification	Ohm meter	Sigmaphi control report
Local insulation	Kapton and G10 sheet	Visual inspection	Sigmaphi control report
Outer insulation thickness	See magnet specification	Visual inspection 1 D measurement	Sigmaphi control report
Outer insulation	G10 sand blasted Drilled for resin impregnation No oil, no grease , no tear accepted	Visual inspection	Sigmaphi control report
Resin hardness	See magnet specification	Hardness meter	Sigmaphi control report
Aspect	No oil, no grease , no tear accepted No turns sticking out No shims or spacers sticking out	Visual inspection	Pictures Sigmaphi control report

12 Coil electrical testing

Parameters	Values acceptable	Control Equipment	Record documents
Turns resistance at 20°C	See magnet specification	Ohm meter	Sigmaphi control report
Turn to turn electrical test	See magnet specification	Capacitive test bench	Sigmaphi control report
Ground electrical test	See magnet specification	Dielectric meter	Sigmaphi control report

13 Coils assembly

Parameters	Values acceptable	Control Equipment	Record documents
Outer insulation material	See magnet specification	Visual inspection 1D measurement	Supplier certificate Sigmaphi control report
Insulation tension	See magnet specification	Dynamo meter	Sigmaphi control report
Curing temperature	See magnet specification	Time / Temperature recorder	Excel file record Sigmaphi control report

Resin hardness	See magnet specification	Hardness meter	Sigmaphi control report
Aspect	No oil, no grease , no tear accepted	Visual inspection	Pictures Sigmaphi control report

14 Coils outer diameter machining

Parameters	Values acceptable	Control Equipment	Record documents
Outer diameter	See drawings	3d measurement	Supplier control report
Resin hardness	See magnet specification	Hardness meter	Sigmaphi control report
Aspect	No oil, no grease , no cracks accepted	Visual inspection	Pictures Sigmaphi control report

15 Collars

Parameters	Values acceptable	Control Equipment	Record documents
Material	See drawings	Chemical analysis	Supplier control report
Heat treatment	See magnet specification	Temperature/time recorder	Supplier control report
Young modulus and Yield strength at 20°C	See magnet specification Testing on samples	Lab mechanical testing	Excel file record Sigmaphi measurement report
Impact test - lateral expansion	See magnet specification	Charpy test	Lab control report
Magnetic permeability	See magnet specification	Permeability meter	Sigmaphi control report
Anodization thickness and electrical resistance	See magnet specification	Dielectric meter	Supplier control report
Geometry	See drawings and 3D cad files	3D measurement	Supplier control report
Aspect	No oil, no grease, no burrs, no sharp edges	Visual inspection	Sigmaphi control report

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16 Collaring

Parameters	Values acceptable	Control Equipment	Record documents
Coils inner diameter and outer diameter before and after collaring	See magnet specification	3d measurement	Sigmaphi control report
Collars heating temperature	See magnet specification	Time / Temperature recorder Thermal camera	Thermal pictures Excel file record Sigmaphi control report
Rods material and magnetic permeability	See magnet specification	Visual inspection Permeability mmeter	Supplier material certificate Sigmaphi control report
Aspect	No oil, no grease, no burrs, no sharp edges accepted	Visual inspection	Sigmaphi control report

17 Coils integration

18 Helium vessel

Parameters	Values acceptable	Control Equipment	Record documents
Material	See drawings	Chemical analysis	Supplier control report
Impact test - lateral expansion	See magnet specification	Charpy test	Supplier control report
Magnetic permeability	No oil, no grease, no burrs, no sharp edges accepted	Permeability meter	Sigmaphi control report
Heat treatment	See magnet specification	Temperature/time recorder	Supplier control report
Geometry	See drawings and 3D cad files	3D measurement	Supplier control report
Cleaning	See magnet specification	Visual inspection	Supplier control report
Pressure test			
Aspect	No oil, no grease, no burrs, no sharp edges accepted	Visual inspection	Sigmaphi control report
Pressure test	See magnet specification	Pressure bench test with	Supplier control

		alcohol	report
Helium leakage test	See magnet specification	Helium bench test	Supplier control report
100 % Welds inspection	See ASME Pressure and Vessel Code	Radiography	Supplier control report

19 Radiation screen

Parameters	Values acceptable	Control Equipment	Record documents
Material	See drawings	Chemical analysis	Supplier control report
Impact test - lateral expansion	See magnet specification	Charpy test	Supplier control report
Magnetic permeability	See magnet specification	Permeability meter	Sigmaphi control report
Heat treatment	See magnet specification	Temperature/time recorder	Supplier control report
Geometry	See drawings and 3D cad files	3D measurement	Supplier control report
Cleaning	See magnet specification	Visual inspection	Supplier control report
Aspect	No oil, no grease, no burrs, no sharp edges accepted	Visual inspection	Sigmaphi control report
Pressure test	See magnet specification	Pressure bench test with alcohol	Supplier control report
Helium leakage test	See magnet specification	Helium bench test	Supplier control report
Welds inspection	See ASME Pressure and Vessel Code	Radiography	Supplier control report

20 Outer vacuum vessel

Parameters	Values acceptable	Control Equipment	Record documents
Material	See drawings	Chemical analysis	Supplier control report
Magnetic permeability	See magnet specification	Permeability meter	Sigmaphi control report
Heat treatment	See magnet specification	Temperature/time recorder	Supplier control report
Geometry	See drawings and 3D cad files	3D measurement	Supplier control report
Cleaning	See magnet specification	Visual inspection	Supplier control report

Aspect	No oil, no grease, no burrs, no sharp edges accepted	Visual inspection	Sigmaphi control report
Helium leakage test	See magnet specification	Helium bench test	Supplier control report
Welds inspection	See Sigmaphi standard	Visual inspection	Supplier control report

21 Suspension links

Parameters	Values acceptable	Control Equipment	Record documents
Material	See drawings	Chemical analysis	Supplier control report
Heat treatment	See magnet specification	Temperature/time recorder	Supplier control report
Young modulus and Yield strength at 20°C	See magnet specification	Lab mechanical testing	Excel file record Sigmaphi measurement report
Impact test - lateral expansion	≥ 0.53 mm at -268°C (4K)	Charpy test	Lab control report
Magnetic permeability	See magnet specification	Permeability meter	Sigmaphi control report
Geometry	See drawings and 3D cad files	3D measurement	Supplier control report
Aspect	No oil, no grease, no burrs, no sharp edges accepted	Visual inspection	Sigmaphi control report

22 Helium Multi layers insulation

Parameters	Values acceptable	Control Equipment	Record documents
Material	See magnet specification	Visual inspection	Supplier material
Number of layers	See magnet specification	Visual inspection	Sigmaphi control report
Geometry	See supplier drawings	1D measurement	Supplier control report
Aspect	No oil, no grease, no burrs, no sharp edges, no holes accepted	Visual inspection	Sigmaphi control report

23 Screen Multi layers insulation

Parameters	Values acceptable	Control Equipment	Record documents
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Material	See magnet specification	Visual inspection	Supplier material
Number of layers	See magnet specification	Visual inspection	Sigmaphi control report
Geometry	See supplier drawings	1D measurement	Supplier control report
Aspect	No oil, no grease, no burrs, no sharp edges, no holes accepted	Visual inspection	Sigmaphi control report

24 Instrumentation

Parameters	Values acceptable	Control Equipment	Record documents
Wires resistance	See magnet specification	Ohm meter	Sigmaphi control report
Installation	See magnet specification	Visual inspection	Sigmaphi control report

25 Cryostat integration

Parameters	Values acceptable	Control Equipment	Record documents
Clearances	See magnet specification	Visual inspection 1D measurement	Sigmaphi control report
Multi layer insulation	No holes accepted	Visual inspection	Sigmaphi control report
Aspect	No oil, no grease, no burrs, no sharp edges, no holes accepted	Visual inspection	Sigmaphi control report

26 Magnetic measurement

Parameters	Values acceptable	Control Equipment	Record documents
Harmonics content at 50 A, 20°C, without iron	See magnet specification	Rotating coil bench	Sigmaphi measurement report
References location	See magnet specification	3d measurement	Sigmaphi control report

27 Helium chimney

Parameters	Values acceptable	Control Equipment	Record documents
Material	See drawings	Chemical analysis	Supplier control report
Impact test - lateral expansion	≥ 0.53 mm at -268°C (4K)	Charpy test	Supplier control report

Magnetic permeability	No oil, no grease, no burrs, no sharp edges accepted	Permeability meter	Sigmaphi control report
Heat treatment	See magnet specification	Temperature/time recorder	Supplier control report
Geometry	See drawings and 3D cad files	3D measurement	Supplier control report
Cleaning	See magnet specification	Visual inspection	Supplier control report
Pressure test			
Aspect	No oil, no grease, no burrs, no sharp edges accepted	Visual inspection	Sigmaphi control report
Pressure test	See magnet specification	Pressure bench test with alcohol	Supplier control report
Helium leakage test	See magnet specification	Helium bench test	Supplier control report
100 % Welds inspection	See ASME Pressure and Vessel Code	Radiography	Supplier control report

28 Nitrogen chimney

Parameters	Values acceptable	Control Equipment	Record documents
Material	See drawings	Chemical analysis	Supplier control report
Impact test - lateral expansion	See magnet specification	Charpy test	Supplier control report
Magnetic permeability	See magnet specification	Permeability meter	Sigmaphi control report
Heat treatment	See magnet specification	Temperature/time recorder	Supplier control report
Geometry	See drawings and 3D cad files	3D measurement	Supplier control report
Cleaning	See magnet specification	Visual inspection	Supplier control report
Aspect	No oil, no grease, no burrs, no sharp edges accepted	Visual inspection	Sigmaphi control report
Pressure test	See magnet specification	Pressure bench test with alcohol	Supplier control report
Helium leakage test	See magnet specification	Helium bench test	Supplier control report
Welds inspection	See ASME Pressure and Vessel Code	Radiography	Supplier control report

29 Chimney screen

Parameters	Values acceptable	Control Equipment	Record documents
Material	See drawings	Chemical analysis	Supplier control report
Heat treatment	See magnet specification	Temperature/time recorder	Supplier control report
Geometry	See drawings and 3D cad files	3D measurement	Supplier control report
Cleaning	See magnet specification	Visual inspection	Supplier control report
Aspect	No oil, no grease, no burrs, no sharp edges accepted	Visual inspection	Sigmaphi control report

30 Chimney vacuum

Parameters	Values acceptable	Control Equipment	Record documents
Material	See drawings	Chemical analysis	Supplier control report
Magnetic permeability	See magnet specification	Permeability meter	Sigmaphi control report
Heat treatment	See magnet specification	Temperature/time recorder	Supplier control report
Geometry	See drawings and 3D cad files	3D measurement	Supplier control report
Cleaning	See magnet specification	Visual inspection	Supplier control report
Aspect	No oil, no grease, no burrs, no sharp edges accepted	Visual inspection	Sigmaphi control report
Helium leakage test	See magnet specification	Helium bench test	Supplier control report
Welds inspection	See Sigmaphi standard	Visual inspection	Supplier control report

31 Helium Chimney Multi layers insulation

Parameters	Values acceptable	Control Equipment	Record documents
Material	See magnet specification	Visual inspection	Supplier material
Number of layers	See magnet specification	Visual inspection	Sigmaphi control report
Geometry	See supplier drawings	1D measurement	Supplier control

			report
Aspect	No oil, no grease, no burrs, no sharp edges, no holes accepted	Visual inspection	Sigmaphi control report

32 Screen Chimney Multi layers insulation

Parameters	Values acceptable	Control Equipment	Record documents
Material	See magnet specification	Visual inspection	Supplier material
Number of layers	See magnet specification	Visual inspection	Sigmaphi control report
Geometry	See supplier drawings	1D measurement	Supplier control report
Aspect	No oil, no grease, no burrs, no sharp edges, no holes accepted	Visual inspection	Sigmaphi control report

33 Installation on site

Parameters	Values acceptable	Control Equipment	Record documents
Welds inspection	See magnet specification	JLAB's radiography	JLAB / Sigmaphi control report
Helium leakage test	See magnet specification	JLAB's Helium bench test	JLAB / Sigmaphi control report
Aspect	No oil, no grease, no burrs, no sharp edges, no holes accepted	Visual inspection	JLAB / Sigmaphi control report

34 Acceptance tests

Parameters	Values acceptable	Control Equipment	Record documents
Cooldown	See magnet specification	JLAB	JLAB / Sigmaphi control report
Instrumentation	See magnet specification	JLAB	JLAB / Sigmaphi control report
Sigmaphi Acceptance current	60% Nominal current	JLAB	JLAB / Sigmaphi control report
JLAB Acceptance current	See magnet specification	JLAB	JLAB / Sigmaphi control report