LABORATORI NAZIONALI DI FRASCATI
SIS – Pubblicazioni

LNF-01/003 (NT)
18 Gennaio 2001

Technical Layout of the TESLA Damping Ring

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Abstract

The electron – positron linear collider TESLA will require two Damping Rings, where the 2820 bunches, with an energy of 5 GeV, will be compressed to obtain a bunch spacing of 20 ns. This bunch spacing fixes a Damping Ring length of 17 km. The major part of the damping ring will be installed in the linac tunnel; short return arcs, with a length of about 1.3 km each, will be installed in dedicated tunnels.

This report describes the technical layout of one damping ring, developed in collaboration with Ansaldo Ricerche, in all its components: magnetic system (dipoles, quadrupoles, sextupoles, steerers, electromagnetic wigglers), RF system (cryo-modules, RF power sources), Vacuum system (vacuum chambers, pumps, valves), Beam diagnostics, Computer control system, Electrical services, Cooling system, etc. Drawings showing the detailed ring layout and also every component of the ring are included.

PACS.: 29.20.-c

1 INTRODUCTION

Damping rings are necessary to reduce the emittances of the beams to the small values required for the linear collider. The reduction is achieved via the radiation damping process, i.e. the combination of synchrotron radiation in bending fields with energy gain in RF cavities.

One of the main design criteria for the damping ring comes from the need to reduce the length of the original 1 ms pulse, containing 2820 bunches, in a compressed mode with a bunch spacing of 20 ns, corresponding to a ring length of 17 km.

To avoid the cost of additional 17 km ring tunnels, about the 82% of the ring will be in the form of straight sections installed in the same main linac tunnel (1). The remaining length will need dedicated tunnels to house the shorts return arcs.

The main parameters for the TESLA positron damping ring are listed in Table 1.

TAB. 1: Positron damping ring parameters.

Energy E	5 GeV
Circumference	17 km
Injected emittance $\gamma\varepsilon_{x(y)}$	0.01 m
Hor. Extracted emittance $\gamma\varepsilon_x$	$8 * 10^{-6}$ m
Ver. Extracted emittance $\gamma\varepsilon_y$	$0.02 * 10^{-6}$ m
Damping time τ_d	28 ms
Number of bunches	2820
Bunch spacing $\Delta\tau_b$	$20 * 10^{-9}$ s
Current	160 mA
Total radiated power	3.2 MW

A detailed description of the damping ring parameters can be found in (2).

The damping ring can be divided into three separate parts: 1. The arcs; 2. The wiggler sections; 3. The long straight sections in the linac tunnel. The lattice of the arc is designed as a minimum emittance cell with two 4.5 m long dipole magnets flanked by quadrupole doublets. Focusing sextupoles, at the points of highest horizontal dispersion and β-function are also foreseen. Each cell is 15.2 m long and 102 cells + 12 half cells will be required for each arc.The layout that follow shows, cell by cell, the composition af each arc.

To achieve the desired positron damping time of 28 ms, the wigglers have to provide a total second field integral $\int B^2 dl \approx 605\ T^2m$. To accomplish this requirement a 1.8 T wiggler electromagnet has been designed and is described in the following.

Each of the 140 straight section cells is about 100 m long. Vertical bending magnets are needed to follow the earth curvature. This part of the ring will be installed in the same tunnel of the main linac.

The RF system is based on the assumption that 12 superconducting cavities will be used to restore the 3.2 MW of synchrotron radiation power , with an accelerating peak voltage of 50 MV at 500 MHz. High Order Mode (HOM) dampers, that will make use of dissipative material applied to the inner surface of the beam tubes, are foreseen to dissipate parasitic power. Three 1.2 MW/cw, at 500 MHz, klystrons will be used. A more detailed description of the RF system together with the RF system parameter list can be found in (3).

Conventional laminated, water cooled magnets have been designed, and presented in the following, for the damping rings. The current densities have been maintained very low (2.5 A/mm^2) to limit the power dissipation inside the tunnel of the rings. Two alternative designs of the wiggler magnets have been studied: permanent magnet and electromagnetic technology. In this note only the second solution is described. References about the first solution can be found in (1), where also a summary of the main characteristics of the magnetic system, can be found.

The Vacuum system has been designed to achieve a mean pressure inside the vacuum chamber of about 10^{-8} mbar in the arc sections and 10^{-9} mbar in the long straight sections. Special vacuum chambers, with distributed pumping system in the bending dipole, and two ante-chambers for the wiggler magnets, have been designed. The synchrotron radiation photo-desorption in the wiggler magnets requires very particular attention due to a photon flux of 3 * 10^{19} photons/magnet/s with a maximum surface power density of 1 kW/mm^2. To absorb this high power a special synchrotron radiation absorber has been designed. Details about the complete vacuum system can be found in the following.

A detailed description of the infrastructure is also reported. A complete layout of the damping ring arc tunnel has been carried out, including the transportation system, for people and materials, including all the ancillary systems like: compressed air distribution line; fire detection and extinguishing system; normal and emergency lighting, including an optical video circuit; ventilation and air extraction system; etc.

The electrical services and cooling systems have been also carefully studied and are described in the following.

The cost evaluation of each component or system has been performed, based on market quotations from specialized manufacturers. No additional costs due to company overprizing has been added. The needs of manpower have also been considered in the economical evaluation which takes into account the project time schedule and the spending profile, including the assembling of the all damping ring and the initial commissioning without the beam.

2 TECHNICAL LAYOUT

In the following the technical layout of the Damping Ring developed and designed by Ansaldo Ricerche is reported.

ANSALDO

Ansaldo Ricerche s.r.l.

Progetto project	Identificativo document no.
TESLA DAMPING RING	File: 0s-secondo-1 S02956UX3000L

Cliente client	Comm.-s/comm. job. no.	Emittente issued by	Pagina page	Di of
I.N.F.N.	UX3.000	ARI/TME/MTM	1	10

Rag. disc. disc.code	Rif. str. prod. prod. str. no	Identificativo componente equipment identification code	Tipo doc. doc type	Cl. ris. class	Allegati enclosures
N/A	.N/A	Damping Ring	S	L	No

Titolo title	Derivato da derived from
ECONOMIC AND SINKING PLAN OF «DAMPING RING TESLA»	
	Sostituisce substitutes

Stato validita`: rev.scope **Issue 11/12/2000**

1	23/02/2001	Sheets **2,3**(§2/5-6),**4**(§3/1-Manpower),**5**(erased), **6⇒5**(1.4.1.9-1.4.2.4), **7⇒6, 8⇒7**(Tot), **9⇒8**(Cap.) **10⇒9**, **11⇒10**(values) modified		Barbagelata Luigi	Grattarola Marco		Rosatelli Franco
0	11/12/20000	Issue		Barbagelata Luigi	Grattarola Marco		Rosatelli Franco
Rev. rev.	**Data** date	**Descrizione** description	**Stato valid.** rev. scope	**Redazione** prepared by	**Controllo** checked by/	**approvazione** checked by/ approved by	**Autorizzazione emissione** issue authorization

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1. AIM

The present Manufacturing Specification aims at:
1. Reporting on the Cost Evaluation agreed upon with the Suppliers starting from both preliminary drawings and available resources (ARI and/or subcontractors)
2. Assessing a Cost Evaluation.

5. REFERENCES

The present specification invokes the following documents:

1. List of deliverables, whose version dated 06/12/2000 has been provided by INFN
2. Tesla Conceptual Design Report
3. ARI Procedure n.P0111767000L dated 13/12/99.
4. ARI Manufacturing Specifications:

n.° S02993UX3000L	referring to « Magnets»	ref.n. INFN 1.4.1
n.°S02958UX3000L	referring to « Multipole Girders/Support»	ref.n. INFN 1.4.1.8
n.° S02975UX3000L	referring to « D.R. Vacuum Chambre»	ref.n. INFN 1.4.4.1
n.° S02977UX3000L	referring to « Vacuum Chamber Supports»	ref.n. INFN 1.4.4.3
n.° S02982UX3000L	referring to « Special Magnets V. C. (Wigglers)»	ref.n. INFN 1.4.4.8
n.° S02983UX3000L	referring to « Beam Diagnostics»	ref.n. INFN 1.4.5

5. Supply Specifications:

n.° S03006UX3000L	referring to « Magnet Power Supplies»	ref.n. INFN 1.4.2
n.° S02978UX3000L	referring to « Pumps and Power Supplies»	ref.n. INFN 1.4.4.4
n.° S02979UX3000L	referring to « Vacuum Diagnostic»	ref.n. INFN 1.4.4.5
n.° S02980UX3000L	referring to « Manual and Automatic Valves»	ref.n. INFN 1.4.4.6
n.° S02981UX3000L	referring to « Control Units»	ref.n. INFN 1.4.4.7
n.° S02991UX3000L	referring to « General Services»	ref.n. INFN 1.6÷1..9-1.14-1.15
n.° S02995UX3000L	referring to « Handling Equipment and Cranes»	ref.n. INFN 1.10
n.° S02996UX3000L	referring to « Tunnel Transport System»	ref.n. INFN 1.11
n.° S03003UX3000L	referring to « Alignement Facilities»	ref.n. INFN 1.12
n.° S03007UX3000L	referring to « Test and Acceptance Tests»	ref.n. INFN 1.17

6. Manpower Specifications:

n.° S03004UX3000L referring to « Installation Time Schedule and Manpower / Engineering and Q.A.» ref.n. INFN 1.19-1.13

3. TASKS

3.1 Engineering and Manpower costs

(for working time evaluation see ARI Spec. n n.° S03004UX3000L referring to « Installation Time Schedule and Manpower / Engineering and Q.A.»

ENGINEERING

	hours	hours				Total Cost (Lire)	Total Cost (Lire)
Ref.	P.M. wigglers	Elect. Wigglers	Site	Lab. In Ge.	Unit Cost. (L/h)	Perm Magn.Wigglers	Electromagnetic Wigglers
5	Desy	19872	x	x	150000	Desy	L. 2.980.800.000
6	Desy	9360		x	120000	Desy	L. 1.123.200.000
7-8	Desy	8736		x	120000	Desy	L. 1.048.320.000
9	Desy	8896	x	x	150000	Desy	L. 1.334.400.000
Total	**Desy**	**46864**				**Desy**	**L. 6.486.720.000**

MANPOWER

Ref	Activity	P.M. Wiggler	Elect. Wigglers	Unit Cost (L/h)	Perm Magn. Wigglers	Electromagnetic Wigglers
51	Tunnel Referents Alignment	3898	3898	150000	L. 584.700.000	L. 584.700.000
52	Dipoles and Wigglers on Site Assembly	8208	8208	150000	L. 1.231.200.000	L. 1.231.200.000
53	Multipoles and Vacuum System Assembly and Alignment on Girders in Laboratory	20345	20345	100000	L. 2.034.500.000	L. 2.034.500.000
54	Multipoles Girders on Site Assembly	11168	11168	150000	L. 1.675.200.000	L. 1.675.200.000
55	Generic Assembly	153867	170283	150000	L. 23.080.050.000	L. 25.542.450.000
56	In Laboratory Assembly of Control Units	26928	26928	100000	L. 2.692.800.000	L. 2.692.800.000
57	On Site Assembly of Control Units	39495	39495	150000	L. 5.400.000.000	L. 5.400.000.000
58	Generic Cabling	71651	75893	150000	L. 10.747.650.000	L. 11.383.950.000
59	Dipoles and Wigglers on Site Alignment	10368	10368	150000	L. 1.555.200.000	L. 1.555.200.000
60	Magnets Alignment on Site	7632	7632	150000	L. 1.144.800.000	L. 1.144.800.000
	Grand Total	**353560**	**374218**	**/**	**L. 50.146.100.000**	**L. 53.244.800.000**
61	**Acceptance Tests**	**29880**	**29880**	**150000**		**L. 4.482.000.000**
62	**Commissioning**	**7200**	**7200**	**150000**		**L. 1.080.000.000**

3. TASKS

3.2 Cost Evaluation Summary

								PRELIMINARY cost			FINAL cost	
Progressive Number					Main Item	Requested Job		Nov. 2000		(*)	14/02/2001	(*)
1	2	3	4	5		Design	Mag/Ther mMech/Ver.	Cost Evaluation (Mlire)	Cost Evaluation (Mlire)	Cost Evaluation MLire	Cost Evaluation (Mlire)	Cost Evaluation (Mlire)
								With Electrom.Wigglers	Without Electrom. Wigglers	Without Electrom. Wigglers	With Electrom. Wigglers	Without Electrom. Wigglers
1					TESLA 5 GeV Damping Rings							
1	1				Damping Ring Lattice	Not		Not	Not	Not	Not	Not
1	2				General Lay-out	Yes		Not	Not	Not	Not	Not
1	2	1			D.R. Arc Tunnel Lay-out	Yes	Not	Not	Not	Not	Not	Not
1	2	2			D.R. 8 km Conn. Tunnel Lay-out	Yes	Not	Not	Not	Not	Not	Not
1	3				Injection/Extraction Sections	Yes	Yes	Not	Not	Not	Not	Not
1	4				Damping Rings							
1	4	1			Magnetic Components							
1	4	1	1		Bending Dipoles	Yes	Yes	9,129	9,129	9,129	9,129	9,129
1	4	1	2		Quadrupoles	Yes	Yes	15,413	15,413	15,413	15,413	15,413
1	4	1	3		Sextupoles	Yes	Yes	4,144	4,144	4,144	4,144	4,144
1	4	1	4		Magnetic Measurements	Not	Not	3,903	3,903	3,903	3,903	3,903
1	4	1	5		Magnet Assembly	Yes	Yes	4,134	4,134	4,134	4,134	4,134
1	4	1	6		H/V Correctors	Yes	Yes	3,589	3,589	3,589	3,589	3,589
1	4	1	7		Dipole Stands and Supports	Yes	Yes	875	875	875	875	875
1	4	1	8		Multipole Girders/Supports	Yes	Yes	2,850	2,850	**2,591**	**2,845**	**2,586**
1	4	1	9		Special Magnets (Electromagnetic Wigglers)	Yes	Yes	12,104	DESY	DESY	12,104	DESY
1	4	2			Power Supply System	Not	Yes	1,477	1,477	1,477	1,477	1,477
1	4	2	1		Mains Connections	Not	Not	see 1.6	see 1.6	see 1.6	see 1.6	see 1.6
1	4	2	2		Med/Low Voltage Breaker	Not	Not	see 1.6	see 1.6	see 1.6	see 1.6	see 1.6
1	4	2	3		Med/Low Voltage Cables and Trays	Not	Yes	see 1.6	see 1.6	see 1.6	see 1.6	see 1.6
1	4	2	4		Electromagnetic Wiggler Power Supplies	Not	Yes	3,477			3,477	
1	4	3			RF System							
1	4	3	1		RF Cryo-modules	Not	Not	30,000	30,000	30,000	30,000	30,000
1	4	3	2		RF Power Sources	Not	Not	9,000	9,000	9,000	9,000	9,000
1	4	3	3		Waveguide network system	Not	Not	1,400	1,400	1,400	1,400	1,400
1	4	3	4		Cryogenic System	Not	Not	10,000	10,000	10,000	10,000	10,000
1	4	3	5		Cooling System	Not	Not	1,000	1,000	1,000	1,000	1,000
1	4	3	6		Others (electronics, controls, intelocks, etc.)	Not	Not	1,000	1,000	1,000	1,000	1,000

1	4	4			Vacuum System							
1	4	4	1		D. R. Vacuum Chamber	Yes	Yes	23,450	23,450	**21,318**	**23,470**	**21,336**
1	4	4	2		Conn. Tunnel Vacuum Chamber	Yes	Yes	Not	Not	Not	Not	Not
1	4	4	3		Vacuum Chamber Supports	Yes	Yes	5,435	5,435	**4,941**	**5,433**	**4,939**
1	4	4	4		Pumps and Power Supplies	Not	Yes	45,038	45,038	**40,944**	**39,289**	**35,717**
1	4	4	5		Vacuum Diagnostics	Not	Yes	7,129	7,129	**6,481**	**6,968**	**6,335**
1	4	4	6		Manual and Automatic Valves	Not	Yes	8,557	8,557	**7,779**	**8,615**	**7,832**
1	4	4	7		Control Units	Not	Yes	16,193	16,193	**14,721**	**16,591**	**15,083**
1	4	4	8		Special Magnets Vacuum Chamber (Wigglers)	Yes	Yes	350	350	**318**	**330**	**300**
1	4	5			Beam Diagnostics							
1	4	5	1		Fluorescent Screens	Not	Yes	685	685	**623**	**810**	**736**
1	4	5	2		Toroidal Current Transformers	Not	Yes	1,219	1,219	**1,108**	**1,799**	**1,635**
1	4	5	3		Wall Current Monitors	Not	Yes	1,219	1,219	**1,108**	**1,799**	**1,635**
1	4	5	4		DC Current Transformers	Not	Yes	213	213	**194**	**213**	**194**
1	4	5	5		BPM Button/Strip Line Monitors	Not	Yes	8,713	8,713	**7,921**	**13,647**	**12,406**
1	4	5	6		Beam Diagnostics Electronics	Not	Not	4,500	4,500	4,500	4,500	4,500
1	4	5	7		Emittance Measurement System	Not	Not	1,000	1,000	1,000	1,000	1,000
1	4	5	8		Scrapers	Not	Not	431	431	**392**	**306**	**278**
1	4	5	9		Tune Monitors	Not	Not	871	871	**792**	**803**	**730**
1	4	5	10		Beam Loss Monitors	Not	Not	686	686	**624**	**824**	**749**
1	5				Computer Control System							
1	5	1			Computer Control System Hardware	Not	Not	14,370	14,370	14,370	14,370	14,370
1	5	2			Computer Control System Software	Not	Not	3,500	3,500	DESY	3,500	DESY
1	6				Electrical Services							
1	6	1			Standard Line Voltage Sources	Not	Not	132	132	132	132	132
1	6	2			Main Power Distribution Boards	Not	Not	1,829	950	950	**1,725**	**1,725**
1	6	3			Medium/Low Voltage Transformers	Not	Not	701	341	341	**750**	**750**
1	6	4			Medium Voltage Breakers	Not	Not	445	312	312	**450**	**450**
1	6	5			Cables and Trays	Not	Not	4,890	4,733	**4,708**	**5,421**	**4,928**
1	6	6			Lightning System	Not	Not	126	126	126	126	126
1	6	7			Emergency Lightning System	Not	Not	59	59	59	59	59

1	7				Process Water Facilities								
1	7	1			Cooling Towers and Anc. Equip.	Not	Not	953	681	681	953	953
1	7	2			Pumps, Motors and Anc. Eqiuip.	Not	Not	800	583	583	**827**	**827**
1	7	3			Heat Exchangers	Not	Not	465	286	286	**470**	**470**
1	7	4			Piping	Not	Not	9,348	8,693	8,693	**9,067**	**9,067**
1	7	5			Filters	Not	Not	104	75	75	104	104
1	7	6			De-ionization Units	Not	Not	365	365	365	**385**	**385**
1	7	7			Tanks	Not	Not	62	41	41	62	62
1	8				Cooling and Ventilation System (only for Arcs)	Not	Not	1,800	1,300	1,300	**1,667**	**1,667**
1	9				Compressed Air Facilities (only for Arcs)	Not	Not	325	325	325	**315**	**315**
1	10				Handling Equipments and Cranes (only for Arcs)	Not	Not	5,150	5,150	**4,682**	5,150	4,682
1	11				Tunnel Transport System (only for Arcs)	Not	Not	See 1.10	See 1.10	See 1.10	See 1.10	See 1.10
1	12				Alignment Facilities (only for Arcs)	Not	Not	2,500	2,500	**2,273**	2,500	2,273
1	13				Installation Time Schedule and Manpower	Not	Not	54,370	50,601	DESY	53,245	DESY
1	14				Fire Detection System (only for Arcs)	Not	Not	1,657	1,657	1,657	1,657	1,657
1	15				Smoke extraction system (only for Arcs)	Not	Not	106	106	106	106	106
1	16				Tunnel TV Monitoring (only for Arcs)	Not	Not	40	40	**36**	40	36
1	17				Tests and Acceptance Tests	Not	Not	4,482	4,482	DESY	4,482	DESY
1	18				Commissioning (with no beam)	Not	Not	1,080	1,080	DESY	1,080	DESY
1	19				Engineering and Q.A.	Not	Not	6,486	6,486	DESY	6,486	DESY
					GRAND TOTAL			355,329	332,577	254,519	355,016	258,200

3. TASKS

3.3 Cost Time Distribution

				years				1				2				3				4				5		5.5		
				months	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60	63	66		
Payment (Type)	Ref. to Valut. Cost	Ref. To Time Sch.	Task	Capital (Mlire)																								
30/20/20/30	1.19	5-6-7-8-9	**Engineering**	6486			1946						1297						1297								1946	0
30/20/20/30	1.4.1	11	**Mag. Dipoles**	11808				3542		2362			2362			3542												0
30/20/20/30	1.4.1	12	**Mag. Wiggler+Sex.**	18927				5678		3785			3785			5678												0
30/20/20/30	1.4.1	13	**Mag. Quadr.+Corr.**	21681				6504		4336	4336				6504													0
30/20/20/30	1.4.2	10	**Mag. Power Supply Sys.**	4954			1486			991			991		1486													0
33/33/33	1.4.4.1	15	**V.L. Extrusions**	444							148	148	148															0
33/33/33	1.4.4.1	16-17	**V.L. Flanges**	4455							1485		1485			1485												0
100	1.4.4.1	18-19	**V.L. Flanges mach.**	29												29												0
30/20/20/30	1.4.4.1	20	**V.L. Gaskets**	705								212	141	141		212												0
33/33/33	1.4.4.1	21	**V.L. Vacuum Cham.**	1208								403		403	403													0
30/20/20/30	1.4.4.1	22	**V.L. Vacuum Cham.**	2241								672		448	448		672											0
33/33/33	1.4.4.1	23	**V.L. Bellows**	3977								1326		1326			1326											0
33/33/33	1.4.4.1	24-25-26	**V.L. Vacuum Stubs**	10161							3387		3387				3387											0
33/33/33	1.4.4.1	27	**V.L. Screws/Nuts**	250							83		83			83												0
30/20/20/30	1.4.4.8	21	**V.L. Vac. Ch. Wiggler**	330								99		66		66	99											0
30/20/20/30	1.4.4.3	28-29-30	**Vac. Ch. Supports**	5433				1630		1087			1087			1630												0
30/20/20/30	1.4.1.7-8	32-33-34	**Alignment Girders**	3720					1116			744		744		1116												0
33/33/33	1.12	35	**Alignment Facilities**	2500			833	833	833																			0
20/20/20/20/20	1.4.4.4	36	**Vacuum Pumps+P.S.**	39289					7858		7858			7858		7858			7858									0
30/20/20/30	1.4.4.5	37	**Vacuum Diagnostic**	6968						2090		1394					1394			2090								0
30/20/20/30	1.4.4.6	38	**Manual/Automatic Valves**	8615						2585			1723					1723		2585								0
30/20/20/30	1.4.4.7	39	**Control Units**	16591					4977				3318					3318			4977							0
30/20/20/30	1.10-11	41	**Cranes/Handling Equip.**	5150					1545		1030		1030		1545													0
20/20/20/20/20	1.4.5.1÷7	43	**Beam Diagnostic**	25701						5140		5140			5140		5140					5140						0
30/20/20/30	1.5.1		**Comp.Contr.Syst. Hw**	14370								4311					2874	2874		4311								0
30/20/20/30	1.6.1÷7	45	**Eletricial Services**	8663							2599	1733	1733		2599													0
30/20/20/30	1.7.1÷7	47	**Hydraulic System**	11868							3560	2374	2374	3560														0
30/20/20/30	1.8-9-14÷16	49	**Auxiliary Systems**	3785							1136	757	757	1136														0
	1.04.03		**RF**	52400					5040			7070		7070	8050		4025	4025		2005	2005	2005	2005	4550		4550		0
				292709			4265	18188	21369	22376	25622	26381	25700	22751	26175	21699	18917	11940	9155	10991	6982	7145	2005	4550	0	4550	1946	0
				Yars				1				2				3				4				5				
				Months	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60	63	66		

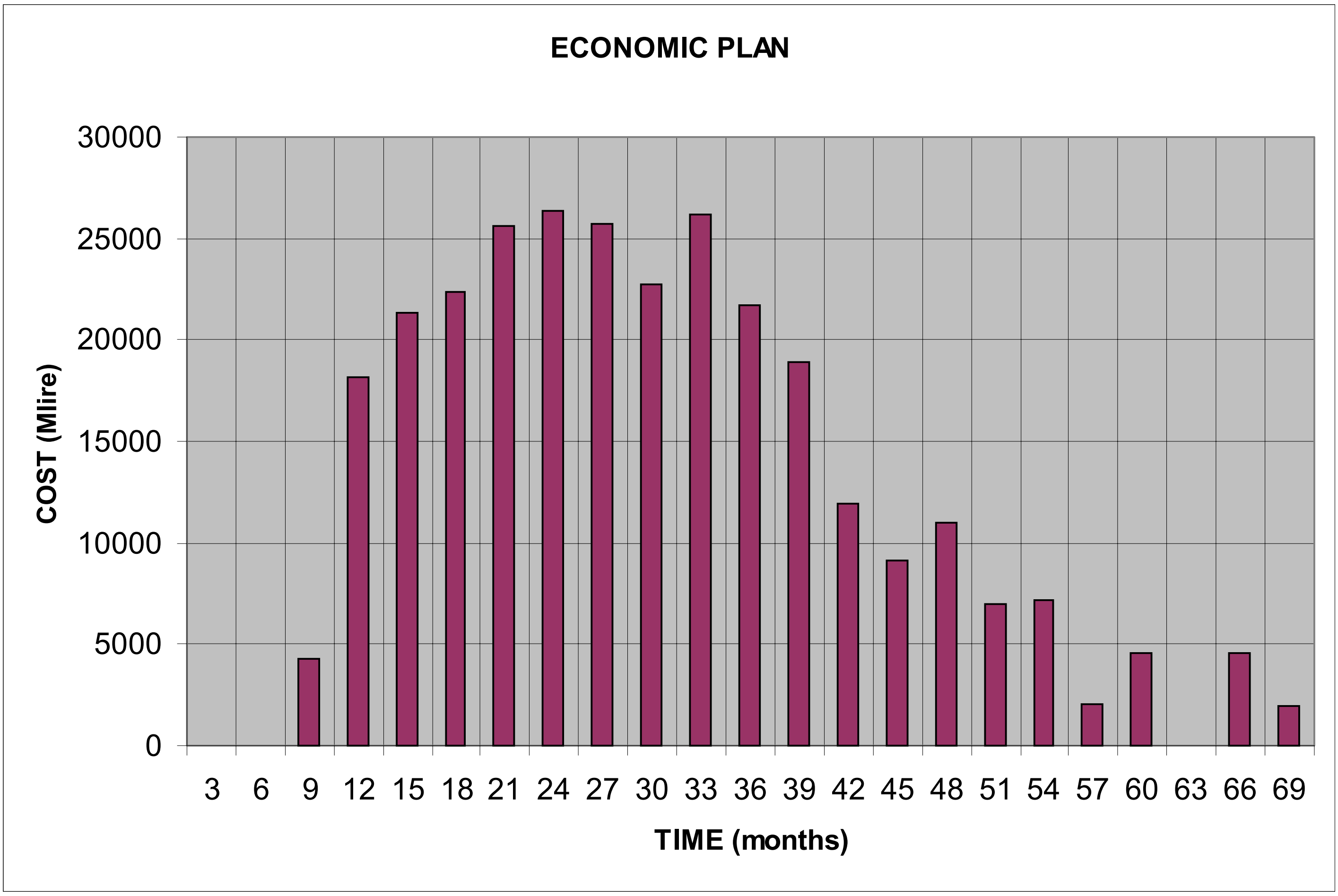
NOTE: The following items are not included in the economic plan:

1) Computer Control Systen Software	3500
2) Manpower	53245
3)Test and Acceptance Test	4482
4) Commissioning	1080
	62307

GRAND TOTAL **355016**

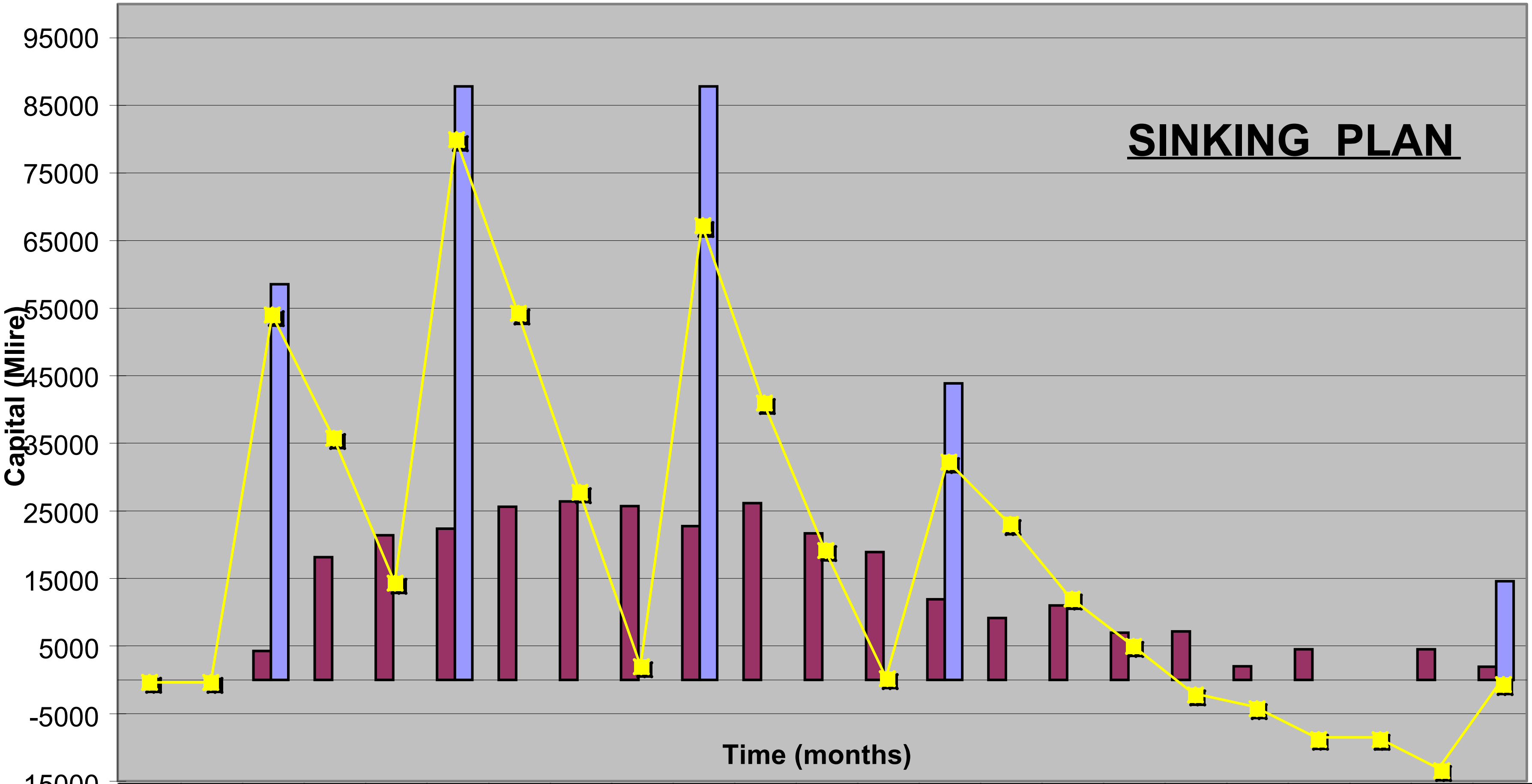
3. TASKS

3.4 Economic Engagement Graph



3. TASK

3.5 Sinking plan graph



	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60	63	66	
Serie2			4265	18188	21369	22376	25622	26381	25700	22751	26175	21699	18917	11940	9155	10991	6982	7145	2005	4550	0	4550	1946
Serie1			58542			87813				87813				43906									14635
Serie3	0	0	54276	36088	14719	80156	54534	28153	2453	67514	41339	19640	723	32689	23534	12543	5561	-1584	-3589	-8139	-8139	-12689	0

Ansaldo Ricerche s.r.l.

Progetto / project	Identificativo / document no.
TESLA DAMPING RING	File: 0s-primo-1 S02957UX3000L

Cliente / client	Comm.-s/comm. / job. no.	Emittente / issued by	Pagina / page	Di / of
I.N.F.N.	UX3.000	ARI/TME/MTM	1	5

Rag. disc. / disc.code	Rif. str. prod. / prod. str. no	Identificativo componente / equipment identification code	Tipo doc. / doc type	Cl. ris. / class	Allegati / enclosures
N/A	.N/A	Damping Ring	S		No

Titolo
title

TIME SCHEDULE FOR THE CONSTRUCTION OF «DAMPING RING TESLA»

Derivato da
derived from

Sostituisce
substitutes

Stato validita`: **Issue 04/12/2000**
rev.scope

1	19/02/2001	Sheets 1,3 and 4 (§57) modified; 6,7 eliminated		Barbagelata Luigi	Grattarola Marco		Rosatelli Franco
0	04/12/2000	Issue		Barbagelata Luigi	Grattarola Marco		Rosatelli Franco
Rev. rev.	**Data** date	**Descrizione** description	**Stato valid.** rev. scope	**Redazione** prepared by	**Controllo** checked by/	**approvazione** checked by/ approved by	**Autorizzazione emissione** issue authorization

TABLE OF CONTENTS

1. OBJECT

The object of the present specification is:

1. To exhibit an abstract of the Time Schedule the Customer agreed to.

2. REFERENCES

The present specification invokes the following documents:
The present specification invokes the following documents:

1. List of deliverables, whose version dated 06/12/2000 has been provided by INFN
2. Tesla Conceptual Design Report
3. ARI Procedure n.P0111767000L dated 13/12/99.

4. ARI Manufacturing Specifications:

n.° S02993UX3000L referring to « Magnets» ref.n. INFN 1.4.1
n.°S02958UX3000L referring to « Multipole Girders/Support» ref.n. INFN 1.4.1.8
n.° S02975UX3000L referring to « D.R. Vacuum Chambre» ref.n. INFN 1.4.4.1
n.° S02977UX3000L referring to « Vacuum Chamber Supports» ref.n. INFN 1.4.4.3
n.° S02982UX3000L referring to « Special Magnets V. C. (Wigglers)» ref.n. INFN 1.4.4.8
n.° S02983UX3000L referring to « Beam Diagnostics» ref.n. INFN 1.4.5

5. Supply Specifications:

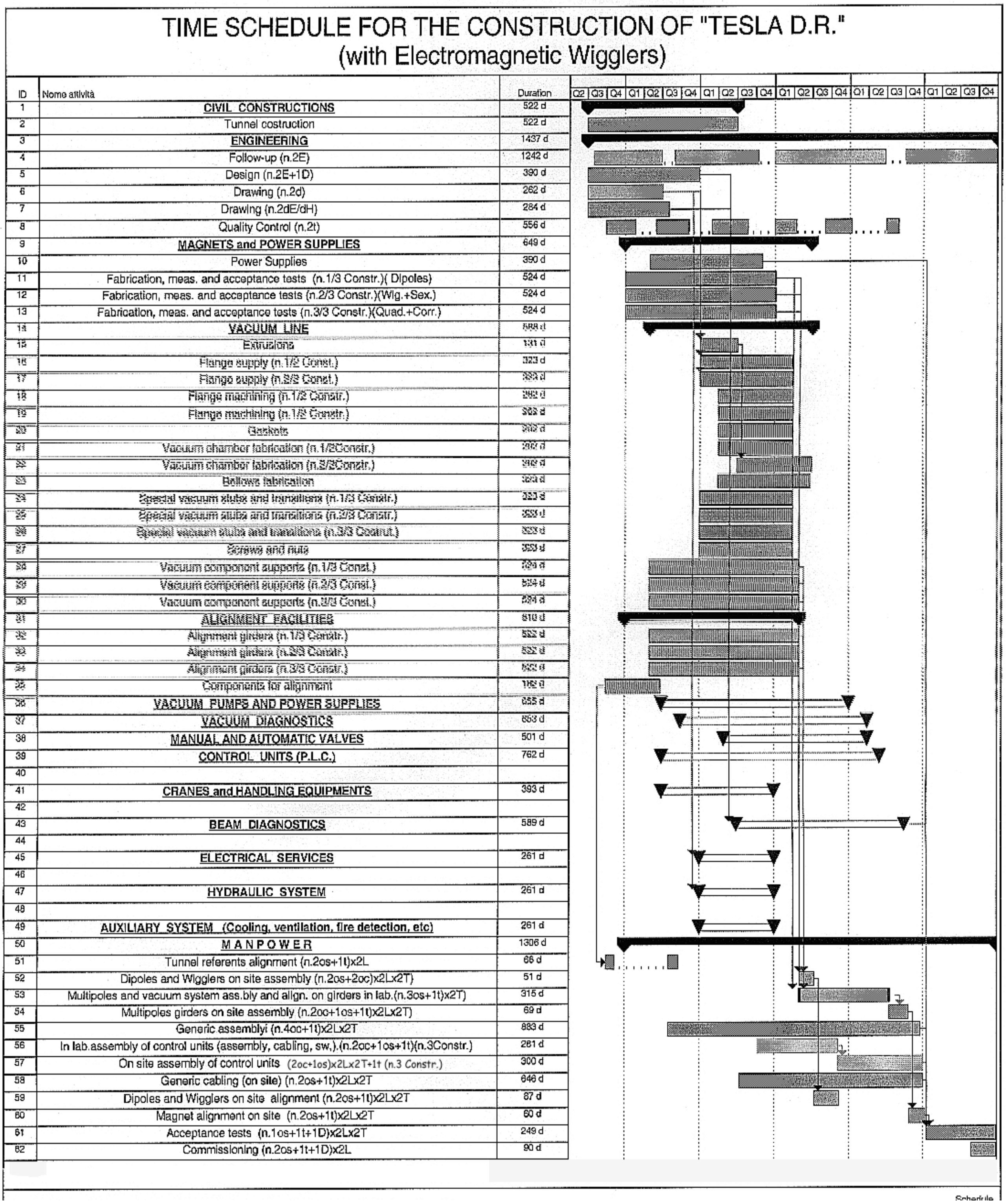
n.° S03006UX3000L referring to « Magnet Power Supplies» ref.n. INFN 1.4.2
n.° S02978UX3000L referring to « Pumps and Power Supplies» ref.n. INFN 1.4.4.4
n.° S02979UX3000L referring to « Vacuum Diagnostic» ref.n. INFN 1.4.4.5
n.° S02980UX3000L referring to « Manual and Automatic Valves» ref.n. INFN 1.4.4.6
n.° S02981UX3000L referring to « Control Units» ref.n. INFN 1.4.4.7
n.° S02991UX3000L referring to « General Services» ref.n. INFN 1.6÷1..9-1.14-1.15
n.° S02995UX3000L referring to « Handling Equipment and Cranes» ref.n. INFN 1.10
n.° S02996UX3000L referring to « Tunnel Transport System» ref.n. INFN 1.11
n.° S03003UX3000L referring to « Alignement Facilities» ref.n. INFN 1.12
n.° S03007UX3000L referring to « Test and Acceptance Tests» ref.n. INFN 1.17

6. Manpower Specifications:

n.° S03004UX3000L referring to « Installation Time Schedule and
Manpower/ Engineering and Q.A» ref.n. INFN 1.13-1.19

3. ACTIVITIES

3.1. Full ARI Time Schedule (date 20 december 2000)



TIME SCHEDULE FOR THE CONSTRUCTION OF "TESLA D.R."
(with Electromagnetic Wigglers)

ID	Nome attività	Duration
1	CIVIL CONSTRUCTIONS	522 d
2	Tunnel costruction	522 d
3	ENGINEERING	1437 d
4	Follow-up (n.2E)	1242 d
5	Design (n.2E+1D)	390 d
6	Drawing (n.2d)	262 d
7	Drawing (n.2dE/dH)	284 d
8	Quality Control (n.2t)	556 d
9	MAGNETS and POWER SUPPLIES	649 d
10	Power Supplies	390 d
11	Fabrication, meas. and acceptance tests (n.1/3 Constr.)(Dipoles)	524 d
12	Fabrication, meas. and acceptance tests (n.2/3 Constr.)(Wlg.+Sex.)	524 d
13	Fabrication, meas. and acceptance tests (n.3/3 Constr.)(Quad.+Corr.)	524 d
14	VACUUM LINE	588 d
15	Extrusions	131 d
16	Flange supply (n.1/2 Const.)	323 d
17	Flange supply (n.2/2 Const.)	[illegible]
18	Flange machining (n.1/2 Constr.)	[illegible]
19	Flange machining (n.1/2 Constr.)	[illegible]
20	Gaskets	[illegible]
21	Vacuum chamber fabrication (n.1/2Constr.)	[illegible]
22	Vacuum chamber fabrication (n.2/2Constr.)	[illegible]
23	Bellows fabrication	[illegible]
24	Special vacuum stubs and transitions (n.1/3 Constr.)	[illegible]
25	Special vacuum stubs and transitions (n.2/3 Constr.)	[illegible]
26	Special vacuum stubs and transitions (n.3/3 Constr.)	[illegible]
27	Screws and nuts	[illegible]
28	Vacuum component supports (n.1/3 Const.)	524 d
29	Vacuum component supports (n.2/3 Const.)	524 d
30	Vacuum component supports (n.3/3 Const.)	524 d
31	ALIGNMENT FACILITIES	610 d
32	Alignment girders (n.1/3 Constr.)	522 d
33	Alignment girders (n.2/3 Constr.)	522 d
34	Alignment girders (n.3/3 Constr.)	522 d
35	Components for alignment	[illegible]
36	VACUUM PUMPS AND POWER SUPPLIES	655 d
37	VACUUM DIAGNOSTICS	653 d
38	MANUAL AND AUTOMATIC VALVES	501 d
39	CONTROL UNITS (P.L.C.)	762 d
40		
41	CRANES and HANDLING EQUIPMENTS	393 d
42		
43	BEAM DIAGNOSTICS	589 d
44		
45	ELECTRICAL SERVICES	261 d
46		
47	HYDRAULIC SYSTEM	261 d
48		
49	AUXILIARY SYSTEM (Cooling, ventilation, fire detection, etc)	261 d
50	MANPOWER	1306 d
51	Tunnel referents alignment (n.2os+1t)x2L	66 d
52	Dipoles and Wigglers on site assembly (n.2os+2oc)x2Lx2T)	51 d
53	Multipoles and vacuum system ass.bly and align. on girders in lab.(n.3os+1t)x2T)	315 d
54	Multipoles girders on site assembly (n.2oc+1os+1t)x2Lx2T)	69 d
55	Generic assemblyi (n.4oc+1t)x2Lx2T	883 d
56	In lab.assembly of control units (assembly, cabling, sw,).(n.2oc+1os+1t)(n.3Constr.)	261 d
57	On site assembly of control units (2oc+1os)x2Lx2T+1t (n.3 Constr.)	300 d
58	Generic cabling (on site) (n.2os+1t)x2Lx2T	646 d
59	Dipoles and Wigglers on site alignment (n.2os+1t)x2Lx2T	87 d
60	Magnet alignment on site (n.2os+1t)x2Lx2T	60 d
61	Acceptance tests (n.1os+1t+1D)x2Lx2T	249 d
62	Commissioning (n.2os+1t+1D)x2L	90 d

3 ACTIVITY

3.2 Legend of item 3.1

TIME SCHEDULE FOR THE CONSTRUCTIONS OF "TESLA D.R."
(with Electromagnetic Wigglers)

ID	Nome attività	Durata	T4	T1	T2	T3	T4	T1	T2	T3	T4	T1	T2	T3	T4	T1	T2	T3	T4	T1	T2	T3	T4
63																							
64																							
65	**SYMBOLOGY**	0g																					
66																							
67	D = Phyisicist	0g																					
68	E = Graduate Engineer	0g																					
69	d = Draftman	0g																					
70	dE = Draftman (Electriciam System)	0g																					
71	dH = Draftman (Hydraulic System)	0g																					
72	os = Skilled Workman	0g																					
73	oc = Fitter	0g																					
74	Constr. = Constructor	0g																					
75	L = Lobe	0g																					
76	T = Shift	0g																					

ANSALDO

Ansaldo Ricerche s.r.l.

Progetto project **TESLA DAMPING RING**				**Identificativo** document no. File: 0s-quarto-1 **S02975UX3000L**			
Cliente client **I.N.F.N.**				**Comm.-s/comm.** job. no. **UX3.000**	**Emittente** issued by **ARI/TME/MTM**	**Pagina** page **1**	**Di** of **35**
Rag. disc. disc.code **N/A**	**Rif. str. prod.** prod. str. no **N/A**	**Identificativo componente** equipment identification code **Damping Ring**		**Tipo doc.** doc type **Spec di Fabbr**	**Cl. ris.** class **L**	**Allegati** enclosures **n.°13**	
Titolo title **VACUUM CHAMBERS**				**Derivato da** derived from **Sostituisce** substitutes			

Stato validita`: **Issue 19/11/2000**
rev.scope

Rev. rev.	Data date	Descrizione description	Stato valid. rev. scope	Redazione prepared by	Controllo checked by/	approvazione checked by/ approved by	Autorizzazione emissione issue authorization
0	19/11/20000	Issue		Barbagelata Luigi	Grattarola Marco		Rosatelli Franco

TABLE OF CONTENTS

1. AIM

The present Manufacturing Specification aims at detailed description of both the manufacturing criteria of the «Vacuum Chambers» (with exclusion of the «Wigglers Vacuum Chambers»), the working materials and procedures, the required number of Suppliers/Manufacturers, the time schedule agreed upon, the number of pieces to be delivered within schedule and the overall costs of the finished product.

2. REFERENCES

The present specification invokes the following documents:

1. List of deliverables, whose version dated 06/12/2000 has been provided by INFN., item 1.4.4.1. (Attachment 13)
2. ARI Procedure n.P0111767000L dated 13/12/1999.
3. Drawings:
   1. **General Drawings**
      D02954UX3000L Damping Ring General Draw.
      D02653UX3000L Damping Ring Lay-out 1
      D02654UX3000L Damping Ring Lay-out 2
      D02655UX3000L Damping Ring Lay-out 3
      D02656UX3000L Damping Ring Lay-out 4
      D02657UX3000L Damping Ring Lay-out 5
   2. **Vacuum Chamber Assembly**
      D02658UX3000L Type CV43 MOD.1/1
      D02660UX3000L Type CV43 MOD.1/3
      D02679UX3000L Type CW80 MOD.4
      D02008UX3000L Type CW80 MOD.5
      D02682UX3000L TypeCV100 MOD.6/1
      D02789UX3000L Type CV100
      D02790UX3000L Type CVD
      D02791UX3000L Type CV43
      D02792UX3000L Type CW80
      D02799UX3000L Type CV43
   3. **Bellows**
      D02659UX3000L Type MOD.1/2
      D02680UX3000L Type MOD.4/3
      D02681UX3000L Type MOD.6
   4. **Vacuum Pump Connections**
      D02661UX3000L Type DN63/DN160-MOD.2
      D02662UX3000L Type DN63/DN160-MOD.3
      D02683UX3000L Vacuum Pump Connection - ϕ43 T1 -

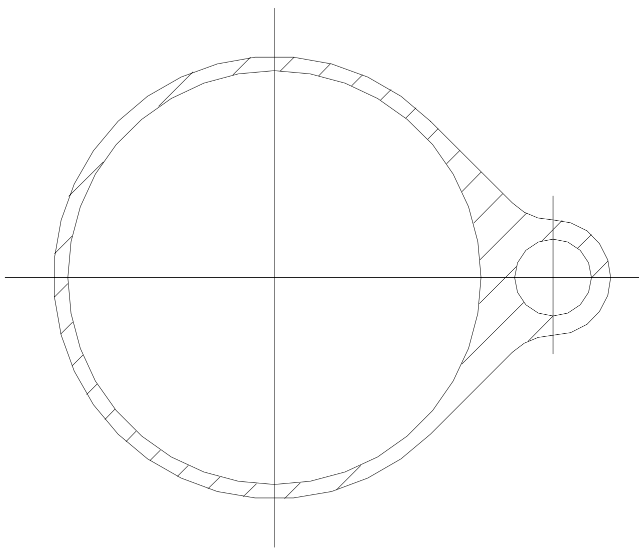
D02684UX3000L Vacuum Pump Connection - ϕ43 T2 -
D02685UX3000L Vacuum Pump Connection - ϕ43 T3 –
D02690UX3000L Type DN100/DN200-CW80 T4
D02691UX3000L Vacuum Pump Connection – CVW/CW80 T5 -
D02692UX3000L Type DN100/DN200- CW80 T6 -
D02693UX3000L Vacuum Pump Connection – CV100 T7 -
D02694UX3000L Type DN63/DN100-ϕ43 T8
D02695UX3000L Type DN100/DN200-CW80 T9
D02696UX3000L Type DN63/DN200-ϕ43/RFϕ200 T10
D02782UX3000L Traversal Kicker Stripline - ϕ43 T15 -
D02785UX3000L Vacuum Pump Connection – RFϕ200 T18-

3. COMPONENTS

3.1 Vacuum Chamber

Different models of Vacuum Chamber exist:

- **CV43** This configuration is sketched below



It is the only one which is cooled. It is utilized in the regions: ± ARC MATCH, ±ARC PNOD, ARC PCELL, ARC DRIFT, ±ARC MNOD, ARC MCELL (dipole regions are excluded).

- **CVD** The second configuration is sketched below

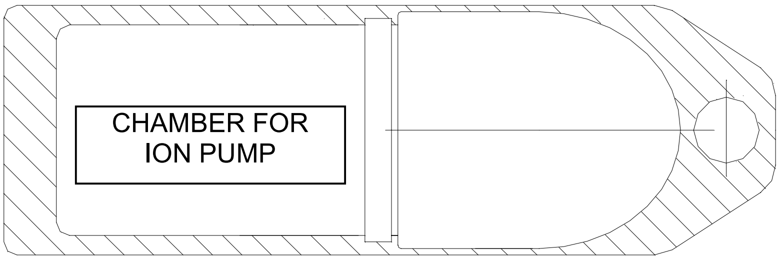


FIG.2

Its design allows location of a «chain» ion pump in the above quoted rectangular cross-section room. It is utilized in the dipole regions: ±ARC PNOD, ARC PCELL, ±ARC MNOD, ARC MCELL

- **C100** The third configuration is sketched below

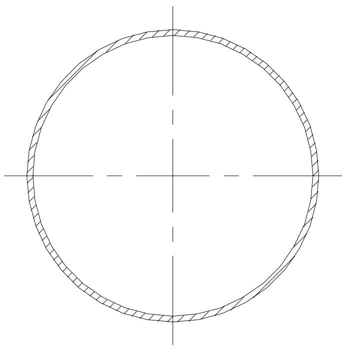


FIG.3

It is the cross-section of the chambers to be utilized in the «Damping Ring» straight regions, i.e.: ± L2A MATCH, LONG CELL.

- **CW80** The fourth configuration is sketched below

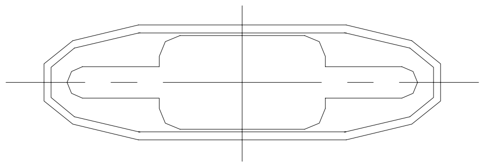


FIG.4

It is the cross-section of the chambers to be utilized in the «Wiggler» regions, i.e.: ± W2A MATCH, WIG CELL.

3.2 Bellows

Three models of Bellows exist:
MOD.1/2 with DN63 flanges is similar to **MOD.4/3** with DN100 flanges. Both are utilized near the Quadrupoles of the beamlines equipped with CV43-Vacuum Chamber:

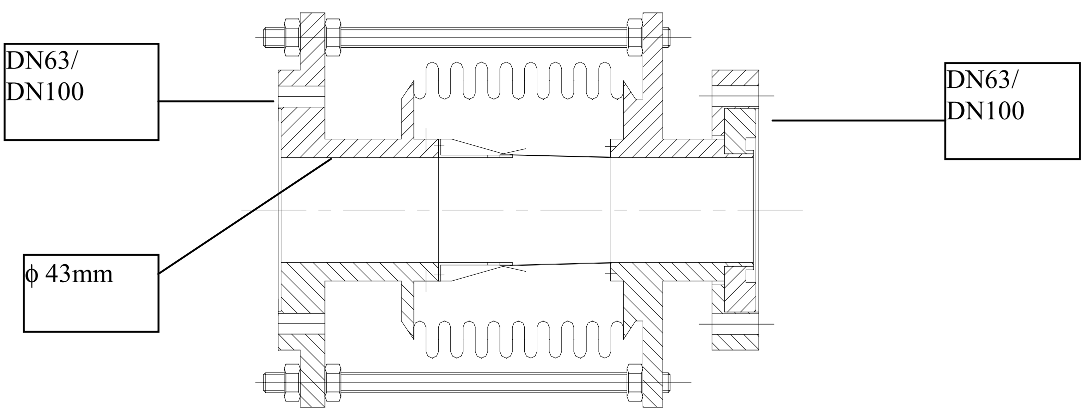


FIG.5

In contrast, **MOD.6** with DN100 flanges is utilized in the regions ± L2A MATCH and LONG CELL, near the Quadrupoles of the beamlines equipped with CV100-Vacuum Chamber:

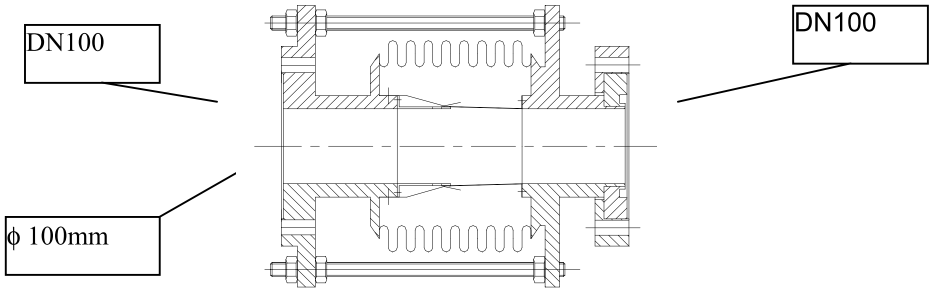


FIG.6

3.3 Vacuum Pump Connections

Their design allows linking of different kinds of flanges. MOD.2 is entirely manifactured starting from aluminium plates. Other models are manifactured through assembling two different flanges with a «Vacuum Chamber» crop (As a matter of example, model D02890UX3000L DN100/DN200-CW80 T4 is drawn below):

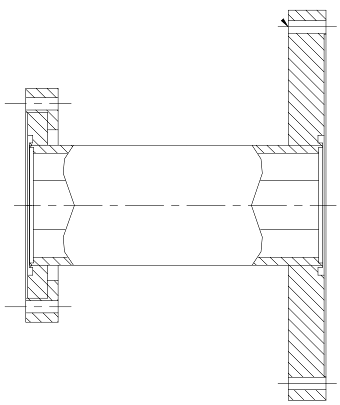


FIG.7

3. MANIFACTURING PERFORMANCES

4.1 Vacuum Chambers

CVD

Assemblies made of three kinds of extrusion material allow careful handling of inner surfaces (see FIG.2).
Furthermore, we envisage utilization of a limited quantity of CVD-relevant pieces (A1,A2 and A3, see Attachment 3) for preliminary testing campaign aimed at geometric optimization of the assembly.

CV43 and CVD

We envisage further cooling with demineralized water (see FIG.1 and FIG.2).

- Both a rotating and a fixed flange will be welded on the edge of all Vacuum Chambers (even the complex ones, i.e. Mod.1/1, Mod.1/3, Mod.5 and Mod.6/1).
- The fixed flange will carry a small reference plate with a calibrated drill; the plate will exhibit both the mark and the orientation of the axis.
- Assembled Vacuum Chamber will fulfil the following length tolerance requirement:

±0,05% for L>1000 mm ; ±0,5mm for L= 1000÷500 mm; ±0,2mm for L<500 mm

- Special Aluminium joining flanges allow joining of different parts of the Vacuum Chamber with negligible damage of their joining planes during assembly/disassembly phases, provided that special metallic gaskets are utilised («diamond» AL - see Attachment 1).
- Suitable inner copper screening -to be placed between Vacuum Chamber flanges- will minimize possible flange-joining induced «beam disturbances».

4.2 Bellows

Mechanical/electrical properties of bellows are listed below (see Attachment 12):

- Stroke (Expansion/Contraction)
  $\pm$8,5 mm (Mod.6) $\pm$15 mm (Mod.1/2 - Mod.1/2)
- Bellows Lifetime : 10^5 times
- Step at Contact Point : 1 mm
- Peak Wall Current: 50A per 20psec (f=50Mhz.)
- Setting of Shield – Contact Force: 60 $\approx$ 70 g/finger

Envisaged Titanium Nitride (TiN) 5μm coating of the Inner Tube prevents unacceptable wear in the contact region between the Inner Tube itself and moving parts.

4. MACHINING

5.1 MATERIALS

Vacuum Chambers and Vacuum Pump Connections

We envisage Aluminium Anticorodal **6060-T4 (9006/1 alloy)** and Aluminium Anticorodal **6082-T6** as the manufacturing material of Vacuum Chambers and of joining flanges respectively. We envisage **Cadmium-Phosphorous-Bronze-(Helicel BR)**-made threads on the joining drills of some flanges, as well as **AISI304**-made joining screws**.**

Bellows

We envisage:

- Beam Tube : Anticorodal 6060
- Inner Tube : Anticorodal 6060 (con TiN)
- Spring Finger : Rame – Berillio
- Shield Finger : Rame – Berillio
- Fixed Flange : Anticorodal 6082
- Rotatable Flange : Anticorodal 6082
- Bellows : AISI 304L
- Welding Transition Flange : AISI 304L/Anticorodal 6082

as the manifacturing material of Bellows (see Attachment 12).

5.2 STATE OF DELIVERY

The state of deliveries is as follows:

Vacuum Chambers and Vacuum Pump Connections

- Flange (typically, Attachment1) : from a 25/30mm-thick slab
- Screws : see catalogue
- Gaskets (Attachment 2) : according to dwg (diamond geometry)
- Pipes (Attachment 3) : Extruded with the following features:

TOLERANCES

-mod A3	+0/-0,4 mm at 34 mm (internal)
-mod A3	+0/-0,1 mm at 34 mm (internal)
-mod A1	+0/-0,5 mm at 34 mm (internal)
-mod B1/B2	±0,35 mm ovality
-mod C1	±0,60 mm ovality
-mod E	±0,20 mm at 18 mm

Elsewhere, no tolerance will exceed ±0,30 mm
Roughness will exceed Ra=0,8μm on no inner surface
Envisaged rolling improves 1-mm thick tongue surface in Mod.3

WEIGHTS and LENGTHS

-mod A1	n°227 pieces	length mm.5500	(≈2000Kg)
-mod A2	n°227 pieces	length mm.5500	(≈ 470Kg)
-mod A3	n°227 pieces	length mm.5500	(≈3150Kg)
-mod B1/B2	n°150 pieces	length mm.6500	(≈ 860Kg)
-mod C1	n°2100 pieces	length mm.7000	(≈24300Kg)
-mod E	n° 45 pieces	length mm.7000	(≈ 650Kg)

- Particular connections : Plates and particular pipes

Bellows

- Flanges : from a 25mm-thick slab
- Pipes : Round Φ80/120mm
- Electrical continuity : Sheet
- Bellows : corrugated sheet
- Connection : 5mm-thick special bimetallic sheet

5.3. MANUFACTURING PROCEDURES

Vacuum Chambers and Vacuum Pump Connections

1. Flanges

- Various Suppliers will manifacture the flanges according to the required tolerances and values of roughness listed in Attachment 1 (typically, CFs100).
- Measures/tolerances concerning flange drilling required by welding for different Vacuum Chamber models («L» cog thickness for boundary fusion is also shown):

Flanges CFs100	(Att. 7)	tolerance	+0.3/+0.5
Flanges CFs200	(Att. 7)	tolerance	+0.5/+0.7
Flanges CFs150	(Att. 8)	tolerance	+0.4/+0.6
Flanges CFs200	(Att. 9)	D=200.8mm	L=5mm
Flanges CFs150	(Att. 9)	D=160.6mm	L=5mm
Flanges CFs100	(Att. 9)	D=100.4mm	L=2mm
Flanges CFs 35	(Att. 9)	D= 38.2mm	L=1.5mm
Flanges CFs 63	(Att. 9)	D= 70.5mm	L=2mm
Flanges CFs100	(Att. 9)	D= 70.5mm	L=2mm
Flanges CFs 63	(Att. 9)	D= 48.3mm	L=2mm
Flanges CFs100	(Att. 9)	D= 48.3mm	L=2mm
Flanges CFs 63	(Att. 9)	D= 46.3mm	L=2mm
Flanges CFs100	(Att. 9)	D= 46.3mm	L=1.5mm

2. Extruded pipes (standard/special)

- Manifacturers agreed to the procedure described in Attachment 10.
- Preliminary tests (roller leveling, hot bending, cold bending, etc.) allow selection of the proper CVD bending procedure for further serial production.
- Welding technology (Electron Beam, TIG, Plasma) will be chosen during tests

5.4. TESTS

We envisage:

- statistical tests on the roughness of particular components;
- dimensional tests on all components;
- Helium leak tests according to the parameters listed in Attachment 10 pag.4/4 item n.3;
- die penetrant tests on all weldings.

at Manifacturer's premises for acceptance before shipping, according to ISO 9000

5.5. OTHERS

«Baking» treatment is required after each manifacturing, machining and washing phase in order to assure proper cleaning of components and adequate stability in time.

All ferrous surfaces will undergo «strong» burnishing in order to prevent oxydization.

5. LOCATION. QUANTITIES

Vacuum Chamber Assembly

Referring to:
- D02954UX3000L Damping Ring General Draw.
- D02653UX3000L Damping Ring **Lay-out 1**

it turns out that the quantities are:

n° **8** D02658UX3000L Type CV43 MOD.1/1
n° **6** D02660UX3000L Type CV43 MOD.1/3
n° **10** D02679UX3000L Type CW80 MOD.4
n° **35** D02008UX3000L Type CW80 MOD.5
n° **4** D02790UX3000L Type CVD
n° **11** D02791UX3000L Type CV43
n° **12** D02792UX3000L Type CW80
n° **4** D02799UX3000L Type CV43

Referring to:
- D02954UX3000L Damping Ring General Draw.
- D02654UX3000L Damping Ring **Lay-out 2**

It turns out that the quantities are:

n° **82** D02658UX3000L Type CV43 MOD.1/1
n° **3** D02660UX3000L Type CV43 MOD.1/3
n° **41** D02790UX3000L Type CVD
n° **53** D02791UX3000L Type CV43
n° **61** D02799UX3000L Type CV43

Referring to:
- D02954UX3000L Damping Ring General Draw.
- D02655UX3000L Damping Ring **Lay-out 3**

It turns out that the quantities are:

n° **79** D02658UX3000L Type CV43 MOD.1/1
n° **3** D02660UX3000L Type CV43 MOD.1/3
n° **39** D02790UX3000L Type CVD
n° **72** D02791UX3000L Type CV43
n° **55** D02799UX3000L Type CV43

Referring to:
- D02954UX3000L Damping Ring General Draw.
- D02656UX3000L Damping Ring **Lay-out 4**

It turns out that the quantities are:

n° **57** D02658UX3000L Type CV43 MOD.1/1
n° **6** D02660UX3000L Type CV43 MOD.1/3
n° **24** D02790UX3000L Type CVD
n° **49** D02799UX3000L Type CV43

n° **34** D02799UX3000L Type CV43
Referring to:

- D02954UX3000L Damping Ring General Draw.
- D02657UX3000L Damping Ring **Lay-out 5**

It turns out that the quantities are:
n°**135** D02682UX3000L TypeCV100 MOD.6/1
n°**950** D02789UX3000L Type CV100

Bellows

Referring to:

- D02954UX3000L Damping Ring General Draw.
- D02653UX3000L Damping Ring **Lay-out 1**

It turns out that the quantities are:
n° **22** D02659UX3000L Type MOD.1/2
n° **55** D02680UX3000L Type MOD.4/3

Referring to:

- D02954UX3000L Damping Ring General Draw.
- D02654UX3000L Damping Ring **Lay-out 2**

It turns out that the quantities are:
n° **87** D02659UX3000L Type MOD.1/2
Referring to:

- D02954UX3000L Damping Ring General Draw.
- D02655UX3000L Damping Ring **Lay-out 3**

It turns out that the quantities are:
n° **85** D02659UX3000L Type MOD.1/2

Referring to:

- D02954UX3000L Damping Ring General Draw.
- D02656UX3000L Damping Ring **Lay-out 4**

It turns out that the quantities are:
n° **82** D02659UX3000L Type MOD.1/2

Referring to:

- D02954UX3000L Damping Ring General Draw.
- D02657UX3000L Damping Ring **Lay-out 5**

It turns out that the quantities are:
n°**938** D02681UX3000L Type MOD.6

Vacuum Pump Connections

Referring to

- D02954UX3000L Damping Ring General Draw.
- D02653UX3000L Damping Ring **Lay-out 1**

It turns out that the quantities are:

n° **7** D02683UX3000L Vacuum Pump Connection - ϕ43 T1 -
n° **4** D02684UX3000L Vacuum Pump Connection - ϕ43 T2 -
n° **6** D02685UX3000L Vacuum Pump Connection - ϕ43 T3 -
n° **36** D02691UX3000L Vacuum Pump Connection – CVW/CW80 T5 -
n° **1** D02661UX3000L Type DN63/DN160-MOD.2
n° **1** D02662UX3000L Type DN63/DN160-MOD.3
n° **18** D02690UX3000L Type DN100/DN200-CW80 T4
n° **1** D02692UX3000L Type DN100/DN200-CW80 T6
n° **7** D02694UX3000L Type DN63/DN100-ϕ43 T8
n° **1** D02782UX3000L Traversal Kicker Stripline - ϕ43 T15 -

Referring to

- D02954UX3000L Damping Ring General Draw.
- D02654UX3000L Damping Ring **Lay-out 2**

It turns out that the quantities are:

n° **23** D02683UX3000L Vacuum Pump Connection - ϕ43 T1 -
n° **41** D02684UX3000L Vacuum Pump Connection - ϕ43 T2 -
n° **1** D02661UX3000L Type DN63/DN160-MOD.2

Referring to

- D02954UX3000L Damping Ring General Draw.
- D02655UX3000L Damping Ring **Lay-out 3**

It turns out that the quantities are:

n° **20** D02683UX3000L Vacuum Pump Connection - ϕ43 T1 -
n° **39** D02684UX3000L Vacuum Pump Connection - ϕ43 T2 -
n° **1** D02662UX3000L Type DN63/DN160-MOD.3

Referring to

- D02954UX3000L Damping Ring General Draw.
- D02656UX3000L Damping Ring **Lay-out 4**

It turns out that the quantities are:

n° **20** D02683UX3000L Vacuum Pump Connection - ϕ43 T1 -
n° **24** D02684UX3000L Vacuum Pump Connection - ϕ43 T2 -
n° **24** D02785UX3000L Vacuum Pump Connection – RFϕ200 T18-
n° **1** D02661UX3000L Type DN63/DN160-MOD.2
n° **1** D02662UX3000L Type DN63/DN160-MOD.3
n° **12** D02696UX3000L Type DN63/DN200-ϕ43/RFϕ200 T10

Referring to

- D02954UX3000L Damping Ring General Draw.
- D02657UX3000L Damping Ring **Lay-out 5**

It turns out that the quantities are:

n° **938** D02693UX3000L Vacuum Pump Connection – CV100 T7 -
n° **2** D02694UX3000L Type DN63/DN100-ϕ43 T8

6. TOTAL QUANTITIES(+ spare)

Vacuum Chamber Assembly

n° **226x2x1.05= 475** D02658UX3000L Type CV43 MOD.1/1
n° **18x2x1.05= 38** D02660UX3000L Type CV43 MOD.1/3
n° **10x2x1.10= 22** D02679UX3000L Type CW80 MOD.4
n° **35x2x1.05= 74** D02008UX3000L Type CW80 MOD.5
n° **135x2x1.05= 284** D02682UX3000L TypeCV100 MOD.6/1
n° **950x2x1.05=1995** D02789UX3000L Type CV100
n° **108x2x1.05= 227** D02790UX3000L Type CVD
n° **185x2x1.10= 407** D02791UX3000L Type CV43
n° **12x2x1.40= 34** D02792UX3000L Type CW80
n° **154x2x1.1= 339** D02799UX3000L Type CV43

Bellows

n° **276x2x1.05= 580** D02659UX3000L Type MOD.1/2
n° **55x2x1.05= 116** D02680UX3000L Type MOD.4/3
n° **938x2x1.05=1970** D02681UX3000L Type MOD.6

Vacuum Pump Connections

n° **3x2x1.10= 8** D02661UX3000L Type DN63/DN160-MOD.2
n° **3x2x1.10= 8** D02662UX3000L Type DN63/DN160-MOD.3
n° **70x2x1.05= 147** D02683UX3000L Vacuum Pump Connection - ϕ43 T1 -
n° **108x2x1.05= 227** D02684UX3000L Vacuum Pump Connection - ϕ43 T2 -
n° **6x2x1.10= 14** D02685UX3000L Vacuum Pump Connection - ϕ43 T3 –
n° **18x2x1.10= 40** D02690UX3000L Type DN100/DN200-CW80 T4
n° **36x2x1.10= 80** D02691UX3000L Vacuum Pump Connection – CVW/CW80 T5 -
n° **1x2x1.10= 3** D02692UX3000L Type DN100/DN200- CW80 T6 -
n° **938x2x1.05= 1970** D02693UX3000L Vacuum Pump Connection – CV100 T7 -
n° **9x2x1.10= 20** D02694UX3000L Type DN63/DN100-ϕ43 T8
n° **17x2x1.10= 38** D02695UX3000L Type DN100/DN200-CW80 T9
n° **12x1.10= 14** D02696UX3000L Type DN63/DN200-ϕ43/RFϕ200 T10
n° **1x2x1.10= 3** D02782UX3000L Traversal Kicker Stripline - ϕ43 T15 -
n° **24x1x1.10= 28** D02785UX3000L Vacuum Pump Connection – RFϕ200 T18-

8. DELIVERY TIME and COST

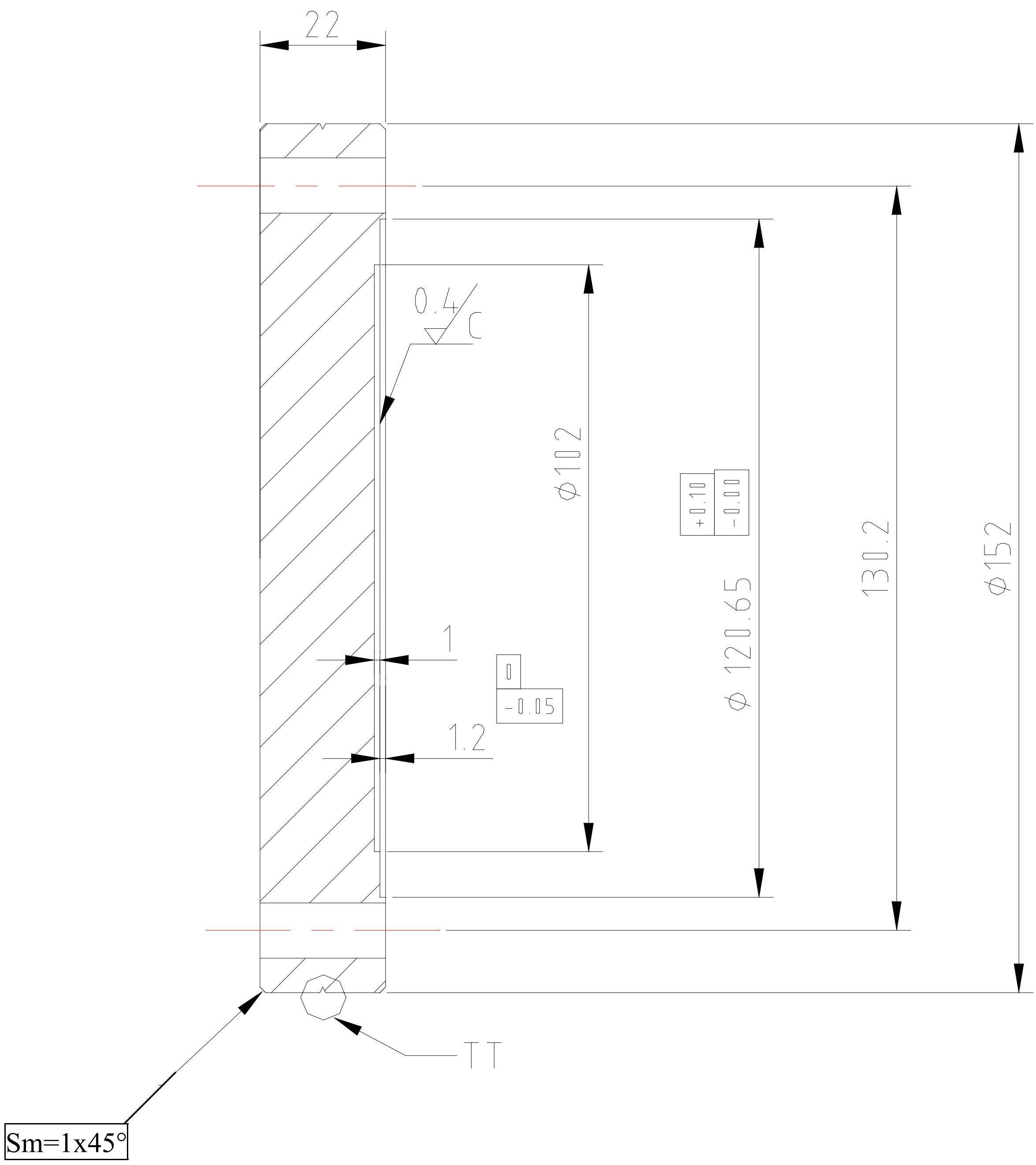
«Time Schedule for the Constructions (Ref. Spec. S02957UX3000L)» encompasses 27 months. Manifacturing of several components is required. Accordingly, we are bound to envisage utilization of seven different Manifacturers, as listed below:

VACUUM CHAMBER

CONSTR.	PLANNING (months)																												Quantity	TOTAL	COST
NUMBER	MONTHS	1	2	3#	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	TOT.	(Mlire)	(Euro)
	COMPONENTS	-	-	-	-	-	-	-	(PIECES X MONTH) -				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	D03031UX3000L	+			227	227	227																						681		
1	D03032UX3000L	+		450	450	450	450	450																					2.250		
	D03034UX3000L	+			45																								45		
	Extrusions																												2.976	412	212.780
2	D02939UX3000L	+		1030	1030	1030	1030	1030	1030	1030	1030	1030	1030	1030	1030	1030	1030	975											15.395	1.479	763.840
3	D02939UX3000L	+		1030	1030	1030	1030	1030	1030	1030	1030	1030	1030	1030	1030	1030	1030	996											15.416	2.783	1.437.300
	Flange																												30.811	4.262	2.201.140
6	D02813UX3000L	+		8350	8350	8350	8350	8350	8350	8350	8350	8350	8350	8350	8346														100.196	698	360.487
	Gaskets																												100.196	698	360.487
2	D03035÷38UX3000L			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	D03035÷38UX3000L	+		#	100	100	100	100	100	100	100	100	100	100	100	82													1.182	12	6.197
	Flange Lavoration for Welding																												1.182	12	6.197
	D02790UX3000L																														
	D02679UX3000L																														
2	D02008UX3000L		+		#	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	112					1.948	1.208	623.880
	D02792UX3000L																														
	D02658UX3000L																														
	D02660UX3000L																														
4	D02791UX3000L		+						#	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	112	1.948	2530	1.306.635
	D02789UX3000L																														
	D02682UX3000L																														
	Vacuum Chambers																												3.895	3738	1.930.515
	D02659UX3000L																														
5	D02680UX3000L			+		#	180	180	180	180	180	180	180	180	180	180	180	180	180	180	146								2.666	3.977	2.053.949
	D02681UX3000L																														
	Bellows																												2.666	3.977	2.053.949
	D02683÷96UX3000L					#	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42								630	1.958	1.011.223
6	D02782 / 85UX3000L			+																											
2	D02693UX3000L			+		#	66	66	66	66	66	66	66	66	66	66	66	66	66	66	61								985	4.494	2.320.957
4	D02693UX3000L			+		#	66	66	66	66	66	66	66	66	66	66	66	66	66	66	61								985	3.694	1.907.792
	Vac. Pump connection/ Flange Joint																												2.600	10.146	5.239.972
7	Supply		+	#	$7x10^5$							$7x10^5$							$7x10^5$									$6.9x10^5$	2.790.000	247	129.114
	Bolts, nuts and washers																												2.790.000	247	129.114
	Order	(+)																													
	First Supply	(#)																													
	GRAND TOTAL																													23.470	12.121.242

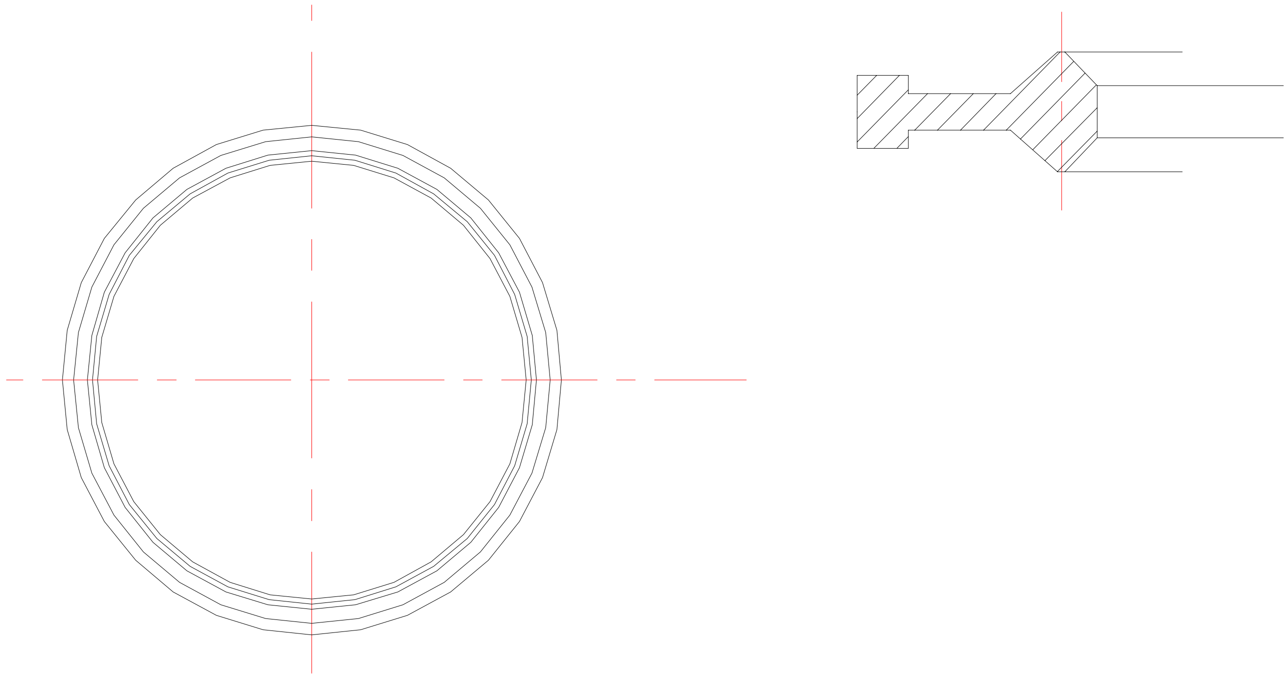
9.1. ATTACHMENT 1

Flange Draw (Typical CFs100)



9.2. ATTACHMENT 2

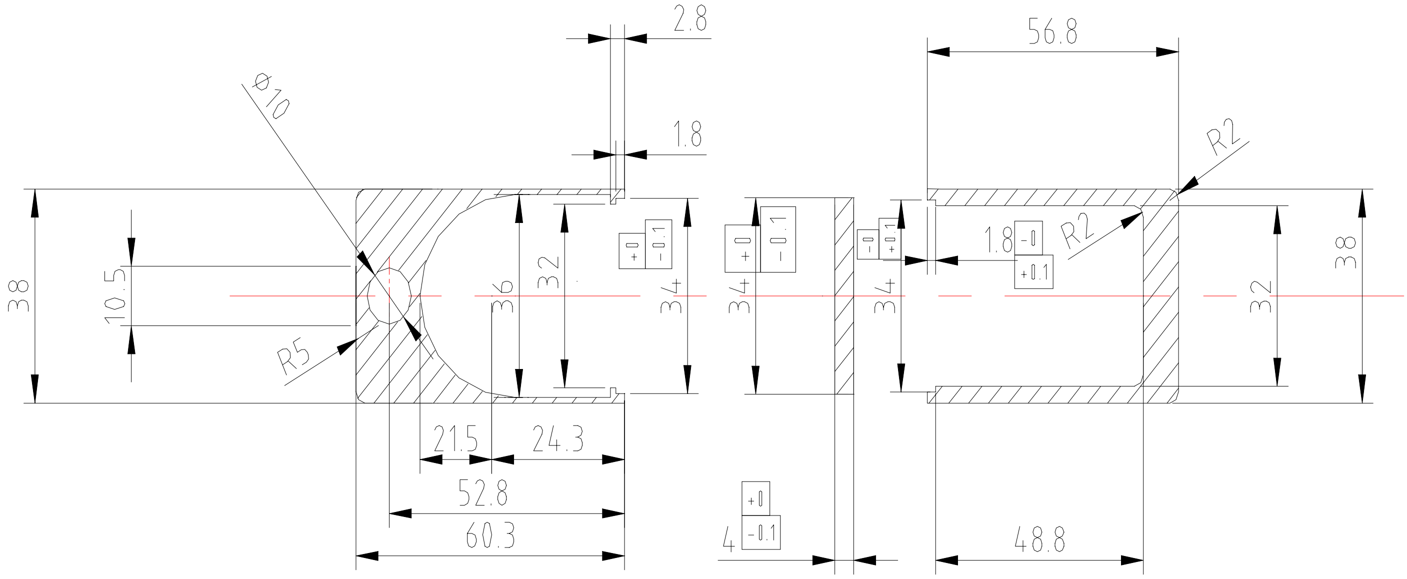
Diamond Gasket Geometry



9.3. ATTACHMENT 3

Extruded Section Type: A1, A2, and A3 (draw D03031UX3000L sheet 2/2)

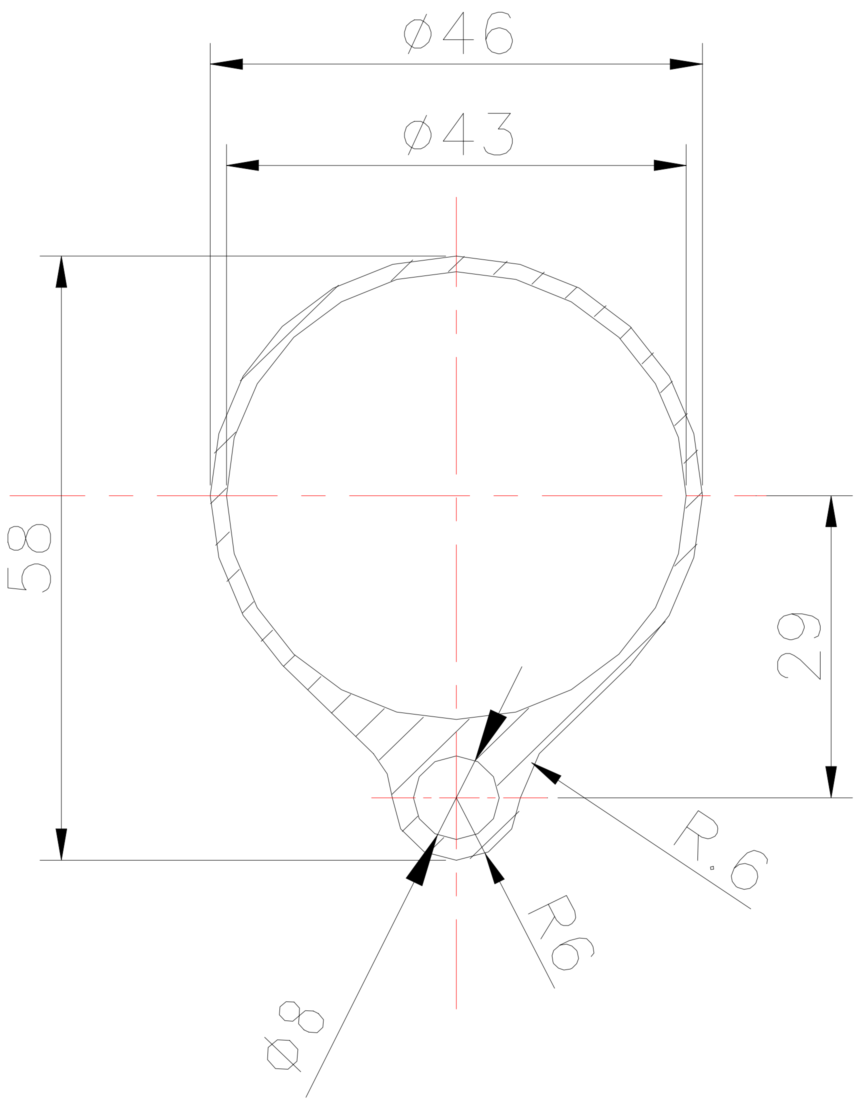
A3 **A2** **A1**



9.4. ATTACHMENT 4

Extruded Section Type: B1/B2 e C1

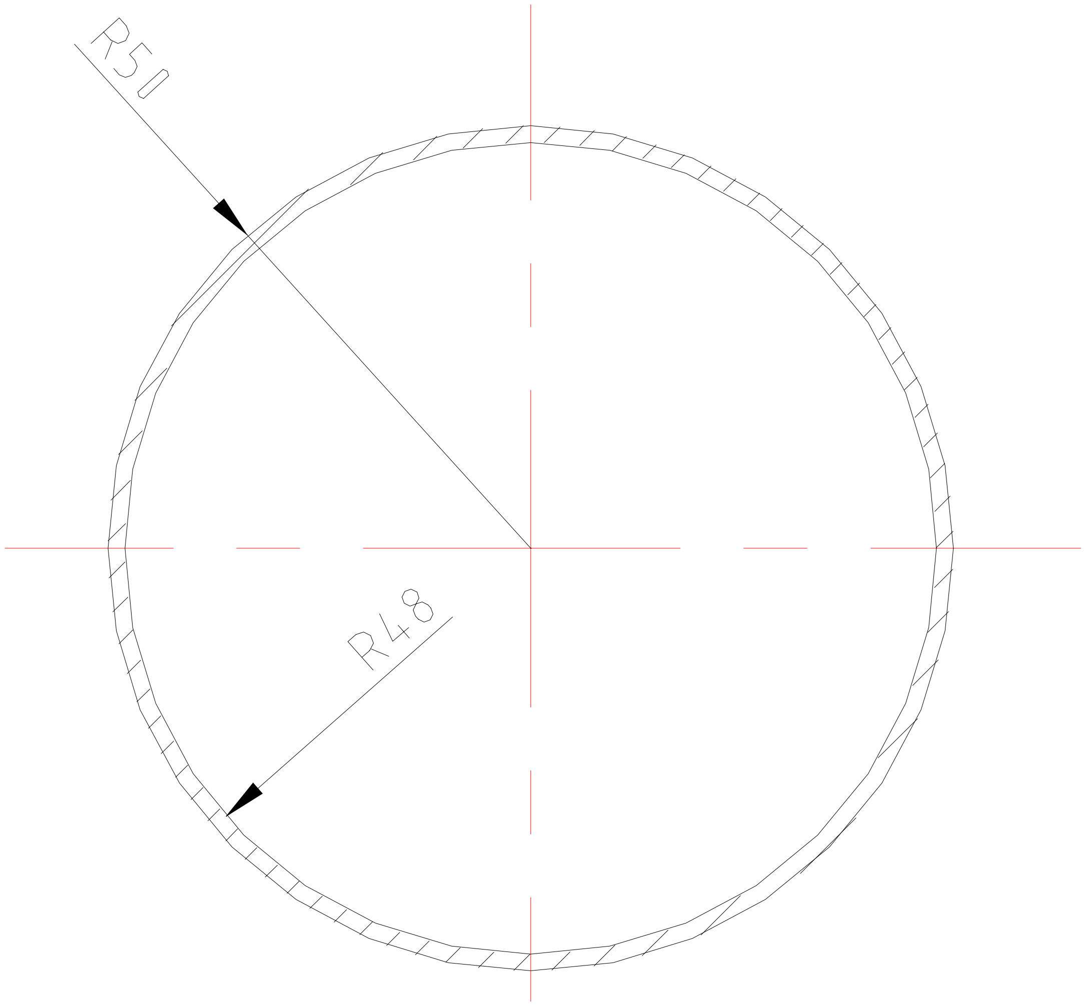
B1 / B2



9.5. ATTACHMENT 5

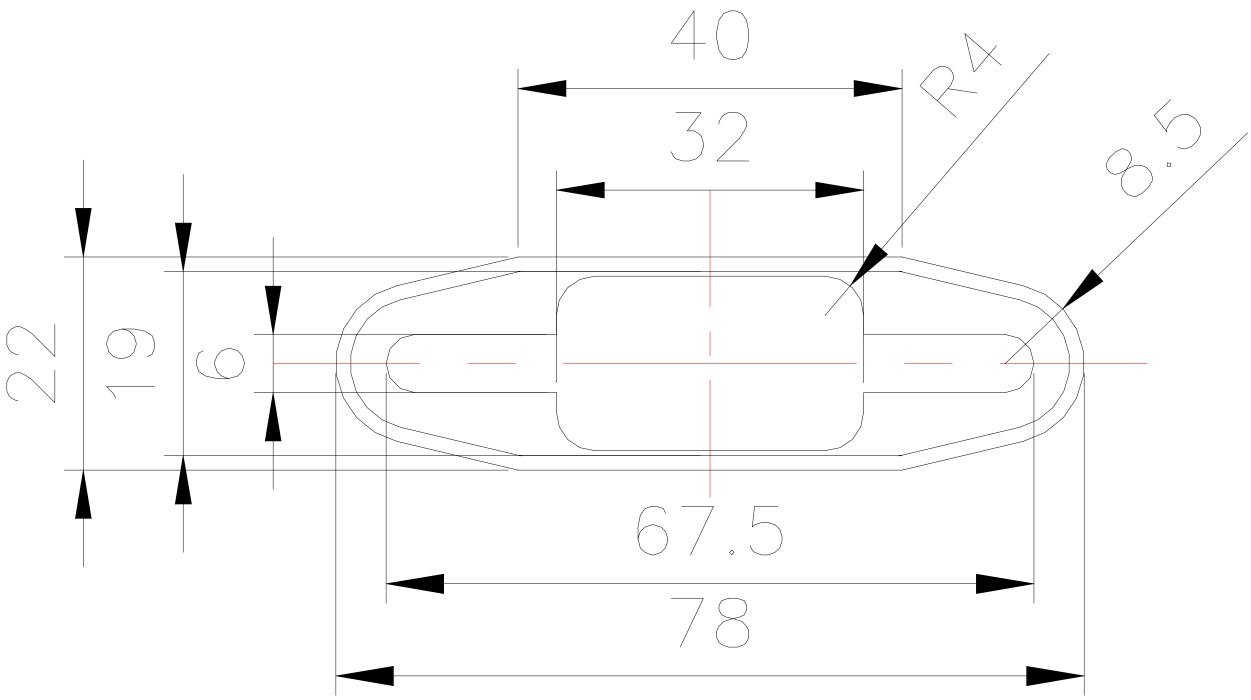
Extruded Section Type: C1

C1



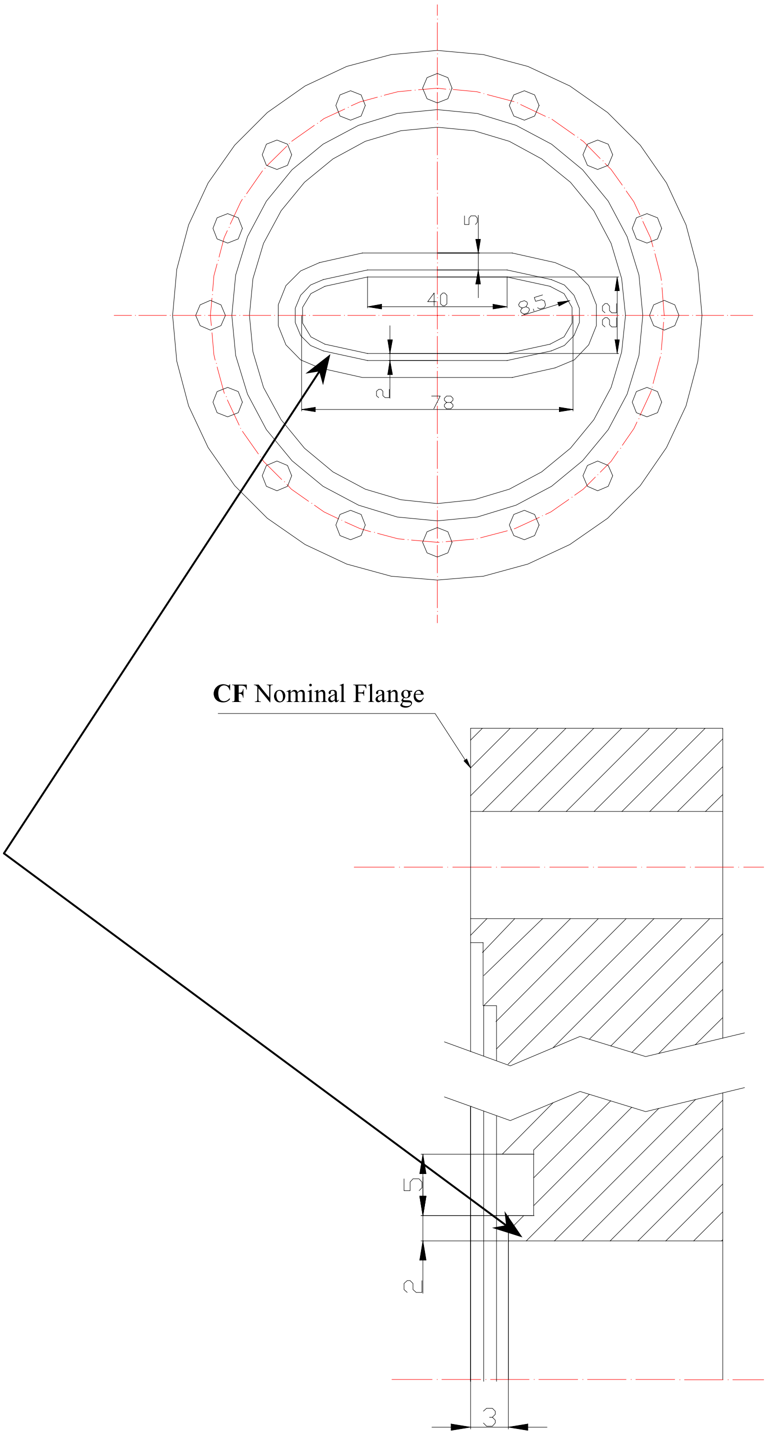
9.6. ATTACHMENT 6

Extruded Section Type: E



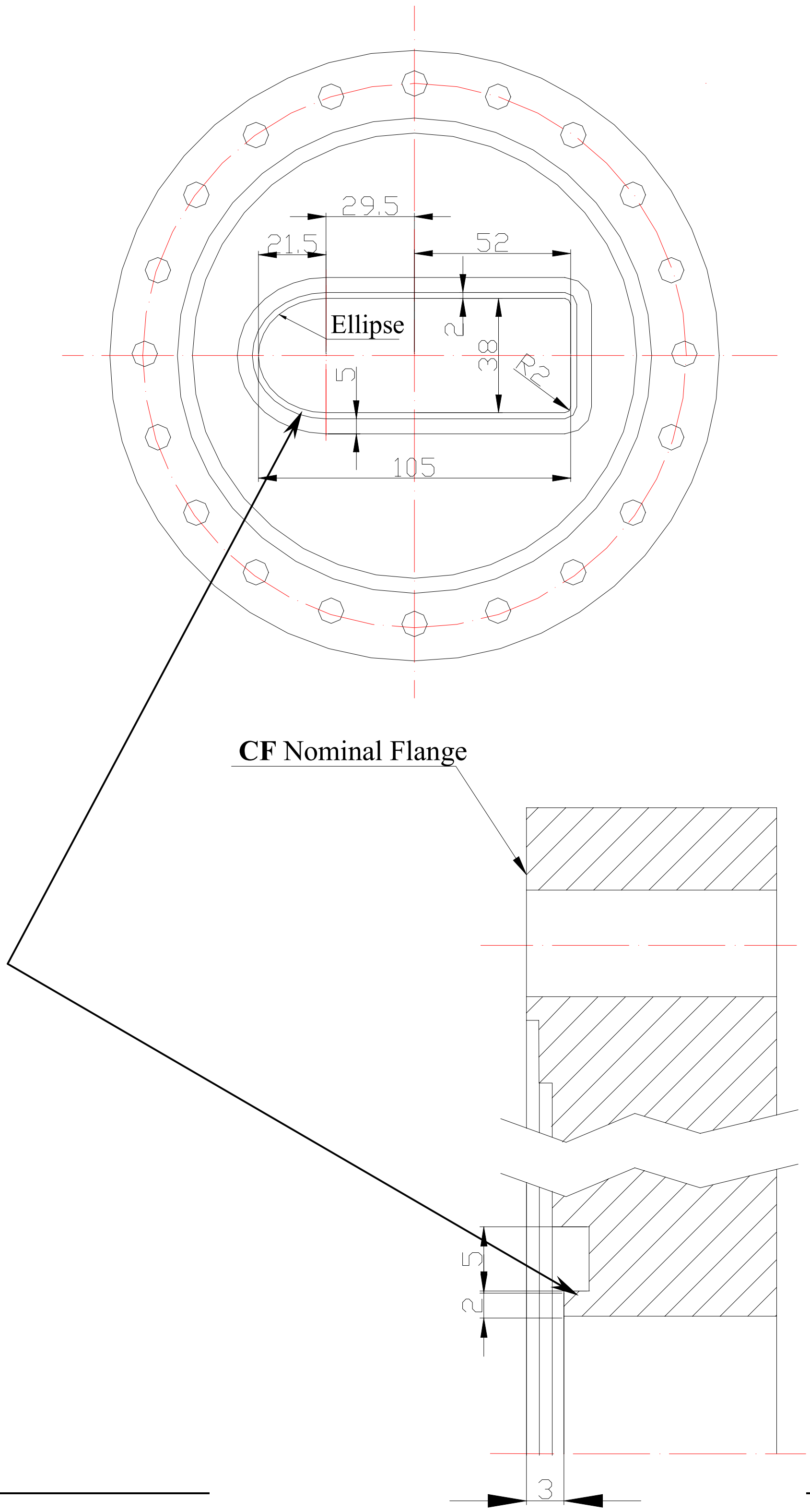
9.7. ATTACHMENT 7

Boring on the Flange for Welding "W 80" Vacuum Chamber



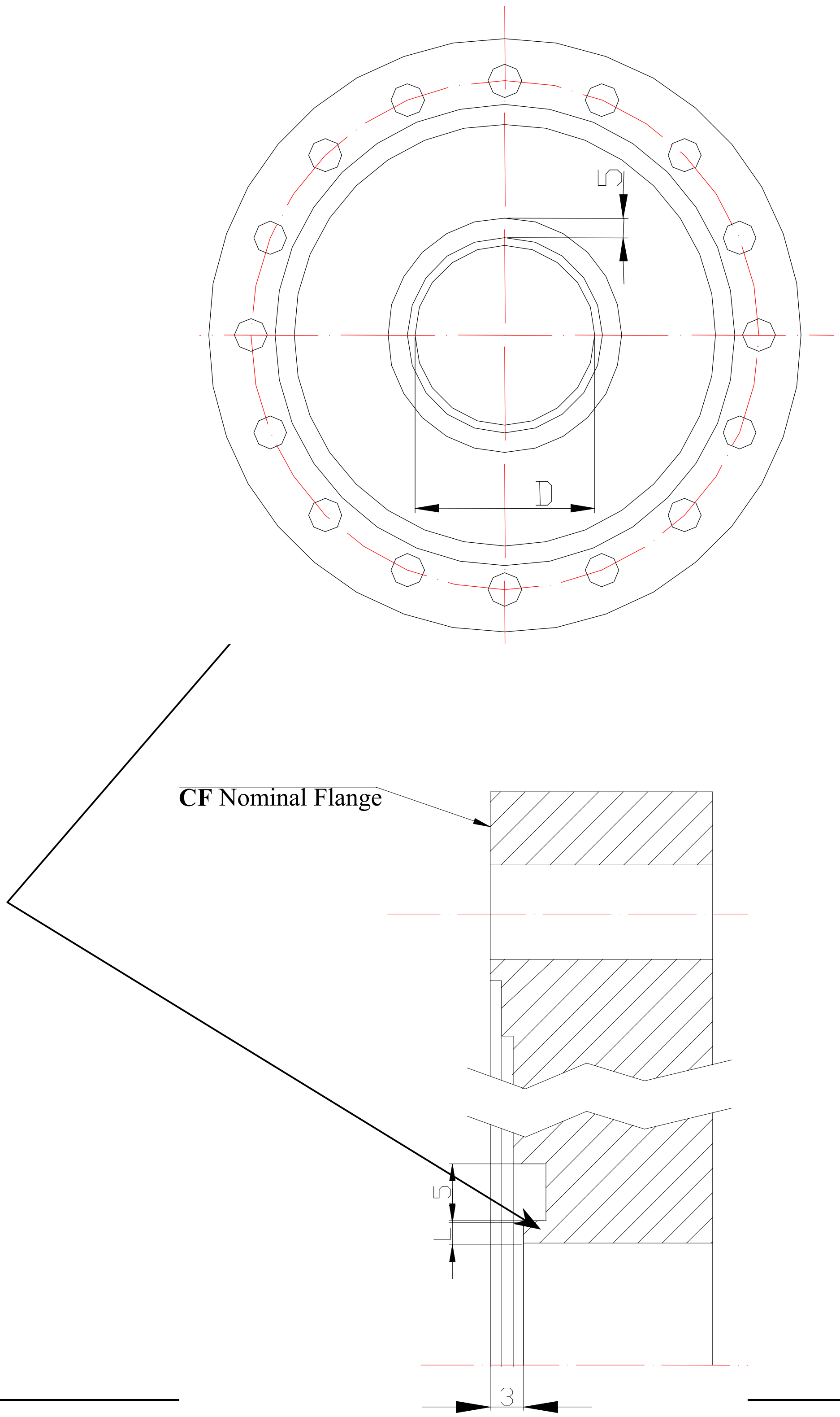
9.8. ATTACHMENT 8

Boring on the Flange for Welding "Dipole" Vacuum Chamber



9.9 ATTACHMENT 9

Boring on the Flange for Welding "Round" Vacuum Chamber



9.10 ATTACHMENT 10

FABRICATION PLAN FOR THE VACUUM CHAMBER

There are two main types of vacuum chambers

a) Types: **CVW, CV43, CW80 e CV 100**

The main sequences for the construction/assembly can be the following

1) Supply of the section bar

2) Machiningof the parts (cutting and bevelling for welding)

3) Cleaning of the component by washings

4) Welding of the flanges (using proper "Tooling" to maintain dimensional and geometrical tolerances)

5) Heat treatment defined "BAKING". (n° 3 times at 120°C)

6) He Leak Test before and after the BAKING.

7) Stocking with nitrogen in polyethylene buckets.

b) Model: **CVD**

The main sequences to construction/assembly can be defined:

1) Supply of three types section bar (A1, A2, A3)

2) Cleaning of the component by washings

3) Location three section bar in Control Tooling type "A "

4) Execution of the two Weld Beads using TIG (or another type), possibly in automatic.

5) Hot/Cold drawing

6) Location in Cut Tooling type "B" for precise cutting and machining of the edges for welding.

7) Welding of the flanges (using the "Tooling" to maintain dimensional and geometrical tolerances

8) Heat treatment defined "BAKING". (n° 3 times at 120°C, once to day)

9) He Leak Test before and after the BAKING.

10) Stocking with nitrogen in polyethylene buckets.

Cleaning Treatment

To obtain the pressure values of $1*10^{-8}$ mbar in the “Arc Zone” and $1*10^{-9}$ mbar in the “Long Straight Sections”, all Vacuum Chamber components must be subjects to an accurate and rigorous “Cleaning Procedure”, followed by an heat treatment before assembly.

The Cleaning operation should be carried out at the end of themachining phase and possibly before welding phases. It is not allowed any cleaning operation after welding.

The washings should be carried out using an alkaline detergent in water solution (ALMEKO-18 to 3% in weight) at the temperature of approximately 50°C. The components should be rinsed with water at the same temperature to remova the residual detergent.

The last washing must be carried out only using warm distillate water.
Immediately after the phase of washing, all components should be accurately dried and every residual of working or dust, removed.
After the phase of washing and drying, all components must be heat treated.

The Vacuum Chamber, eventually pre-assembled should be be closed with blank flanges.
The same procedure should be applied to the metal gaskets and then heat treated in a vacuum furnace at T 120 °C for 24 hours.
At the end of the heat treatement the chambers must be filled up with dry nitrogen.

This procedure (heating and successive filling with nitrogen), it must be repeated three times.

The vacuum chamber parts should be opened only immediately before the final assembly.

Welding

All welds must be TIG, or other equivalent process.
The parts to be welded must be perfectly clean.
All welds must be executed in a clean area with relative humidity ≤ 40%.
Back side welding oxidation should be prevented by means of a proper inert gas flow (Ar or He)
No cleaning processes are allowed after welding.

Helim leak test

Each component of the Vacuum Chamber must be subjected to the He leak test.

A vacuum systems “oil free” type should be use. The leak tests must be performed before and after an heat treatement at T=120°C.
The maximun acceptable leak rate is $1*10^{-10}$ mbar*l*s^{-1} .

Assembly Procedure

Particular attention should be payed during the TDR Vacuum Chamber assembly. All the operations has to be carried out in the best possible cleaning conditions. Any kind of contamination inside the vacuum chamber has to be avoided. A slight dry nitrogen overpressure inside the vacuum chambers should be adopted in order to avoid any possible entrance of contaminant transported by air.

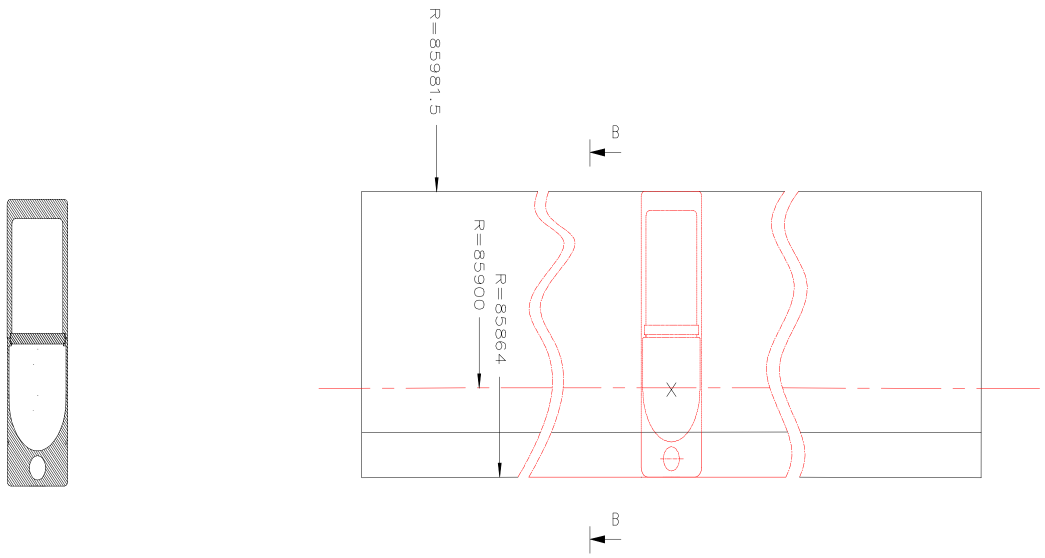
Final leak Test

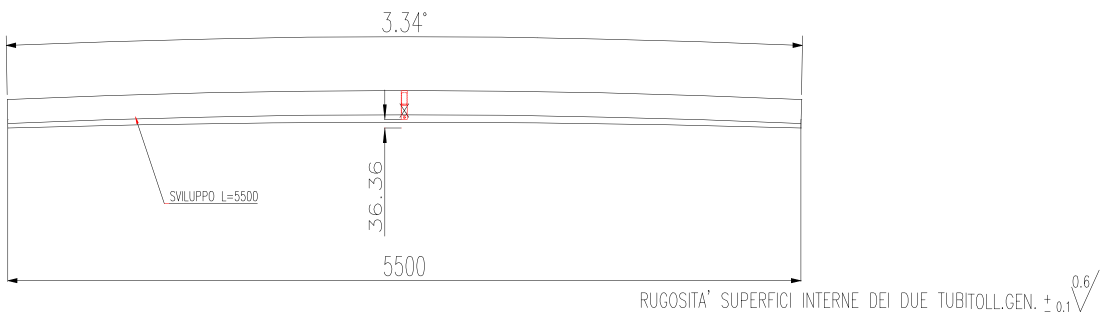
A final He leak test should be carried out on the assembled components.

The maximum allowable leack rate is $1*10^{-10}$ mbar*l*s^{-1} .

9.11 ATTACHMENT 11

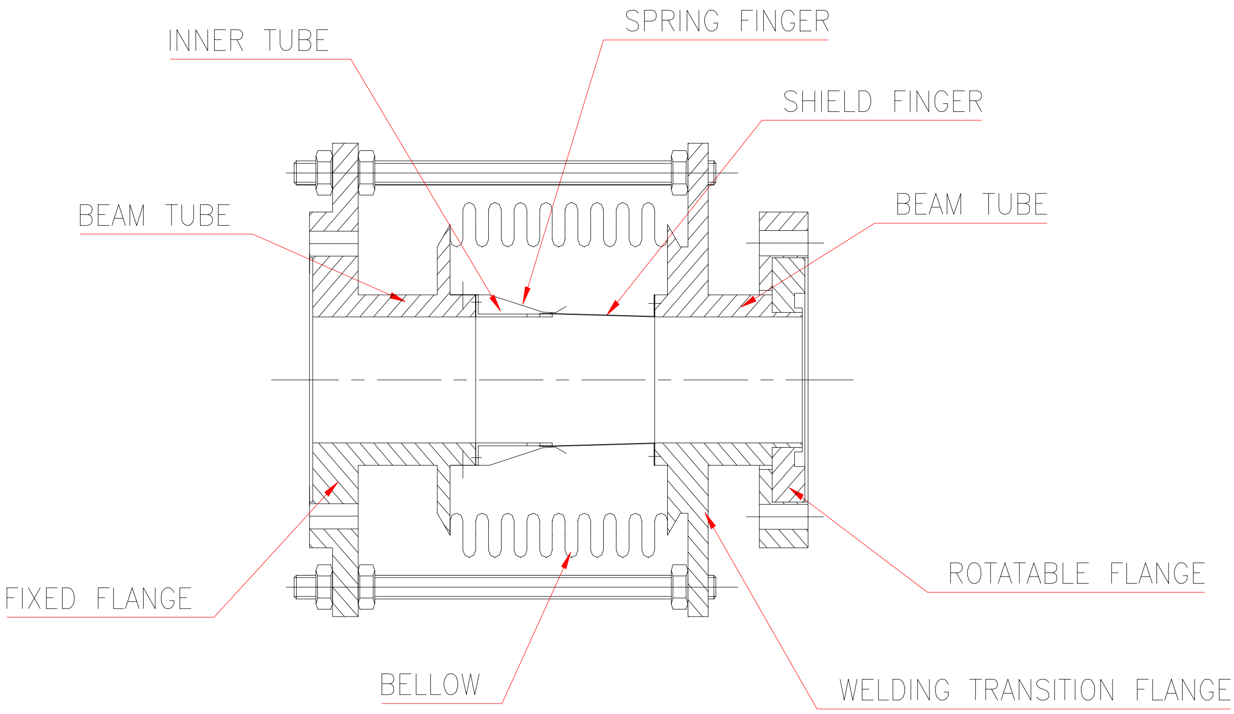
Vacuum Chamber Type: CVD (Draw D03031UX3000L sheet 1/2)





9.12. ATTACHMENT 12

Draw of a Bellow with all mechanical details



9.13. ATTACHMENT 13

Editing List (Activity) to carry out (I.N.F.N) to the 06/12/2000

Progressive Number					Main Item	Requested Job	
1	2	3	4	5		Des.	Mag/Therm Mechan/Ver.
1					TESLA 5 GeV Damping Rings		
1	1				Damping Ring Lattice	Not	
1	2				General Lay-out	Yes	
1	2	1			D.R. Arc Tunnel Lay-out	Yes	Not
1	2	2			D.R. 8 km Conn. Tunnel Lay-out	Yes	Not
1	3				Injection/Extraction Sections	Yes	Yes
1	4				Damping Rings		
1	4	1			Magnetic Components		
1	4	1	1		Bending Dipoles	Yes	Yes
1	4	1	2		Quadrupoles	Yes	Yes
1	4	1	3		Sextupoles	Yes	Yes
1	4	1	4		Magnetic Measurements	Not	Not
1	4	1	5		Magnet Assembly	Yes	Yes
1	4	1	6		H/V Correctors	Yes	Yes
1	4	1	7		Dipole Stands and Supports	Yes	Yes
1	4	1	8		Multipole Girders/Supports	Yes	Yes
1	4	1	9		Special Magnets (Electromagnetic Wigglers)	Yes	Yes
1	4	2			Power Supply System	Not	Yes
1	4	2	1		Mains Connections	Not	Not
1	4	2	2		Med/Low Voltage Breaker	Not	Not
1	4	2	3		Med/Low Voltage Cables and Trays	Not	Yes
1	4	2	4		Electromagnetic Wiggler Power Supplies	Not	Yes
1	4	3			RF System		
1	4	3	1		RF Cryo-modules	Not	Not
1	4	3	2		RF Power Surces	Not	Not
1	4	3	3		Waveguide network system	Not	Not
1	4	3	4		Cryogenic System	Not	Not
1	4	3	5		Cooling System	Not	Not
1	4	3	6		Others (electronics, controls, interlocks, etc.)	Not	Not
1	4	4			Vacuum System		
1	4	4	1		D. R. Vacuum Chamber	Yes	Yes
1	4	4	2		Conn. Tunnel Vacuum Chamber	Not	Not
1	4	4	3		Vacuum Chamber Supports	Yes	Yes
1	4	4	4		Pumps and Power Supplies	Not	Yes
1	4	4	5		Vacuum Diagnostics	Not	Yes
1	4	4	6		Manual and Automatic Valves	Not	Yes

1	4	4	7		Control Units	Not	Yes
1	4	4	8		Special Magnets Vacuum Chamber (Wigglers)	Yes	Yes
1	4	5			Beam Diagnostics		
1	4	5	1		Fluorescent Screens	Not	Yes
1	4	5	2		Toroidal Current Transformers	Not	Yes
1	4	5	3		Wall Current Monitors	Not	Yes
1	4	5	4		DC Current Transformers	Not	Yes
1	4	5	5		BPM Button/Strip Line Monitors	Not	Yes
1	4	5	6		Beam Diagnostics Electronics	Not	Not
1	4	5	7		Emittance Measurement System	Not	Not
1	5				Computer Control System		
1	5	1			Computer Control System Hardware	Not	Not
1	5	2			Computer Control System Software	Not	Not
1	6				Electrical Services		
1	6	1			Standard Line Voltage Sources	Not	Not
1	6	2			Main Power Distribution Boards	Not	Not
1	6	3			Medium/Low Voltage Transformers	Not	Not
1	6	4			Medium Voltage Breakers	Not	Not
1	6	5			Cables and Trays	Not	Not
1	6	6			Lightning System	Not	Not
1	6	7			Emergency Lightning System	Not	Not
1	7				Process Water Facilities		
1	7	1			Cooling Towers and Anc. Equip.	Not	Not
1	7	2			Pumps, Motors and Anc. Eqiuip.	Not	Not
1	7	3			Heat Exchangers	Not	Not
1	7	4			Piping	Not	Not
1	7	5			Filters	Not	Not
1	7	6			De-ionization Units	Not	Not
1	7	7			Tanks	Not	Not
1	8				Cooling and Ventilation System (only for Arcs)	Not	Not
1	9				Compressed Air Facilities (only for Arcs)	Not	Not
1	10				Handling Equipments and Cranes (only for Arcs)	Not	Not
1	11				Tunnel Transport System (only for Arcs)	Not	Not
1	12				Alignment Facilities (only for Arcs)	Not	Not
1	13				Installation Time Schedule and Manpower	Not	Not
1	14				Fire Detection System (only for Arcs)	Not	Not
1	15				Smoke extraction system (only for Arcs)	Not	Not
1	16				Tunnel TV Monitoring (only for Arcs)	Not	Not
1	17				Tests and Acceptance Tests	Not	Not
1	18				Commissioning (with no beam)	Not	Not
1	19				Engineering and Q.A.	Not	Not

ANSALDO

Ansaldo Ricerche s.r.l.

Progetto project	Identificativo document no.
TESLA DAMPING RING	File: 0s-sesto-1 S02977UX3000L

Cliente client	Comm.-s/comm. job. no.	Emittente issued by	Pagina page	Di of
I.N.F.N.	UX3.000	ARI/TME/MTM	1	13

Rag. disc. disc.code	Rif. str. prod. prod. str. no	Identificativo componente equipment identification code	Tipo doc. doc type	Cl. ris. class	Allegati enclosures
N/A	N/A	Damping Ring	Spec di Fabbr	L	n.1

Titolo title	Derivato da derived from
VACUUM CHAMBER SUPPORTS	Sostituisce substitutes

Stato validita`: **Issue 05/12/2000**
rev.scope

0	05/12/20000	Issue		Ottonello G.B.	Barbagelata Luigi	Grattarola Marco	Rosatelli Franco
Rev. rev.	Data date	Descrizione description	Stato valid. rev. scope	Redazione prepared by	Controllo checked by/	approvazione checked by/ approved by	Autorizzazione emissione issue authorization

Table of contents

1. AIM

The present Manufacturing Specification aims at detailed description of both the manufacturing criteria of «Vaccum Line Supports», the working materials and procedures, the number of required Suppliers/Manifacturers, the time schedule agreed upon, the number of pieces to be delivered in time and the overall costs of the delivered product.

2. REFERENCES

The present specification invokes the following documents:

1. List of deliverables, whose version dated 06/12/2000 has been provided by INFN, item 1.4.4.3 (see Attachment 1).
2. ARI Procedure n.P0111767000L dated 13/12/1999.
3. Drawings:
   - D02954UX3000L Damping Ring General Draw.
   - D02653UX3000L Damping Ring Lay-out 1
   - D02654UX3000L Damping Ring Lay-out 2
   - D02655UX3000L Damping Ring Lay-out 3
   - D02656UX3000L Damping Ring Lay-out 4
   - D02657UX3000L Damping Ring Lay-out 5
   - D02798UX3000L Damping Ring Vacuum Chamber Support (CV43 / CV100 / CW80)
   - D02799UX3000L Damping Ring Sextupole Vacuum Chamber (S2PB / S1P / S2PA / S2PC - CVW)
   - D02893UX3000L Damping Ring Arc Pcel Line – Dipole, Quadrupole, Sextupole Particular -
   - D02894UX3000L Damping Ring Wig Line – Wiggler, Quadrupole Particular

3. COMPONENTS

1. CV100 Vacuum Line Supports

Two models exist:

1. Rigid
   Dwg. D02797UX3000L positioned at Beam Position Monitors

2. Lengthwise elastic
   Dis. D02798UX3000L positioned at vacuum line loads (pumps, valves, special heavy components, others)

regions: ±L2A MATCH and LONG CELL

3. CW80 Supports Vacuum Chambers

Two models exist:

1. Rigid
   Dwg. D02797UX3000L positioned at Beam Position Monitors

2. Lengthwise elastic
   Dwg. D02798UX3000L positioned at vacuum line loads (pumps, valves, special heavy components, others)

regions: ±W2A MATCH , WIG CEL

3. CV43 Supports Vacuum Chambers

Two models exist:

1. Rigid
   Dwg. D02797UX3000L positioned at Beam Position Monitors

2. Lengthwise elastic
   Dwg. D02798UX3000L positioned at vacuum line loads (pumps, valves, special heavy components, others)

regions: ±ARC MATCH, , ARC DRIFT, ±ARC PNOD, ARC PCELL, ±ARC MNOD and ARC MCELL.

4. MANIFACTURING PERFORMANCES

Such Supports allow integral mechanical anchorage of Vacuum Chambers to the lower region of the Damping Ring Line tunnel, even if both fine alignment adjustment and considerable expansion are allowed.

It turns out that D.R.-plane-referred positioning ranges are ± 50 mm, ±40mm (with fine adjustment) and ±30mm on «X», «Y» and the axis heigth »Z» respectively. Further fine adjustment (±5mm) on »Z» is envisaged.

According to dwg. D02894UX3000L e D02893UX3000L, we envisage simultaneous partial laboratory assembly and setting of both «Multipole Girders/Supports»and other components, in order to achieve realization of the «Plane Reference Axis». The latter allows further assembly and in-situ alignment of the component as a whole.

5. MACHINING

5.1 MATERIALS

As for the manifacturing material, we envisage **FE42** steel, Anticorodal **6060** Aluminium and **AISI 304** for lower Support manifacturing, upper manifacturing (bearing, clamps and adjustment) and bolts-and-screws respectively.

5.2 STATE OF DELIVERY

The state of deliveries is as follows:

- D02797UX3000L Damping Ring B.P.M. Support - CV43/CV100/CW80 -
  FE42
  Square pipe 60x40x2mm
  15mm-thick Plate
  AL 6060
  10mm-thick Plate
  20 mm-thick Plate
  2mm-thick Sheet
  60x60x5mm Channel
- D02798UX3000L Damping Ring Vacuum Chamber Support - CV43/CV100/CW80
  FE42
  2mm-thick Plate
  15mm-thick Plate
  AL 6060
  10mm-thick Plate
  20mm-thick Plate
  2mm-thick Sheet
  5mm-thick Sheet
- Screws and Bolts

  AISI 304

NB. Weldability fastening requires annealing of all delivered sheets.

5.3. TESTS

We envisage both dimensional and statistic (1/50) functional tests of all components at Manifacturer's location for acceptance before shipping, according to ISO 9000

5.4. OTHERS

An agreement with the Constructor upon a relieving treatment to be performed before finishing and after welding is required, in order to assure time stability.

All ferrous parts will undergo «strong» burnishing in order to prevent oxydization. In contrast, Aluminium parts will undergo black oxidation coating.

6. LOCATION. QUANTITIES

As for the regions: ±ARC PNOD, ±ARC MNOD, ARC PCEL and ARC MCEL (tot.=6 per lobe), envisaged quantities are listed in the following drawings (see Specification n.S02958UX3000L item 7):

	Quantities		Dwg.**D02798**	Dwg.**D02797**		T O T A L S	
D02811UX3000L	N.110	x	3		=	330	
D02811UX3000L	N.110	x		2	=		220
D02812UX3000L	N.108	x	3		=	324	
D02812UX3000L	N.108	x		2	=		216
D02811UX3000L	N.402	x	2		=	804	
D02811UX3000L	N.402	x		1	=		402
		T O T A L S				**1458**	**838**

As for the regions: ±ARC MATCH (tot.=6 per lobe)

Length of one region: 12m. 1 piece is positioned every 4 m. Twice near pumps.
12x6=72/4=18x2lobes= (Dwg.**D02798)** ……..……………………..**36**

Number of magnets (QAM) in these regions: 62. 1 piece corresponds to 1 magnet. We get 62x2lobes= (Dwg.**D02797)** …………………… ... ... ………………..**124**

As for the regions: ±W2A MATCH (tot.=2 per lobe)

Length of one region: 40m. 1 piece is positioned every 4 m. Twice near pumps.
40x2=80/4=20x2lobes= (Dwg.**D02798)** ……..……………………..**40**

Number of magnets(QAW) in these regions: 20. 1 piece corresponds to 1 magnet. We get 20x2lobes= (Dwg.**D02797)** ………..………... ... ...…………………**40**

As for the regions: ARC DRIFT (tot.=1)

Length of one region: 136m. 1 piece is positioned every 4 m. Twice near pumps.
136x1=136/4=34x1lobes= (Dwg.**D02798)** …………..…………………..**34**

Number of magnets(QAD) in these regions:16. 1 piece corresponds to 1 magnet. We get 16x1lobes= (Dwg.**D02797)** ………..…………... ... ... ………….………..**16**

As for the regions: ±L2A MATCH (tot.=2 per line)

Length of one region: 35m. 1 piece is positioned every 4 m. Twice near pumps.
35x2=70/4=17.5x2lines= (Dwg.**D02798)** ……………………………..…..**35**

As for the regions: LONG CELL (tot.=1 per linea)

Length of one region: 7170m; 135 girdrs (lunghi 1.450m) dwg. are already supported.
As for the remaining ones: 1 piece is positioned every 4 m. Twice near pumps.
7170-(135x1.45)/4=1744x2lines (Dwg.**D02798)** ………………....**3488**

Number of magnets(QLF,QLD) is 135 here. 1 piece corresponds to 1 magnet. We get
135x1=135x2lines= (Dwg.**D02797)** ……….……... ... ...……... **270**

7. TOTAL QUANTITIES (spare=20%,30%)

dis.D02798UX3000L Damping Ring Tesla **Vacuum Chamber Support** – CV43,CV100,CW80 -

n° **(1458+36+40+34+35)x1.3+3488x1.2=6270**

dwg.D02797UX3000L Damping Ring Tesla **B.P.M. Support** – CV43,CV100,CW80 -

n° **(838+124+40+16+270)x1.2=1545**

8. DELIVERY TIME and COST

«Time Schedule for the Constructions (Rif. Spec. S02957UX3000L)» encompasses 24 months.
Manifacturing of several components is required. Accordingly, we are bound to envisage utilization of three different Manifacturers, as listed below:

VACUUM CHAMBER SUPPORTS

CONSTR. NUMBER	MONTHS	0	1	2	3 (#)	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	PIECES TOT.	COST (Mlire)	TOTAL (Euro)
	COMPONENT	(PIECES X MONTH)																											
1	D02797UX3000L	+				74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	65	1.545	1.185	612.000
	Type 1 Support																										1.545	1.185	612.000
2	D02798UX3000L	+				150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	135	3.135	2.124	1.096.955
3	D02798UX3000L	+				150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	135	3.135	2.124	1.096.955
	Type 2 Support																										6.270	4.248	2.193.910
	Order	(+)																											
	First Supply	(#)																											
	GRAND TOTAL																										7.815	5.433	2.805.910

9. 1 ATTACHMENT 1

9.1 Attachment 1: Tasks to be completed (I.N.F.N.) within 06/12/2000

Progressive Number					Main Item	Requested Job	
1	2	3	4	5		Des.	Mag/Therm Mechan/Ver.
1					TESLA 5 GeV Damping Rings		
1	1				Damping Ring Lattice	Not	
1	2				General Lay-out	Yes	
1	2	1			D.R. Arc Tunnel Lay-out	Yes	Not
1	2	2			D.R. 8 km Conn. Tunnel Lay-out	Yes	Not
1	3				Injection/Extraction Sections	Yes	Yes
1	4				Damping Rings		
1	4	1			Magnetic Components		
1	4	1	1		Bending Dipoles	Yes	Yes
1	4	1	2		Quadrupoles	Yes	Yes
1	4	1	3		Sextupoles	Yes	Yes
1	4	1	4		Magnetic Measurements	Not	Not
1	4	1	5		Magnet Assembly	Yes	Yes
1	4	1	6		H/V Correctors	Yes	Yes
1	4	1	7		Dipole Stands and Supports	Yes	Yes
1	4	1	8		Multipole Girders/ Supports	Yes	Yes
1	4	1	9		Special Magnets (Electromagnetic Wigglers)	Yes	Yes
1	4	2			Power Supply System	Not	Yes
1	4	2	1		Mains Connections	Not	Not
1	4	2	2		Med/Low Voltage Breaker	Not	Not
1	4	2	3		Med/Low Voltage Cables and Trays	Not	Yes
1	4	2	4		Electromagnetic Wiggler Power Supplies	Not	Yes
1	4	3			RF System		
1	4	3	1		RF Cryo-modules	Not	Not
1	4	3	2		RF Power Surces	Not	Not
1	4	3	3		Waveguide network system	Not	Not
1	4	3	4		Cryogenic System	Not	Not
1	4	3	5		Cooling System	Not	Not
1	4	3	6		Others (electronics, controls, interlocks, etc.)	Not	Not
1	4	4			Vacuum System		
1	4	4	1		D. R. Vacuum Chamber	Yes	Yes
1	4	4	2		Conn. Tunnel Vacuum Chamber	Not	Not
1	4	4	3		Vacuum Chamber Supports	Yes	Yes
1	4	4	4		Pumps and Power Supplies	Not	Yes
1	4	4	5		Vacuum Diagnostics	Not	Yes
1	4	4	6		Manual and Automatic Valves	Not	Yes
1	4	4	7		Control Units	Not	Yes

1	4	4	8		Special Magnets Vacuum Chamber (Wigglers)	Yes	Yes
1	4	5			Beam Diagnostics		
1	4	5	1		Fluorescent Screens	Not	Yes
1	4	5	2		Toroidal Current Transformers	Not	Yes
1	4	5	3		Wall Current Monitors	Not	Yes
1	4	5	4		DC Current Transformers	Not	Yes
1	4	5	5		BPM Button/Strip Line Monitors	Not	Yes
1	4	5	6		Beam Diagnostics Electronics	Not	Not
1	4	5	7		Emittance Measurement System	Not	Not
1	5				Computer Control System		
1	5	1			Computer Control System Hardware	Not	Not
1	5	2			Computer Control System Software	Not	Not
1	6				Electrical Services		
1	6	1			Standard Line Voltage Sources	Not	Not
1	6	2			Main Power Distribution Boards	Not	Not
1	6	3			Medium/Low Voltage Transformers	Not	Not
1	6	4			Medium Voltage Breakers	Not	Not
1	6	5			Cables and Trays	Not	Not
1	6	6			Lightning System	Not	Not
1	6	7			Emergency Lightning System	Not	Not
1	7				Process Water Facilities		
1	7	1			Cooling Towers and Anc. Equip.	Not	Not
1	7	2			Pumps, Motors and Anc. Eqiuip.	Not	Not
1	7	3			Heat Exchangers	Not	Not
1	7	4			Piping	Not	Not
1	7	5			Filters	Not	Not
1	7	6			De-ionization Units	Not	Not
1	7	7			Tanks	Not	Not
1	8				Cooling and Ventilation System (only for Arcs)	Not	Not
1	9				Compressed Air Facilities (only for Arcs)	Not	Not
1	10				Handling Equipments and Cranes (only for Arcs)	Not	Not
1	11				Tunnel Transport System (only for Arcs)	Not	Not
1	12				Alignment Facilities (only for Arcs)	Not	Not
1	13				Installation Time Schedule and Manpower	Not	Not
1	14				Fire Detection System (only for Arcs)	Not	Not
1	15				Smoke extraction system (only for Arcs)	Not	Not
1	16				Tunnel TV Monitoring (only for Arcs)	Not	Not
1	17				Tests and Acceptance Tests	Not	Not
1	18				Commissioning (with no beam)	Not	Not
1	19				Engineering and Q.A.	Not	Not

ANSALDO

Ansaldo Ricerche s.r.l.

Progetto / project	Identificativo / document no.			
TESLA DAMPING RING	File: 0s-settimo-1 S02978UX3000L			
Cliente / client	**Comm.-s/comm.** / job. no.	**Emittente** / issued by	**Pagina** / page	**Di** / of
I.N.F.N.	UX3.000	ARI/TME/MTM	1	16

Rag. disc. / disc.code	Rif. str. prod. / prod. str. no	Identificativo componente / equipment identification code	Tipo doc. / doc type	Cl. ris. / class	Allegati / enclosures
N/A	N/A	Damping Ring	Spec di Fabbr	L	n.°2

Titolo / title

PUMPS and POWER SUPPLIES

Derivato da / derived from

Sostituisce / substitutes

Stato validita`: / rev.scope **Issue 09/01/2001**

0	09/01/2001	Issue		Gualco Carlo	Barbagelata Luigi	Grattarola Marco	Rosatelli Franco
Rev. rev.	**Data** date	**Descrizione** description	**Stato valid.** rev. scope	**Redazione** prepared by	**Controllo** checked by/	**approvazione** checked by/ approved by	**Autorizzazione emissione** issue authorization

Table of contents

1. AIM

The present Specification aims at detailed description of both the manufacturing criteria, the working materials, the number of required Suppliers/Deliverers, the time schedule agreed upon, the number of pieces to be delivered in due time and the overall costs of the delivered product.

2. REFERENCES

The present specification invokes the following documents:

1. List of deliverables, whose version dated 06/12/2000 has been provided by INFN, (see Attachment 1)
2. ARI Procedure n.P0111767000L dated 13/12/1999.
3. Drawings:
   - D02954UX3000L Damping Ring General Draw.
   - D02653UX3000L Damping Ring Lay-out 1
   - D02654UX3000L Damping Ring Lay-out 2
   - D02655UX3000L Damping Ring Lay-out 3
   - D02656UX3000L Damping Ring Lay-out 4
   - D02657UX3000L Damping Ring Lay-out 5
   - D02683UX3000L Damping Ring Vacuum Pump Connection - Ø43 T1 -
   - D02684UX3000L Damping Ring Vacuum Pump Connection - Ø43 T2 -
   - D02685UX3000L Damping Ring Vacuum Pump Connection - Ø43 T3 -
   - D02691UX3000L Damping Ring Wiggler Section Syncrotron Radiation Absorber Chamber – CVW/CW80 T5 – (sheet 1,2)
   - D02693UX3000L Damping Ring Vacuum Pump Connection - CV100 T7 -
   - D02785UX3000L Damping Ring Vacuum Pump Connection - RF Ø200 T18 -
   - D02893UX3000L Damping Ring Arc Pcel Line – Dipole, Quadrupole, Sextupole Particular -
   - D02894UX3000L Damping Ring Wig Line – Wiggler, Quadrupole Particular
   - D02790UX3000L Dipole Vacuum Chamber – CVD -

3. COMPONENTS

1. Ion Pumps (IP/CIP)

There are four models of ion pumps:

- «Chain» (CIP) : inside dipole Vacuum Chambers
  (Chain Ion Pump) (CVD) see Fig.1
  192 l/sec (B=1900Gauss)

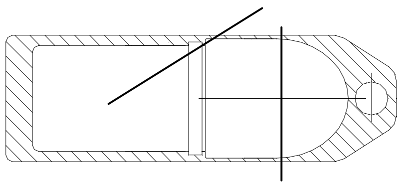


Fig.1

- CF100 - 120l/sec :At dipole ends, between dipoles and in intermediate lines
- CF200 - 400l/sec :In both Wiggler and R.F. lines
- CF 63 - 60l/sec :In straight lines, integrated with Titanium sublimation pumps (TSP).

2. Titanium Sublimation Pumps (TSP)

One model only:

- CF 35 –1000l/sec :In straight lines, integrated with 60l/sec- CF63 pumps

3. Pre-Vacuum Complete Systems

They are transportable and made of:

1. Pre-vacuum
   - Triscroll PTS 300 (Varian) (300 l/min, 18 m^3/h) with 2m -DN40 flexible

2. Vacuum
   - Trolley (Varian) made of Turbo V300HT with DN63 adapter, Feeder, Inlet Screen, Air Cooling Kit, MD60 (60 l/min, 3.6 m^3/h) Diaphragm Pump, equipped with vacuum controller Sentorr with Convectorr Gauge EIMG (cold cathode Gauge) and connecting cables.

3. Residual Gas Analyzers
   - Mod. VG Quadrupole’s Sapphire (Lesker) with Mass Range 1÷100, and 10^{-4}÷10^{-11} mbar Total Pressure Faraday-only Detector.

4. Leak Detectors
   - Mod 979D Single Pump Dry Detectors (Varian), with 300 l/min Dry Scroll Pump, Universal Cart, range 10^{-3}÷10^{-10} mbar, and sensitivity 2^{-10}mbar liter/sec.

4. Vacuum HV Electric Feedthroughs

They feed Chain Ion Pumps:
- Single Feedthroughs NW35 (Varian)

5. Feeders, Connection Cables, and Switching

- Dual/Single Power Supply and Wire Connection (radiation-proof)
- One input/Six outputs automatic sequential Switching

4. DELIVERY PERFORMANCES

- Delivered Custom-type Chain Ion Pumps are already assembled, made of 16 compnents and tested by the Supplier. As a whole, they are stored in suitable Nitrogen-gas containers.
- 120l/sec Ion Pumps will be 150 l/sec, 50.000-h($1x10^{-6}$mbar)-lifetime Diode (Varian) .
- 250l/sec Ion Pumps will be 300 l/sec, 50.000-h($1x10^{-6}$mbar)-lifetime Diode (Varian).
- 60l/sec Ion Pumps will be 50 l/sec, 80.000-h($1x10^{-6}$mbar)-lifetime Star Cell (Varian).

- Titanium Sublimation Pumps will be TSTs (Varian); their CO, 30°Celsius pumping speed will be:
  6000 l/sec (intrinsic)
  800/1000 l/sec (net, conductance-adjusted)

- Delivered vacuum electric feedthroughs (Varian) are already welded with CF35 (Varian) threaded flange with suitably long inner end, tested and warranted with 12kV-voltage electric insulation.

- Given the plant performances, both cost containment and lifetime improvement led to:
  1) TSP-pump number doubling.
  2) component insertion outlined in Attachment 2
  3)automatic PLC-driven activation of six TSP filaments with sequential six-choice switching.

- There will be just one model of power supplies (Varian) (range 20÷500L/s). Remotized control, 240v feed, ±5Kvdc dual output, P=21W power, vacuum-grade display.

Feeding cables (max. length =30m) will be RR (Radiation Resistent).

According to dwg. D02894UX3000L and D02893UX3000L, we envisage laboratory assembly of several pumps.

5. MACHINING

5.1 MATERIALS

Suppliers issue suitable warranty for all materials, in agreement with relevant standard.

5.2 STATE OF DELIVERY

All components shipped to the assembling Laboratories will be suitably packed and shielded from both dust, dump and shocks.

5.3. TESTS

Is is envisaged that the Constructor issues a test certificate. The latter follows each component, and assures correct operation with reference to ISO 9000.

6. LOCATION. QUANTITIES

1. Ion Pumps (IP/CIP)

Referring to

- D02954UX3000L Damping Ring General Draw.
- D02653UX3000L Damping Ring **Lay-out 1**

It turns out that the quantities are:

n° **7 IP 150 L/s** D02683UX3000L Vacuum Pump Connection - ϕ43 T1 –
n° **4 IP 150 L/s** D02684UX3000L Vacuum Pump Connection - ϕ43 T2 –
n° **4 CIP 192 L/s** D02790UX3000L Dipole Vacuum Chamber – CVD –
n° **6 IP 150 L/s** D02685UX3000L Vacuum Pump Connection - ϕ43 T3 –
n° **72 IP 300 L/s** D02691UX3000L Vacuum Pump Connect. –CVW/CW80 T5 –

Referring to

- D02954UX3000L Damping Ring General Draw.
- D02654UX3000L Damping Ring **Lay-out 2**

It turns out that the quantities are:

n° **23 IP 150 L/s** D02683UX3000L Vacuum Pump Connection - ϕ43 T1 –
n° **41 IP 150 L/s** D02684UX3000L Vacuum Pump Connection - ϕ43 T2 –
n° **41 CIP 192 L/s** D02790UX3000L Dipole Vacuum Chamber – CVD –

Referring to

- D02954UX3000L Damping Ring General Draw.
- D02655UX3000L Damping Ring **Lay-out 3**

It turns out that the quantities are:

n° **20 IP 150 L/s** D02683UX3000L Vacuum Pump Connection - ϕ43 T1 –
n° **39 IP 150 L/s** D02684UX3000L Vacuum Pump Connection - ϕ43 T2 –
n° **39 CIP 192 L/s** D02790UX3000L Dipole Vacuum Chamber – CVD –

Referring to

- D02954UX3000L Damping Ring General Draw.
- D02656UX3000L Damping Ring **Lay-out 4**

It turns out that the quantities are:

n° **20 IP 150 L/s** D02683UX3000L Vacuum Pump Connection - ϕ43 T1 –
n° **24 IP 150 L/s** D02684UX3000L Vacuum Pump Connection - ϕ43 T2 –
n° **24 CIP 192 L/s** D02790UX3000L Dipole Vacuum Chamber – CVD –
n° **48 IP 300 L/s** D02785UX3000L Vacuum Pump Connection – RFϕ200 T18-

Referring to

- D02954UX3000L Damping Ring General Draw.
- D02657UX3000L Damping Ring **Lay-out 5**

It turns out that the quantities are:

n°**938 IP 50 L/s** D02693UX3000L Vacuum Pump Connection – CV100 T7 –

2. Titanium Sublimation Pumps (TSP)

Referring to
- D02954UX3000L Damping Ring General Draw.
- D02657UX3000L Damping Ring **Lay-out 5**

It turns out that the quantities are:
n°**938x2 TSPs 800/1000 L/s** D02693UX3000L Vacuum Pump Connection-CV100 T7 –

3. Pre-Vacuum Complete Systems

Referring to
- D02954UX3000L Damping Ring General Draw.

It turns out that the quantities are:
n° **3 Vacuum Group**
n° **3 Leak Detectors**
n° **3 Residual Gas Analyzers**

4. Vacuum HV Electric Feedthroughs

Referring to
- D02954UX3000L Damping Ring General Draw.
- D02653UX3000L Damping Ring **Lay-out 1**

It turns out that the quantities are:
n° **4** D02684UX3000L Vacuum Pump Connection - ϕ43 T2 –

Referring to
- D02954UX3000L Damping Ring General Draw.
- D02654UX3000L Damping Ring **Lay-out 2**

It turns out that the quantities are:
n° **41** D02684UX3000L Vacuum Pump Connection - ϕ43 T2 –

Referring to

- D02954UX3000L Damping Ring General Draw.
- D02655UX3000L Damping Ring **Lay-out 3**

It turns out that the quantities are:

n° **39** D02684UX3000L Vacuum Pump Connection - ϕ43 T2 –

Referring to

- D02954UX3000L Damping Ring General Draw.
- D02656UX3000L Damping Ring **Lay-out 4**

It turns out that the quantities are:

n° **24** D02684UX3000L Vacuum Pump Connection - ϕ43 T2 –

5. Feeders, Connection Cables, and Switching

Referring to

- D02954UX3000L Damping Ring General Draw.
- D02653UX3000L Damping Ring **Lay-out 1**

It turns out that the quantities are:

n° 93 Ion Pumps **=** n° **47** Dual Power Supplies
n° **94** Cables for Dual P.S.

Referring to

- D02954UX3000L Damping Ring General Draw.
- D02654UX3000L Damping Ring **Lay-out 2**

It turns out that the quantities are:

n° 105 Ion Pumps **=** n° **53** Dual Power Supplies
n°**106** Cables for Dual P.S

Referring to

- D02954UX3000L Damping Ring General Draw.
- D02655UX3000L Damping Ring **Lay-out 3**

It turns out that the quantities are:

n° 98 Ion Pumps **=** n° **49** Dual Power Supplies
n° **98** Cables for Dual P.S

Referring to

- D02954UX3000L Damping Ring General Draw.
- D02656UX3000L Damping Ring **Lay-out 4**

It turns out that the quantities are:

n° 116 Ion Pumps **=** n **58** Dual Power Supplies
n°**116** Cables for Dual P.S

Referring to

- D02954UX3000L Damping Ring General Draw.
- D02657UX3000L Damping Ring **Lay-out 5**

It turns out that the quantities are:

n° 938 Ion Pumps **=** n° **469** Dual Power Supplies
n° **938** Cables for Dual P.S (Controller)

n° 938 TSPs **=** n° **313** Single Power Supplies for 3 Pumps
n° **938** Cables for Single P.S (Controller)
n° **938** Cable with TSP connector and 3+1 welding wires

n° 938 SW **=** n° **938** Six automatic Switching

7. TOTAL QUANTITIES (+ spare)

Vacuum Pump

n° **184x2x1.05= 387** IP 150
n°**(72x2+48)x1.05=202** IP 300
n° **938x2x1.05= 1970** IP 50
n° **108x2x1.05= 227** CIP
n°**938x2x2x1.05= 3940** TSPs

Pre-vacuum Systems

n° **3+1= 4** Vacuum Groups
n° **3+1= 4** Leak Detectors
n° **3+1= 4** Residual Gas Analyzers

Vacuum Feedthroughs

n° **108x2x1.10= 238** D02692UX3000L Type DN100/DN200- CW80 T6 -

Power Supplies, Cables and Swithing

n° **711x2x1.10= 1564** Dual P.S.
n° **313x2x1.10= 688** Single P.S. (Controller)

n° **711x2x1.10= 1564** Cable for dual P.S.
n° **938x2x1.10= 2064** Cable for single P.S. (Controller)
n°**938x2x2x1.10=4128** Cable with TSP connector and 3+1 welding wires

n° **938x2x1.10= 2064** Sw

8. DELIVERY TIME and COST

«Time Schedule for the Constructions (Ref. To Spec.S02957UX3000L)» encompasses 30 months. Supply of several components is required. Accordingly, we are bound to envisage utilization of both one large Supplier -for the most relevant delivery- and some smaller Suppliers -for details. See below:

Pumps and Power Supplies

CONSTR. NUMBER	PLANNING (two/months) MONTHS	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	PIECES TOT.	COST (Mlire)	TOTAL (Euro)
	COMPONENT	(PIECES X MONTH)																		
	IP 50	+			152	152	152	152	152	152	152	152	152	152	152	152	146	1.970	8.372	4.323.777
1	IP 150	+			57		55		55		55		55		55		55	387	2.612	1.348.985
	IP 300	+			22	30		30		30		30		30		30		202	1.995	1.030.331
	CIP	+				38	38	38	38	38	37							227	1.901	981.785
	TSTs	+			305	305	305	305	305	305	305	305	305	305	305	305	280	3.940	5.910	3.052.260
	Vacuum Pumps																	6.726	20.790	10.737.138
	Vacuum Group	+			1						1			2				4	150	77.468
1	Leak Detectors	+										2				2		4	220	113.620
2	Residual Gas Analyzer	+			1								3					4	115	59.393
	Vacuum Systems																	12	485	250.481
1	Feedthroughs	+			40	40	40	40	40	38								238	104	53.711
	Feedthroughs																	238	104	53.711
	P.S.	+			175	175	175	175	175	175	175	175	175	175	175	175	152	2.252	10.590	5.469.278
	Cables	+			600	600	600	600	600	600	600	600	600	600	600	600	556	7.756	4.805	2.481.575
1	Power Supplies/Cables																	10.008	15.395	7.950.853
4	Sw 1	+			80	80	80	80	80	80	80	80	80	80	80	80	72	1032	1.258	649.702
	Sw 2	+			80	80	80	80	80	80	80	80	80	80	80	80	72	1032	1.257	649.187
3	Switching																	2.064	2.515	1.298.889
	Order	(+)																		
	First Supply	(#)																		
GRAND TOTAL																			39.289	20.291.075

9.1 ATTACHMENT 1

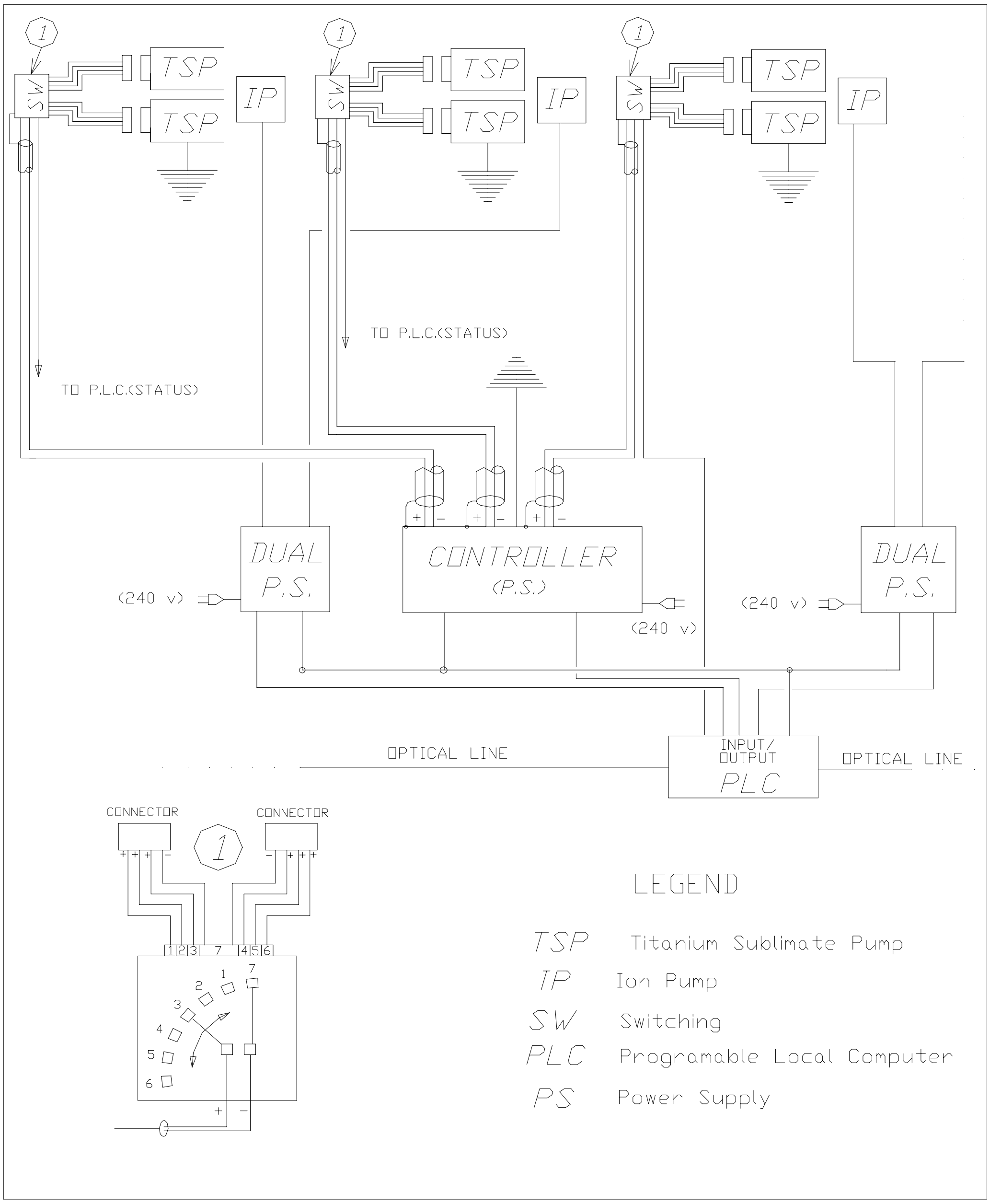
Tasks to be completeted (I.N.F.N.) within 06/12/2000

Progressive Number					Main Item	Requested Job	
1	2	3	4	5		Des.	Mag/Therm Mechan/Ver.
1					TESLA 5 GeV Damping Rings		
1	1				Damping Ring Lattice	Not	
1	2				General Lay-out	Yes	
1	2	1			D.R. Arc Tunnel Lay-out	Yes	Not
1	2	2			D.R. 8 km Conn. Tunnel Lay-out	Yes	Not
1	3				Injection/Extraction Sections	Yes	Yes
1	4				Damping Rings		
1	4	1			Magnetic Components		
1	4	1	1		Bending Dipoles	Yes	Yes
1	4	1	2		Quadrupoles	Yes	Yes
1	4	1	3		Sextupoles	Yes	Yes
1	4	1	4		Magnetic Measurements	Not	Not
1	4	1	5		Magnet Assembly	Yes	Yes
1	4	1	6		H/V Correctors	Yes	Yes
1	4	1	7		Dipole Stands and Supports	Yes	Yes
1	4	1	8		Multipole Girders/Supports	Yes	Yes
1	4	1	9		Special Magnets (Electromagnetic Wigglers)	Yes	Yes
1	4	2			Power Supply System	Not	Yes
1	4	2	1		Mains Connections	Not	Not
1	4	2	2		Med/Low Voltage Breaker	Not	Not
1	4	2	3		Med/Low Voltage Cables and Trays	Not	Yes
1	4	2	4		Electromagnetic Wiggler Power Supplies	Not	Yes
1	4	3			RF System		
1	4	3	1		RF Cryo-modules	Not	Not
1	4	3	2		RF Power Surces	Not	Not
1	4	3	3		Waveguide network system	Not	Not
1	4	3	4		Cryogenic System	Not	Not
1	4	3	5		Cooling System	Not	Not
1	4	3	6		Others (electronics, controls, interlocks, etc.)	Not	Not
1	4	4			Vacuum System		
1	4	4	1		D. R. Vacuum Chamber	Yes	Yes
1	4	4	2		Conn. Tunnel Vacuum Chamber	Not	Not
1	4	4	3		Vacuum Chamber Supports	Yes	Yes
1	4	4	4		Pumps and Power Supplies	Not	Yes
1	4	4	5		Vacuum Diagnostics	Not	Yes
1	4	4	6		Manual and Automatic Valves	Not	Yes
1	4	4	7		Control Units	Not	Yes

1	4	4	8		Special Magnets Vacuum Chamber (Wigglers)	Yes	Yes
1	4	5			Beam Diagnostics		
1	4	5	1		Fluorescent Screens	Not	Yes
1	4	5	2		Toroidal Current Transformers	Not	Yes
1	4	5	3		Wall Current Monitors	Not	Yes
1	4	5	4		DC Current Transformers	Not	Yes
1	4	5	5		BPM Button/Strip Line Monitors	Not	Yes
1	4	5	6		Beam Diagnostics Electronics	Not	Not
1	4	5	7		Emittance Measurement System	Not	Not
1	5				Computer Control System		
1	5	1			Computer Control System Hardware	Not	Not
1	5	2			Computer Control System Software	Not	Not
1	6				Electrical Services		
1	6	1			Standard Line Voltage Sources	Not	Not
1	6	2			Main Power Distribution Boards	Not	Not
1	6	3			Medium/Low Voltage Transformers	Not	Not
1	6	4			Medium Voltage Breakers	Not	Not
1	6	5			Cables and Trays	Not	Not
1	6	6			Lightning System	Not	Not
1	6	7			Emergency Lightning System	Not	Not
1	7				Process Water Facilities		
1	7	1			Cooling Towers and Anc. Equip.	Not	Not
1	7	2			Pumps, Motors and Anc. Eqiuip.	Not	Not
1	7	3			Heat Exchangers	Not	Not
1	7	4			Piping	Not	Not
1	7	5			Filters	Not	Not
1	7	6			De-ionization Units	Not	Not
1	7	7			Tanks	Not	Not
1	8				Cooling and Ventilation System (only for Arcs)	Not	Not
1	9				Compressed Air Facilities (only for Arcs)	Not	Not
1	10				Handling Equipments and Cranes (only for Arcs)	Not	Not
1	11				Tunnel Transport System (only for Arcs)	Not	Not
1	12				Alignment Facilities (only for Arcs)	Not	Not
1	13				Installation Time Schedule and Manpower	Not	Not
1	14				Fire Detection System (only for Arcs)	Not	Not
1	15				Smoke extraction system (only for Arcs)	Not	Not
1	16				Tunnel TV Monitoring (only for Arcs)	Not	Not
1	17				Tests and Acceptance Tests	Not	Not
1	18				Commissioning (with no beam)	Not	Not
1	19				Engineering and Q.A.	Not	Not

9.2 ATTACHMENT 2

Sublimation System Layout



ANSALDO

Ansaldo Ricerche s.r.l.

Progetto project	Identificativo document no.
TESLA DAMPING RING	File: 0s-nona-1 S02979UX3000L

Cliente client	Comm.-s/comm. job. no.	Emittente issued by	Pagina page	Di of
I.N.F.N.	UX3.000	ARI/TME/MTM	1	12

Rag. disc. disc.code	Rif. str. prod. prod. str. no	Identificativo componente equipment identification code	Tipo doc. doc type	Cl. ris. class	Allegati enclosures
N/A	N/A	Damping Ring	Spec di Fabbr	L	n.°1

Titolo title	Derivato da derived from
VACUUM DIAGNOSTICS	Sostituisce substitutes

Stato validita`: **Issue 15/01/2001**
rev.scope

0	15/01/2001	Issue		Gualco Carlo	Barbagelata Luigi	Grattarola Marco	Rosatelli Franco
Rev. rev.	**Data** date	**Descrizione** description	**Stato valid.** rev. scope	**Redazione** prepared by	**Controllo** checked by/	**approvazione** checked by/ approved by	**Autorizzazione emissione** issue authorization

Table of contents

1. AIM

The present Specification aims at detailed description of both the components involved in the Supply, the working materials, the number of required Suppliers/Constructors, the time schedule agreed upon, the number of pieces to be delivered in due time and the overall costs of the delivered product.

2. REFERENCES

The present specification invokes the following documents:

1. List of deliverables, whose version dated 06/12/2000 has been provided by INFN, item 1.4.4.5 (see Attachment 1)
2. ARI Procedure no.P0111767000L dated 13/12/1999.
3. Drawings:
   - D02954UX3000L Damping Ring General Draw.
   - D02653UX3000L Damping Ring Lay-out 1
   - D02654UX3000L Damping Ring Lay-out 2
   - D02655UX3000L Damping Ring Lay-out 3
   - D02656UX3000L Damping Ring Lay-out 4
   - D02657UX3000L Damping Ring Lay-out 5
   - D02683UX3000L Vacuum Pump Connection - ϕ43 T1 -
   - D02684UX3000L Vacuum Pump Connection - ϕ43 T2 -
   - D02685UX3000L Vacuum Pump Connection - ϕ43 T3 –
   - D02691UX3000L Vacuum Pump Connection – CVW/CW80 T5 -
   - D02693UX3000L Vacuum Pump Connection – CV100 T7 -
   - D02785UX3000L Vacuum Pump Connection – RFϕ200 T18-
   - D02893UX3000L Damping Ring Arc Pcel Line – Dipole, Quadrupole, Sextupole Particular -
   - D02894UX3000L Damping Ring Wig Line – Wiggler, Quadrupole Particular

3. COMPONENTS

Vacuum line pressure measuring components

- **Ionization Gauge** for high vacuum control
  (Ref. Mod. UHV 24 – Varian))

- **Cold Cathode Penning** for line safety, suitably adjusted (Ref. Mod. I-MAG – Lasker)

- **Pirani** for low vacuum control
  (Ref. Mod. 945 - Lesker)

- **Gauge Controllers** for Ionization Gauge feeding and control (Ref. Mod. senTORR UHV - Varian)

- **Cable** for Ionization Gauge, Penning and Pirani

- **Ionization Vacuometer HPS** for Cold Cathode Penning feeding and control (Ref. mod. 943 - Lesker)

- **Pirani Vacuometer HPS** for Pirani feeding and control
  (Ref. Mod. 945 – Lesker)

4. DELIVERY PERFORMANCES

- UHV pressure range of Ionization Gauge Tubes is $1*10^{-3} \div 3*10^{-11}$mbar. The latter utilize a «long-life thoriacoated iridium filament» (which is easily replaceable on the field) and are assembled on a DN35 flange. These heads are both fed and controlled by the
- Controller senTORR UHV. The latter is shielded against overpressure, and gets both Degas option and RS-485 comunication.

- Pressure range of HPS cold-cathode I-MAG (Penning) Measurement Heads is $10^{-2} \div 10^{-11}$ mbar. The only vacuum-facing material is SS. These heads are equipped with a DN35 «rotating flange» and are both fed and controlled by the
- Ionization Vacuometer HPS. The latter is equipped with both 2 programmable and independent setpoints, digital decimal-digit display and analog output.
- Vacuometer setpoints are «not volatile» and are safety-oriented. Once a value $1*10^{-6}$mbar is set, at lower pressure the general control assures fast beam shutdown and closing of local gate valves in order to prevent overall leakage.

- Pressure range of Pirani Sensors is 75÷
- $1,3*10^{-4}$mbar. They are equipped with a DN35 «rotating flange» and are both fed and controlled by the
- Pirani Vacuometer HPS. The latter is equipped with both 2 programmable and independent setpoints and several reading units.

- We envisage P.L.C.-connected outputs, in order to display vacuum grade at different line sections to the «Control Room».

- Sensors are to be positioned at ¼ - ¾ total length of each region delimitated by gate/gate.

- The length of all delivered cables is 20m.; Varian cables are «All Rad Proof»

5. MACHINING

5.1 MATERIALS

Suppliers issue suitable warranty for all materials, in agreement with relevant standard (see catalogue Varian/Lesker).

5.2 STATE OF DELIVERY

All components will be suitably packed and shielded from both dust, dump and shocks and shipped to the Damping Ring Tesla warehouse; there, they will be unpacked and assembled on the line in due time.

5.3. TESTS

Is is envisaged that the Constructor issues a test certificate. The latter folows each component, and assures correct operation with reference to ISO 9000.

6. LOCATION. QUANTITIES

Vacuum Diagnostics Components

Referring to

- D02954UX3000L Damping Ring General Draw.
- D02653UX3000L Damping Ring **Lay-out 1**

It turns out that the quantities are:

n° 26 Gate delimit n° 26 regions gate/gate hence:

n° **26 Ionization Gauge** mod. UHV 24 con
n° **26 Gauge Controllers** mod. senTORR con
n° **26 Cable** for Ionization Gauge

n° **26 Cold Cathode Penning** mod. I-MAG con
n° **26 Ionization Vacuometer HPS** mod. 943 con
n° **26 Cable** for Penning

n° **26 Pirani Sensor** con
n° **26 Ionization Vacuometer HPS** mod. 945 con
n° **26 Cable** for Pirani

Referring to

- D02954UX3000L Damping Ring General Draw.
- D02654UX3000L Damping Ring **Lay-out 2**

It turns out that the quantities are:

n° 6 Gate delimit n° 6 regions gate/gate hence:

n° **6 Ionization Gauge** mod. UHV 24 con
n° **6 Gauge Controllers** mod. senTORR con
n° **6 Cable** for Ionization Gauge

n° **6 Cold Cathode Penning** mod. I-MAG con
n° **6 Ionization Vacuometer HPS** mod. 943 con
n° **6 Cable** for Penning

n° **6 Pirani Sensor** con
n° **6 Ionization Vacuometer HPS** mod. 945 con
n° **6 Cable** for Pirani

Referring to

- D02954UX3000L Damping Ring General Draw.
- D02655UX3000L Damping Ring **Lay-out 3**

It turns out that the quantities are:

n° 7 Gate delimit n° 7 regions gate/gate hence:

n° **7 Ionization Gauge** mod. UHV 24 con
n° **7 Gauge Controllers** mod. senTORR con
n° **7 Cable** for Ionization Gauge

n° **7 Cold Cathode Penning** mod. I-MAG con
n° **7 Ionization Vacuometer HPS** mod. 943 con
n° **7 Cable** for Penning

n° **7 Pirani Sensor** con
n° **7 Ionization Vacuometer HPS** mod. 945 con
n° **7 Cable** for Pirani

Referring to

- D02954UX3000L Damping Ring General Draw.
- D02656UX3000L Damping Ring **Lay-out 4**

It turns out that the quantities are:

n° 18 Gate delimit n° 18 regions gate/gate hence:

n° **18 Ionization Gauge** mod. UHV 24 con
n° **18 Gauge Controllers** mod. senTORR con
n° **18 Cable** for Ionization Gauge

n° **18 Cold Cathode Penning** mod. I-MAG con
n° **18 Ionization Vacuometer HPS** mod. 943 con
n° **18 Cable** for Penning

n° **18 Pirani Sensor** con
n° **18 Ionization Vacuometer HPS** mod. 945 con
n° **18 Cable** for Pirani

Referring to

- D02954UX3000L Damping Ring General Draw.
- D02657UX3000L Damping Ring **Lay-out 5**

It turns out that the quantities are:

n° 68-1 Gate delimit n° 67 regions gate/gate hence:

n° **67** **Ionization Gauge** mod. UHV 24 con
n° **67** **Gauge Controllers** mod. senTORR con
n° **67** **Cable** for Ionization Gauge

n° **67** **Cold Cathode Penning** mod. I-MAG con
n° **67** **Ionization Vacuometer HPS** mod. 943 con
n° **67** **Cable** for Penning

n° **67** **Pirani Sensor** con
n° **67** **Ionization Vacuometer HPS** mod. 945 con
n° **67** **Cable** for Pirani

7. TOTAL QUANTITIES (+ spare)

Vacuum Diagnostic Sensors, Controllers and Cables

n° **124x2x2x1.10= 546** **Ionization Gauge** mod. UHV 24
n° **124x2x2x1.10= 546** **Gauge Controllers** mod. senTORR
n° **124x2x2x1.10= 546** **Cable** for Ionization Gauge

n° **124x2x2x1.10= 546** **Cold Cathode Penning** mod. I-MAG
n° **124x2x2x1.10= 546** **Ionization Vacuometer HPS** mod. 943
n° **124x2x2x1.10= 546** **Cable** for Penning

n° **124x2x2x1.10= 546** **Pirani Sensor**
n° **124x2x2x1.10= 546** **Ionization Vacuometer HPS** mod. 945
n° **124x2x2x1.10= 546** **Cable** for Pirani

8. DELIVERY TIME and COST

«Time Schedule for the Constructions» encompasses 24 months (Ref.to Spec. S02957UX3000L). Supply of several components is required. Accordingly, we are bound to envisage utilization of two large Suppliers, (Varian and Lesker; the agent of the latter in Italy is Gambetti Kenologia Srl.) as listed below:

VACUUM DIAGNOSTIC COMPONENTS

CONSTR.					#							PLANNING (months)															PIECES	COST	TOTAL
NUMBER	MONTHS	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOT.	(Mlire)	(Euro)
	COMPONENT													(PIECES X MONTH)															
	Ionization Gauge	+			26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	546		
	Gauge Controllers	+			26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	546		
1	Cable	+			26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	546		
	Varian Components																										1638	3.515	1.815.346
	Cold Cathode Penning	+			26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	546	514	265.459
	Ionization Vacuom.HPS	+			26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	546	1.137	587.211
	Cable for Penning	+			26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	546	461	238.087
2	Pirani Sensor	+			26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	546	256	132.213
	Pirani Vacuometer.HPS	+			26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	546	686	354.290
	Cable for Pirani	+			26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	546	399	206.066
	Lesker Components																										3276	3.453	1.783.326
	Order	(+)																											
	First Supply	(#)																											
	GRAND TOTAL																											6.968	3.598.672

9.1 ATTACHMENT 1

Tasks to be completed (I.N.F.N.) within 06/12/2000

Progressive Number					Main Item	Requested Job	
1	2	3	4	5		Des.	Mag/Therm Mechan/Ver.
1					TESLA 5 GeV Damping Rings		
1	1				Damping Ring Lattice	Not	
1	2				General Lay-out	Yes	
1	2	1			D.R. Arc Tunnel Lay-out	Yes	Not
1	2	2			D.R. 8 km Conn. Tunnel Lay-out	Yes	Not
1	3				Injection/Extraction Sections	Yes	Yes
1	4				Damping Rings		
1	4	1			Magnetic Components		
1	4	1	1		Bending Dipoles	Yes	Yes
1	4	1	2		Quadrupoles	Yes	Yes
1	4	1	3		Sextupoles	Yes	Yes
1	4	1	4		Magnetic Measurements	Not	Not
1	4	1	5		Magnet Assembly	Yes	Yes
1	4	1	6		H/V Correctors	Yes	Yes
1	4	1	7		Dipole Stands and Supports	Yes	Yes
1	4	1	8		Multipole Girders/Supports	Yes	Yes
1	4	1	9		Special Magnets (Electromagnetic Wigglers)	Yes	Yes
1	4	2			Power Supply System	Not	Yes
1	4	2	1		Mains Connections	Not	Not
1	4	2	2		Med/Low Voltage Breaker	Not	Not
1	4	2	3		Med/Low Voltage Cables and Trays	Not	Yes
1	4	2	4		Electromagnetic Wiggler Power Supplies	Not	Yes
1	4	3			RF System		
1	4	3	1		RF Cryo-modules	Not	Not
1	4	3	2		RF Power Surces	Not	Not
1	4	3	3		Waveguide network system	Not	Not
1	4	3	4		Cryogenic System	Not	Not
1	4	3	5		Cooling System	Not	Not
1	4	3	6		Others (electronics, controls, interlocks, etc.)	Not	Not
1	4	4			Vacuum System		
1	4	4	1		D. R. Vacuum Chamber	Yes	Yes
1	4	4	2		Conn. Tunnel Vacuum Chamber	Not	Not
1	4	4	3		Vacuum Chamber Supports	Yes	Yes
1	4	4	4		Pumps and Power Supplies	Not	Yes
1	4	4	5		Vacuum Diagnostics	Not	Yes

1	4	4	6		Manual and Automatic Valves	Not	Yes
1	4	4	7		Control Units	Not	Yes
1	4	4	8		Special Magnets Vacuum Chamber (Wigglers)	Yes	Yes
1	4	5			Beam Diagnostics		
1	4	5	1		Fluorescent Screens	Not	Yes
1	4	5	2		Toroidal Current Transformers	Not	Yes
1	4	5	3		Wall Current Monitors	Not	Yes
1	4	5	4		DC Current Transformers	Not	Yes
1	4	5	5		BPM Button/Strip Line Monitors	Not	Yes
1	4	5	6		Beam Diagnostics Electronics	Not	Not
1	4	5	7		Emittance Measurement System	Not	Not
1	5				Computer Control System		
1	5	1			Computer Control System Hardware	Not	Not
1	5	2			Computer Control System Software	Not	Not
1	6				Electrical Services		
1	6	1			Standard Line Voltage Sources	Not	Not
1	6	2			Main Power Distribution Boards	Not	Not
1	6	3			Medium/Low Voltage Transformers	Not	Not
1	6	4			Medium Voltage Breakers	Not	Not
1	6	5			Cables and Trays	Not	Not
1	6	6			Lightning System	Not	Not
1	6	7			Emergency Lightning System	Not	Not
1	7				Process Water Facilities		
1	7	1			Cooling Towers and Anc. Equip.	Not	Not
1	7	2			Pumps, Motors and Anc. Eqiuip.	Not	Not
1	7	3			Heat Exchangers	Not	Not
1	7	4			Piping	Not	Not
1	7	5			Filters	Not	Not
1	7	6			De-ionization Units	Not	Not
1	7	7			Tanks	Not	Not
1	8				Cooling and Ventilation System (only for Arcs)	Not	Not
1	9				Compressed Air Facilities (only for Arcs)	Not	Not
1	10				Handling Equipments and Cranes (only for Arcs)	Not	Not
1	11				Tunnel Transport System (only for Arcs)	Not	Not
1	12				Alignment Facilities (only for Arcs)	Not	Not
1	13				Installation Time Schedule and Manpower	Not	Not
1	14				Fire Detection System (only for Arcs)	Not	Not
1	15				Smoke extraction system (only for Arcs)	Not	Not
1	16				Tunnel TV Monitoring (only for Arcs)	Not	Not
1	17				Tests and Acceptance Tests	Not	Not
1	18				Commissioning (with no beam)	Not	Not
1	19				Engineering and Q.A.	Not	Not

ANSALDO

Ansaldo Ricerche s.r.l.

Progetto project **TESLA DAMPING RING**		**Identificativo** document no. File: 0s-ottavo-1 **S02980UX3000L**			
Cliente client **I.N.F.N.**		**Comm.-s/comm.** job. no. **UX3.000**	**Emittente** issued by **ARI/TME/MTM**	**Pagina** page **1**	**Di** of **12**

Rag. disc. disc.code	**Rif. str. prod.** prod. str. no	**Identificativo componente** equipment identification code	**Tipo doc.** doc type	**Cl. ris.** class	**Allegati** enclosures
N/A	**N/A**	**Damping Ring**	**Spec di Fabbr**	**L**	**n.°1**

Titolo title **MANUAL and AUTOMATIC VALVES**	**Derivato da** derived from **Sostituisce** substitutes

Stato validita`: **Issue 15/01/2001**
rev.scope

0	15/01/2001	Issue		Lutri Antonino	Barbagelata Luigi	Grattarola Marco	Rosatelli Franco
Rev. rev.	**Data** date	**Descrizione** description	**Stato valid.** rev. scope	**Redazione** prepared by	**Controllo** checked by/	**approvazione** checked by/ approved by	**Autorizzazione emissione** issue authorization

Table of contents

1. AIM

The present Specification aims at detailed description of both the components involved in the Supply, the working materials, the number of required Suppliers/Constructors, the time schedule agreed upon, the number of pieces to be delivered in due time and the overall costs of the delivered product.

2. REFERENCES

The present specification invokes the following documents:

1. List of deliverables, whose version dated 06/12/2000 has been provided by INFN., item 1.4.4.6. (Attachment 1)
2. ARI Procedure n.P0111767000L dated 13/12/1999.
3. Drawings:
   - D02954UX3000L Damping Ring General Draw.
   - D02653UX3000L Damping Ring Lay-out 1
   - D02654UX3000L Damping Ring Lay-out 2
   - D02655UX3000L Damping Ring Lay-out 3
   - D02656UX3000L Damping Ring Lay-out 4
   - D02657UX3000L Damping Ring Lay-out 5

3. COMPONENTS

1. VAT Sezionamento Valves VAT

- **DN63** electropneumatic, RF contact, fully equipped
  (Ref. code 48236-CE24),

- **DN100** electropneumatic, RF contact, fully equipped
  (Ref. code 48240-CE24)

- **DN200** electropneumatic, RF contact, fully equipped
  (Ref. code 48146-CE24)

2. VAT Pre-Vacuum Valves

- **DN63** manual angle valve, with both handwheel and couple limiter
  (Ref. code 57136-GE02)

- **DN40** manual angle valve, with both handwheel and couple limiter
  (Ref. code 57132-GE02)

4. DELIVERY PERFORMANCES

- All delivered valves are entirely metallic
- Metal-hard metal closing (Radiation Resistent RR = 10^8 Rd).
- RF flange-flange contacts are envisaged, in order to assure low RF resistance
- «Up to extreme UHV» seal is guaranteed.
- 24Vcc solenoid valve feeding is envisaged
- Valve-state displaying ouputs are envisaged
- 100.000-cycles life-time is guaranteed.

5. MACHINING

5.1 MATERIALS

Suppliers issue suitable warranty for all materials, in agreement with relevant standard (see catalogue VAT).

5.2 STATE OF DELIVERY

All components will be suitably packed, shielded from both dust, dump and shocks and shipped to the Damping Ring Tesla warehouse; there, they will be unpacked and assembled on the line in due time.

5.3. TESTS

Is is envisaged that the Constructor issues a test certificate. The latter follows each component, and assures correct operation with reference to ISO 9000.

6. LOCATION. QUANTITIES

Valves

Referring to

- D02954UX3000L Damping Ring General Draw.
- D02653UX3000L Damping Ring **Lay-out 1**

It turns out that the quantities are:

n° **2 Gate DN63**
n° **24 Gate DN100**
n° **26 Manual DN63**
n° **26 Manual DN40**

Referring to

- D02954UX3000L Damping Ring General Draw.
- D02654UX3000L Damping Ring **Lay-out 2**

It turns out that the quantities are:

n° **6 Gate DN63**
n° **6 Manual DN63**
n° **6 Manual DN40**

Referring to

- D02954UX3000L Damping Ring General Draw.
- D02655UX3000L Damping Ring **Lay-out 3**

It turns out that the quantities are:

n° **7 Gate DN63**
n° **7 Manual DN63**
n° **7 Manual DN40**

Referring to

- D02954UX3000L Damping Ring General Draw.
- D02656UX3000L Damping Ring **Lay-out 4**

It turns out that the quantities are:

n° **12 Gate DN63**
n° **6 Gate DN200**
n° **18 Manual DN63**
n° **18 Manual DN40**

Referring to

- D02954UX3000L Damping Ring General Draw.
- D02657UX3000L Damping Ring **Lay-out 5**

It turns out that the quantities are:

n° **68 Gate DN100**
n° **68 Manual DN63**
n° **68 Manual DN40**

Power Supplies, «Odds and Ends»

Referring to

- D02954UX3000L Damping Ring General Draw.
- D02653UX3000L Damping Ring **Lay-out 1**

It turns out that the quantities are:

n° 26 Gates **=** n° **26** Mini Power Supplies
n° **52** Cables, air compressed valves, Aisi piping, etc.

Referring to

- D02954UX3000L Damping Ring General Draw.
- D02654UX3000L Damping Ring **Lay-out 2**

It turns out that the quantities are:

n° 6 Gates **=** n° **6** Mini Power Supplies
n° **12** Cables, air compressed valves, Aisi piping, etc.

Referring to

- D02954UX3000L Damping Ring General Draw.
- D02655UX3000L Damping Ring **Lay-out 3**

It turns out that the quantities are:

n° 7 Gates **=** n° **7** Mini Power Supplies
n° **14** Cables, air compressed valves, Aisi piping, etc.

Referring to

- D02954UX3000L Damping Ring General Draw.
- D02656UX3000L Damping Ring **Lay-out 4**

It turns out that the quantities are:

n° 18 Gates **=** n° **18** Mini Power Supplies
n° **36** Cables, air compressed valves, Aisi piping, etc.

Referring to

- D02954UX3000L Damping Ring General Draw.
- D02657UX3000L Damping Ring **Lay-out 5**

It turns out that the quantities are:

n° 68 Gates **=** n° **68** Mini Power Supplies
n°**136** Cables, air compressed valves, Aisi piping, etc.

7. TOTAL QUANTITIES (+ spare)

Valves

n°	**27x2x1.05= 57**	Gate 63
n°	**92x2x1.05= 193**	Gate100
n°	**6x1x1.05= 8**	Gate200
n°	**125x2x1.05= 262**	Manual DN40
n°	**125x2x1.05= 262**	Manual DN63

Power Supplies, «Odds and Ends»

n° **125x2x1.10= 275** Mini Power Supplies

n° **250x2x1.10= 550** Cables, air compressed valves, Aisi piping, etc.

8. DELIVERY TIME and COST

«Time Schedule for the Constructions» encompasses 24 months (Ref. To Spec. S02957UX3000L). Supply of several components is required. Accordingly, we are bound to envisage utilization of both one large Supplier for the largest delivery and some smaller Suppliers for details, as listed below:

Manual and Automatic Valves

CONSTR. NUMBER	MONTHS	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	PIECES TOT.	COST (Mlire)	TOTAL (Euro)
					#							PLANNING (months)																	
	COMPONENT	(PIECES X MONTH)																											
1	Gate 63	+						6		6		6		6		6		6		6		6		6		3	57	1.038	536.324
	Gate 100	+					10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	3	193	4.550	2.350.201
	Gate 200	+							8																		8	330	170.366
	Manual DN40	+					15	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	262	843	435.534
	Manual DN63	+					15	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	262	1.548	799.185
	Autom/Man. Valves																										782	8.309	4.291.145
2	Cables, air valves, etc.	+					28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	18	550	151	78.114
	Odds and Ends																										550	151	78.114
3	Mini P.S.	+					14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	9	275	155	79.890
	Power Supplies																										275	155	79.114
	Order	(+)																											
	First Supply	(#)																											
	(1 CHF=1250 Lire)																												
	GRAND TOTAL																											8.615	4.449.276

9.1 ATACHMENT 1

Tasks to be completed (I.N.F.N.) within 06/12/2000

Progressive Number					Main Item	Requested Job	
1	2	3	4	5		Des.	Mag/Therm Mechan/Ver.
1					TESLA 5 GeV Damping Rings		
1	1				Damping Ring Lattice	Not	
1	2				General Lay-out	Yes	
1	2	1			D.R. Arc Tunnel Lay-out	Yes	Not
1	2	2			D.R. 8 km Conn. Tunnel Lay-out	Yes	Not
1	3				Injection/Extraction Sections	Yes	Yes
1	4				Damping Rings		
1	4	1			Magnetic Components		
1	4	1	1		Bending Dipoles	Yes	Yes
1	4	1	2		Quadrupoles	Yes	Yes
1	4	1	3		Sextupoles	Yes	Yes
1	4	1	4		Magnetic Measurements	Not	Not
1	4	1	5		Magnet Assembly	Yes	Yes
1	4	1	6		H/V Correctors	Yes	Yes
1	4	1	7		Dipole Stands and Supports	Yes	Yes
1	4	1	8		Multipole Girders/Supports	Yes	Yes
1	4	1	9		Special Magnets (Electromagnetic Wigglers)	Yes	Yes
1	4	2			Power Supply System	Not	Yes
1	4	2	1		Mains Connections	Not	Not
1	4	2	2		Med/Low Voltage Breaker	Not	Not
1	4	2	3		Med/Low Voltage Cables and Trays	Not	Yes
1	4	2	4		Electromagnetic Wiggler Power Supplies	Not	Yes
1	4	3			RF System		
1	4	3	1		RF Cryo-modules	Not	Not
1	4	3	2		RF Power Surces	Not	Not
1	4	3	3		Waveguide network system	Not	Not
1	4	3	4		Cryogenic System	Not	Not
1	4	3	5		Cooling System	Not	Not
1	4	3	6		Others (electronics, controls, interlocks, etc.)	Not	Not
1	4	4			Vacuum System		
1	4	4	1		D. R. Vacuum Chamber	Yes	Yes
1	4	4	2		Conn. Tunnel Vacuum Chamber	Not	Not
1	4	4	3		Vacuum Chamber Supports	Yes	Yes
1	4	4	4		Pumps and Power Supplies	Not	Yes
1	4	4	5		Vacuum Diagnostics	Not	Yes

1	4	4	6		Manual and Automatic Valves	Not	Yes
1	4	4	7		Control Units	Not	Yes
1	4	4	8		Special Magnets Vacuum Chamber (Wigglers)	Yes	Yes
1	4	5			Beam Diagnostics		
1	4	5	1		Fluorescent Screens	Not	Yes
1	4	5	2		Toroidal Current Transformers	Not	Yes
1	4	5	3		Wall Current Monitors	Not	Yes
1	4	5	4		DC Current Transformers	Not	Yes
1	4	5	5		BPM Button/Strip Line Monitors	Not	Yes
1	4	5	6		Beam Diagnostics Electronics	Not	Not
1	4	5	7		Emittance Measurement System	Not	Not
1	5				Computer Control System		
1	5	1			Computer Control System Hardware	Not	Not
1	5	2			Computer Control System Software	Not	Not
1	6				Electrical Services		
1	6	1			Standard Line Voltage Sources	Not	Not
1	6	2			Main Power Distribution Boards	Not	Not
1	6	3			Medium/Low Voltage Transformers	Not	Not
1	6	4			Medium Voltage Breakers	Not	Not
1	6	5			Cables and Trays	Not	Not
1	6	6			Lightning System	Not	Not
1	6	7			Emergency Lightning System	Not	Not
1	7				Process Water Facilities		
1	7	1			Cooling Towers and Anc. Equip.	Not	Not
1	7	2			Pumps, Motors and Anc. Eqiuip.	Not	Not
1	7	3			Heat Exchangers	Not	Not
1	7	4			Piping	Not	Not
1	7	5			Filters	Not	Not
1	7	6			De-ionization Units	Not	Not
1	7	7			Tanks	Not	Not
1	8				Cooling and Ventilation System (only for Arcs)	Not	Not
1	9				Compressed Air Facilities (only for Arcs)	Not	Not
1	10				Handling Equipments and Cranes (only for Arcs)	Not	Not
1	11				Tunnel Transport System (only for Arcs)	Not	Not
1	12				Alignment Facilities (only for Arcs)	Not	Not
1	13				Installation Time Schedule and Manpower	Not	Not
1	14				Fire Detection System (only for Arcs)	Not	Not
1	15				Smoke extraction system (only for Arcs)	Not	Not
1	16				Tunnel TV Monitoring (only for Arcs)	Not	Not
1	17				Tests and Acceptance Tests	Not	Not
1	18				Commissioning (with no beam)	Not	Not
1	19				Engineering and Q.A.	Not	Not

ANSALDO

Ansaldo Ricerche s.r.l.

Progetto project	Identificativo document no.
TESLA DAMPING RING	File: 0s-tredici-1 S02981UX3000L

Cliente client	Comm.-s/comm. job. no.	Emittente issued by	Pagina page	Di of
I.N.F.N.	UX3.000	ARI/TME/MTM	1	16

Rag. disc. disc.code	Rif. str. prod. prod. str. no	Identificativo componente equipment identification code	Tipo doc. doc type	Cl. ris. class	Allegati enclosures
N/A	N/A	Damping Ring	Spec di Fabbr	L	n.°3

Titolo title	Derivato da derived from
CONTROL UNITS	
	Sostituisce substitutes

Stato validita`: rev.scope **Issue 29/01/2001**

1	22/02/2001	Sheets 5(§4) and 7(§E/1-2-3) modified.		Rizzo Sergio	Barbagelata Luigi	Grattarola Marco	Rosatelli Franco
0	29/01/2001	Issue		Rizzo Sergio	Barbagelata Luigi	Grattarola Marco	Rosatelli Franco
Rev. rev.	**Data** date	**Descrizione** description	**Stato valid.** rev. scope	**Redazione** prepared by	**Controllo** checked by/	**approvazione** checked by/ approved by	**Autorizzazione emissione** issue authorization

Table of contents

1. AIM

The present Manufacturing Specification aims at detailed description of both the components involved in the Delivery, the working materials, the required number of Suppliers/Manufacturers, the time schedule agreed upon, the number of pieces to be delivered within schedule and the overall costs of the finished product.

2. REFERENCES

The present specification invokes the following documents:

1. List of deliverables, whose version dated 06/12/2000 has been provided by INFN., item 1.4.4.7. (Attachment1)
2. ARI Procedure no.P0111767000L del 13/12/1999.
3. Drawings:
   - D02954UX3000L Damping Ring General Draw.
   - D02653UX3000L Damping Ring Lay-out 1
   - D02654UX3000L Damping Ring Lay-out 2
   - D02655UX3000L Damping Ring Lay-out 3
   - D02656UX3000L Damping Ring Lay-out 4
   - D02657UX3000L Damping Ring Lay-out 5

3. COMPONENTS

1. Net Masters

There are two models of Net Masters (see Attachment 2):

- General Electric (GE):
  2. IC646TDV000 (Server unlimited I/O development)
  3. IC646TRT000 (Unlimited Runtime I/O)
  4. IC640HWC706 (Programming Software)
  5. Converter Wiring/Optical Line

- Siemens (SI):
  1. PCI RI45PIII 600Mhz (Complete Personal Computer)
  2. CPU WinAC 416-2 (CPU)
  3. WinCc RC256tag (Programming Software)
  4. PS 24 for Win AC

2. PLC (Programmable Logic Controller)

There are two models of PLC (see Attachment 2):

- General Electric (GE):
  1. IC type 697
  2. IC697CPX772 (CPU)

- Siemens (SI):
  1. type S7-300
  2. 6ES7-315 (CPU)

3. Electronics Boxes

Box wall are «air-space»

4. Power supply cables, signal cables and fiber optics

There are four models of Cables:

- Power Supply (Pirelli/Belden):
  1. PGZ 4XH GammaP

- Signal (Pirelli/Belden):
  2. type HGZ 213 GammaP
  3. QHZ 25CP GammaP

- Fiber optics (Pirelli):
  1. HFZ 725 GammaP

5. Shielding Panels

These shields are made of «Custom»-type Pb

6. Remote Current Tuner

Current Tuners supply current. Thererefore, they control Corrector-induced magnetic field. Their main features are as follows:
Power supply with 240 Vac, V out (max) = 20Vcc, I = 0÷7A with 500µA resolution, V input = 0÷10 Vcc and Ripple = $5x10^{-4}$ full-scale.

4. DELIVERY PERFORMANCES

A) There are 3 (+1) Damping Ring Tesla Remote Control Systems (see Attachment 2):

2. Beam Control and Line Industrialization – Line3 and Line4 -(GE)
3. Safety System – Line1 e Line2 -(Siemens)
4. Fire Detection and Smoke Extraction Sustem – Line5 -(Siemens)
5. (Beam Diagnostic See Spec. S02983UX3000L)

B. **GE**-type Supervisor Net Masters are positioned in the Control Room. They control those remote system -e.g. 4.A.1 and 4.A.2.- which require fast control (loop closure time ~ 500ms)
SI-type Supervisor Net Masters too are positioned in the Control Room. They control those remote system - e.g. 4.A.3.- which require slower control (loop closure time ~ 1500ms)
A Cabled Eternet net inside the Control Room is the interface with Master Control System (see Attachment 2).

C. Remote PLCs are distributed along several rings; they provide both data acquisition from different users, control of such users (with the help of analog and/or digital output devices) and data transmission to the relevant supervisor:

D.

	GE	**SI**
Digital Input	72D/I	16D/I
Digital Output	72D/O	16D/O
Analog Input	120A/I(14bit)	80A/I(15bit)
Analog Output	24A/O(14bit)	16A/O(12bit)

Within every subsystem, all PLCs are connected to each other through an active serial line with the help of a Profibas protocol (or a similar one).
A «Wiring/Optical Line Converter» is positioned at the Net Master Supervisor. It provides both analog/optical conversion and signal transmission across fiber optics. The latter connects all PLCs within every subsystem. (see Attachment 2)
Every PLC is equipped with an analog converter; the latter provides optical/analog conversion. (This link is called «daisy»).

D. Electronics boxes are to be radiation-shielded against a 6Rad/h dose **X** and γ. (Alternatively, shielding of the box location area is allowed).
Maximum size is 600x600x1200 mm.
Each box is equipped with one front door and a back door. Each door is equipped with both locking, pilot light and alarm.

E. Connection cable are as follows:

1. Power supply:
   - Current Density = 5 A/mm^2
   - Voltage max = 150Vdc
   - Power max = 1Kw
   - Insulation = 1Kv
2. Signal:
   - Type RG with max attenuation at 1000 Mhz ≤ 3 db
   - Standard, with seven-0,25mm-strands conductor pairs, pair-twisted with mass conductor. No.25 conductor pairs per cable, Imax = 0,2A, Impedance 100Ω .Insulation= 300v
3. Fiber optics:
   - Equipped with no.2x8 x (62.6/125)mm «multimodal» model conductors, allowing 12MHz fiber transmission frequency. Ø external = 13.67mm. Net weght= 200Kg/Km

All cables are to be equipped with a:

- RR (Radiation Resistent) Shielding of the external sheath against both **X** and γ rays.
- Flame Resistance according to both Standards VDE 0472, part 804/B, IEC 60332-1.
- No flame Propagation on bunched cables VDE 0472, part 804/C, IEC 60332-3C
- Halogen-free, according to both Standards VDE 0472, part 813 and IEC 60754-1.
- Smoke density: L.S.E. according to the Standard (CEI 20.37)
- Oxygen Index at least 30% according to ASTM D2863
- Temperature index 260°C according to ASTM D2863

F. The size of the Shielding Panels against both **X** and γ radiation is: 1100x550x50mm.

5. MACHINING

5.1 MATERIALS

Suppliers issue suitable warranty concerning all materials according to relevant standards.

5.2 STATE OF DELIVERY

All electronic components undergo both suitable preparation and pre-assembly at Suppliers' Laboratories. Then, all electronic components are both suitably packed and shielded against dust, dump and shocks. Finally, they are shipped to the Site. Final assemby -including dedicated cables- is also in charge of the Suppliers.

5.3. TESTS

For acceptance, we envisage preliminary tests of both the Hardware and the Software required by the Customers. Such tests are to be performed at Supplier's Laboratories on a typical PLC, equipped with a suitable simulation system.

However, it is envisaged that the Constructor issues a test certificate for each one of the following components. The latter follows the component, and assures correct operation with reference to ISO 9000.

6. LOCATION. QUANTITIES

Referring to (**LOBE 1**):

- D02954UX3000L Damping Ring General Draw.
- D02653UX3000L Damping Ring **Lay-out 1**
- D02654UX3000L Damping Ring **Lay-out 2**
- D02655UX3000L Damping Ring **Lay-out 3**
- D02656UX3000L Damping Ring **Lay-out 4**
- Attachment no. 3

It turns out that the quantities are:

n°	**2SI+2GE+1SI**	Net Master
n°	**13SI+13GE+12SI**	PLC (Programmable Logic Controller)
n°	**(7+4x12+3x11)**	Electronics boxes
n°	**(14x1+9x12+8x11)**	Shielding Panels
n°	**180**	Remote Control Tuner

Referring to (**Long Straight Section**):

- D02954UX3000L Damping Ring General Draw.
- D02657UX3000L Damping Ring **Lay-out 5**
- Attachment 3

It turns out that the quantities are::

n°	**61SI+61GE+61SI**	PLC (Programmable Logic Controller)
n°	**(5x2+4x60+3x59)**	Electronics boxes
n°	**(12x2+9x60+8x59)**	Shielding Panels
n°	**269**	Remote Control Tuner

Referring to (**LOBE 2**):

- D02954UX3000L Damping Ring General Draw.
- D02653UX3000L Damping Ring **Lay-out 1**
- D02654UX3000L Damping Ring **Lay-out 2**
- D02655UX3000L Damping Ring **Lay-out 3**
- D02656UX3000L Damping Ring **Lay-out 4**
- Attachment 3

It turns out that the quantities are::

n°	**13SI+13GE+12SI**	PLC (Programmable Logic Controller)
n°	**(7+4x12+3x11)**	Electronics boxes
n°	**(14x1+9x12+8x11)**	Shielding Panels
n°	**180**	Remote Control Tuner

Referring to (**Damping Ring Complete**):

- D02954UX3000L Damping Ring General Draw.
- D02653UX3000L Damping Ring **Lay-out 1**
- D02654UX3000L Damping Ring **Lay-out 2**
- D02655UX3000L Damping Ring **Lay-out 3**
- D02656UX3000L Damping Ring **Lay-out 4**
- D02657UX3000L Damping Ring **Lay-out 5**

It turns out that the quantities are::

n° **100mt-average x Rack**	Low-power Multipolar Cable (20 wires)
n° **45mt-average x Botton (B.P.M.)**	Coaxial Cable RG 213
n° **60mt-average x Rack**	Multipolar Cable (50 wire) for Signals
n° **10000mt for D.R.**	Fiber Optics (16 wires)
n° **200mt medi x Rack**	Bipolar Common Cable (2 wires)

7. TOTAL QUANTITIES (+ spare)

Net Masters

n° **2GE+1= 3** Supervisor (General Electric)
n° **3 SI+1= 4** Supervisor (Siemens)

Programmable Logic Controller

n° **(13+61+13)*1.1= 96** PLC (General Electric)
n° **(25+122+25)*1.1= 189** PLC (Siemens)

Boxes

n° **(74+364+78)*1.05= 542**

Shielding Panels

n° **(222+1092+234)*1.05= 1625**

Remote Current Tuner

n° **(180+269+180)*1.10= 692**

Cables

n°**100mt x 516 Rack x 1.2 = 62.000mt** Low-power Multipolar Cable (20wires)
n°**45mt x 2920 Botton x 1.1 = 144.500mt** Coaxial Cable RG 213
n°**60mt x 516 Rack x 1.2 = 37.000mt** Multipolar Cable (50wires) for signals
n°**10.000mt x 1.3 = 13.000mt** Fiber optics (16 conductors)
n°**200mt x 516 Rack x1.3 = 135.000mt** heterogeneous bipolar Cable (2wires)

8. DELIVERY TIME and COST

«Time Schedule for the Constructions» encompasses 36 months (Ref. Spec. S02957UX3000L). Supply of several components is required. Accordingly, we are bound to envisage utilization of both a couple of large Suppliers -for the most relevant delivery- and some smaller Suppliers -for details. See below:

CONTROL UNITS

CONSTR. NUMBER	PLANNING (two/months)																				PIECES	COST	TOTAL
	MONTHS	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	TOT.	(Mlire)	(Euro)
	COMPONENT	(PIECES X MONTH)																					
	Master Computer	+		1				2													3	82	42.349
1	PLC	+		5	13		13		13		13		13		13		13				96	7.272	3.755.674
	RACK	+		22		26		26		26		26		26		26		26			204	908	468.942
	Control System GE																					8.262	4.266.965
	Master Computer	+		1				3													4	100	51.645
	PLC	+		14		25		25		25		25		25		25		25			189	4.510	2.329.220
2	RACK	+		44			52		52		52		52		52		52		52		408	1.816	937.885
	Control System SI																					6.426	3.318.750
3	RR Screen	+						125	125	125	125	125	125	125	125	125	125	125	125	125	1625	1.254	
	Radiation Resistent Screen																					1.254	647.637
4	Remote Current Tun			40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	52	692	649	335.180
	Remote Current Tuner																					649	335.180
	Power Cable	+			15			15			15			15			2				62Km	690	356.355
	Coaxial Cable	+									15	15	15	15	15	15	15	15	15	14.5	144.5Km	621	320.720
	Cable for Signals	+			5		5		5		5		5		5		7				37Km	231	119.301
	Fiber Optics	+				2		2		2		2		2		2		1			13Km	569	293.864
	Standard Cable	+			15	15		15	15		15	15		15		15		15			135Km	421	217.428
5	Cables																					(@)	(@)
	Order	(+)	(@) See Spec. S02991UX3000L																				
	First Supply	(#)																					
	GRAND TOTAL																					16.591	8.568.536

9.1 ATTACHMENT 1

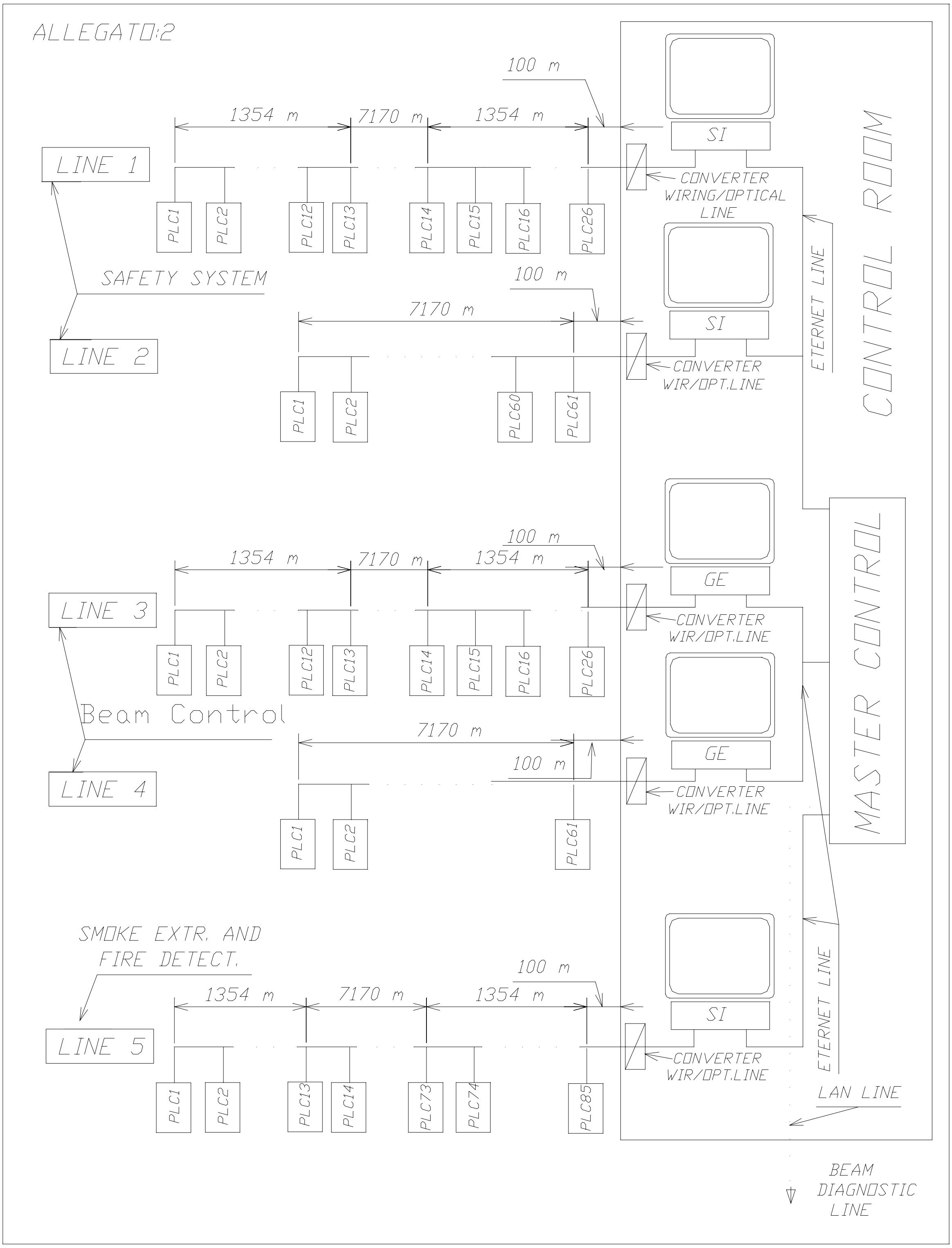
Tasks to be completed (I.N.F.N.) within 06/12/2000

Progressive Number					Main Item	Requested Job	
1	2	3	4	5		Des.	Mag/Therm Mechan/Ver.
1					TESLA 5 GeV Damping Rings		
1	1				Damping Ring Lattice	Not	
1	2				General Lay-out	Yes	
1	2	1			D.R. Arc Tunnel Lay-out	Yes	Not
1	2	2			D.R. 8 km Conn. Tunnel Lay-out	Yes	Not
1	3				Injection/Extraction Sections	Yes	Yes
1	4				Damping Rings		
1	4	1			Magnetic Components		
1	4	1	1		Bending Dipoles	Yes	Yes
1	4	1	2		Quadrupoles	Yes	Yes
1	4	1	3		Sextupoles	Yes	Yes
1	4	1	4		Magnetic Measurements	Not	Not
1	4	1	5		Magnet Assembly	Yes	Yes
1	4	1	6		H/V Correctors	Yes	Yes
1	4	1	7		Dipole Stands and Supports	Yes	Yes
1	4	1	8		Multipole Girders/Supports	Yes	Yes
1	4	1	9		Special Magnets (Electromagnetic Wigglers)	Yes	Yes
1	4	2			Power Supply System	Not	Yes
1	4	2	1		Mains Connections	Not	Not
1	4	2	2		Med/Low Voltage Breaker	Not	Not
1	4	2	3		Med/Low Voltage Cables and Trays	Not	Yes
1	4	2	4		Electromagnetic Wiggler Power Supplies	Not	Yes
1	4	3			RF System		
1	4	3	1		RF Cryo-modules	Not	Not
1	4	3	2		RF Power Surces	Not	Not
1	4	3	3		Waveguide network system	Not	Not
1	4	3	4		Cryogenic System	Not	Not
1	4	3	5		Cooling System	Not	Not
1	4	3	6		Others (electronics, controls, interlocks, etc.)	Not	Not
1	4	4			Vacuum System		
1	4	4	1		D. R. Vacuum Chamber	Yes	Yes
1	4	4	2		Conn. Tunnel Vacuum Chamber	Not	Not
1	4	4	3		Vacuum Chamber Supports	Yes	Yes
1	4	4	4		Pumps and Power Supplies	Not	Yes
1	4	4	5		Vacuum Diagnostics	Not	Yes
1	4	4	6		Manual and Automatic Valves	Not	Yes

1	4	4	7		Control Units	Not	Yes
1	4	4	8		Special Magnets Vacuum Chamber (Wigglers)	Yes	Yes
1	4	5			Beam Diagnostics		
1	4	5	1		Fluorescent Screens	Not	Yes
1	4	5	2		Toroidal Current Transformers	Not	Yes
1	4	5	3		Wall Current Monitors	Not	Yes
1	4	5	4		DC Current Transformers	Not	Yes
1	4	5	5		BPM Button/Strip Line Monitors	Not	Yes
1	4	5	6		Beam Diagnostics Electronics	Not	Not
1	4	5	7		Emittance Measurement System	Not	Not
1	5				Computer Control System		
1	5	1			Computer Control System Hardware	Not	Not
1	5	2			Computer Control System Software	Not	Not
1	6				Electrical Services		
1	6	1			Standard Line Voltage Sources	Not	Not
1	6	2			Main Power Distribution Boards	Not	Not
1	6	3			Medium/Low Voltage Transformers	Not	Not
1	6	4			Medium Voltage Breakers	Not	Not
1	6	5			Cables and Trays	Not	Not
1	6	6			Lightning System	Not	Not
1	6	7			Emergency Lightning System	Not	Not
1	7				Process Water Facilities		
1	7	1			Cooling Towers and Anc. Equip.	Not	Not
1	7	2			Pumps, Motors and Anc. Eqiuip.	Not	Not
1	7	3			Heat Exchangers	Not	Not
1	7	4			Piping	Not	Not
1	7	5			Filters	Not	Not
1	7	6			De-ionization Units	Not	Not
1	7	7			Tanks	Not	Not
1	8				Cooling and Ventilation System (only for Arcs)	Not	Not
1	9				Compressed Air Facilities (only for Arcs)	Not	Not
1	10				Handling Equipments and Cranes (only for Arcs)	Not	Not
1	11				Tunnel Transport System (only for Arcs)	Not	Not
1	12				Alignment Facilities (only for Arcs)	Not	Not
1	13				Installation Time Schedule and Manpower	Not	Not
1	14				Fire Detection System (only for Arcs)	Not	Not
1	15				Smoke extraction system (only for Arcs)	Not	Not
1	16				Tunnel TV Monitoring (only for Arcs)	Not	Not
1	17				Tests and Acceptance Tests	Not	Not
1	18				Commissioning (with no beam)	Not	Not
1	19				Engineering and Q.A.	Not	Not

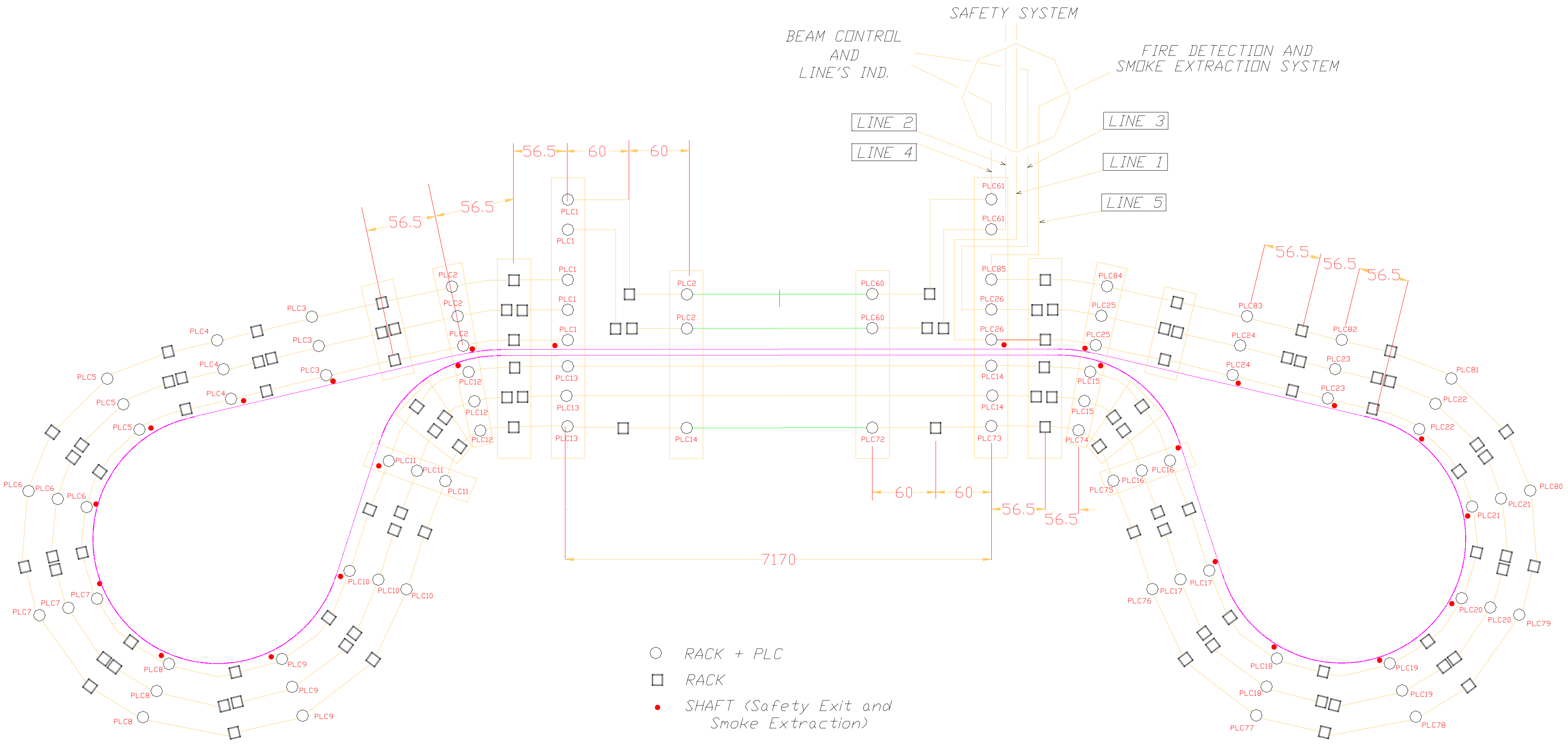
9.2 ATTACHMENT 2

Remote Control System - Functional Lay-out



9.3 ATTACHMENT 3

Layout Line Boxes (PLC and Signal Management)



ANSALDO

Ansaldo Ricerche s.r.l.

Progetto project **TESLA DAMPING RING**		**Identificativo** document no. File: 0s-quinto-1 **S02982UX3000L**		
Cliente client **I.N.F.N.**	**Comm.-s/comm.** job. no. **UX3.000**	**Emittente** issued by **ARI/TME/MTM**	**Pagina** page **1**	**Di** of **19**

Rag. disc. disc.code	**Rif. str. prod.** prod. str. no	**Identificativo componente** equipment identification code	**Tipo doc.** doc type	**Cl. ris.** class	**Allegati** enclosures
N/A	**N/A**	**Damping Ring**	**Spec di Fabbr**	**L**	**n.°6**

Titolo title **SPECIAL MAGNETS VACUUM CHAMBERS (WIGGLER)**	**Derivato da** derived from **Sostituisce** substitutes

Stato validita`: rev.scope **Issue 30/11/2000**

0	30/11/20000	Issue		Lutri Antonino	Barbagelata Luigi	Grattarola Marco	Rosatelli Franco
Rev. rev.	**Data** date	**Descrizione** description	**Stato valid.** rev. scope	**Redazione** prepared by	**Controllo** checked by/	**approvazione** checked by/ approved by	**Autorizzazione emissione** issue authorization

Table of contents

1. AIM

The pesent manufacturing Specification aims at detailed description of both the manufacturing criteria of the «Wigglers Vacuum Chambers», the working materials and procedures, the number of Suppliers/Manufacturers, the time schedule agreed upon, the number of pieces to be delivered within schedule and the overall costs of the finished product.

2. REFERENCES

The present specification invokes the following documents:

1. List of deliverables, whose version dated 22/11/1999 has been provided by INFN., item 1.4.4.8. (Attachment 6)
2. ARI Procedure n.P0111767000L del 13/12/1999.

3. Drawings:
    1. **General Drawings**
       D02954UX3000L Damping Ring General Draw.
       D02653UX3000L Damping Ring Lay-out 1

    2. **Vacuum Chamber Assembly**
       D02788UX3000L Type CV W

3. COMPONENTS

3.1 Vacuum Chamber

The cross-section of the Vacuum Chambers called **CVW** is as follows:

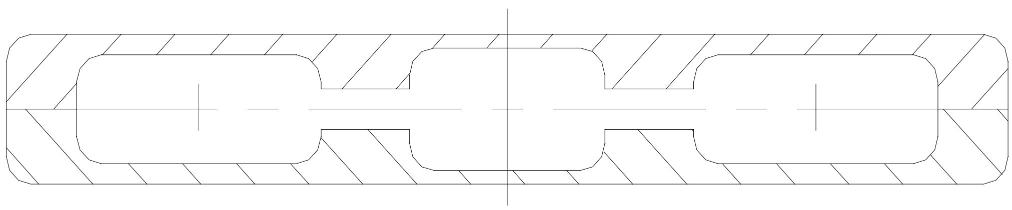


FIG.1

This is the cross-section corresponding to the Wiggler zone cross (namely, WIG CELL).

4. MANUFACTURING PERFORMANCES

4.1 Vacuum Chambers

CVW

A limited quantitiy of pieces (type D, see Attachment 3) is envisaged for this kind of Vacuum Chamber too, in order to allow preliminary test aiming at assembly optimization.

- Both a rotating and a fixed flange will be welded on the edge of all Vacuum Chambers.
- The fixed flange will carry a small reference plate with a calibrated drill; the plate will exhibit both the mark and the orientation of the axis.
- Assembled Vacuum Chamber will fulfil the following length tolerance requirement:

±0,05% for L>1000 mm ; ±0,5mm for L= 1000÷500 mm; ±0,2mm for L<500 mm

- Special Aluminium joining flanges allow joining of different parts of the Vacuum Chamber with negligible damage of their joining planes during assembly/diassembly phases, provided that special metallic gaskets are utilised («diamond» AL - see Attachment.2).
- Suitable inner copper screening -to be placed between Vacuum Chamber pipes- will minimize possible flange-joining induced «beam disturbances».

5. MACHINING

5.1 MATERIALS

Wiggler Vacuum Chambers

We envisage Aluminium Anticorodal **6060-T4 (9006/1 alloy)** and Aluminium Anticorodal **6082-T6** as the manufacturing material of Vacuum Chambers and of joining flanges respectively. We envisage **Cadmium-Phosphorous-Bronze-(Helicel BR)**-made threads on the joining drills of some flanges, as well as **AISI304**-made joining screws**.**

5.2 STATE OF DELIVERY

The state of deliveries is as follows:

Vacuum Chambers

- Flange (typically, Attachment1) : from a thickness=25/30mm-thick slab
- Screws : see catalogue
- Gaskets (Attachment 2) : according to dwg (diamond geometry)
- Pipes (Attachment 3) : Extruded with the following features:

TOLERANCES

-mod D	±0,20 mm at heigth 18 e 22 mm
Elsewhere, no tolerance will exceed ±0,30 mm	
Roughness will exceed Ra=0,8μm on no inner surface	

WEIGHTS and LENGTHS

-mod D	n° 80 pieces	length mm.6000	(≈2250Kg)

- Particular connections : Plates and particular pipes

5.3. MANUFACTURING PROCEDURES

Wiggler Vacuum Chambers

1. Flanges

- Various Suppliers will manifacture the flanges according to the required tolerances and values of roughness listed in Attachment 1 (typically, CFs100).
- Measures/tolerances concerning flange drilling required by welding for the present kind of Vacuum Chamber («L» cog thickness for boundary fusion is also shown):

Flanges CFs200 tolerance +0.5/+0.7

2. Extruded pipes (standard/special)

- Manifacturers agreed to the procedure described in Attachment 5.
- Welding technology (Electron Beam, TIG, Plasma) will be chosen during tests

5.4. TESTS

We envisage:

- statistical tests on the roughness of particular components;
- dimensional tests on all components;
- vacuum leakage tests according to the parameters listed in Attachment 5 pag.4/4 item n.3;
- penetrating liquid tests on all weldings.

at Manifacturer's location for acceptance before shipping, according to ISO 9000

5.5. OTHERS

«Baking»treatment is required after each manifacturing, machining and washing phase in order to assure proper cleaning of components and adequate stability in time.

All ferrous surfaces will undergo «strong» burnishing in order to prevent oxydization.

6. LOCATION. QUANTITIES

Wiggler Vacuum Chamber Assembly

Referring to:

- D02954UX3000L Damping Ring General Draw.
- D02653UX3000L Damping Ring **Lay-out 1**

it turns out that the quantities are:

n° **36** D02788UX3000L Type CV W

7. TOTAL QUANTITIES (+ spare)

Wiggler Vacuum Chamber Assembly

n° **36x2x1.1= 80** D02788UX3000L Type CV W

8. DELIVERY TIME and COST

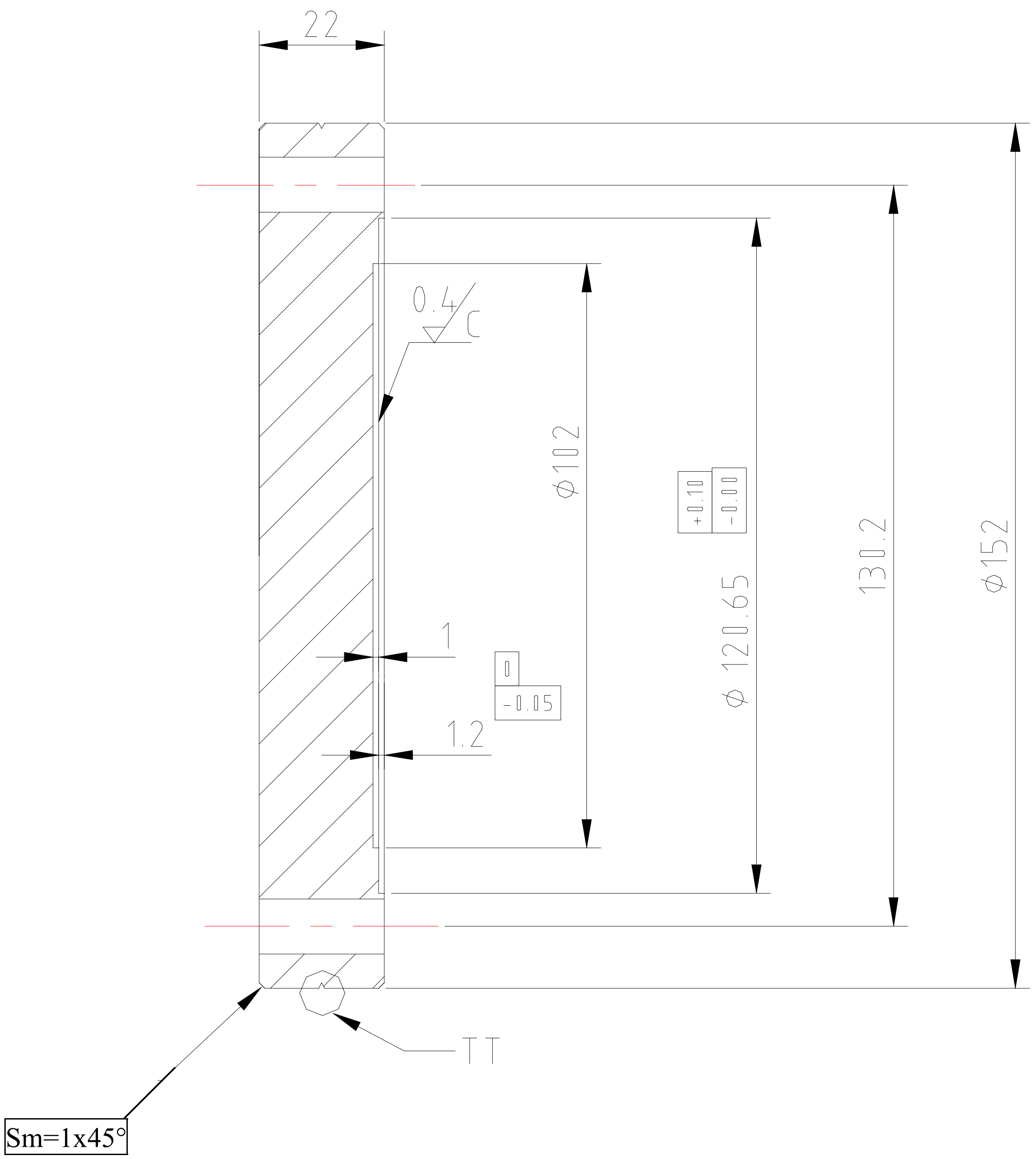
«Time Schedule for the Constructions» encompasses 24 months (Ref to Spec. S02957UX3000L). Accordingly, we envisage utilization of five different Manifacturers for the construction of these components, as listed below:

SPECIAL MAGNETS VACUUM CHAMBER (Wigglers)

CONSTR.	PLANNING (months)																									Quantity	TOTAL	COST
NUMBER	MONTHS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOT.	(Mlire)	(Euro)
	COMPONENT	-	-	-	-	-	-	-	(PIECES X MONTH) -				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	D03033UX3000L	+		#	27	27	26																			80		
	Extrusions																									80	32	16.527
2	D02939UX3000L	+				#	50	50	50	35																185	209	107.940
	Flange																									185	209	107.940
3	D02813UX3000L					+			#	200	200	150														550	7	3.615
	Gaskets																									550	7	3.615
2	D03037UX3000L	+					#	50	50	50	35															185	18	9.296
	Flange Lavoration for Welding																									185	18	9.296
4	D02788UX3000L				+			#	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5		80	61	31.504
	Vacuum Chambers																									80	61	31.504
5	Supply							+				#	5000						5000						1875	11.875	3	1.549
	Bolts, nuts and washers																									11.875	3	1.549
	Order	(+)																										
	First Supply	(#)																										
	GRAND TOTAL																										**330**	**170.430**

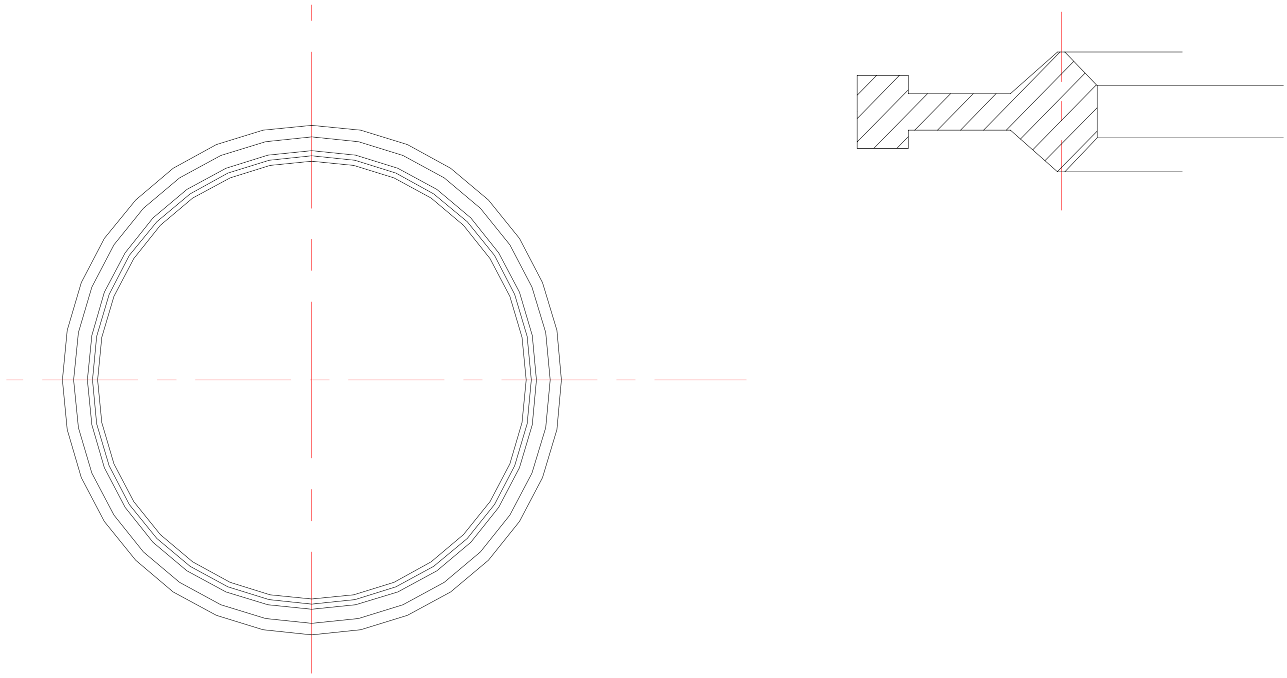
9.1. ATTACHMENT 1

Flange Draw (Typical CFs100)



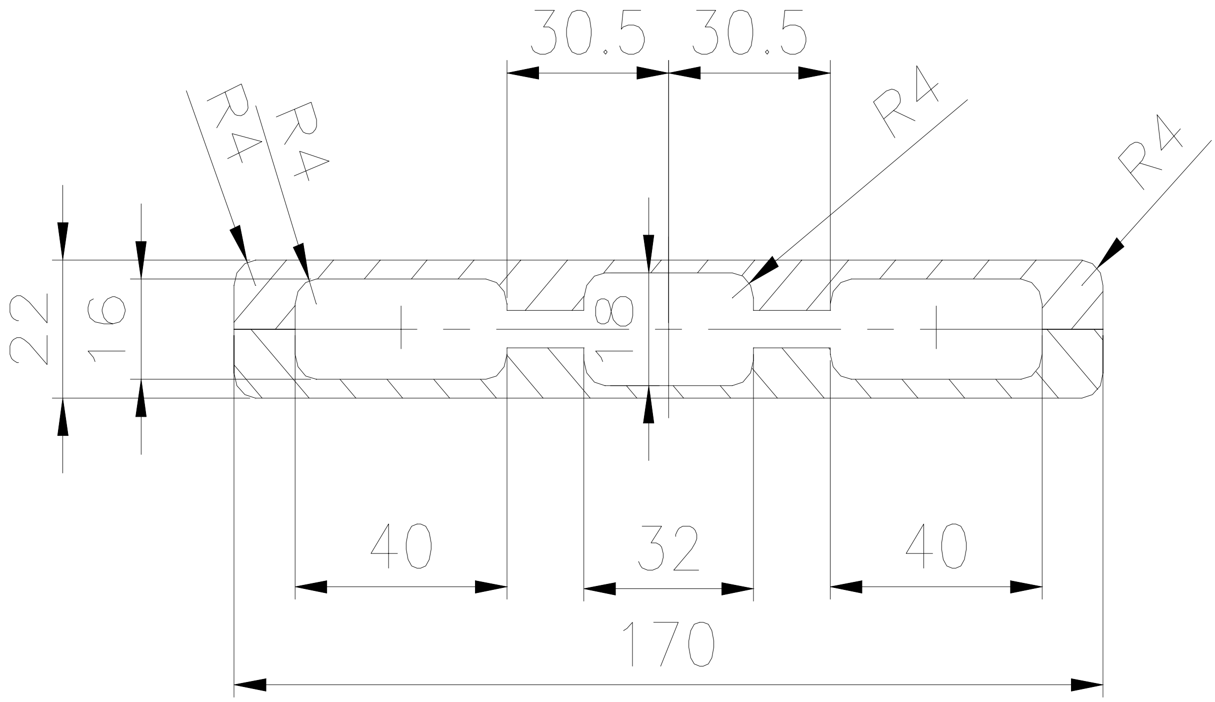
9.2. ATTACHMENT 2

Diamond Gasket Geometry



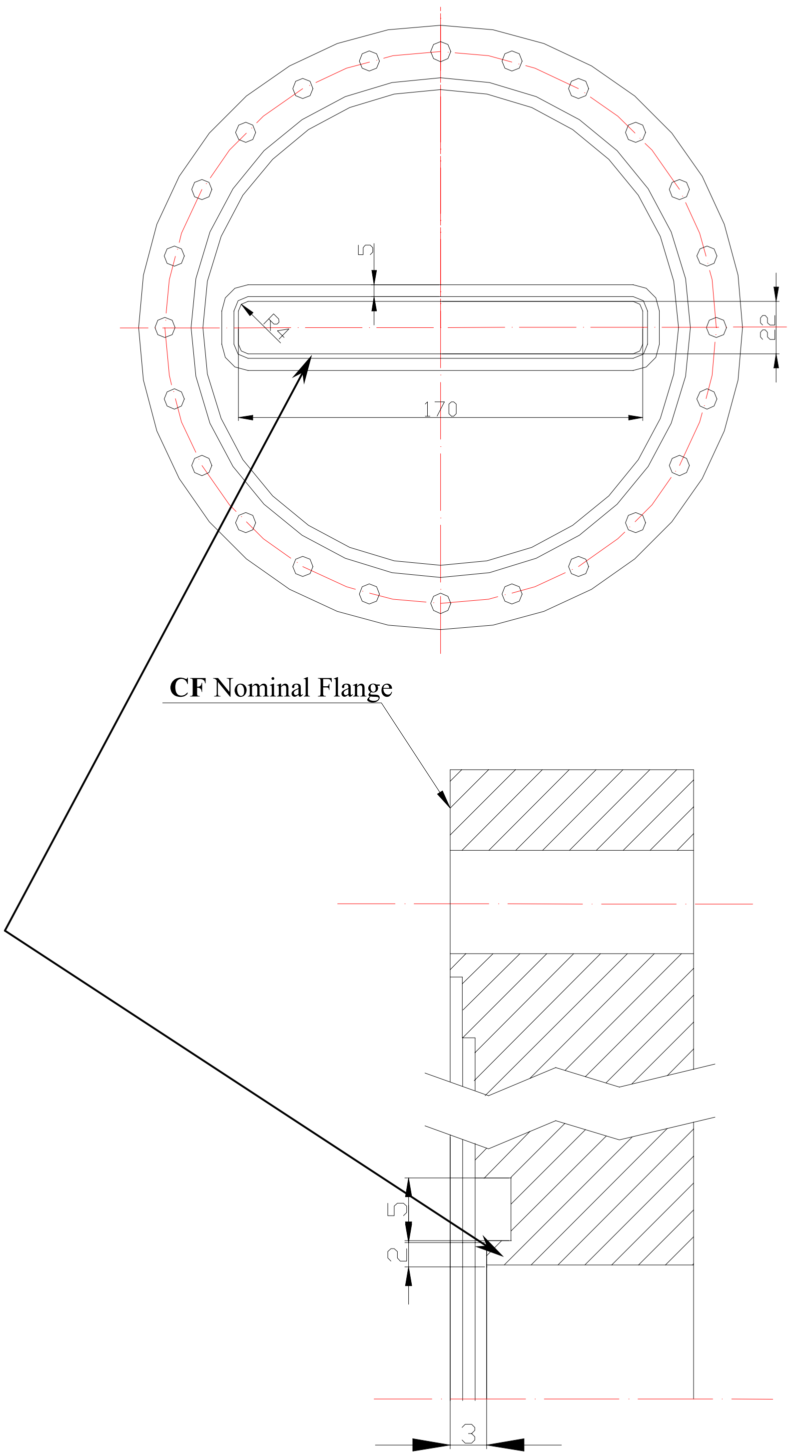
9.3 ATTACHMENT 3

Extruded Section Type: D



9.4 ATTACHMENT 4

Boring on the Flange for Welding "Wiggler" Vacuum Chamber



9.5 ATTACHMENT 5

VACUUM CHAMBER MANUFACTURING - THE PROCEDURES

Two distinct types of Vacuum Chambers exist:

a) Type: **CVW, CV43, CW80 e CV 100**

We may define the main sequences of manufacturing/assembly as follows:

1) Supply of the section bar
2) Preparation for flange welding, both on the edges and lengthwise
3) Washing (see pages ¾)
4) Welding of both flanges and (probably) cooling tubes, while assuring orthogonality to the axle beam. Suitable termination inside the Vacuum Chamber with clean and not contaminating material is recommended.
5) The heat treatment called «BAKING». (n° 3 times at 120°C, once a day)
6) Held Test, both before and after the BAKING.
7) Stocking with nitrogen in polyethylene buckets.

a) Model: **CVD**

We may define the main sequences of manufacturing/assembly as follows:

1) Supply of three section bars (A1, A2, A3)

2) Washing (see pages ¾)

3) Location of the three section bar in Control Tooling type «A »

4) (Possibly automatic) execution of the two Weld Beads -e.g. by TIG.

5) Hot/Cold (other) Rolled, like to draw

6) Location in Cut Tooling type «B», in order to allow lengthwise measurement cutting. The preparation of both edges and flanges for welding should preserve orthogonality with axle beam.

7) Welding of both flanges and (probably) cooling tubes, while assuring orthogonality to the axle beam. Suitable termination inside the Vacuum Chamber with clean and not contaminating material is recommended

1) The heat treatment called «BAKING». (n° 3 times at 120°C, once to day)

2) Held Test, both before and after the BAKING.

3) Stocking with nitrogen in polyethylene buckets.

Cleaning Treatment

In order to obtain both «Arc Zone» pressure values of $1*10^{-8}$ mbar and «Long Straight Sections» pressure values of $1*10^{-9}$ mbar, all Vacuum Chamber components have to undergo accurate «Cleaning Treatment», followed by thermal treatment, before being assembled.

Cleaning must be carried out at the end of the machining phase and possibly before welding. Once the Vacuum Chamber is welded, no further washing is allowed.

Washing requires alkaline detergent in H_2O solution (ALMEKO-18 to 3% in weight) at ~ 50°C. Further washing with water at the same temperature is needed up to complete removal of all pollutants (e.g. the cutting fluid).
Last washing must be carried out using lukewarm distillate water only.
Immediately after washing, all components have to be accurately dried, and all residues (e.g. dust) have to be removed.
After drying, all components must undergo BAKING.
The (eventually pre-assembled) Vacuum Chamber must be closed with blind flanges. A metal gasket must be applied. Then, they must undergo vacuum heating at T≅120°C for 24 hours.
At the end of the heating phase, they must be filled up to the atmospheric pressure with dry nitrogen, starting from liquid nitrogen.
This procedure (heating and successive filling with nitrogen) must be repeated three times.
When the above described sequences are completed, the several Vacuum Chamber sections must be kept sealed and filled up with dry nitrogen. They may be opened only immediately before the final assembly.

Weldings

Only TIG welding seals are allowed (unless otherwise stated). No structural welding is allowed. The parts to be welded must be perfectly clean; the surfaces created after welding must be reduced, lessened, and «discharged», in order to prevent the formation of bags and cavities. All weldings must be performed in a suitably cleaned-up space, with relative humidity ≤ 40%. Should the welding be performed externally to the Vacuum Chamber, a suitable inert gas flow inside the Vacuum Chamber must be envisaged, in order to prevent oxidization. After welding, the Vacuum Chamber cannot undergo any further cleaning treatment.

Seal Test

Every component of the Vacuum Chamber must undergo rigorous seal testing with the help of either a « Helium Leak Finder » or a mass spectrometer with suitably adapted pumping system.
In both cases, «oil-free» vacuum systems are required. Seal tests have to be performed both before and after heating at T=120°C.
Leak values $\leq 1*10^{-10}$ mbar*l*s^{-1} (helium) are accepted.

Assembly Procedure

Particular attention is due during all phases of TDR Vacuum Chamber assembly. It is of paramount importance that all operations are carried out in optimal cleaning conditions.
Prevention of every type of contamination inside the surfaces of the Vacuum Chamber requires in-depth care. Adequate dry nitrogen flow must be assured in order to avoid every possible air-induced contamination of the internal Vacuum Chamber surfaces during all assembly phases, when the Vacuum Chamber is open.

End Seal Test

The End Seal Test must be carried out after the last Vacuum Chamber assembly operation.
Leak values $\leq$ to $1*10^{-10}$ mbar*l*s^{-1} (helium) are accepted.

9.6. ATTACHMENT 6

Tasks to be completed (I.N.F.N) within 06/12/2000

Progressive Number					Main Item	Requested Job	
1	2	3	4	5		Des.	Mag/Therm Mechan/Ver.
1					TESLA 5 GeV Damping Rings		
1	1				Damping Ring Lattice	Not	
1	2				General Lay-out	Yes	
1	2	1			D.R. Arc Tunnel Lay-out	Yes	Not
1	2	2			D.R. 8 km Conn. Tunnel Lay-out	Yes	Not
1	3				Injection/Extraction Sections	Yes	Yes
1	4				Damping Rings		
1	4	1			Magnetic Components		
1	4	1	1		Bending Dipoles	Yes	Yes
1	4	1	2		Quadrupoles	Yes	Yes
1	4	1	3		Sextupoles	Yes	Yes
1	4	1	4		Magnetic Measurements	Not	Not
1	4	1	5		Magnet Assembly	Yes	Yes
1	4	1	6		H/V Correctors	Yes	Yes
1	4	1	7		Dipole Stands and Supports	Yes	Yes
1	4	1	8		Multipole Girders/Supports	Yes	Yes
1	4	1	9		Special Magnets (Electromagnetic Wigglers)	Yes	Yes
1	4	2			Power Supply System	Not	Yes
1	4	2	1		Mains Connections	Not	Not
1	4	2	2		Med/Low Voltage Breaker	Not	Not
1	4	2	3		Med/Low Voltage Cables and Trays	Not	Yes
1	4	2	4		Electromagnetic Wiggler Power Supplies	Not	Yes
1	4	3			RF System		
1	4	3	1		RF Cryo-modules	Not	Not
1	4	3	2		RF Power Surces	Not	Not
1	4	3	3		Waveguide network system	Not	Not
1	4	3	4		Cryogenic System	Not	Not
1	4	3	5		Cooling System	Not	Not
1	4	3	6		Others (electronics, controls, interlocks, etc.)	Not	Not
1	4	4			Vacuum System		
1	4	4	1		D. R. Vacuum Chamber	Yes	Yes
1	4	4	2		Conn. Tunnel Vacuum Chamber	Not	Not
1	4	4	3		Vacuum Chamber Supports	Yes	Yes
1	4	4	4		Pumps and Power Supplies	Not	Yes
1	4	4	5		Vacuum Diagnostics	Not	Yes
1	4	4	6		Manual and Automatic Valves	Not	Yes
1	4	4	7		Control Units	Not	Yes

1	4	4	8		Special Magnets Vacuum Chamber (Wigglers)	Yes	Yes
1	4	5			Beam Diagnostics		
1	4	5	1		Fluorescent Screens	Not	Yes
1	4	5	2		Toroidal Current Transformers	Not	Yes
1	4	5	3		Wall Current Monitors	Not	Yes
1	4	5	4		DC Current Transformers	Not	Yes
1	4	5	5		BPM Button/Strip Line Monitors	Not	Yes
1	4	5	6		Beam Diagnostics Electronics	Not	Not
1	4	5	7		Emittance Measurement System	Not	Not
1	5				Computer Control System		
1	5	1			Computer Control System Hardware	Not	Not
1	5	2			Computer Control System Software	Not	Not
1	6				Electrical Services		
1	6	1			Standard Line Voltage Sources	Not	Not
1	6	2			Main Power Distribution Boards	Not	Not
1	6	3			Medium/Low Voltage Transformers	Not	Not
1	6	4			Medium Voltage Breakers	Not	Not
1	6	5			Cables and Trays	Not	Not
1	6	6			Lightning System	Not	Not
1	6	7			Emergency Lightning System	Not	Not
1	7				Process Water Facilities		
1	7	1			Cooling Towers and Anc. Equip.	Not	Not
1	7	2			Pumps, Motors and Anc. Eqiuip.	Not	Not
1	7	3			Heat Exchangers	Not	Not
1	7	4			Piping	Not	Not
1	7	5			Filters	Not	Not
1	7	6			De-ionization Units	Not	Not
1	7	7			Tanks	Not	Not
1	8				Cooling and Ventilation System (only for Arcs)	Not	Not
1	9				Compressed Air Facilities (only for Arcs)	Not	Not
1	10				Handling Equipments and Cranes (only for Arcs)	Not	Not
1	11				Tunnel Transport System (only for Arcs)	Not	Not
1	12				Alignment Facilities (only for Arcs)	Not	Not
1	13				Installation Time Schedule and Manpower	Not	Not
1	14				Fire Detection System (only for Arcs)	Not	Not
1	15				Smoke extraction system (only for Arcs)	Not	Not
1	16				Tunnel TV Monitoring (only for Arcs)	Not	Not
1	17				Tests and Acceptance Tests	Not	Not
1	18				Commissioning (with no beam)	Not	Not
1	19				Engineering and Q.A.	Not	Not

ANSALDO

Ansaldo Ricerche s.r.l.

Progetto project	Identificativo document no.
TESLA DAMPING RING	File::0s-quattordici-1 S02983UX3000L

Cliente client	Comm.-s/comm. job. no.	Emittente issued by	Pagina page	Di of
I.N.F.N.	UX3.000	ARI/TME/MTM	1	16

Rag. disc. disc.code	Rif. str. prod. prod. str. no	Identificativo componente equipment identification code	Tipo doc. doc type	Cl. ris. class	Allegati enclosures
N/A	N/A	Damping Ring	Spec di Fabbr	L	n.°2

Titolo title	Derivato da derived from
BEAM DIAGNOSTICS	Sostituisce substitutes

Stato validita`: Issue 12/02/2001
rev.scope

0	12/02/2001	Issue		Rizzo Sergio	Barbagelata Luigi	Grattarola Marco	Rosatelli Franco
Rev. rev.	Data date	Descrizione description	Stato valid. rev. scope	Redazione prepared by	Controllo checked by/	approvazione checked by/ approved by	Autorizzazione emissione issue authorization

Table of contents

1. AIM

The present Specification aims at detailed description of both the components involved in the Supply, the working materials, the number of required Suppliers/Constructors, the time schedule agreed upon, the number of pieces to be delivered in due time and the overall costs of the delivered product.

2. REFERENCES

The present specification invokes the following documents:

1. List of deliverables, whose version dated 06/12/2000 has been provided by INFN, item 1.4.5.1÷1.4.5.5. (see Attachment 1)
2. ARI Procedure no.P0111767000L dated 13/12/1999.
3. Drawings:
   - D02954UX3000L Damping Ring General Draw.
   - D02653UX3000L Damping Ring Lay-out 1
   - D02654UX3000L Damping Ring Lay-out 2
   - D02655UX3000L Damping Ring Lay-out 3
   - D02656UX3000L Damping Ring Lay-out 4
   - D02657UX3000L Damping Ring Lay-out 5
   - D02658UX3000L Quadrupole vacuum chamber assembly - CV43 MOD.1/1-
   - D02660UX3000L Quadrupole vacuum chamber assembly - CV43 MOD.1/3-
   - D02679UX3000L Quadrupole vacuum chamber assembly - CW80 MOD.4 –
   - D02682UX3000L Quadrupole vacuum chamber assembly - CV100 MOD.6/1 -
   - D02793UX3000L Beam position monitor -CV100/MOD .6-2-
   - D02794UX3000L Beam position monitor -CW80/5-
   - D02795UX3000L Beam position monitor -CW80/4-
   - D02796UX3000L Beam position monitor -CV43/1-3-
   - D02778UX3000L Ceramic flag/otr indicator plate positioner -ø43 T11-
   - D02779UX3000L Slit/Scraper positioner -ø43 T12-
   - D02780UX3000L Toroidal current monitor -ø43 T13-
   - D02781UX3000L DC current monitor (DCCT) -ø43 T14-
   - D02782UX3000L Transversal kicker stripline -ø43 T15-
   - D02783UX3000L B.P.S. stripline -ø43 T16-
   - D02784UX3000L Wall current monitor -T17-
   - D02787UX3000L Support beam loss monitor -T20-

3. COMPONENTS

3.1 Beam Diagnostics

1. Fluorescent Screens

Targets are either OTR or ceramic type.
(D02778UX3000L Ceramic flag/otr indicator plate positioner -ø43 **T11**-)

2. Slit scrapers

Step motors are provided to control slit position.
(D02779UX3000L Slit/Scraper positioner -ø43 **T12**-)

3. Toroidal Current Monitors

Toroidal current transformer Bergoz, model ICT 122, is employed with Agilent oscilloscope, model 54845.
(D02780UX3000L Toroidal current monitor -ø43 **T13**-)

4. Wall Current Monitors

An array of parallel resistors across a ceramic break in the vacuum chamber, placed in a suitably shielded enclosure, is arranged to obtain a wall current monitor. Signal is read by an Agilent oscilloscope, model 54845.
(D02784UX3000L Wall current monitor **-T17-**)

5. Beam Loss Monitors

Bergoz model BLM-XS is employed, with an Agilent E1333A Counter.
(D02787UX3000L Support beam loss monitor -T20-)

6. DC Current Monitors

DC Current monitors are Parametric Current Transformer Bergoz model PCT 115; it is coupled to a Agilent model E1412 A multimeter.
(D02781UX3000L DC current monitor (DCCT) -ø43 **T14**-)

7. BPM Button

Bergoz model LR-BPM Electronics is employed, couled to an Agilent multimeter model E1412 A.
(D02793UX3000L Beam position monitor -CV100/MOD .6-2-)
(D02794UX3000L Beam position monitor -CW80/5-)
(D02795UX3000L Beam position monitor -CW80/4-)
(D02796UX3000L Beam position monitor -CV43/1-3)-

8. B.P.S. / Transversal Kickers Strip Lines

Signals from Striplines are fed to an Agilent oscilloscope, model 54845
(D02782UX3000L Transversal kicker stripline -ø43 **T15**-)
(D02783UX3000L B.P.M. stripline -ø43 **T16**-)

9. Tune Monitor

A couple of Tune Monitor is provided, consisting of a Network Analyzer (Aglient model 4395A / 87511A) and RF amplifier (Amplifier Research model 100W1000). The system is able to work in the range 1 – 500 MHz.

4. PERFORMANCES

1. Fluorescent Screens

The beam lights up a spot on a fluorescent target. The target is either OTR or ceramic type. Electropneumatic actuators allow ON/OFF operation with 1/100 mm repeatability. A B/W camera records the spot size and position, as seen through a sapphire window. The B/W camera allows for a resolution better than 1/10 mm. The camera output is fed to the Control Room through a LAN connection.

2. Slit scrapers

Slit scrapers position is controlled via the PLC system. Step motors are employed. Position is controlled over a 50 mm stroke with an accuracy in the 5/100 mm range.

3. Toroidal Current Monitors

Toroidal Current Monitors are supplied by Bergoz, model ICT 122, arranged across a ceramic break in the vacuum chamber; each output is fed to an oscilloscope supplied by Agilent, model 54845. The Oscilloscope has a 1.5 GHz bandwidth, two channels. Output data is fed to the Control Room through a LAN connection.

4. Wall Current Monitors

The Wall Current is monitored placing an array of parallel resistors across a ceramic break in the vacuum chamber, placed in a suitably shielded enclosure. The output is fed to an oscilloscope supplied by Agilent, model 54845. The system is able to capture a 50 μs long bunch of 2500 pulses, FWHM 300 ps each. The Oscilloscope has a 1.5 GHz bandwidth, two channels. Output data is fed to the Control Room through a LAN connection.

5. Beam Loss Monitors

Beam Loss monitoring is provided employing Bergoz model BLM-XS. When the sensor surface is crossed by a charged particle a TTL-pulse is generated, feeding an Agilent E1333A Counter through a Multiplexer. Output data is fed to the Control Room through a LAN connection.

6. DC Current Monitors

DC Current monitors are Parametric Current Transformer Bergoz model PCT 115, 1 Amp Full Scale. The device is water cooled. Its output is read by a 6.5 digit multimeter (Agilent model E1412 A) on a VXI cage connected to the Control Room through a LAN connection.

7. BPM Button

Beam Position Monitor Buttons feed a Bergoz model LR-BPM Electronics which is fed to VXI cages collecting 16 or 64 channels, depending on location. Locations are chosen in order to reduce connection lengths to less than 80 meters. The signal is read by an Agilent MUX model E1442 and fed to an Agilent multimeter model E1412 A; then readings are sent through a LAN connection.

8. B.P.S. / Transversal Kickers Strip Lines

Two different kinds of Transversal Kickers Striplines are provided, namely with 4 Striplines (BPS) placed at 90° and with 2 Striplines (Transversal) placed at 180°. In both cases signals are fed to an oscilloscope supplied by Agilent, model 54845. The Oscilloscope has a 1.5 GHz bandwidth, two channels. Output data is fed to the Control Room through a LAN connection.

9. Tune Monitor

A couple of Tune Monitor is provided, consisting of a Network Analyzer (Aglient model 4395A / 87511A) and RF amplifier (Amplifier Research model 100W1000). The system is able to work in the range 1 – 500 MHz.

5. MACHINING

5.1MATERIALS

Suppliers issue suitable warranty for all materials, in agreement with relevant standard (see catalogue Varian/Lesker).

5.2 STATE OF DELIVERY

All components will be suitably packed and shielded from both dust, dump and shocks and shipped to the Damping Ring Tesla warehouse; there, they will be unpacked and assembled on the line in due time.

5.3. TESTS

Is is envisaged that the Constructor issues a test certificate. The latter folows each component, and assures correct operation with reference to ISO 9000.

6. LOCATION. QUANTITIES

Referring to

- D02954UX3000L Damping Ring General Draw.
- D02653UX3000L Damping Ring **Lay-out 1**
- Attachement 2

It turns out that the quantities are:

n° **2 (T11) Fluorescent Screens**
n° **1 (T12) Slit Scrapers**
n° **1 (T13) Toroidal Current Monitors**
n° **1 (T17) Wall Current Monitors**
n° **1 (T14) DC Current Monitors**
n° **4x2 (T20) Beam Loss Monitors (vert./ horiz.)**
n° **1 (T15) Transversal Kickers Strip-lines**
n° **1 (T16) B.P.S. Strip-lines**
n° **1 Tune monitors**
n° **8 BPM CV43/1**
n° **6 BPM CV43/3**
n° **10 BPM CW80/4**
n° **35 BPM CW80/5**

Electronic Components

B/W camera	Bergoz ICT 122	Agilent 54845 Osc.	Bergoz BLM-XS	Agilent E1333A Counter MUX	Bergoz PCT-115	Agilent DMM E1412A	Bergoz LR-BPM	Agilent DMM E1412A MUX E1442	Agilent Network Analizer 4395A / 87511A	Amplifier Research 100W1000 Power Meter Dir. Coupler
2	1	3	8	1	1	9	118	8	1	1

Referring to

- D02954UX3000L Damping Ring General Draw.
- D02654UX3000L Damping Ring **Lay-out 2**

It turns out that the quantities are:

n° **2 (T11) Fluorescent Screens**
n° **3 (T13) Toroidal Current Monitors**
n° **3 (T17) Wall Current Monitors**
n° **3x2 (T20) Beam Loss Monitors (vert./ horiz.)**
n° **82 BPM CV43/1**
n° **3 BPM CV43/3**

Electronic Components

B/W camera	Bergoz ICT 122	Agilent 54845 Osc.	Bergoz BLM-XS	Agilent E1333A Counter MUX	Agilent DMM E1412A	Bergoz LR-BPM	Agilent DMM E1412A MUX E1442
2	3	6	6	1	11	170	11

Referring to

- D02954UX3000L Damping Ring General Draw.
- D02655UX3000L Damping Ring **Lay-out 3**

It turns out that the quantities are:

n° **2 (T11) Fluorescent Screens**
n° **2 (T13) Toroidal Current Monitors**
n° **2 (T17) Wall Current Monitors**
n°**3x2 (T20) Beam Loss Monitors (vert./ horiz.)**
n° **79 BPM CV43/1**
n° **3 BPM CV43/3**

Electronic Components

B/W camera	Bergoz ICT 122	Agilent 54845 Osc.	Bergoz BLM-XS	Agilent E1333A Counter MUX	Agilent DMM E1412A	Bergoz LR-BPM	Agilent DMM E1412A MUX E1442
2	2	4	6	1	11	164	11

Referring to

- D02954UX3000L Damping Ring General Draw.
- D02656UX3000L Damping Ring **Lay-out 4**

It turns out that the quantities are:

n° **2 (T11) Fluorescent Screens**
n° **1 (T12) Slit Scrapers**
n° **2 (T13) Toroidal Current Monitors**
n° **2 (T17) Wall Current Monitors**
n°**4x2 (T20) Beam Loss Monitors (vert./ horiz.)**
n° **57 BPM CV43/1**
n° **6 BPM CV43/3**

Electronic Components

B/W camera	Bergoz ICT 122	Agilent 54845 Osc.	Bergoz BLM-XS	Agilent E1333A Counter MUX	Agilent DMM E1412A	Bergoz LR-BPM	Agilent DMM E1412A MUX E1442
2	2	4	8	1	8	126	8

Referring to

- D02954UX3000L Damping Ring General Draw.
- D02657UX3000L Damping Ring **Lay-out 5**

It turns out that the quantities are:

n° **1 (T11) Fluorescent Screens**
n°**100x2 (T20) Beam Loss Monitors (vert./ horiz.)**
n° **135 BPM CV100/Mod.6/2**

Electronic Components

B/W camera	Bergoz BLM-XS	Agilent E1333A Counter MUX	Agilent DMM E1412A	Bergoz LR-BPM	Agilent DMM E1412A MUX E1442
1	200	13	9	135	9

7. TOTAL QUANTITIES (+ spare)

n° (8+1)x2+1+1) = 20 (T11) Fluorescent Screens
n° (1ve+1ho)x2+1+1 = 6 (T12) Slit Scrapers (vert./ horiz.)
n° (8x2)+1 = 17 (T13) Toroidal Current Monitors
n° (8x2)+1 = 17 (T17) Wall Current Monitors
n° (1x2)+1 = 3 (T14) DC Current Monitors
n° ((14x2+100x2))x2x1.10= 502 (T20) Beam Loss Monitors (vert./ horiz.)
n° (1x2)+1 = 3 (T15) Transversal Kickers Strip-lines
n° (1x2)+1 = 3 (T16) B.P.S. Strip-lines
n° (1x2)+1 = 3 Tune monitors

Beam Position Monitors with Bottons

n° 226x2x1.05= 475 BPM CV43/1
n° 18x2x1.05= 38 BPM CV43/3
n° 10x2x1.10= 22 BPM CW80/4
n° 35x2x1.05= 74 BPM CW80/5
n° 135x2x1.05= 284 BPM CV100

Electronic Components

B/W camera	Bergoz ICT 122	Agilent 54845 Osc.	Bergoz BLM-XS	Agilent E1333A Counter MUX	Bergoz PCT-115	Agilent DMM E1412A	Bergoz LR-BPM	Agilent DMM E1412A MUX E1442	Agilent Network Analizer 4395A / 87511A	Amplifier Research 100W1000 Power Meter Dir. Coupler
18+2= **20**	19+1= **17**	34+3= **37**	456+46= **502**	34+3= **37**	2+1= **3**	96+6= **102**	1426+76= **1502**	94+5= **99**	2+1= **3**	2+1= **3**

8. DELIVERY TIME and COST

«Time Schedule for the Constructions» encompasses 27 months (Ref.to Spec. S02957UX3000L). Supply of several components is required. Accordingly, we are bound to envisage utilization of several Suppliers as listed below:

BEAM DIAGNOSTIC COMPONENTS

N.°	MONTHS	0	1	2	3 #	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	PIECES TOT.	COST (Mlire)	TOTAL (Euro)
	COMPONENT	PLANNING (months) (PIECES X MONTH)																														
1	Fluorescent Screens				2		2		2		2		2		2		2		2		2		2							20	685	
	Visualization System	+				2		2		2		2		2		2		2		2		2		2						20	125	
	Fluorescent Screens (T11)																															
1	Slit Scrapers	+					1				1				1					1				1				1		6	306	
	Slit Scrapers (T12)																														1.116	576.366
2	Toroidal Current Monitor				2		2		2		2		2		2		2		2		1									17	102	
6	Wall Current Monitors					5				2		2				2		2					2				2			17	58	
5	Visualization System (54845)					4				4				4				4		4		4		4		4		2		34	2.465	
4	Electr. Components (ICT 122)	+			1		1	1	1		1	1	1		1	1	1	1	1	1	1	1	1	1						17	973	
	Toroidal and Wall Current Monitor (T13 + T17)																														3.598	1.858.211
3	DC Current Monitor						1					1					1													3	19	
4	El.Comp. (E1412A/PCT115)	+				1				1				1																3	194	
	DC Current Monitor (T14)																														213	110.005
1	Transversal Kickers (stripline)	+							1						1						1									3	151	
5	Electronic Components					1				1				1																3	206	
	Transversal Kickers (stripline) (T15)																															
6	B.P.S. Stripline	+						1						1						1										3	56	
5	**Visualization System (54845)**					1				1				1																3	217	
	B.P.S. Strpline (T16)																															
4	Beam Loss Monitors	+				50		50		50		50		50		50		50		50		50		52						502	326	
8	Acqisition Cards Counter)				3		3		3		3		3		3		3		3		3		3		3		4			37	398	
7	Supports							25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	27		502	100	
	Beam Loss Monitors (T20)																															
6	B.P.M. Bot and supports				70		70		70		70		70		70		70		70		70		70		70		70		53	893	2.633	
4	Acquisitin Cards (LR BPM)				115		115		115		115		115		115		115		115		115		115		115		115		122	1502	7.538	
5	Electronic Components				10		5		10		5		10		5		10		5		10		5		10		5		9	99	2.846	
	BPM Bottons and Supports																															
8	Network Analizer																													3	375	
9	RF Power																													3	428	
	Tune Monitors																														15.274	7.888.363
	Order	(+)																														
	First Supply	(#)																														
	GRAND TOTAL																														19.085	9.856.580

9. ATTACHMENTS

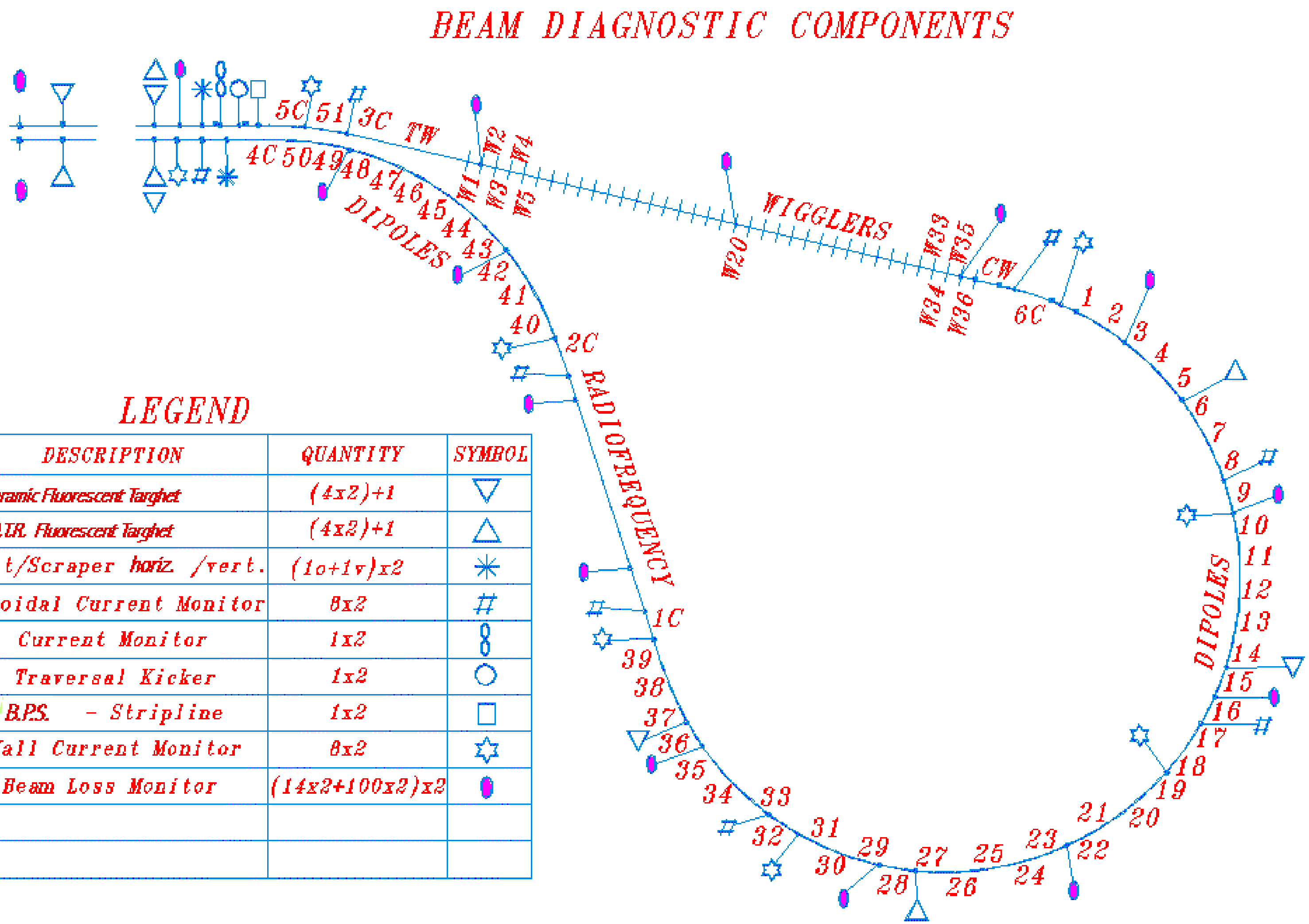
9.1 Attachment 1: Tasks to be completed (I.N.F.N.) within 06/12/2000

Progressive Number					Main Item	Requested Job	
1	2	3	4	5		Des.	Mag/Therm Mechan/Ver.
1					TESLA 5 GeV Damping Rings		
1	1				Damping Ring Lattice	Not	
1	2				General Lay-out	Yes	
1	2	1			D.R. Arc Tunnel Lay-out	Yes	Not
1	2	2			D.R. 8 km Conn. Tunnel Lay-out	Yes	Not
1	3				Injection/Extraction Sections	Yes	Yes
1	4				Damping Rings		
1	4	1			Magnetic Components		
1	4	1	1		Bending Dipoles	Yes	Yes
1	4	1	2		Quadrupoles	Yes	Yes
1	4	1	3		Sextupoles	Yes	Yes
1	4	1	4		Magnetic Measurements	Not	Not
1	4	1	5		Magnet Assembly	Yes	Yes
1	4	1	6		H/V Correctors	Yes	Yes
1	4	1	7		Dipole Stands and Supports	Yes	Yes
1	4	1	8		Multipole Girders/Supports	Yes	Yes
1	4	1	9		Special Magnets (Electromagnetic Wigglers)	Yes	Yes
1	4	2			Power Supply System	Not	Yes
1	4	2	1		Mains Connections	Not	Not
1	4	2	2		Med/Low Voltage Breaker	Not	Not
1	4	2	3		Med/Low Voltage Cables and Trays	Not	Yes
1	4	2	4		Electromagnetic Wiggler Power Supplies	Not	Yes
1	4	3			RF System		
1	4	3	1		RF Cryo-modules	Not	Not
1	4	3	2		RF Power Surces	Not	Not
1	4	3	3		Waveguide network system	Not	Not
1	4	3	4		Cryogenic System	Not	Not
1	4	3	5		Cooling System	Not	Not
1	4	3	6		Others (electronics, controls, interlocks, etc.)	Not	Not
1	4	4			Vacuum System		
1	4	4	1		D. R. Vacuum Chamber	Yes	Yes
1	4	4	2		Conn. Tunnel Vacuum Chamber	Not	Not
1	4	4	3		Vacuum Chamber Supports	Yes	Yes
1	4	4	4		Pumps and Power Supplies	Not	Yes
1	4	4	5		Vacuum Diagnostics	Not	Yes
1	4	4	6		Manual and Automatic Valves	Not	Yes
1	4	4	7		Control Units	Not	Yes

1	4	4	8		Special Magnets Vacuum Chamber (Wigglers)	Yes	Yes
1	4	5			Beam Diagnostics		
1	4	5	1		Fluorescent Screens	Not	Yes
1	4	5	2		Toroidal Current Transformers	Not	Yes
1	4	5	3		Wall Current Monitors	Not	Yes
1	4	5	4		DC Current Transformers	Not	Yes
1	4	5	5		BPM Button/Strip Line Monitors	Not	Yes
1	4	5	6		Beam Diagnostics Electronics	Not	Not
1	4	5	7		Emittance Measurement System	Not	Not
1	5				Computer Control System		
1	5	1			Computer Control System Hardware	Not	Not
1	5	2			Computer Control System Software	Not	Not
1	6				Electrical Services		
1	6	1			Standard Line Voltage Sources	Not	Not
1	6	2			Main Power Distribution Boards	Not	Not
1	6	3			Medium/Low Voltage Transformers	Not	Not
1	6	4			Medium Voltage Breakers	Not	Not
1	6	5			Cables and Trays	Not	Not
1	6	6			Lightning System	Not	Not
1	6	7			Emergency Lightning System	Not	Not
1	7				Process Water Facilities		
1	7	1			Cooling Towers and Anc. Equip.	Not	Not
1	7	2			Pumps, Motors and Anc. Eqiuip.	Not	Not
1	7	3			Heat Exchangers	Not	Not
1	7	4			Piping	Not	Not
1	7	5			Filters	Not	Not
1	7	6			De-ionization Units	Not	Not
1	7	7			Tanks	Not	Not
1	8				Cooling and Ventilation System (only for Arcs)	Not	Not
1	9				Compressed Air Facilities (only for Arcs)	Not	Not
1	10				Handling Equipments and Cranes (only for Arcs)	Not	Not
1	11				Tunnel Transport System (only for Arcs)	Not	Not
1	12				Alignment Facilities (only for Arcs)	Not	Not
1	13				Installation Time Schedule and Manpower	Not	Not
1	14				Fire Detection System (only for Arcs)	Not	Not
1	15				Smoke extraction system (only for Arcs)	Not	Not
1	16				Tunnel TV Monitoring (only for Arcs)	Not	Not
1	17				Tests and Acceptance Tests	Not	Not
1	18				Commissioning (with no beam)	Not	Not
1	19				Engineering and Q.A.	Not	Not

9. ATTACHMENTS

9.2 Attachment 2: Beam Diagnostic Components Layout



LEGEND

REF.	DESCRIPTION	QUANTITY	SYMBOL
T11	Ceramic Fluorescent Targhet	(4x2)+1	▽
T11	O.T.R. Fluorescent Targhet	(4x2)+1	△
T12	Slit/Scraper horiz. /vert.	(1o+1v)x2	✳
T13	Toroidal Current Monitor	8x2	#
T14	DC Current Monitor	1x2	8
T15	Traversal Kicker	1x2	○
T16	B.P.S. - Stripline	1x2	□
T17	Wall Current Monitor	8x2	✡
T20	Beam Loss Monitor	(14x2+100x2)x2	●

ANSALDO

Ansaldo Ricerche s.r.l.

Progetto project	Identificativo document no.
TESLA DAMPING RING	File: 0s-dodici-1 S02991UX3000L

Cliente client	Comm.-s/comm. job. no.	Emittente issued by	Pagina page	Di of
I.N.F.N.	UX3.000	ARI/TME/MTM	1	46

Rag. disc. disc.code	Rif. str. prod. prod. str. no	Identificativo componente equipment identification code	Tipo doc. doc type	Cl. ris. class	Allegati enclosures
N/A	N/A	Damping Ring	Spec di Fabbr	L	n.°2+ 11 annexed

Titolo title	Derivato da derived from
GENERAL SERVICES	Sostituisce substitutes

Stato validita`: rev.scope **Issue 26/01/2001**

0	26/01/2001	Issue		Bixio Angelo	Barbagelata Luigi	Grattarola Marco	Rosatelli Franco
Rev. rev.	**Data** date	**Descrizione** description	**Stato valid.** rev. scope	**Redazione** prepared by	**Controllo** checked by/	**approvazione** checked by/ approved by	**Autorizzazione emissione** issue authorization

Table of contents

1. AIM

The present Specification aims at detailed description of both the components involved in the Delivery, the working materials, the number of required Suppliers/Deliverers, the time schedule agreed upon, the number of pieces to be delivered in due time and the overall costs of the delivered product.

2. REFERENCES

The present specification invokes the following documents:

1. List of deliverables, whose version dated 06/12/2000 has been provided by INFN, items 1.6.1÷1.6.7 - 1.7.1÷1.7.7 –1.8 – 1.9 – 1.14 – 1.15. (Attachment2)
2. ARI Procedure no.P0111767000L dated 13/12/1999.
3. Specification «Tesla Damping Ring – DOGBONE – Service Plants, dated 10/01/2001 (Attachment1)

3. COMPONENTS

1. Electrical Services

See Specification «Tesla Damping Ring – DOGBONE – Service Plants, dated 10/01/2001 (Attachment1) paragraph 3

2. Process Water Facilities

See Specification «Tesla Damping Ring – DOGBONE – Service Plants, dated 10/01/2001 (Attachment1) paragraph 4

3. Cooling and Ventilation Systems

See Specification «Tesla Damping Ring – DOGBONE – Service Plants, dated 10/01/2001 (Attachment1) paragraph 5

4. Compressed Air Facilities

See Specification «Tesla Damping Ring – DOGBONE – Service Plants, dated 10/01/2001 (Attachment1) paragraph 6

5. Fire Detection Systems

See Specification «Tesla Damping Ring – DOGBONE – Service Plants, dated 10/01/2001 (Attachment1) paragraph 7

6. Smoke Extraction Systems

See Specification «Tesla Damping Ring – DOGBONE – Service Plants, dated 10/01/2001 (Attachment1) paragraph 8

4. DELIVERY PERFORMANCES

See Specification «Tesla Damping Ring – DOGBONE – Service Plants, dated 10/01/2001 (Attachment1)

5. MACHINING

5.1 MATERIALS

Suppliers issue suitable warranty for all materials, in agreement with relevant standard.

5.2 STATE OF DELIVERY

All components shipped to the assembling Laboratories will be suitably packed and shielded from both dust, dump and shocks.

5.3. TESTS

Is is envisaged that the Constructor issues a test certificate. The latter folows each component, and assures correct operation with reference to ISO 9000.

6. LOCATION. QUANTITIES

See Specification «Tesla Damping Ring – DOGBONE – Service Plants, dated 10/01/2001

(Attachment1)

7. TOTAL QUANTITIES (+ spare)

See Specification «Tesla Damping Ring – DOGBONE – Service Plants, dated 10/01/2001

(Attachment1)

8. DELIVERY TIME and COST

«Time Schedule for the Constructions (Ref. To Spec. S02957UX3000L)» encompasses 24 months. Accordingly, we envisage utilization only one Manifacturers for the construction of these components, as listed below:

GENERAL SERVICES

CONSTR.	PLANNING (two/months)														COST TOTAL	
N 1	MONTHS	0	2	4	6	8	10	12	14	16	18	20	22	24	(Mlire)	(Euro)
	COMPONENT	(PIECES X MONTH)														
1.6.1	Standard Line Volt.S	+													132	
1.6.2	Main Power Distrib.B.	+													1.725	
1.6.3	M/L Voltage Transfor	+													750	
1.6.4	M. Voltage Breakers	+													450	
1.6.5	Cables and Trays	+													2.889+(@ 2532)	
1.6.6	Lightning System	+													126	
1.6.7	Emergency Ligh.Syst	+													59	
1.6	Electrical Services														8.663	4.474.066
1.7.1	Cooling Towers+Eq.	+													953	
1.7.2	Pumps, Motors+Eq.	+													827	
1.7.3	Heat Exchangers	+													470	
1.7.4	Piping	+													9.067	
1.7.5	Filters	+													104	
1.7.6	De-ionization Units	+													385	
1.7.7	Tanks	+													62	
1.7	Process Water Facilities														11.868	6.129.310
	Cooling / Ventilation	+													1.667	
1.8	Cooling and Venti-lation System														1.667	860.933
	Compressed Air F.	+													315	
1.9	Compressede Air Facilities														315	162.684
	Fire Det.. System	+													1.657	
1.14	Fire Detection System														1.657	855.769
	Smoke Extr. System	+													106	
1.15	Smoke Extraction System														106	54.744
	(+) Order (@) See Spec. S02981UX3000L) (#) First Supply															
	GRAND TOTAL														24.276	12.537.507

9.1 Attachement 1

TESLA DAMPING RING - DOGBONE

Hamburg - D

Service plants

Feasibility study and preliminary design

Genoa, 10/02/01

Studio Associato Ing. A.Bixxio e Ing C. Ottonello – Via Romana di Voltri 2A/2 16158 GENOVA (Italy)

Table of contents

1. SUBJECT

The present paper aims at preliminary sizing of the following service plants of the Tesla Damping Ring:
1.6 ELECTRICAL SERVICE SYSTEMS
1.7 PROCESS WATER FACILITIES
1.8 COOLING AND VENTILATION SYSTEMS
1.9 COMPRESSED AIR FACILITIES
1.14 FIRE DETECTION SYSTEMS
1.15 SMOKE EXTRACTION SYSTEMS
We maintain the original, general design plant numeration everywhere throughout the paper.

We have chosen suitable numerical approximations having in mind the general design only; furhter adjustment requires future in-depth analysis.

Partially, the Tesla Damping Ring layout is positioned partially in the very Tesla Facility tunnel as well as in two symmetrical appendices (arcs). Hence, the power supply and the cooling is required for the magnets positioned in both tunnels , wheter the whole set of service systems is required only by magnets positioned in the arcs.

2. PLANT OPERATIONAL PARAMETERS

2.1 Site. Climate

Hamburg (D)

Summer design conditions 28°C dry bulb
19°C wet bulb (RH 41%)

Winter design conditions -9°C

2.2 basic dimensions

arc total length: 1354 m
arc tunnel inner diameter 3 m
straight section - total length (Tesla Facility) 7170 m

allowed inner temperature during operation 35°C

in-ground tunnel depth : unknown, ~ 15 m assumed
15-m-depth ground temperature: 10°C const. assumed

2.3 in-field devices: basic features

	number	power (kW)
RIGHT ARC (RA)		
dipoles	288	276
quadrupoles	108	157
sextupoles	156	9
correctors (wigglers)	102	10
correctors (extra wig.)	126	12
wigglers	36	3310
LEFT ARC (LA)		
dipoles	288	276
quadrupoles	108	157
sextupoles	156	9
correctors (wigglers)	102	10
correctors (extra wig.)	126	12
wigglers	36	3310
cavities		7000
STRAIGHT SECTION (Tesla facility tunnel)		
quadrupoles	269	292
correctors	269	trasc.

3. ELECTRICAL SERVICE SYSTEMS

3.1 overall absorbed power computation

Sizing of both transformers and main supply lines requires computation of the apparent power. The latter is just a sum. Its result depends on the computations listed below:

- **magnets and wigglers**: simplifying assumptions allow reduction of the computation of the DC magnet-absorbed active power during operation to the computation of an installed power: the averaged value of the efficiency η of power supplies on active power ratio is 0,90-0,92, as **cosφ** varies between 0,8-0,9 (operation phase) and 0,5 (ramp-up). The larger apparent power value during the ramp-up does not affect computations, provided that sequential magnet activation is supposed per families. We are cautious and assume η = 0,9 and cosφ = 0,8

Furthermore, computations take into account dissipation in power supply cables.The latter is quite relevant for small-power magnets, which are fed through shorter cables.:

dissipated power in cables for magnet Right Arc or Left Arc:	139 kW
dissipated power in cables for wigglers RA or LA:	15 kW
dissipated power in cables for magnet SS:	62 kW
dissipated power in cables for correctors:	negligible

- **resonant cavities**: the required active power value is a design figure. It is assumed that apparent power has the same value.

- t**unnel illumination**: see computations at the end of section 3.4

- **cooling plant**: see computations at the end of section 4

- **conditioning and ventilation plant**: see computations at the end of section 5.

- **compressed air plant**: see computations, section 6.

- **control boards on line**: no.35 on-line control boxes, with overall absorbed power ~ 40 kW

- **vacuum pumps supply**: 50 kVA assumed

- **diagnostics and ancillary equipement**: 50 kVA assumed

items	absorbed power - direct current - (KW)	η	cosΦ	Installed power 400V 3-phase (KVA)
LEFT ARC				
dipoles+cables	330	0,9	0,8	458
quads on arc+cables	235	0,9	0,8	326
quads on half straight+cables	178	0,9	0,8	247
sext+correctors + cables	46	0,9	0,8	64
wigglers+cables	3325	0,9	0,8	4618
magnets+c half straight sect.	177	0,9	0,8	246
lighting	63		0,9	70
process water facilities	461		0,9	512
cooling & ventilation system	327		0,9	363
compressed air facility	32		0.8	40
control boards on line + cable	40		0,8	50
vacuum pumps supply				50
diagnostics				50
other services				100
TOTAL LEFT ARC				7.194

RIGHT ARC				
dipoles+cables	330	0,9	0,8	458
quads on arc+cables	235	0,9	0,8	326
quads on half straight+cables	178	0,9	0,8	247
sext+correctors + cables	46	0,9	0,8	64
wigglers+cables	3325	0,9	0,8	4618
magnets+c half straight sect.	177	0,9	0,8	246
lighting	63		0,9	70
process water facilities	574		0,9	638
cooling & ventilation system	327		0,9	363
compressed air facility	32		0.8	40
control boards on line + cable	40		0,8	50
vacuum pumps supply				50
diagnostics				50
other services				100
cavities power supply				7000
TOTAL RIGHT ARC				14.320

3.2 functional electrical box lay-out

We have chosen to manifacture independent electrical boxes for each arc. The same holds as far as all other service devices are concerned. Large distances between arcs justify this choice.

The components are sketched in the functional lay-outs of **Annexes 1, 2** of both electrical boxes and main boards.

The values of the required minimum power is 8 MVA and 15 MVA for the left arc and the right arc respectively. Accordingly, every plug is to be suitably sized for an overall power value which is the sum of the required power values. The requirement for a medium-voltage emergency connection between arcs provides even stronger justification of this choice.

The sum of all medium-voltage plugs will be 23 MVA @ 20kV; its nominal current will be ~ 670 A.
MV bus bars will provide the envisaged right-arc cavity power directly, at medium-voltage.

Every arc will have two groups of transformers in parallel. One transformer of such group will be kept off-line, as a reserve, so that the short-circuit power walue is not increased. In fact, we envisage separation of wiggler power supply (~4700 kVA) form all other power supplies (~ 2500 kVA max).
We envisage no.2 2500-kVA resin transformers + reserve for wiggler power supplies, and no.2 1600-kVA resin transformers + reserve for power supply of both magnets and service systems.

Switching main boards for power supply to various main boards, lie on 400V- LV bus bars, downstream in respect to the transformers. They are divided according to the families of wigglers (or magnets and other service systems).
Low-voltage bus bar data are listed below (again, we take into account two transformers in parallel + a reserve one for computation of short circuit current):

bus bar	nom. voltage V	nom. current A	short circuit current - kA	nom. power kVA	requested power - kVA
R or L wiggler LV bus bar	400	7200	119	5000	4618
Left magnets & service systems LV bus bar	400	4600	76	3200	2576
Right magnets & service systems LV bus bar	400	4600	76	3200	2702

Power switch size follows for various circuits:

circuit	nom. power kVA	nom. current 3-phase - A	breaker nom. size - A	nom breaking power - kA
one wiggler family (4 wigglers)	513	740	800	150
dipoles family	458	661	800	150
n.16 quads families on arcs	326	471	630	150
n.2 quads families on half str.	247	357	400	150
n.2 sext and corrector families	64	92	125	150
process water facilities Right arc	638	921	1250	150
process water facilities Left arc	512	739	1000	150
cooling and ventilation system	363	524	630	150
lighting	70	101	160	150
compressed air facility	40	58	100	150
control board, vacuum, diagnostics	150	217	400	150
other services	100	144	250	150
reserve	100	144	250	150

3.3 Power supply for tunnel devices

The features of supply cables for both devices and service systems are as follows:
- lack of propagation for both fire and flame
- extremely reduced fire-induced emission of both opaque fumes, toxicals and corrosive gases
- high quality G7 standard of hetilenepropilene rubber

The choiced type of cable complies with essential directive requirements of BT 73/23 CEE e 93/68 CEE:

commercial name: FG7(O)M1 0,6/1 kV

Technical data:
- standard voltage 0,6/1 kV
- voltage test 4 kV
- maximum rated normal temperature 90 °C
- maximum rated short-circuit temperature 250°C
- insulated with HEPR G7 quality
- outer sheet in thermoplastic M1 quality

Cables will be housed on zinc-plated-steel-made 400x50 mm gangways. The latter will be both wall-stirred up and overlapped up to a maximum of 5 gangways in the wiggler section.

While sizing magnet cables, we assumed:
A. Overall cable voltage should not exceed 1 kV. This voltage is the sum of:
- sum of voltage drops of the magnets connected in series
- DC cable resistive voltage drop
- sum of voltage drops of the magnets during activation ramp, for a maximum 10 A/s ramp-up
B. minimum heating
C. n.5 dim. 400x50 mm trays should provide enough containment

The resulting sizing is described in the enclosed **table 01**

3.4 lighting

3.4.1 Generalities

Design assures two-stage (200 and 400 lux, the former just for maintenance purposes and the latter for transfer purposes as well as possible TV inspection) illumination, + emergency illumination (minimum 20 lux). The very main-circuit lamps will work for emergency illumination too; the latter will be given power by an UPS and a generating set for the first minutes of emergency and the following minutes respectively.
The 400-lux illumination requires ~40000 lm every 10 m tunnel length, according to preliminary computations. The latter simulate the tunnel as a 3-m-side square duct. Indeed this is a conservative assumption, since several obstacles prevent effective light diffusion).
The uniformity requirement in average emergency illumination is fulfilled by a lengthwise symmetric, regular structure in the tunnel. In order to realize such structure, we utilize lamps with 2 fluorescent, 58W - 5200 lm tubes.
We get a 41600 lm/10 m overall light flux, provided that we utilize 4 two-tube lamps every 10 m tunnel length. They lie on the vault, on both sides of the transfer rail alternatively.Thy will be divided in two three-phase alternate clusters.
The selected lamp for emergency belongs to the phase of one group. Accordingly, there will be one emergency lamp every 15 m tunnel length.
As for the lay-out of the lamps with isolux plots, see **annex 04**

3.4.2 Lighting plant power consumption

Arrangement:	no.4 lamps 2x58W every 10 m tunnel
total no. lamps per arc:	no.542
Absorption per lamp:	2 x 58 = 116 W ≅ 130 VA

Arc total absorption	63 kW ≅ 70 kVA with 400 lux illumination 31,5 kW ≅ 35 kVA with 200 lux illumination

3.4.3 emergency illumination

Overall number of emergency lamps is 90 per arc, provided that the emergency arrangement with no. 1 lamp every 6 in a row is adopted. Thus:
overall emergency absorption per arc: 10,5 kW ≅ 11,6 kVA
The emergency rescue group will be made of:
- one 15-kVA diesel generating set; suitably sized tank allows 12-hours autonomy of operation
- one 15-KVA UPS with 10-minutes autonomy of operation allows suitable tunnel illumination during the start-up of the generating set

Emergency cables will be separately housed in zinc-plated pipes.

4. PROCESS WATER FACILITIES

4.1 overall dissipated power computation

NOTE: computations are referred to each arc

4.1.1 magnets and wigglers

Demineralized-water cooling system carries away almost the whole amount of Joule-dissipated power (Pj) from the electromagnetic device. Temperature gradients between the machine and the environment can induce heat losses in air. The latter will be cautiously neglected but for tunnel conditioning computations.

Pjm magnets = 588 kW per arc including half straight section (correctors are not water cooled)

442 kW magnet in arc
146 kW magnets in half straight section

Pjw wigglers = 3310 kW per arc

4.1.2 light absorbers

Similar cooling systems apply to the absorbers of the wiggler-produced synchrotron radiation. The absorbed power (Pabs) by each absorber is roughly equal to 50 kW, and 36 wigglers are present. Hence:

Pabs = 50x36 = 1800 kW per arc

4.1.3 cavities

As for the resonant cavity power supply system, most dissipated power (Psc) is required by systems -like e.g. the radiofrequency power supply- which are positioned in the right-arc service buildings. The relevant design figure is:

Psc = 2700 kW left arc only

Some superconducting cavity plants in the tunnel require additional refrigeration. The relevant design figure is:

Pci = 92 kW left arc only

4.1.4 power supply

As for both magnets and wigglers, water cooling of the power supply devices is assumed. We are dealing with SCR systems (or similar ones), so that the steady-state dissipation is generally assumed to be about 10% of the delivered power. Accordingly:

Psm magnets = 789*10% = 79 Kw per arc + half straight section

Psw wigglers = 3325*10% = 333 kW per arc

4.2 cooling water mass flow computation

We derive the following table from both the above discussed computations and the boundary conditions on temperature gradients. Moreover, the criteria listed below allow selection of possible cooling lines:
- homogeneous temperature step
- simultaneous utilization of different devices
- suitable pipe diameter sizing, in order to prevent tunnel cross-section encumbering

cooling line	layout of cooling line	dissipated power	temp. step	inlet water temp.	demineralized water flow
		kW	°C	°C	mc/h
magnets	R or L arc	442	7,5	30	51
quads	R or L half str. sect.	146	7	30	18
wigglers	R or L arc	3310	25	30	114
light absorber	R or L arc	1800	10	30	155
cavities power supply	R arc service halls	2700	15	30	155
cavities	R arc	92	10	30	8
magnets and quads power supply	R or L arc service halls	79	10	30	7
wigglers power supply	R or L arc service halls	333	25	30	11

Weighted average of magnet family outlet temperatures allows magnet temperature step computation. Totals are approximated.

4.3 hydraulic circuit - overall design

The overall design of the cooling hydraulic circuit is sketched in **Annexes 05-06**.
Each demineralized-water, closed-circuit cooling line (primary circuit) is to loose heat through open-circuit evaporator towers with thelp of an heat exchanger. Maximum summer subcooling of evaporator towers provides constraints on exchange temperatures.
Given the design values of external temperature, towers can process water at the following temperatures:
Tin tower = 35°C (max)
Tout tower = 25°C (this minimum value is constrained by both external temperature and humidity)
The tower (primary) circuit utilizes usual conditioned water. Evaporation of the latter requires a permanent re-feeding plant. Both mass flows and temperature at the main circuit exchangers are briefly reported in the attached **table 03**.

4.3.1 tower circuit

As you can see in the functional lay-out, we selected the same Pt=4000 kW size for all evaporator towers. All of them is equipped with both an installed reserve and suitable in-parallel devices. The latter allow utilization of the former in the case of either malfunction or maintenance.

Tower pipes are made of carbon-steel. They are insulated by both an elastomeric sheath and an aluminium shell.

We envisaged utilization of standard pumps with both connection and baseplate. Their features are

max mass flow:	350 mc/h
max head:	40 m water column (4 bar)
absorbed power:	45 kW

An installed reserve pump corresponds to each pump. An inverter controls each pump for optimal flux operation.

Secondary outlet temperature drives a regulation switch valve, which is installed on the exchanger primary circuit.

Exchangers are made of detachable aisi 304 stainless-steel plates. For each exchanger, an installed reserve allows periodic maintenance.

As for both circuit flow resistance computation and pump size, see attached **table 04.**

4.3.2 cooling lines

All cooling lines are made of AISI 304 stainless-steel welded pipes of different size. Pipes are insulated by both elastomeric sheath and aluminium shell.

Both cooling line data, circuit resistance flow computations and pump size are briefly exposed in the attached tab.05. We utilize AISI 316 stainless-steel pumps. Each pumping station is equipped with a reserve. An inverter controls the main pump of each pumping station for optimal flux operation.

The design value of the delivery head at magnets manifold is 4 bar. True calibration of the optimum cooling water flow will be achieved during start-up with the help of a manual needle valve. The latter is positioned after on-off valves at each device.

Flexible radiation-proof pipelines will connect all devices. Their design will take into account the envisaged overall radiation dose (e.g. EDPM)

4.3.3 expansion tanks

The amount of circulating fluid assures good thermal inertia. Consequently, no water accumulation is foreseen.

We envisage nitrogen-pressurized stainless-steel expansion tanks for both closed circuits and demineralized-water cooling lines. Their variable volume depends on the overall pipeline capacity.

4.3.4 water treatment

The tower circuit utilizes a filling group with service water. Its treatment system is equipped with both anti-weed products and other antiscaling chemical products.
A 15 mc/h deionizer processes the cooling line water. It is equipped with both cationic column, anionic column, carbonate-removing tower, tanks, control board and accessories.

4.3.5 bilge pump plant

An open duct (~300x200 mm) is positioned on the bottom of the tunnel, for both collection and outflow of water losses due to accidents, leakages etc.
We envisage one outlet (fire exit) every about 113 m tunnel. There are 12 outlets. Each outlet is equipped with one pumping plant. In turn, the latter is equipped with no.2 sump bilge pumps, pushing water towards the nearest drain.
As a matter of example, let us consider a 30-mc/2-hours water flow due to magnet pipeline leakage. We select no.2 pumps with the following features:

mass flow 10 mc/h
head 25 m water column (2,5 bar)
absorbed electric power: 2,4 kW

4.4 electric power absorbed by the cooling plant

ITEM	RIGHT ARC kW	LEFT ARC kW
pumping groups, towers	135	90
pumping groups, cooling circuits	199	191
cooling towers	180	120
ancillary equipement	50	50
controls	10	10
TOTAL power	574	461

5. COOLING AND VENTILATION SYSTEMS

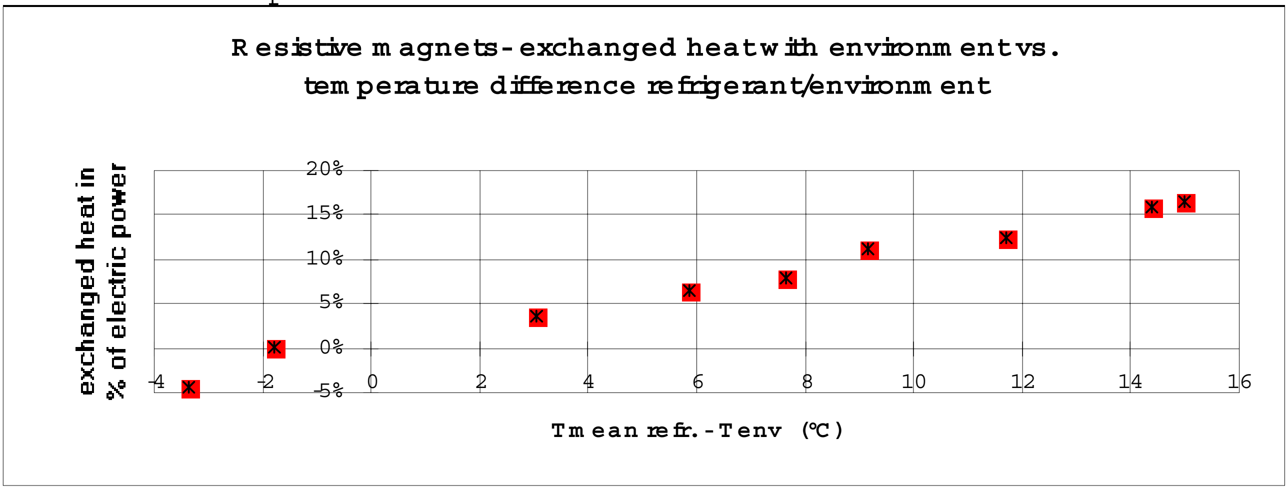
5.1 tunnel air heat loss computation

NOTE: computations are referred to each arc

Inside the tunnel, we assume steady-state temperature 35°C during operation. Moreover, we assume that the off-duty temperature value is never lower than 20°C , so that expansion-induced misalignment is prevented.

5.1.1 heat dissipated by devices

Empirical experience on similar machines shows that resistive magnet heat transmission depends on the difference between the environment temperature and the average temperature of the refrigerant fluid. This dependence is outlined below:



Hence, we draw te following conclusions for each arc:

- magnets do not affect tunnel heating, as the average temperature of the refrigerant fluid is never higher than the environment temperature
- light absorbers do not affect tunnel heating, as the average temperature of the refrigerant fluid is never higher than the environment temperature
- calibrators affect environment heating, because of electric power dissipation in air
- line cavity equipments do not affect tunnel heating, as the average temperature of the refrigerant fluid is never higher than the environment temperature
- both control boards and other line electrical devices affect environment heating, because of electric power dissipation in air
- wigglers affect tunnel heating, as the average temperature of the refrigerant fluid is 42,5°C. The resulting temperature difference in respect with the environment is 7,5°C. Then, we estimate a contribution ~ 8% the absorbed electric power, the latter being ~ 265 kW.

5.1.2 power dissipated by both power cables and illumination plant

We assumed in §3 a cabling system which is able to fulfil different requirements. As for the air-dissipated heat, we compute the Joule heat as in tab.01.

The total amount of heat dissipated by cables is 139 kW. Further 15 kW are dissipated by wigglers service cables.

In order to make a distinction between the contribution of the cables which cross the wiggler region from the contribution of the remaining part of the tunnel, we estimated a ratio 6:1 between the overall length and the wiggler length between adjacent outlets. Accordingly, we estimate the extra-wiggler cable contibution and the wiggler region contributions as 116 kW and 38 kW respectively.

For the sake of simplicity, we neglect power supply cables of small auxiliary users.

We neglect also the contribution of the illumination plant, as the latter is suposed to be switched off during operation.

5.1.3 Shortened report - tunnel heat dissipation during operation

ITEM		Pd (kW)
magnets	do not affect tunnel heating	0
light absorber	do not affect tunnel heating	0
equipment on cavities on the line	do not affect tunnel heating	0
control boards on the line and cables	do affect tunnel heating	40
power cables for magnets (extra wigglers zone)	do affect tunnel heating	116
correctors (extra wigglers zone)	do affect tunnel heating	12
other equipment	do affect tunnel heating (rough estimate)	32
lights	do not affect tunnel heating(if switched off)	0
	TOTAL - EXTRA-WIGGLERS REGION	**200**

wigglers	do affect tunnel heating	265
power cables	do affect tunnel heating	38
correctors	do affect tunnel heating	10
other equipment	do affect tunnel heating (rough estimate)	7
	TOTAL - WIGGLERS SECTION	**320**

The illumination plant provides the main off-duty contribution (about 70 kW).

5.2 cooling and ventilation systems

Basically, there are no.12 tunnel regions. The length of each region is 113 m. Exits are positioned at the end of each region. Both underground and open-air machineries will be positioned at the exits.

5.2.1 wiggler-free sections

There are 10 wiggler-free sections. The overall dissipated power in each section is 20 kW, i.e. 177 w/m if the tunnel temperature and the envisaged humidity are 35°C and 25% respectively.
We estimate the heat exchange with the ground as
k = 0,45 w/mq/°C (empirical figure for underground room).
We take a ground temperature 10°C, regardless of surface conditions.
Tunnel thermal exchange surface is 9,4 m per meter.Then, we estimate a maximum value of 106 w/m for ground losses. Consequently, compensation of the remaining power requires suitable cooling plant.

pd = dissipated power by devices per tunnel m: pd = 177 W/m
pe = heat exchanged with the ground per tunnel m: pe = 106 W/m
pc = cooling-plant removed heat: pc = 71 W/m
hence
Pr = sensible heat to be removed per section: Pr = 8023 W = 6900 kcal/h per section
This heat is totally sensible heat, because there are no sources of latent heat; we can hypotize a little contribute of humidity content from surrounding ground through the concrete shell.

We assume:
Tenv= 35°C with RHenv = 25% (mass of steam Xenv = 8,5 g per kg of dry air)
in the tunnel in steady-state. The below-described cooling air flow provides suitable section cooling:
Tair = 20°C with RHair = 55% (mass of steam Xair = 7,99 g per kg of dry air)
These parameters hold for both summer and winter air inlet temperature, in order to prevent exceedingly high temperature gradients on inlet devices.

Accordingly, approximate air flow per section is:
Q = 3 x Pr / dT = 3 x 8023 / 15 ≅ 1600 mc/h
Supposedly, latent heat difference compensates ground-derived humidity.

Tunnel cross-section is about 7 mq, and the volume of each 113m-long section is about 800 mc. Accordingly, a 1600-mc/h air flows allows no.2 air changes per hour in the tunnel.

These sections are conditioned by a conditioning station. The latter is made by a surface air-water heat pump at the outlet of the way of escape and an air treatment unit near the tunnel. The latter unit has a surface air intake with filtering section, an electric post-heating stage, and a cooling stage (or heating stage, depending on outer temperature) with the heat-pump water.
Each conditioning station will serve two adjacent sections, and air evacuation wiil be done by near fire exits.
In order to spare room, we envisage no canalization inside the tunnel. At one end, air flows into the tunnel across grates. At the other end, both fans and filtering groups drive air outflow.
Air motion is very slow (at a speed ~ 0,063 m/s) , so that it affects inner devices no way, but may allow lengthwise temperature gradients.
Otherwise, a 300mm-diameter penstock should both exhibit negligible flow resistance and prevent lengthwise temperature gradients. Its design requires thorough evaluation of all relevant dimensions inside the tunnel.

5.2.1.1 conditioning station and air extraction system in no-wiggler sections: size

Q nominal air flow Q = 3200 mc/h (1600 mc/h per section)

Summer air conditioning requires:
Text=28°C RHext=41% Xext=10 g/kg
It turns out that the refrigeration power is about 22 kW, with a post-heating unit ~ 8,5 kW

Winter air conditioning requires:
Text=-9°C RHext=90% Xext=1,57 g/kg
It turns out that the heating power is about 32 kW. A ~17 kW battery heated with the heat-pump derived water and a post-heating unit 15 kW will do the job.

Then, we utilize both an air-tretment unit (ATU) and an air-to-water heat pump. The former is equipped with both water battery, 15 kW electric post-heating battery and a power fan (supposedly 3 kW). The nominal power of the latter is 25kW; it provides 18 kW heating power at least, with external temperature -9°C.

An extraction system is positioned in the outlet between two adjacent conditioning stations. It is made of both primary filters, secondary filters and a two-speed centrifugal van. In particular, the latter has both a normal speed for ordinary air change (3200 mc/h flow) and a different speed for fast scavenging of smoke and gas in the case of fire (see § 8)
See **Annex 10** for system functional sketch.

5.2.2 wiggler sections

Overall dissipated power in the two wiggler sections is 320 kW, i.e. 160 kW per section; out of them, 12 kw only per section are exchanged with the ground.
We assume that the air conditioning system drives air changes. We find an heat excess ~ 140 kW (i.e. 1,24 kw/m) per section, to be removed
Water exchange batteries are a conventional choice. Their refrigeration capacity is 7 kW. Inlet water and air temperatures are 7°C and 35°C respectively. They are positioned every ~5,5 tunnel m., and fed by a surface refrigerator.
We asume a 5°C thermal head. Overall water flow for both the air treatment unit and the fan-coils of the two adjacent sections is 55 mc/h. Estimated flow resistance for each DN80 pipeline is 20 mm/m per ~ 3000 equivalent pipe meters. Then, the sum of the fan-coil flow resistance and other concentrated losses at about 1 bar leads to an estimate head ~ 1,6 bar.

5.2.1.2 wiggler section conditioning station size

We assume that the size of both air treatment stations and ventilation sections corresponds to the size discussed above. Lack of heat pumps leads to higher electric resistance of the air treatment unit in winter. Wiggler section conditioning station is made of:

- a silenced, surface air-water refrigerator (minimum 340 kW in extreme summer conditions). It is positioned at theintermediate way of escape of the wiggler region. It is equipped with a free-cooling system. Refrigerating gas is R407c (ref. RC Maximo.A.ELN.385.S2 407c)
- a pump station, equipped with DN100, 55-mc/h pumps with both 1,9 bar head and absorbed power 5,5 kW (ref. Grundfoss LP 100-125/130)
- an insulated carbon steel DN80 pipeline for each section, lying along tunnel wall for parallel fan-coils feeding.
- no 20 fan-coils per sections, at a distance ~ 5,5 m from each other , with minimum power 7 kW. Inlet water and air temperatures are 7°C and 35°C d.b - 20°C w.b. respectively. Their fan is equipped with a built-in thermostat. Condensate drain is led to the duct on the bottom of the tunnel

5.3 conditioning and ventilation plants - electrical absorption

Maximum electric absorption for each conditioning station in the non-wiggler regions is:

heat pump COP=2	9 kW
heating elecric battery	15 kW
ATU fan	3 kW
water pump and ancillary equipment	3 kW
TOTAL	29 kW

Standard maximum electric absorption for each extractor for all regions is:

extractor	3 kW

Maximum electric absorption for each conditioning station in the wiggler regions is:

silenced refrigerator 350 kW a R407c	113 kW
heating elecric battery	35 kW
ATU fan	3 kW
refrigerator water pump	5,5 kW
no.40 fan-coils	6 kW
ancillary equipment	1,5 kW
TOTAL	164 kW

OVERALL electric absorption CDZ per arc without wiggler region: 5x29 kW = 145 kW
OVERALL electric absorption CDZ per arc wiggler region: 164 kW
OVERALL electric absorption air extraction aria per arc: 6x3 kW = 18 kW

Overall electric power required for both climatization and ventilation of each arc is **Pcdz=327 kW.**

6. COMPRESSED AIR FACILITIES

To date, no detailed information concerning compressed air is available. In particular, servomechanisms of both flags, beam stopper and other facilities require compressed air.
A 2000 l/min peak flow is likely to be enough for diagnostics-related users. However, compressor statuion design should take into account all device-related users, as well as maintenance requirements.
We are cautious and assume a 5500 l/min compressor.
Suitable filtering and drying of compressed air is required. Thus, the compressor station is equipped with both filters, frigorific driers and adsorptions driers.
Each device has an on-line installed reserve.

Compression station layout is made of:
no.2 5500 l/min, 7,5 bar compressors, absorbed power 30 kW
no.2 dust exhaust / oil precleaners
no.2 6000 l/min frigoriferic driers with wet point 3°C and 35°C, 7 bar inlet air
no.2 coalescence filters
no.2 1500 l tanks
no.2 S HEPA - grade coalescence filters
no.2 7500 l/min adsorption driers (15% purge air) with wet point -40°C
no.2 dust exhaust postcleaners
no.8 electronic timed condensate drainage systems
no.1 plant for oil separation from condensate drain

Compressed air pipeline for tunnel users is made of DN50 zinc-plated steel, with a maximum nuber of no.150 ball valves (DN15 or DN20) for both equipements - and maintenance purposes.

Compression station electric absorption:

no.1 compressor		30 kW
no.1 frigoriferic drier	1,2 kW	
no.1 adsorption drier	0,2 kW	
others		0,6 kW
TOTAL	32 kW	

7. FIRE DETECTION SYSTEMS

7.1 definition of «fire prevention compartment»

For the sake of safety, we divide both fire detection and extinction systems in the tunnel as «fire prevention compartments», which are called «sections»in the following.
Usually, the maximum allowable length for safe escape paths is 60 m in normal working environment. Admittedly, unavoidable obstacle make escape through Dogbone Facility tunnel quite difficult. However, personnel has to be both highly qualified and suitably equipped for emergency. Unless differently stated by safety authority, we assume the 60 m maximum limit to be acceptable.
Accordingly, we divide the tunnel in sections. The latter are separated from each other by ways of escape. Fire-proof doors separate each way of escape from both climatization rooms and stairs to surface. Thus, the maximum distance separating two adjacent exits is 120 m, and we are allowed to divide the tunnel in no.12 virtual 113m-long sections. A way of escape is positioned at the end of each section. Detailed design fixes possible lack of self-consistency.

7.2 fire detection systems and extinction procedures

A smoke detection system is installed in each section, with local analogue fire detection equipement.
We utilize analogic addressable detectors with optical smoke detection. They are positioned at a distance about 10 m from the monorail. Zinc-plated pipes shield connections. The overall number of detectors per section is 11.
Analogic station for both detection and extinction is positioned in the corresponding way-of-escape room and is connected with one central supervisor per arc (or to just one supervisor for the whole ring).
If one detection occurs, the fire detection equipement issues a pre-alarm signal and the second detection starts the discharge procedure in its own section with the help of both optical and acoustical signals, thus allowing personnel to escape.
At the end of discharge count-down, section ends are closed with the help of either compressed-air bags, or explosive bags, or sliding doors (depending on the local beam-line structure), and the gas discharge is activated.

7.3 gas discharge extinction

Both activation time, danger and walking difficulties prevent manned intervention in the case of fire. Accordingly, an automatic extinction system is installed. We choose a gas discharge system, because both water, foam and powder damage devices beyond repair.

We would prefer not to utilize chemical extinguisher gases, for the sake of present standards. An inert gas (Argon) is preferred. Reference quantities are as follows:

reference section volume: 800 mc

minimum design concentration aimed at 12,5% O_2- residue concentration: 40% weight

corresponding to 0,5108 mc-gas / mc-env (volume, 20°C)

overall gas volume per section: 409 mc

no.1 200-bar,15°C, 140 l loaded cylinder protects 63,6 mc-env

total no. 140-lt cylinders = 800/63,6 = 12,57 = 13 cylinders per section.

The cylinder holder is connected to a DN65 pipeline. The lay-out of the latter across the tunnel is sketched in the attached figure. This lay-out assures discharge homogeneity.

Total discharge time must last 1 minute.

See **Annex 11** for typical fire extinction system sketch.

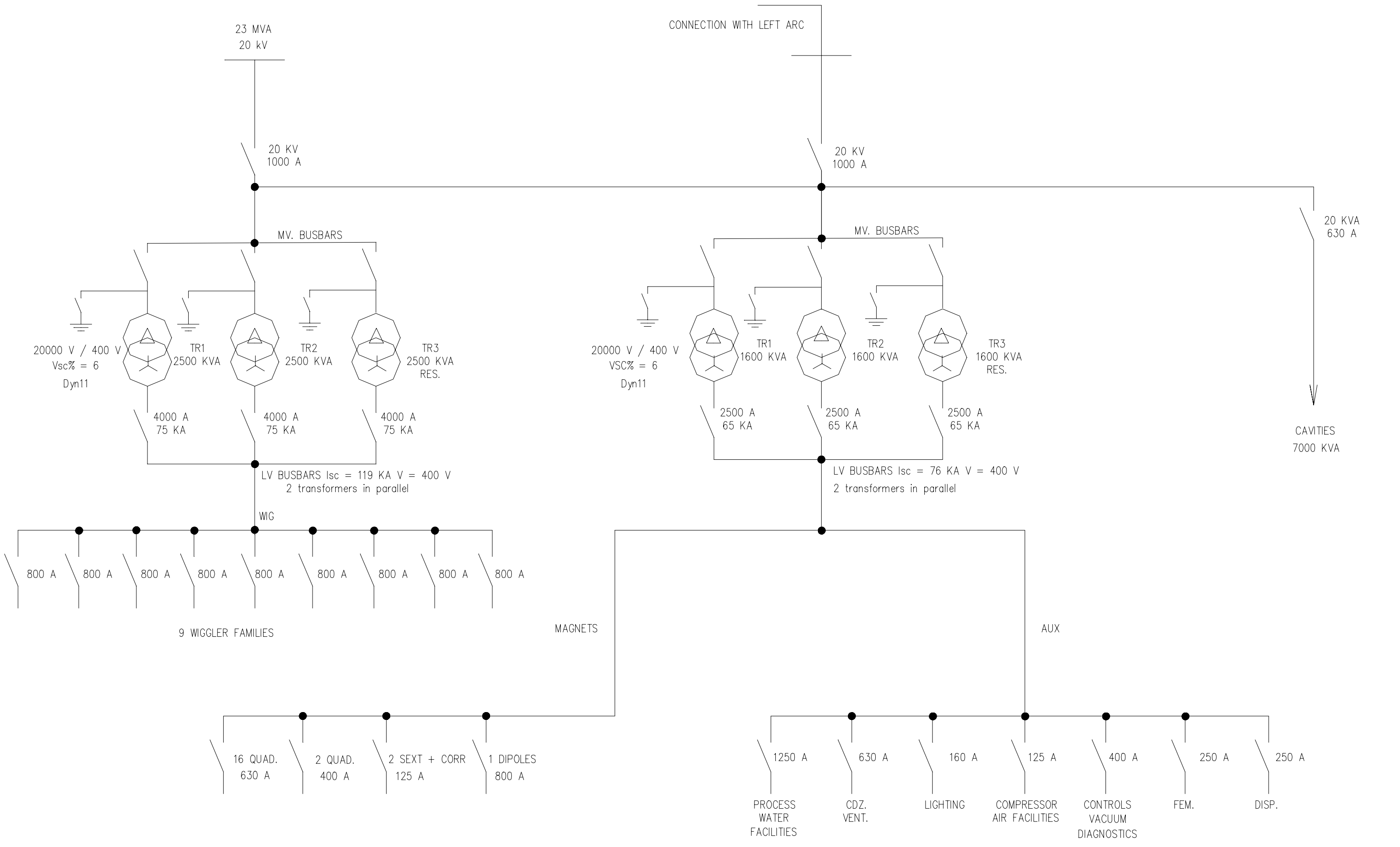
8. SMOKE EXTRACTION SYSTEMS

A smoke extraction system is required after either gas discharge in the case of fire or in the case of process-induced smoke or dust in the fire prevention compartments. Its air delivery has to be larger than the usual air change plant delivery.
No further paths to surface are envisaged. Then, the easiest way is just to increase the air inflow. Accordingly, double-speed extractors are envisaged in the above discussed canalizations,both for the inlet and in the extraction systems. Their emergency air flow is about three times the nominal inflow (i.e., about 5000 mc/h). The control system allows temporary stop of nearby extractors, in order to fasten air flow towards the extraction point.

9. ANNEXED

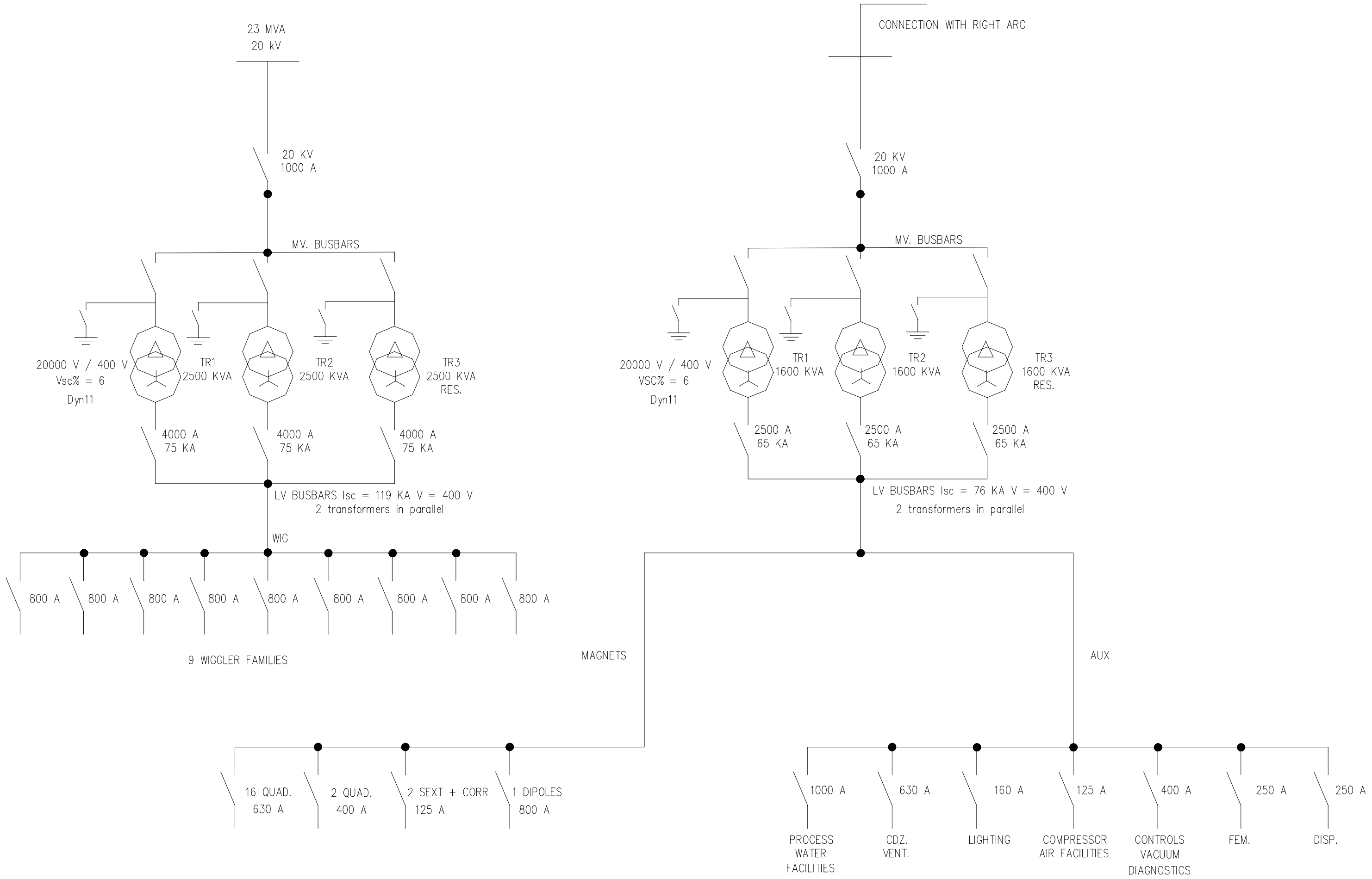
ANNEX	DOCUMENT	REV.	DATE	TITLE
01	AAR01A01 sh.02	0	22-01-01	right arc power station and main boards
02	AAR01A01 sh.01	0	22-01-01	left arc power station and main boards
03	table 01	0	10-02-00	power cables for magnets
04	table 02	0	10-02-00	lighting - design for tunnel illumination
05	AAR02A01 sh.02	0	22-01-01	process water facilities - right arc
06	AAR02A01 sh.01	0	22-01-01	process water facilities - left arc
07	table 03	0	10-02-00	heat exchanger design - flow and temperature
08	table 04	0	10-02-00	cooling towers main parameters
09	table 05	0	10-02-00	refrigeration lines main parameters
10	AAR03B01 sh.02	0	06-02-01	cooling and ventilation systems
11	AAR03B01 sh.01	0	06-02-01	typical fire extinction system

9. ANNEXED 01 (AAR01A01 sh.02)



Studio associato Ing. A. Bixio & Ing. C. Ottonello Via Romana di Voltri 2A / 2 GENOVA	Design: Dott. Ing. Angelo Bixio	Description: RIGHT ARC POWER STATION AND MAIN BOARDS Client: ANSALDO RICERCHE	DWG N. AAR01A01 Date: 22/01/2001 Sh. 2

9. ANNEXED 02 (AAR01A01 sh.01)



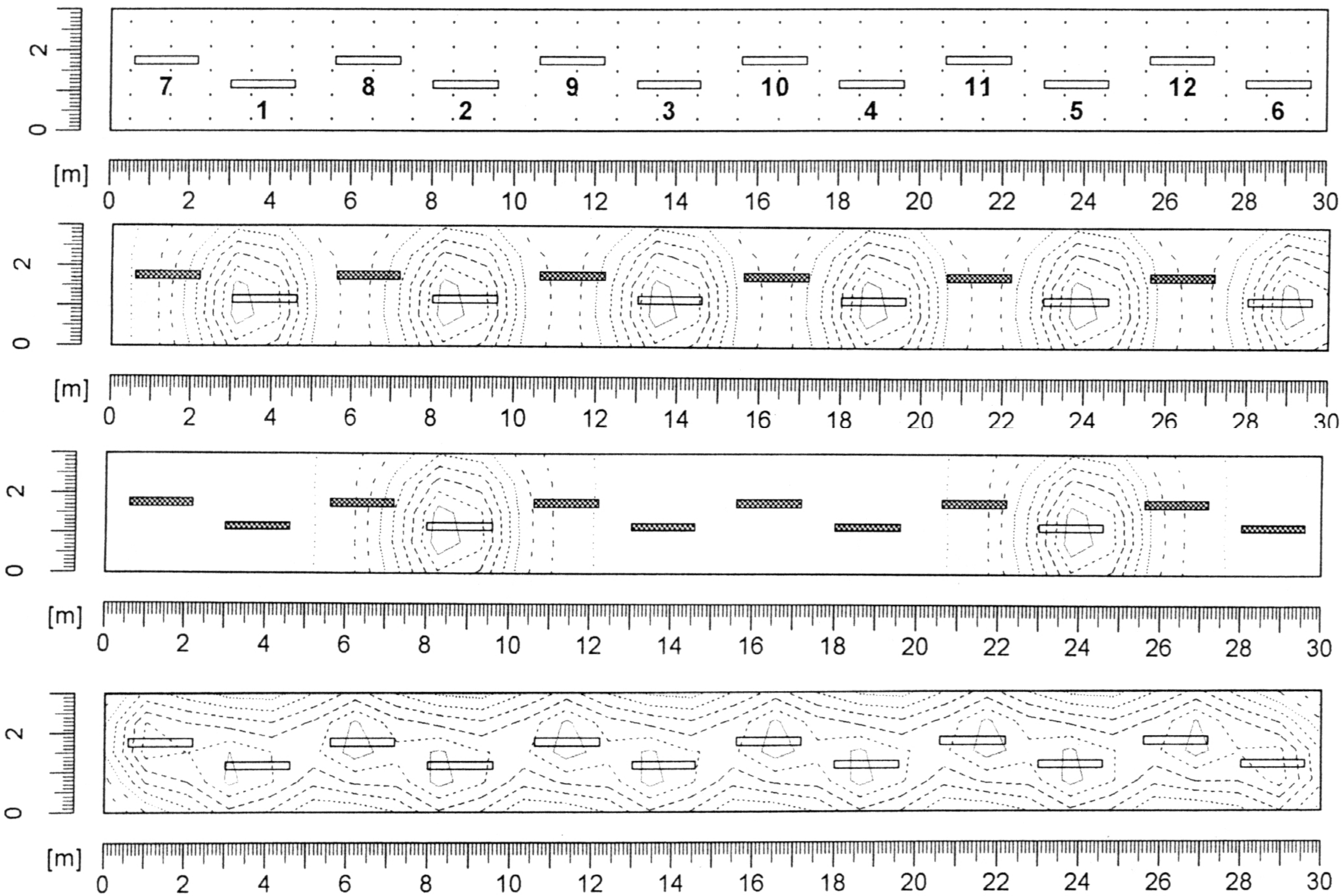
Studio associato Ing. A. Bixio & Ing. C. Ottonello Via Romana di Voltri 2A / 2 GENOVA	Design: Dott. Ing. Angelo Bixio	Description: LEFT ARC POWER STATION AND MAIN BOARDS Client: ANSALDO RICERCHE	DWG N. AAR01A01 Date 22/01/2001 Sh. 1

9. ANNEXED 03 (table 01)

power cables for magnets

TYPE	MAGNET		MAGNET PER FAMILY				CABLE PARAMETERS FOR EACH MAGNET FAMILY							POWER SUPPLY			
	VOLTAGE (Volt)	POWER (Kw)	NO.	VOLTAGE (Volt)	POWER (Kw)	CURRENT (A)	SIZE (mm2)	RESISTANCE PER M (ohm/km)	VOLTAGE DROP PER M (mV/A/m)	LENGHT IN TUNNEL (m)	POWER LOSS IN TUNNEL (kW)	TOTAL LENGHT (m)	TOTAL VOLT. DROP (V)	OUTPUT POWER (kW) each p.s.	POWER LOSS (kW) each p.s.	NO. OF FAMILIES	TOTAL POWER LOSS (kW)
QUADRUPOLES on arcs																	
QAM 1	4.56	0.631	6	27.4	3.8	138.4	120	0.164	0.373	2736	8.6	2936	75.8	14.27	1.43	2	2.85
QAM 2	4.56	0.631	6	27.4	3.8	138.4	120	0.164	0.373	2736	8.6	2936	75.8	14.27	1.43	2	2.85
QAM 3	2.62	0.258	6	15.7	1.5	98.5	120	0.164	0.373	2736	4.4	2936	53.9	6.86	0.69	2	1.37
QAM 4	2.62	0.258	6	15.7	1.5	98.5	120	0.164	0.373	2736	4.4	2936	53.9	6.86	0.69	2	1.37
QAM 5	2.62	0.258	7	18.3	1.8	98.5	120	0.164	0.373	2742	4.4	2942	54.0	7.13	0.71	2	1.43
QAF	4.56	0.631	102	465.1	64.4	138.4	120	0.164	0.373	3312	10.4	3512	90.6	76.90	7.69	2	15.38
QAD	4.56	0.631	102	465.1	64.4	138.4	120	0.164	0.373	3312	10.4	3512	90.6	76.90	7.69	2	15.38
QAD 1	4.56	0.631	3	13.7	1.9	138.4	120	0.164	0.373	2718	8.5	2918	75.3	12.31	1.23	2	2.46
QAD 2	4.56	0.631	5	22.8	3.2	138.4	120	0.164	0.373	2730	8.6	2930	75.6	13.62	1.36	2	2.72
QWF	1.6	0.122	18	28.8	2.2	76.3	95	0.21	0.472	808	1.0	1008	18.1	3.58	0.36	2	0.72
QWD	1.6	0.122	17	27.2	2.1	76.3	95	0.21	0.472	802	1.0	1002	18.0	3.45	0.34	2	0.69
QWA 1	4.59	0.650	2	9.2	1.3	141.6	120	0.164	0.373	312	1.0	512	13.5	3.21	0.32	2	0.64
QWA 2	4.59	0.650	2	9.2	1.3	141.6	120	0.164	0.373	412	1.4	612	16.2	3.59	0.36	2	0.72
QWA 3	4.59	0.650	2	9.2	1.3	141.6	120	0.164	0.373	512	1.7	712	18.8	3.96	0.40	2	0.79
QWA 4	4.59	0.650	2	9.2	1.3	141.6	120	0.164	0.373	612	2.0	812	21.4	4.34	0.43	2	0.87
QWA 5	4.59	0.650	2	9.2	1.3	141.6	120	0.164	0.373	712	2.3	912	24.1	4.71	0.47	2	0.94
DIPOLES																	
DIPOLE 4.5 m	3.31	2.557	108	357.5	276.2	772.5	3x240	0.027	0.062	3348	54.4	3548	84.5	341.44	34.14	2	68.29
SEXTUPOLES																	
S1P	0.98	0.046	102	99.8	4.7	47.0	50	0.393	0.947	3312	2.9	3512	78.2	8.37	0.84	2	1.67
S2P(HALF)	1.62	0.078	48	83.1	4.0	48.1	50	0.393	0.947	2988	2.7	3188	72.7	7.50	0.75	2	1.50
S2P(FULL)	0.89	0.043	6														
WIGGLERS																	
WIGGLER	134.57	91.956	4	538.3	367.8	683.3	2x240	0.041	0.093	800	15.3	1000	31.6	389.42	38.94	18	700.96
QUADRUPOLES on straight line																	
QLF	4.84	1.085	135	653.4	146.5	224.2	2x240	0.041	0.093	7910	16.2	8110	84.1	165.32	16.53	1	16.53
QLD	4.84	1.085	134	648.6	145.4	224.2	2x240	0.041	0.093	7904	16.2	8104	84.0	164.23	16.42	1	

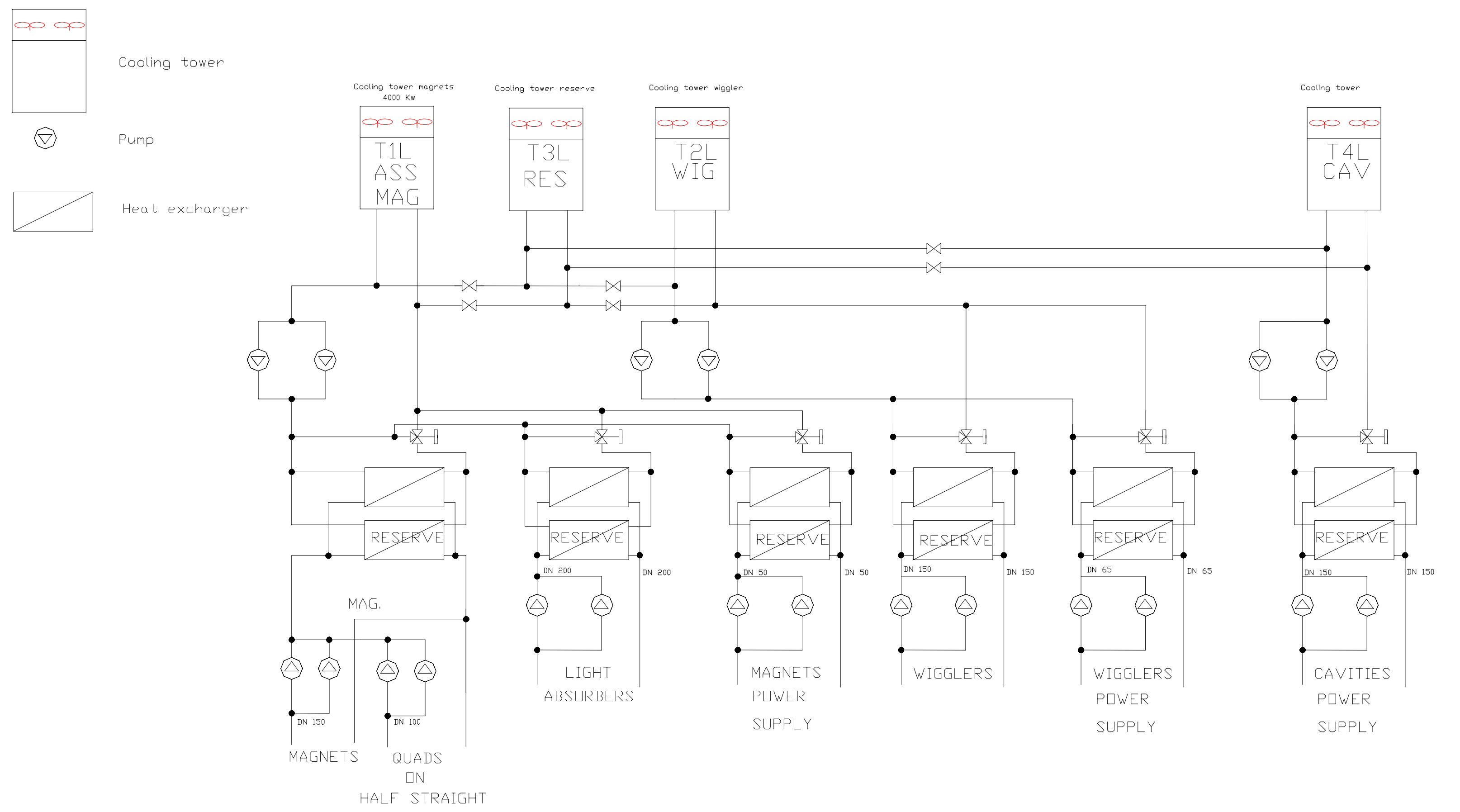
9. ANNEXED 04 (table02)



Ansaldo Ricerche s.r.l.

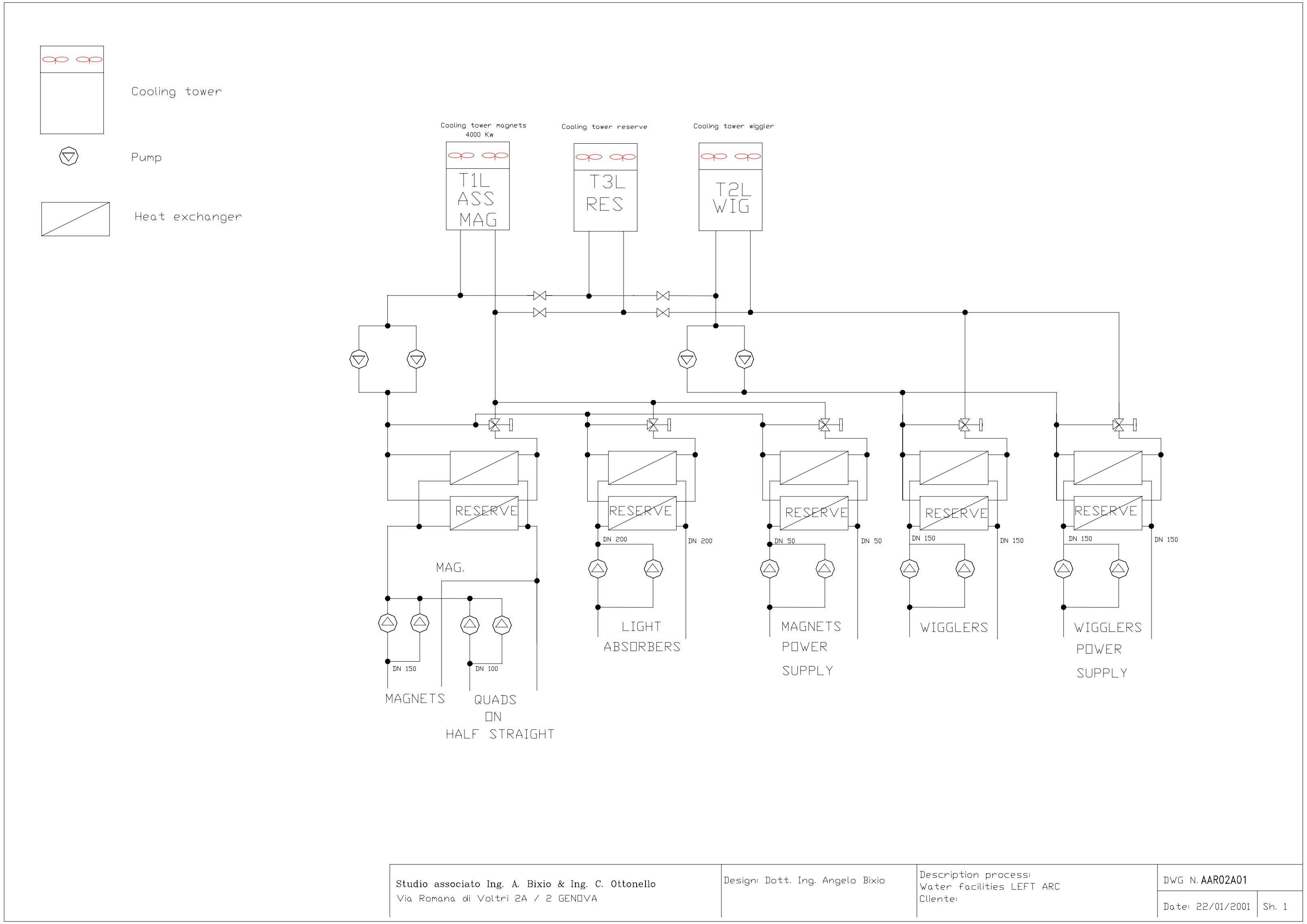
Progetto project	TESLA DAMPING RING	Identificativo document no. S02991UX3000L	Rev. rev. 0	Pagina page 38

9. ANNEXED 05 (AAR02A01 sh.02)



Studio associato Ing. A. Bixio & Ing. C. Ottonello Via Romana di Voltri 2A / 2 GENOVA	Design: Dott. Ing. Angelo Bixio	Description process: Water facilities RIGHT ARC Client: ANSALDO RICERCHE	DWG N. AAR02A01 Date: 22/01/2001 Sh 2

9. ANNEXED 06 (AAR02A01 sh.01)



9. ANNEXED 07 (table 03)

heat exchangers design - flow and temperature

SECONDARY CIRCUIT cooling line	layout of cooling line	secondary inlet temperature °C	secondary outlet temperature °C	demi water flow mc/h	exchanged power kW	tower water flow mc/h	primary inlet temperature °C	primary outlet temperature °C	PRIMARYCIRCUIT cooling line
magnets + quads	L arc and half str. sect.	37.4	30	68	588	51	35	25	tower 1L
light absorber	R or L arc	40	30	155	1800	155	35	25	tower 1R
magnets and quads power supply	R or L arc service halls	40	30	7	78	7	35	25	tower 1R
magnets+quads+cavities	R arc and half str. sect.	37.5	30	78	680	58	35	25	tower 1R
wigglers	R or L arc	55	30	114	3310	285	35	25	tower 2R and 2L
wigglers power supply	R or L arc service halls	55	30	11	333	29	35	25	tower 2R and 2L
cavities power supply	R arc service halls	45	30	155	2700	232	35	25	tower 3r

9. ANNEXED 08 (table 04)

cooling towers main parameters

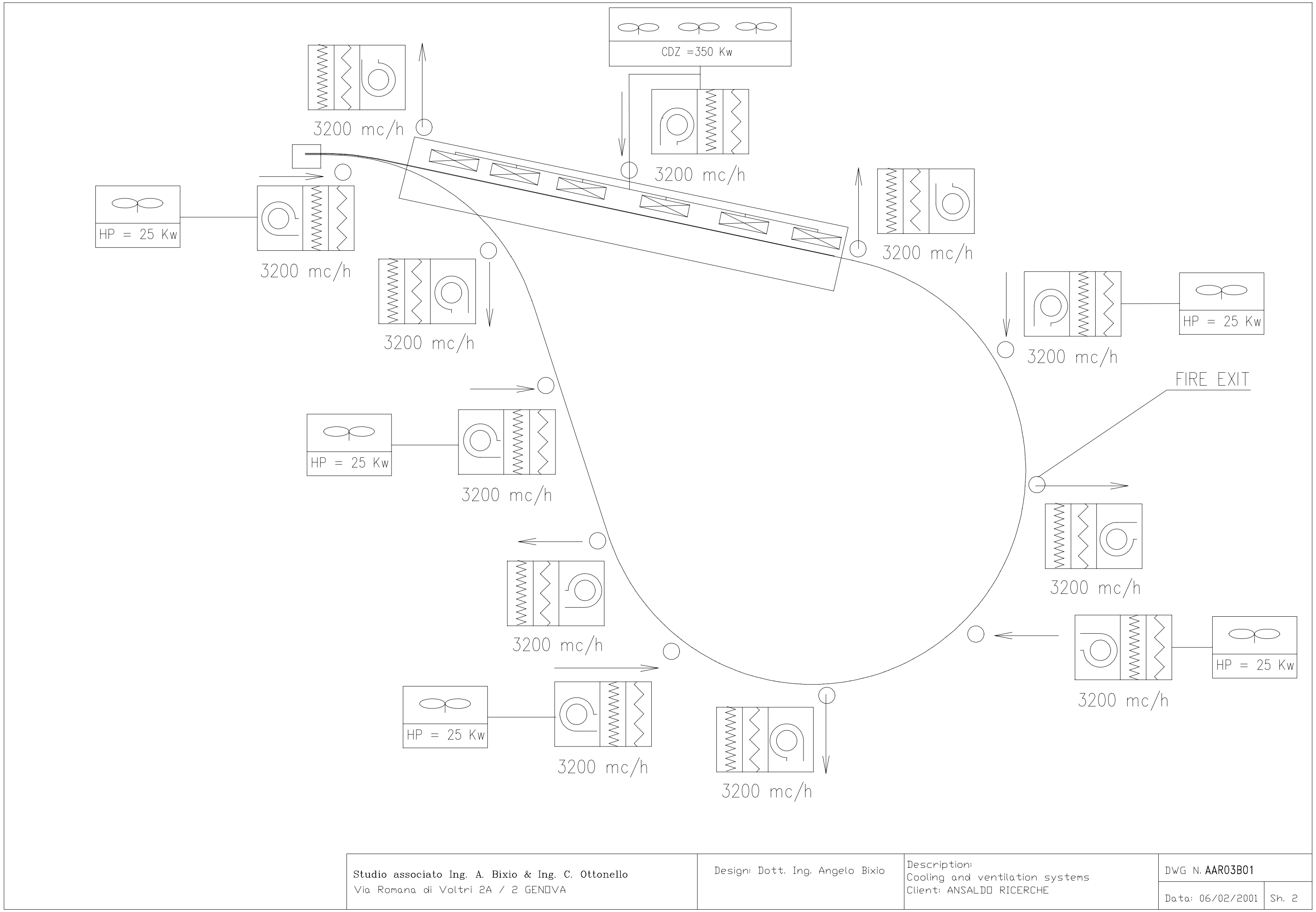
TOWER no.	water flow mc/h	fall of temperature °C	teorical power kW	tower power kW	absorbed power kW
tower 1L	212	10	2.466	4.000	2x30
tower 1R	220	10	2.558	4.000	2x30
tower 2R and 2L	313	10	3.643	4.000	2x30
tower 3R	232	10	2.700	4.000	2x30

9. ANNEXED 09 (table 05)

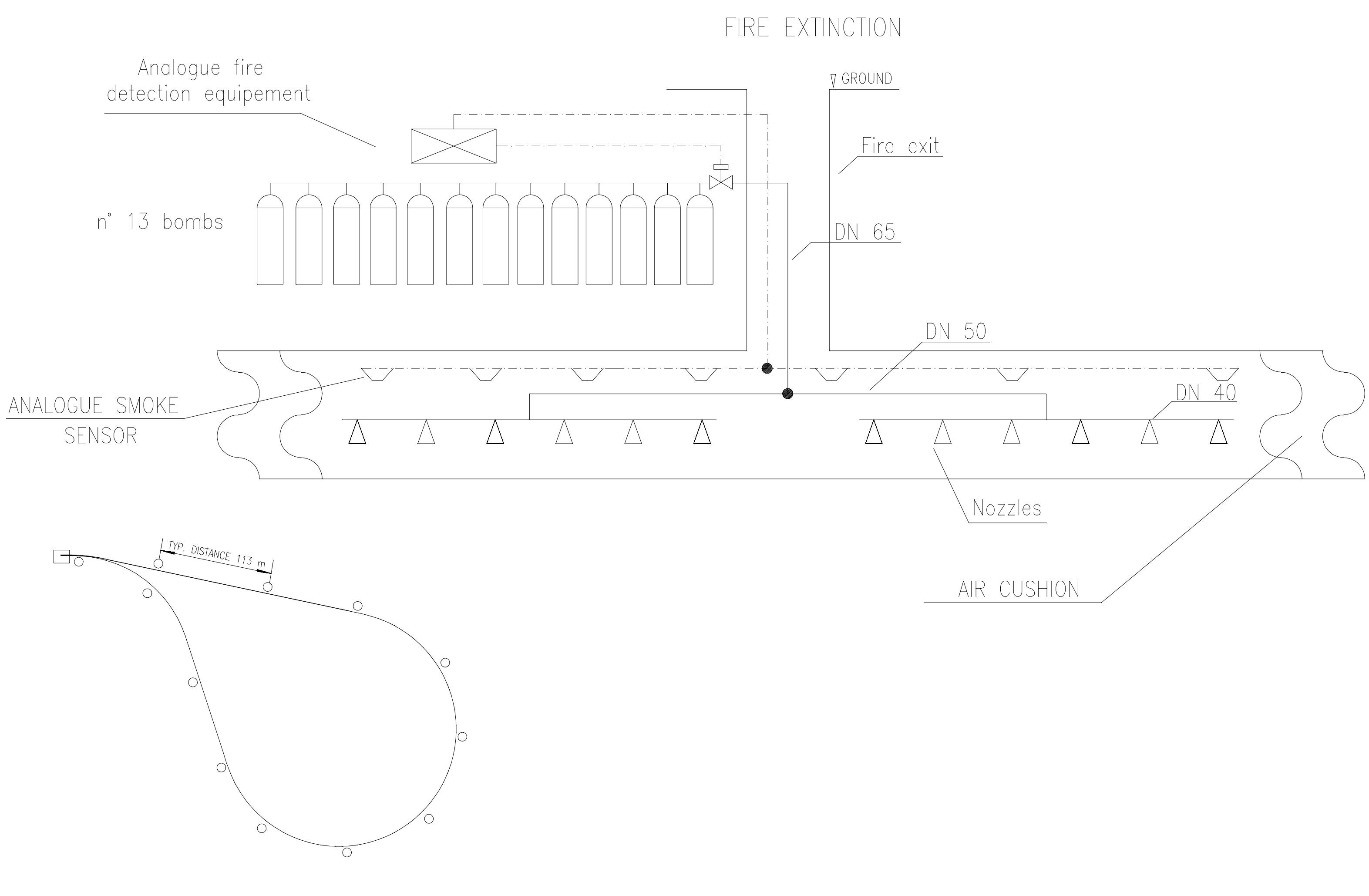
refrigeration lines main parameters

PIPE LINE	pipe DN	water flow	pressure drop/m	pipe lenght	equivalent pipe lenght	total pipe pressure drop	head difference	pressure drop at manifolds	total pressure drop	no. of pumps	max pumps flow	max pumps head	pumps abs. power	pump type
	DN	mc/h	mbar	m	m	bar	bar	bar	bar	n	mc/h	bar	kW	
tower 1L	DN 200	212	1.1	60	90	0.10	2.6		2.7	1	350	4	45	Etanorm 150-315/334
tower 1R	DN 200	220	1.2	60	90	0.11	2.6		2.7	1	350	4	45	Etanorm 150-315/334
tower 2R and 2L	DN 200	313	2.4	60	90	0.22	2.6		2.8	1	350	4	45	Etanorm 150-315/334
tower 3R	DN 200	232	1.3	60	90	0.12	2.6		2.7	1	350	4	45	Etanorm 150-315/334
magnets, L	DN150	51	0.3	2900	3770	1.13	0.7	4	5.8	1	58	9	22	CRN 64-4/1
magnets+cavities, R	DN150	59	0.36	2900	3770	1.36	0.7	4	6.1	1	79	9	30	CRN 64-5/1
half straight quads	DN100	18	0.29	7350	8820	2.56	0.7	4	7.3	1	22	9	11	CRN16-100
light absorber	DN200	155	0.6	1000	1300	0.78	0.7	4	5.5	2	2x79	9	2x30	n.2 CRN 64-5/1
wigglers	DN150	114	1.3	1000	1300	1.69	0.7	4	6.4	2	2x58	9	2x22	n.2 CRN 64-4/1
mag power supply	DN50	7	0.36	300	390	0.14	0.7	4	4.8	1	10	6	4	CRN 8-80
wig power supply	DN65	11	0.9	300	390	0.35	0.7	4	5.1	1	15	6	5.5	CRN 16-50
cavities power supply	DN150	155	2.4	300	390	0.94	0.7	4	5.6	3	3x64	6	3x15	n.3 CRN 64-3/1

9. ANNEXED 10 (AAR03B01 sh.02)



9. ANNEXED 11 (AAR03B01 sh.01)



Studio associato Ing. A. Bixio & Ing. C. Ottonello Via Romana di Voltri 2A / 2 GENOVA	Design: Ing. Angelo Bixio	Descption: TYPICAL FIRE EXTINCTION SYSTEM Client: ANSALDO RICERCHE	DWG N. AAR03B01 Date: 06/02/2001 Sh. 1

9. 2 ATTACHMENT 2

9.2 Attachment 2: Tasks to be completed (I.N.F.N.) within 06/12/2000

Progressive Number					Main Item	Requested Job	
1	2	3	4	5		Des.	Mag/Therm Mechan/Ver.
1					TESLA 5 GeV Damping Rings		
1	1				Damping Ring Lattice	Not	
1	2				General Lay-out	Yes	
1	2	1			D.R. Arc Tunnel Lay-out	Yes	Not
1	2	2			D.R. 8 km Conn. Tunnel Lay-out	Yes	Not
1	3				Injection/Extraction Sections	Yes	Yes
1	4				Damping Rings		
1	4	1			Magnetic Components		
1	4	1	1		Bending Dipoles	Yes	Yes
1	4	1	2		Quadrupoles	Yes	Yes
1	4	1	3		Sextupoles	Yes	Yes
1	4	1	4		Magnetic Measurements	Not	Not
1	4	1	5		Magnet Assembly	Yes	Yes
1	4	1	6		H/V Correctors	Yes	Yes
1	4	1	7		Dipole Stands and Supports	Yes	Yes
1	4	1	8		Multipole Girders/ Supports	Yes	Yes
1	4	1	9		Special Magnets (Electromagnetic Wigglers)	Yes	Yes
1	4	2			Power Supply System	Not	Yes
1	4	2	1		Mains Connections	Not	Not
1	4	2	2		Med/Low Voltage Breaker	Not	Not
1	4	2	3		Med/Low Voltage Cables and Trays	Not	Yes
1	4	2	4		Electromagnetic Wiggler Power Supplies	Not	Yes
1	4	3			RF System		
1	4	3	1		RF Cryo-modules	Not	Not
1	4	3	2		RF Power Surces	Not	Not
1	4	3	3		Waveguide network system	Not	Not
1	4	3	4		Cryogenic System	Not	Not
1	4	3	5		Cooling System	Not	Not
1	4	3	6		Others (electronics, controls, interlocks, etc.)	Not	Not
1	4	4			Vacuum System		
1	4	4	1		D. R. Vacuum Chamber	Yes	Yes
1	4	4	2		Conn. Tunnel Vacuum Chamber	Not	Not
1	4	4	3		Vacuum Chamber Supports	Yes	Yes
1	4	4	4		Pumps and Power Supplies	Not	Yes
1	4	4	5		Vacuum Diagnostics	Not	Yes

1	4	4	6		Manual and Automatic Valves	Not	Yes
1	4	4	7		Control Units	Not	Yes
1	4	4	8		Special Magnets Vacuum Chamber (Wigglers)	Yes	Yes
1	4	5			Beam Diagnostics		
1	4	5	1		Fluorescent Screens	Not	Yes
1	4	5	2		Toroidal Current Transformers	Not	Yes
1	4	5	3		Wall Current Monitors	Not	Yes
1	4	5	4		DC Current Transformers	Not	Yes
1	4	5	5		BPM Button/Strip Line Monitors	Not	Yes
1	4	5	6		Beam Diagnostics Electronics	Not	Not
1	4	5	7		Emittance Measurement System	Not	Not
1	5				Computer Control System		
1	5	1			Computer Control System Hardware	Not	Not
1	5	2			Computer Control System Software	Not	Not
1	6				Electrical Services		
1	6	1			Standard Line Voltage Sources	Not	Not
1	6	2			Main Power Distribution Boards	Not	Not
1	6	3			Medium/Low Voltage Transformers	Not	Not
1	6	4			Medium Voltage Breakers	Not	Not
1	6	5			Cables and Trays	Not	Not
1	6	6			Lightning System	Not	Not
1	6	7			Emergency Lightning System	Not	Not
1	7				Process Water Facilities		
1	7	1			Cooling Towers and Anc. Equip.	Not	Not
1	7	2			Pumps, Motors and Anc. Eqiuip.	Not	Not
1	7	3			Heat Exchangers	Not	Not
1	7	4			Piping	Not	Not
1	7	5			Filters	Not	Not
1	7	6			De-ionization Units	Not	Not
1	7	7			Tanks	Not	Not
1	8				Cooling and Ventilation System (only for Arcs)	Not	Not
1	9				Compressed Air Facilities (only for Arcs)	Not	Not
1	10				Handling Equipments and Cranes (only for Arcs)	Not	Not
1	11				Tunnel Transport System (only for Arcs)	Not	Not
1	12				Alignment Facilities (only for Arcs)	Not	Not
1	13				Installation Time Schedule and Manpower	Not	Not
1	14				Fire Detection System (only for Arcs)	Not	Not
1	15				Smoke extraction system (only for Arcs)	Not	Not
1	16				Tunnel TV Monitoring (only for Arcs)	Not	Not
1	17				Tests and Acceptance Tests	Not	Not
1	18				Commissioning (with no beam)	Not	Not
1	19				Engineering and Q.A.	Not	Not

Ansaldo Ricerche s.r.l.

Progetto project	Identificativo document no.
TESLA DAMPING RING	File: 0s-quinto-1 S02993UX3000L

Cliente client	Comm.-s/comm. job. no.	Emittente issued by	Pagina page	Di of
I.N.F.N.	UX3.000	ARI/TME/MTM	1	26

Rag. disc. disc.code	Rif. str. prod. prod. str. no	Identificativo componente equipment identification code	Tipo doc. doc type	Cl. ris. class	Allegati enclosures
N/A	N/A	Damping Ring	S	L	

Titolo title	Derivato da derived from
MAGNETS	Sostituisce substitutes

Stato validita`: rev.scope **Issue dated 30/11/2000**

0	30/11/20000	Issue		Canepa Giuseppe	Grattarola Marco	Grattarola Marco	Ros Fra
Rev. rev.	Data date	Descrizione description	Stato valid. rev. scope	Redazione prepared by	Controllo checked by/	approvazione checked by/ approved by	Autorizzazione emis iss author

TABLE OF CONTENT

1. Introduction

The development of the design of the damping ring magnetic system with a detail level sufficient for a cost evaluation was the aim of this work. he results of the design and the cost evaluation are described in this document. Even if only a functional design was required, many iterations were necessary to fulfill all the constrains and minimize costs at the same time.

The magnetic system of the Tesla Damping Ring is composed of resistive water cooled magnets. The main parameters and number of magnets of each family for the two arcs, the wiggler sections and the long straight sections of a single Damping Ring are listed in table 1.I. A laminated yoke for both dipoles and multipoles has been foreseen, while a massive forged yoke has been designed for the electromagnetic wiggler magnets. Bending dipoles and steering magnets are C shaped while multipole magnets and wigglers can be split in two halves in order to allow an easy assembly of the vacuum chamber. The coils have been designed to minimize the power dissipation in the crowded and narrow tunnel. In order to fulfill such a requirement the current densities have been maintained always below 2.5 A/mm^2. However, due to cost and space constrains, such a criterion cannot be applied to wigglers where a current density of 8.6 A/mm^2 is reached. The power to be supplied to the wiggler magnets is about 85 % of the total power required by all the magnetic system. Special girders, where magnets, vacuum chambers and pumps, etc., are pre-assembled and carefully aligned outside the tunnel, have been designed to reduce the assembling time inside the D.R. tunnel. At this stage of the design the pole profile of all the magnets has not been optimized and a careful study of the harmonic content of the magnetic field must follow in a second stage. In the same way the mechanical length of each type of magnet has been scaled from experience and detailed 3D simulations must be performed to set the final dimensions.

Table 1.I - Main characteristics of the Damping Ring Magnets

Bending magnets	*Quantity*	*Magnetic length [m]*	*Defl. angle [deg]*	*Mag. field [T]*	*Gap [mm]*	*Ampere turns [A]*	Power / magnet [W]
	216	4.5	3	0.194	40	6176	2557

Quadrupoles	*Quantity*	*Magnetic length [m]*	*Maximum Gradient [T/m]*	*Bore radius [mm]*	*Ampere turns/pole [A]*	*Power per quad. [W]*
Arc	456	0.2	21.7	24	4973	631
Arc match	38	0.3	10.3	24	2361	258
Wiggler	70	0.2	14.2	24	3254	270
Wiggler match	16	0.4	10.9	28	3400	270
Long straight	269	0.2	7.5	52	8070	1085

Sextupoles	*Quantity*	*Magnetic length [m]*	*Maximum gradient [T/m2]*	*Bore radius [mm]*	*Ampere turns/pole [A]*	*Power per quad. [W]*
SF	204	0.3	101.7	24	187	46
SDA	96	0.4	130.1	24	240	78
SDB	12	0.2	130.1	24	240	43

Electromagnetic wigglers	*Quantity*	*Period length [mm]*	*Number of periods*	*Nominal field [T]*	*Nominal gap [mm]*	*Ampere turns/pole [A]*	*Power per wiggler [W]*
	72	550	8	1.8	25	20500	94000

Steering magnets	*Quantity*	*Magnetic length [m]*	*Nominal field [Gauss]*	*Bore aperture [mm]*	*Ampere turns [A]*	*Power per quad. [W]*
Arc & wiggler section	360	0.1	833	120	8620	190
Long straight section	269	0.1	33	105	288	2

2. References

The present document invokes the following documents:

- List of deliverables, whose version dated 22/11/1999 has been provided by INFN, "Magnetic components", items 1.4.1.1, 1.4.1.2, 1.4.1.3, 1.4.1.6 and 1.4.1.9 (annex 1).
- ARI Procedure n. P0111767000L dated 13/12/1999.
- Drawings:

D02954UX3000L Lay-out 0 (Damping Ring Line)

D02653UX3000L Lay-out1 (Detail Damping Ring Line sheet 001÷030)

D02654UX3000L Lay-out2 (Detail Damping Ring Line sheet 031÷053)

D02655UX3000L Lay-out3 (Detail Damping Ring Line sheet 054÷076)

D02656UX3000L Lay-out4 (Detail Damping Ring Line sheet 077÷109)

D02657UX3000L Lay-out5 (Detail Damping Ring Line sheet 110÷112)

D01623UX3000C Dipole assembly

D01624UX3000C Dipole lamination

D01633UX3000C QAD/QAF/QAM1,2/QAD1,1 Quadrupole assembly

D01670UX3000C QAD/QAF/QAM1,2/QAD1,1 Quadrupole yoke assembly

D01639UX3000C QAD/QAF/QAM1,2/QAD1,1/QWF/QWD Quadrupole lamination

D01634UX3000C QAD/QAF/QAM/QWA/QWF/QWD Quadrupole support

D01636UX3000C QAM 3, 4, 5 Quadrupole assembly

D01667UX3000C QAM 3, 4, 5 Quadrupole yoke assembly

D01638UX3000C QWF, QWD Quadrupole assembly

D01637UX3000C QWA 1, 2, 3, 4, 5 Quadrupole assembly

D01669UX3000C QWA 1, 2, 3, 4, 5 Quadrupole yoke assembly

D01640UX3000C QWA 1, 2, 3, 4, 5 Quadrupole lamination

D01629UX3000C QLF, QLD Quadrupole assembly

D01666UX3000C QLF, QLD Quadrupole yoke assembly

D01631UX3000C QLF, QLD Quadrupole lamination

D01630UX3000C QLF, QLD Quadrupole support

D01626UX3000C S1P, S1M Sextupole assembly

D01672UX3000C S1P, S1M Sextupole yoke assembly

D01625UX3000C S2PA, S2MA Sextupole assembly

D01673UX3000C S2PA, S2MA Sextupole yoke assembly

D01627UX3000C S2PB, S2MB Sextupole assembly

D01671UX3000C S2PB, S2MB Sextupole yoke assembly

D01628UX3000C S1P, S1M, S2PA, S2MA, S2PB, S2MB Sextupole lamination

D01614UX3000C S1P, S1M, S2PA, S2MA, S2PB, S2MB Sextupole support

D02603UX3000C ARC_CELL and Wiggler section corrector

D02604UX3000C Long straight section corrector

D01620UX3000C Electromagnetic wiggler assembly

D01620UX3000C Electromagnetic wiggler support

3. Dipoles

The main parameters of the magnet are written in table 1.I. The dipoles are assembled by lamination stacking. Drawing D01623UX3000C shows the main dimensions of the yoke, coils and conductors. In the same drawing a detailed table contains all the relevant magnetic, mechanical, weight, electrical and cooling parameters of the magnet. Drawing D01624UX3000C shows the dimension of the dipole yoke lamination. Two dimensional calculations have been performed to verify the coil ampere turns and the distribution of the magnetic field in the iron yoke. The plot of the magnetic field of figure 3.1 shows that there are no saturation effects.

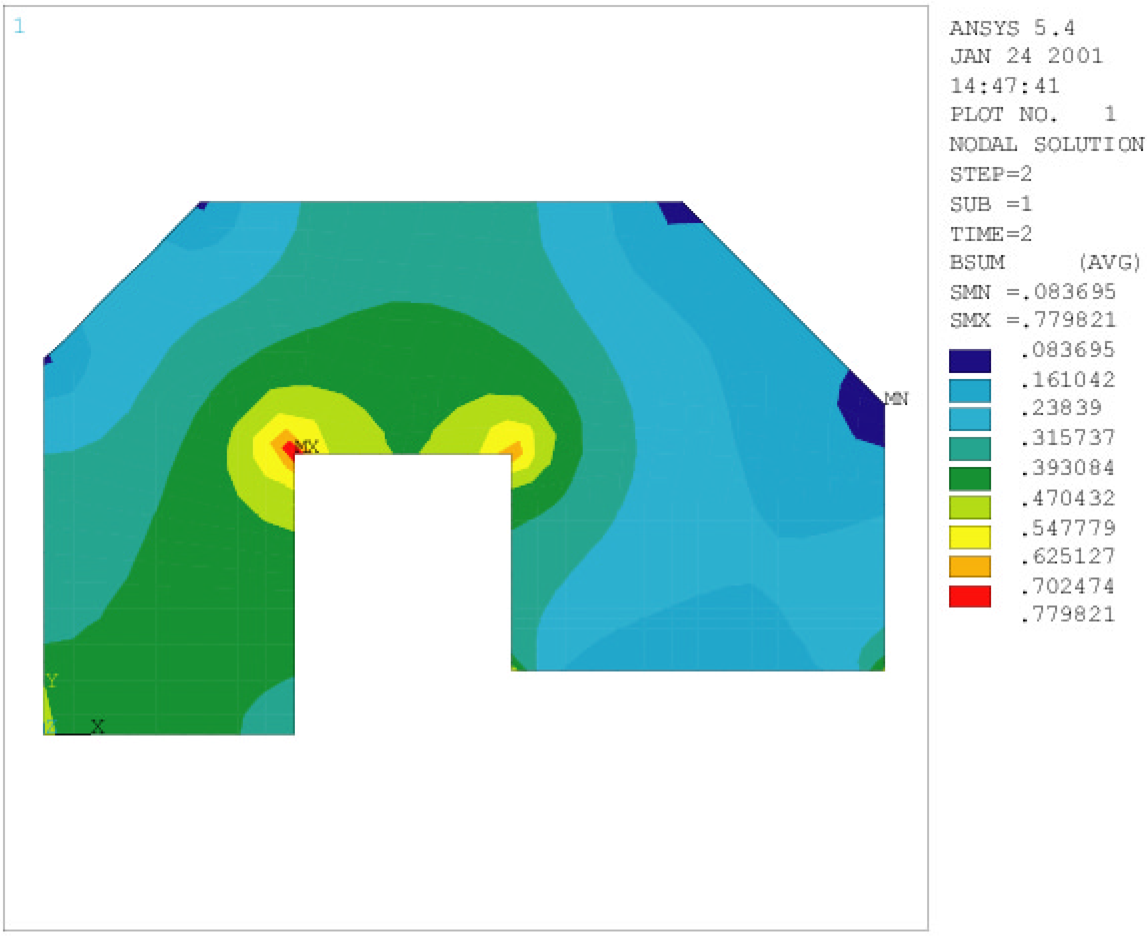


Figure 3.1 - Magnetic field B in the Dipole yoke (Tesla)

The yoke is magnetized by two coils. Each coils is composed of 4 turns. The copper conductor is rectangular with a hole for water cooling. The geometrical and electrical details are summarized in the drawing D01623UX3000C.
The method for stacking the laminations must be carefully defined to preserve the dimensional tolerances. The laminations will be maintained in position by means of two thick constrain plates welded on the top and bottom of the yoke. The dipole is a very long and thin structure which would require very large constrain plates so the dipole shown in drawing D01623UX3000C would not be stiff enough to be handled stand alone. The supporting structures will act as stiffening element and allows a safe lifting and handling of the component.

4. Arc quadrupoles

The reference names of the arc quadrupoles in the layout and magnet drawings are QAD, QAF,QAM1, QAM2, QAD1 and QAD2.
The main parameters of the magnets are written in table 1.I. The quadrupoles are assembled by lamination stacking. Drawing D01633UX3000C shows the main dimensions of the yoke, coils and conductors. In the same drawing a detailed table contains all the relevant magnetic, mechanical, weight, electrical and cooling parameters of the magnet. Drawing D01639UX3000C shows the dimension of the typical lamination and drawing D01670UX3000C the yoke assembly. Two dimensional calculations have been performed to verify the coil ampere turns and the distribution of the magnetic field in the iron yoke. The plot of the magnetic field of figure 4.1 shows that there are no saturation effects.

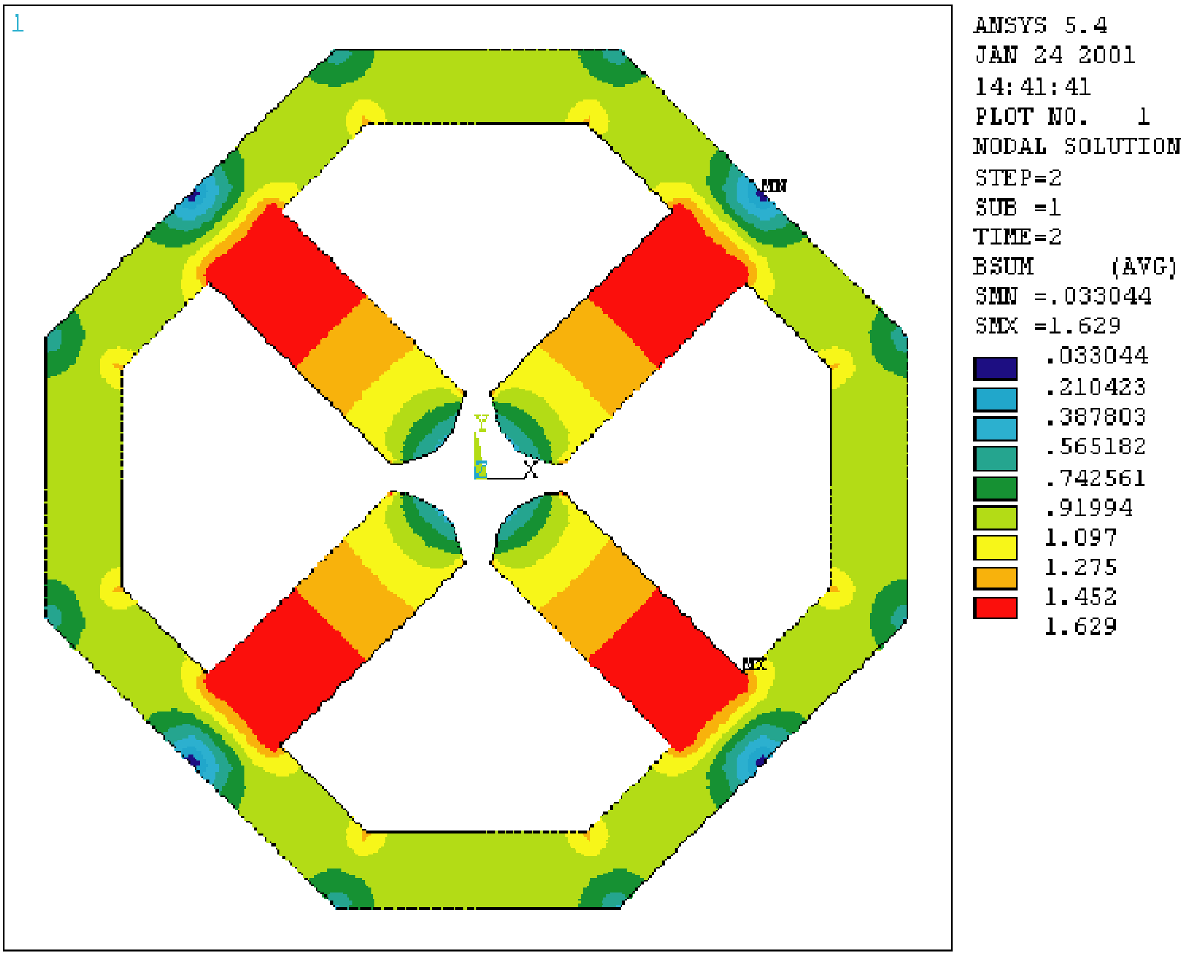


Figure 4.1 - Magnetic field B in the Arc Quadrupole yoke (Tesla)

The dimensional tolerances shown in the drawing do not come from any calculation for the optimization of the pole profile. They are just typical tolerances for this type of component and they are intended only for cost evaluation.

The quadrupoles are split into four symmetric parts in order to allow the insertion of the coils and will be assembled around the vacuum chamber by means of precision pins and screws.

The laminations are staked and maintained in position by means of longitudinal constrain plates welded in correspondence of the poles.

The yoke is magnetized by four coils. Each coils is composed of 36 turns. The copper conductor is rectangular with a hole for water cooling. The geometrical and electrical details are summarized in the drawing D01633UX3000C. Drawing D01634UX3000C shows the typical aluminum alloy support.

5. Arc match quadrupoles

The reference names of the arc match quadrupoles in the layout and magnet drawings QWF and QWD. The main parameters of the magnets are written in table 1.I. The quadrupoles are assembled by lamination stacking. Drawing D01636UX3000C shows the main dimensions of the yoke, coils and conductors. In the same drawing a detailed table contains all the relevant magnetic, mechanical, weight, electrical and cooling parameters of the magnet.

Drawing D01667UX3000C shows the lamination stack of the magnet. The arc and the arc match quadrupoles have the same cross section so the same lamination and the same aluminum support have been adopted (drawings D01639UX3000C and D01634UX3000C).

Two dimensional calculations have been performed to verify the coil ampere turns and the distribution of the magnetic field in the iron yoke. The plot of the magnetic field of figure 5.1 shows that there are no saturation effects. The dimensional tolerances shown in the drawing do not come from any calculation for the optimization of the pole profile. They are just typical tolerances for this type of component and they are intended only for cost evaluation.

The quadrupoles are split into four symmetric parts in order to allow the insertion of the coils and will be assembled around the vacuum chamber by means of precision pins and screws.

The laminations are staked and maintained in position by means of longitudinal constrain plates welded in correspondence of the poles.

The yoke is magnetized by four coils. Each coils is composed of 24 turns. The copper conductor is rectangular with a hole for water cooling. The geometrical and electrical details are summarized in the drawing D01636UX3000C.

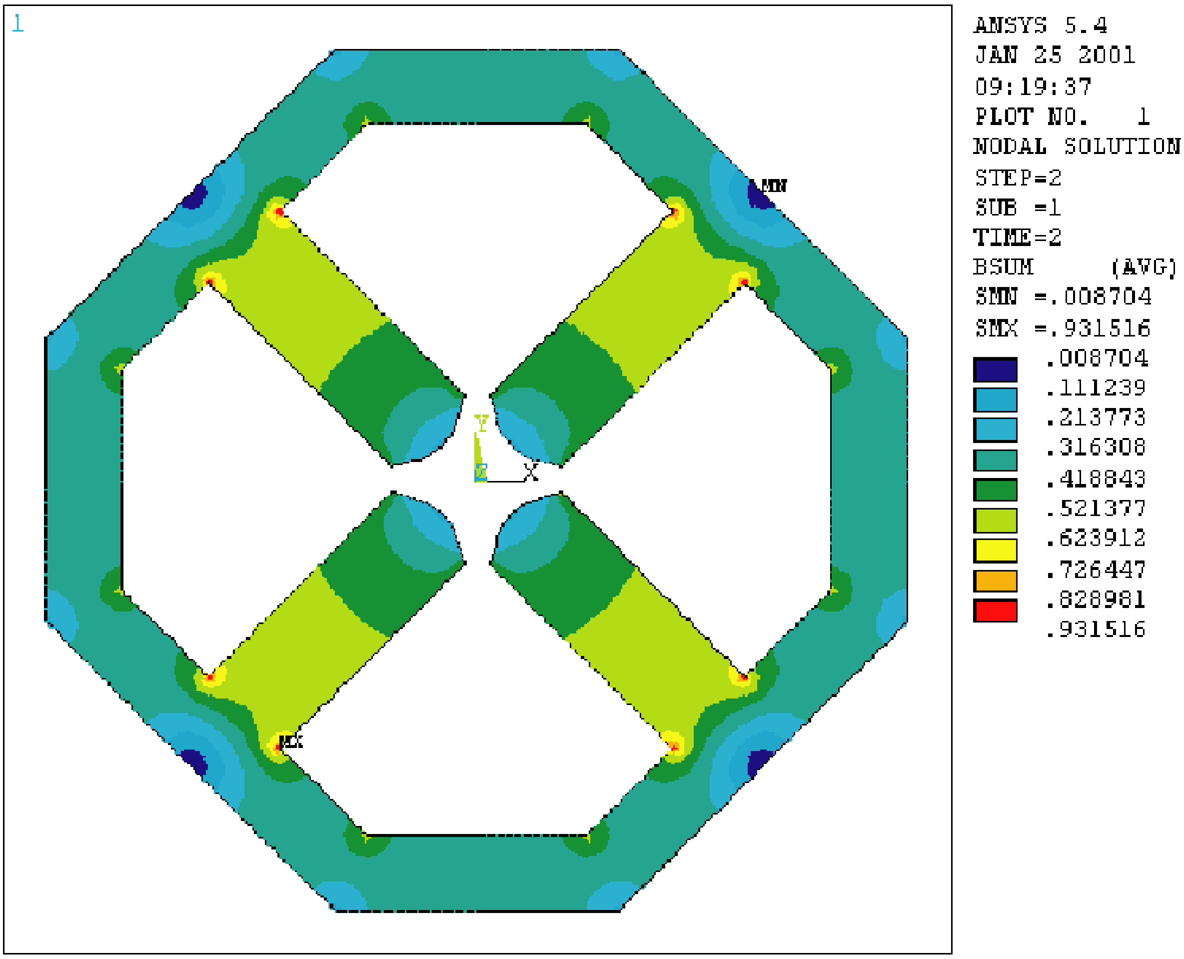


Figure 5.1 - Magnetic field B in the Arc Match Quadrupole yoke (Tesla)

6. Wiggler quadrupoles

The reference names of the wiggler quadrupoles in the layout and magnet drawings are QWF and QWD.

The main parameters of the magnets are written in table 1.I. The quadrupoles are assembled by lamination stacking. Drawing D01638UX3000C shows the main dimensions of the yoke, coils and conductors. In the same drawing a detailed table contains all the relevant magnetic, mechanical, weight, electrical and cooling parameters of the magnet.

The wiggler section quadrupoles have the same yoke cross-section and magnetic length of the arc quadrupoles so the same yoke geometry can be assumed (drawing D01639UX3000C, D01670UX3000C and D01634UX3000C). Furthermore the nominal gradient is in between the arc and the arc match quadrupoles, so the iron yoke can be considered safe from the saturation point of view without performing any further finite element calculation.

The quadrupoles are split into four symmetric parts in order to allow the insertion of the coils and will be assembled around the vacuum chamber by means of precision pins and screws.

The laminations are staked and maintained in position by means of longitudinal constrain plates welded in correspondence of the poles.

The yoke is magnetized by four coils. Each coils is composed of 36 turns. The copper conductor is rectangular with a hole for water cooling. The geometrical and electrical details are summarized in the drawing D01638UX3000C.

7. Wiggler match quadrupoles

The reference names of the wiggler section quadrupoles in the layout and magnet drawings are QWA1, QWA2, QWA3, QWA4 and QWA5.

The main parameters of the magnets are written in table 1.I. The quadrupoles are assembled by lamination stacking. Drawing D01637UX3000C shows the main dimensions of the yoke, coils and conductors. In the same drawing a detailed table contains all the relevant magnetic, mechanical, weight, electrical and cooling parameters of the magnet.

The typical lamination and the yoke assembly are shown in drawings D01640UX3000C and D01669UX3000C. The aluminum support is shown in drawing D01634UX3000C.

Both the yoke cross-section and the nominal gradient are not far from the values assumed for the arc match quadrupoles, so also in this case the iron yoke can be considered safe from the saturation point of view without performing any further finite element calculation.

The quadrupoles are split into four symmetric parts in order to allow the insertion of the coils and will be assembled around the vacuum chamber by means of precision pins and screws.

The laminations are staked and maintained in position by means of longitudinal constrain plates welded in correspondence of the poles.

The yoke is magnetized by four coils. Each coils is composed of 24 turns. The copper conductor is rectangular with a hole for water cooling. The geometrical and electrical details are summarized in the drawing D01637UX3000C.

8. Long straight section quadrupoles

The reference names of the arc quadrupoles in the layout and magnet drawings are QLF and QLD. The main parameters of the magnets are written in table 1.I. The quadrupoles are assembled by lamination stacking. Drawing D01629UX3000C shows the main dimensions of the yoke, coils and conductors. In the same drawing a detailed table contains all the relevant magnetic, mechanical, weight, electrical and cooling parameters of the magnet. Drawing D01631UX3000C shows the dimension of the typical lamination and drawing D01660UX3000C the yoke assembly. Two dimensional calculations have been performed to verify the coil ampere turns and the distribution of the magnetic field in the iron yoke. The plot of the magnetic field of figure 8.1 shows that there are no saturation effects.

The dimensional tolerances shown in the drawing do not come from any calculation for the optimization of the pole profile. They are just typical tolerances for this type of component and they are intended only for cost evaluation.

The quadrupoles are split into four symmetric parts in order to allow the insertion of the coils and will be assembled around the vacuum chamber by means of precision pins and screws.

The laminations are staked and maintained in position by means of longitudinal constrain plates welded in correspondence of the poles.

The yoke is magnetized by four coils. Each coils is composed of 36 turns. The copper conductor is rectangular with a hole for water cooling. The geometrical and electrical details are summarized in the drawing D01629UX3000C. Drawing D01630UX3000C shows the typical aluminum alloy support.

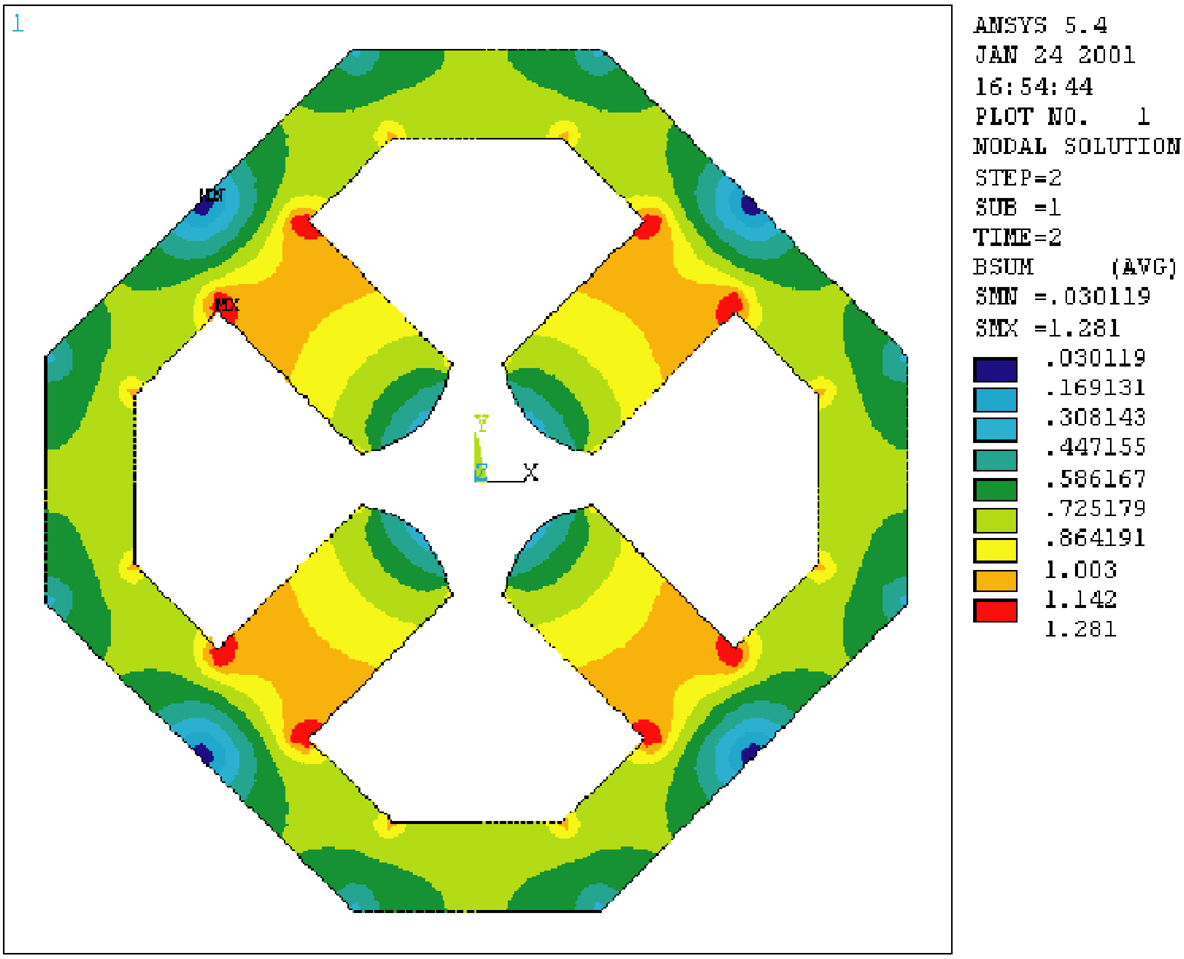


Figure 8.1 - Magnetic field B in the Long Straight Section Quadrupole yoke (Tesla)

9. Sextupoles

The reference names of the sextupoles in the layout and magnet drawings are S1P/S1M (SF), S2PA/S2MA (SDA) and S2PB/S2MB (SDB).

The main parameters of the magnets are written in table 1.I where it can be observed that all sextupoles have the same bore radius and similar nominal gradient. The sextupoles are assembled by lamination stacking. Drawing D01626UX3000C, D01625UX3000C and D01627UX3000C show the main dimensions of the yoke, coils and conductors of quadrupoles SF, SDA and SDB respectively. In the same drawing a detailed table contains all the relevant magnetic, mechanical, weight, electrical and cooling parameters of the magnet. Drawing

D01672UX3000C, D01673UX3000C and D01671UX3000C the yoke assembly. The typical lamination is the same for all sextupoles and is shown in drawing D01628UX3000C. Two dimensional calculations have been performed to verify the coil ampere turns and the distribution of the magnetic field in the iron yoke. The plot of the magnetic field of figure 9.1 shows that there are no saturation effects even in the worst condition (130.1 T/m^2).

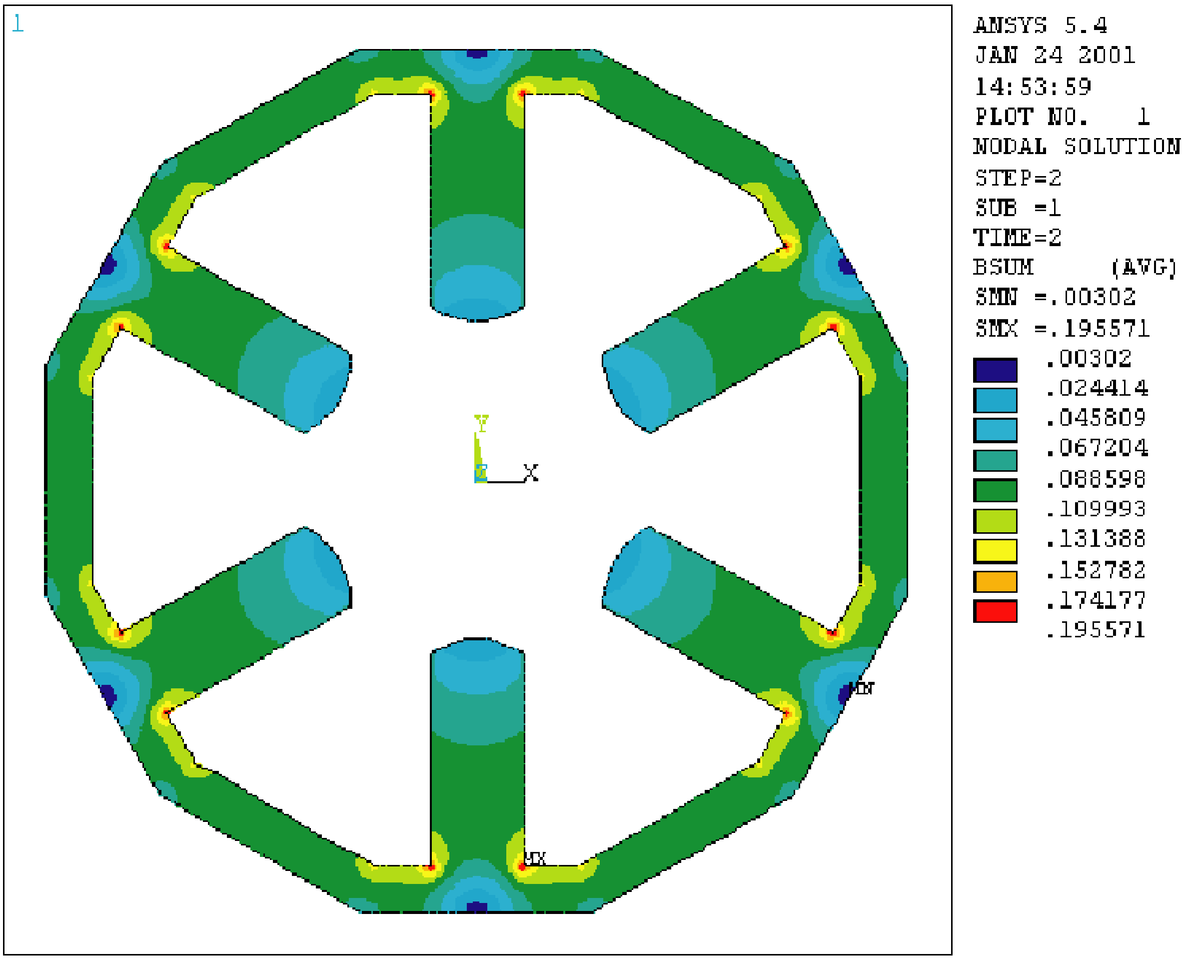


Figure 9.1 - Magnetic field B in the iron yoke of the 130.1 T/m2 Sextupole (Tesla)

The dimensional tolerances shown in the drawing do not come from any calculation for the optimization of the pole profile. They are just typical tolerances for this type of component and they are intended only for cost evaluation.

The sextupoles are split into two symmetric parts in order to allow the assembly around the vacuum chamber by means of precision pins and screws.

The laminations are staked and maintained in position by means of longitudinal constrain plates welded in correspondence of the poles.
Drawing D01630UX3000C shows the typical aluminum alloy support.

10. Steering magnets

The main parameters of the steering magnets are written in table 1.I. The steering magnets of the arc and wiggler sections are shown in drawing D02603UX3000C and the long straight section ones in drawing D02604UX3000C. In the same drawing a detailed table contains all the relevant magnetic, mechanical, weight, electrical and cooling parameters of the magnet. Also the steering magnets are water cooled to minimize power dissipation in the tunnel. The gap of the steering magnets of the arc and wiggler section is quite large because, due to space constrains, they have to be placed around the bellows. They are "C" shaped and are provided with two supports at 90 deg so that the same type of magnet can be utilized as vertical or horizontal corrector.

11. Wiggler

The main parameters of the wiggler are written in table 1.I. The wiggler is shown in drawing D01620UX3000C. In the same drawing a detailed table contains all the relevant magnetic, mechanical, weight, electrical and cooling parameters of the magnet. Figure 11.1 (a) and 11.1 (b) show the results of the magnetic calculations (provided by INFN-LNF Frscati).
The wiggler is composed of massive steel parts. The poles are screwed to two long and stiff beams supported by a series of aluminum alloy lateral supports (drawing D02837UX3000C). The distance between the supports has been calculated in order to fulfill the requirement of a maximum gap variation of 0.05 mm during operation. Assuming a fabrication tolerance of 0.02 mm on each pole assembly surface, the maximum deflection allowed for each supporting beam under the magnetic force is 0.005 mm. Figure 11.2 (a) shows the model for the calculations while figure 11.2 (b) shows the upper beam deflection (not in scale). Arrows represent the magnetic forces concentrated in the poles while the triangles represent the supports. In this configuration the maximum gap variation along the whole length of the wiggler is 0.006 mm.
Drawing D02895UX3000L shows the wiggler positioned on the tunnel floor.

Wiggler TTF 1/4 of period + end pole - March 23, 2000 Cycle = 490

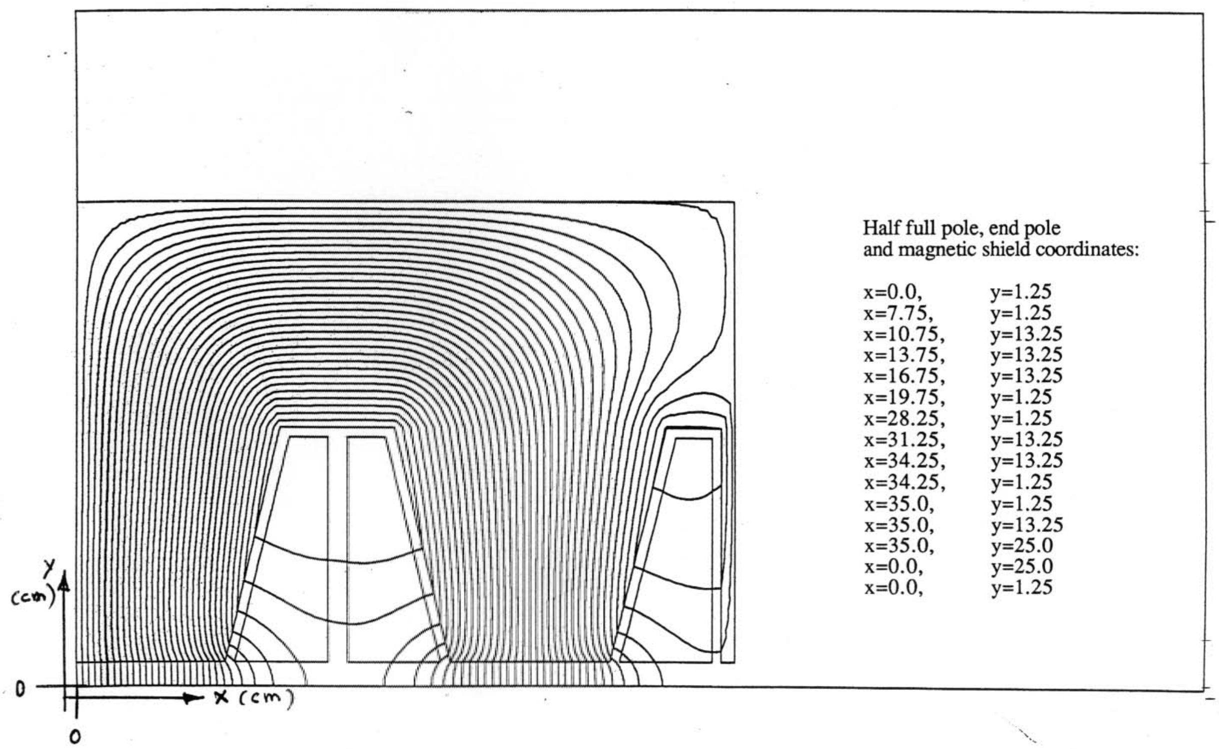


Figure 11.1 (a) - Magnetic field plot

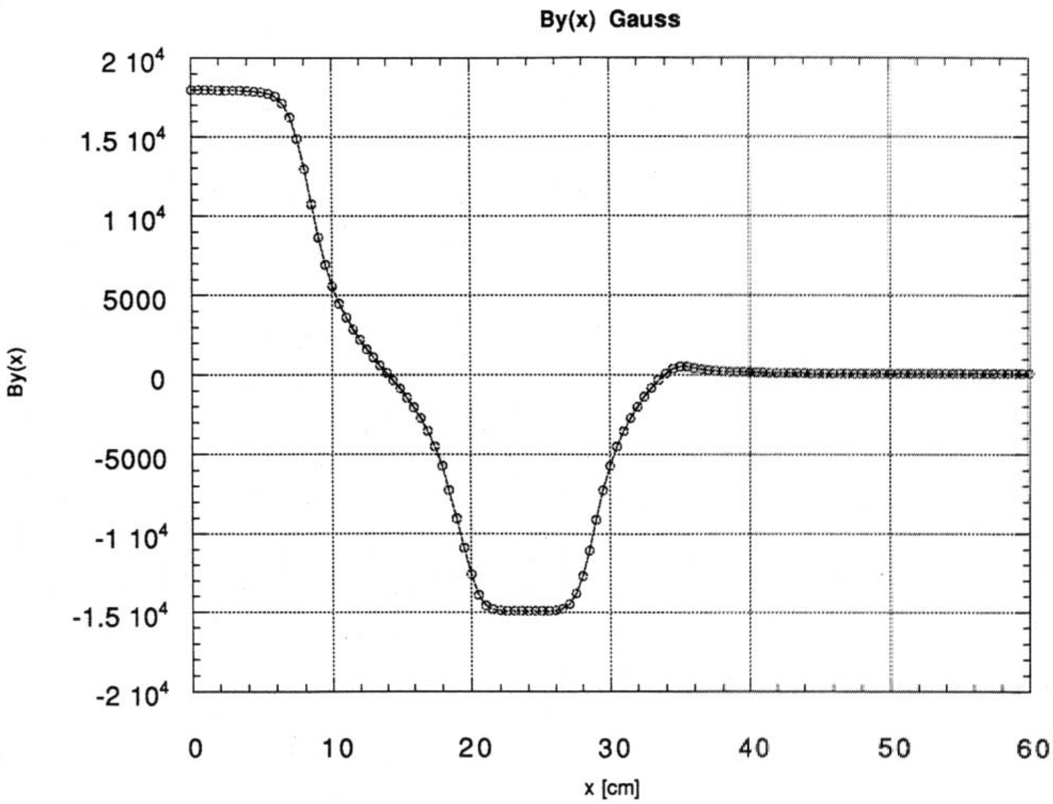
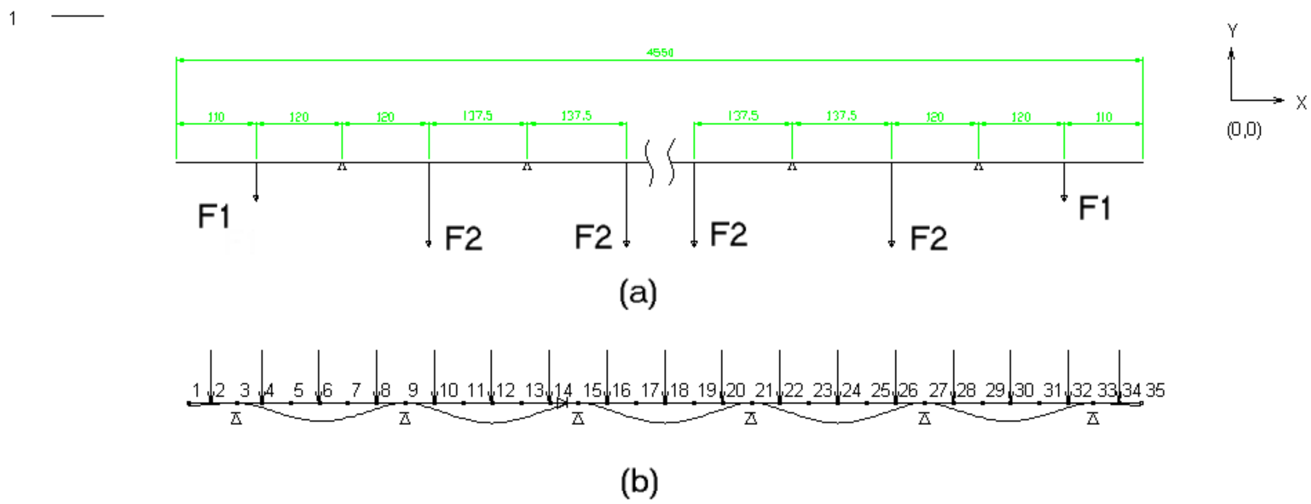


Figure 11.1 (b) - Magnetic field values



F1 = 11,000 N (half pole)
F2 = 20,100 N (full pole)

Figure 11.2 - Wiggler beam deflection.

12. Materials

In this chapter the main material taken into consideration for the preliminary design of the magnetic components and the successive cost exercise are described.

For both laminations of magnet yokes and massive parts, poles and stiff beams, of the wigglers, a 1010 type steel has been adopted (indicated as SA1010 in the drawings).

Applicable Specifications for this material are:

AMS 5040, AMS 5042, AMS 5044, AMS 5047, AMS 5050, AMS 5053, AMS 5055, AMS 7225, ASTM A108, ASTM A29, ASTM A510, ASTM A512 (1010, MT 1010), ASTM A513 (1010, MT 1010), ASTM A513 Type 2, ASTM A513 Type 3, ASTM A519 (1010, MT 1010), ASTM A545, ASTM A549, ASTM A576, ASTM A635, ASTM A787 (MT 1010), ASTM A830;

MIL S-11310 (1010), MIL S-11310 (CS 1010);

SAE J1397, SAE J403, SAE J412

UNS G10100

The typical chemistry data are:

Carbon	0.08 - 0.13
Iron	Balance
Manganese	0.3 - 0.6
Phosphorus	0.04 max
Sulphur	0.05 max

This type of material is a plain carbon steel with a nominal 0.10% carbon content. It is a relatively low strength steel but it may be quenched and tempered for increased strength.

Machinability of 1010 steel is fairly good, especially in the cold drawn or cold worked condition. Based upon carbon steel 1112 as a reference that is considered 100% machinable (easily machined) the 1010 steel has a rating of 55%.

Formability of 1010 steel is good. The alloy has good ductility and is readily formed by conventional means.

This is a plain carbon steel and has no corrosion resistance. It will rust unless protected.

The 1010 steel may be welded by all of the standard welding techniques and is easily cold worked by traditional means. Following severe cold working a stress relief, or full, anneal should be performed.

Figure 11.1 shows the induction curve of the generic SA 1010 steel contained in the finite element code (ANSYS) used for magnetic calculation (ANSYS) compared to the real AISI 1010 one.

As far as the copper conductor is concerned, only hollow conductors from Outokumpu Oy have been taken into consideration (Cu min 99.99, O max 0.0005). The " reference number" shown in the drawings refers to the manufacturer data sheets.

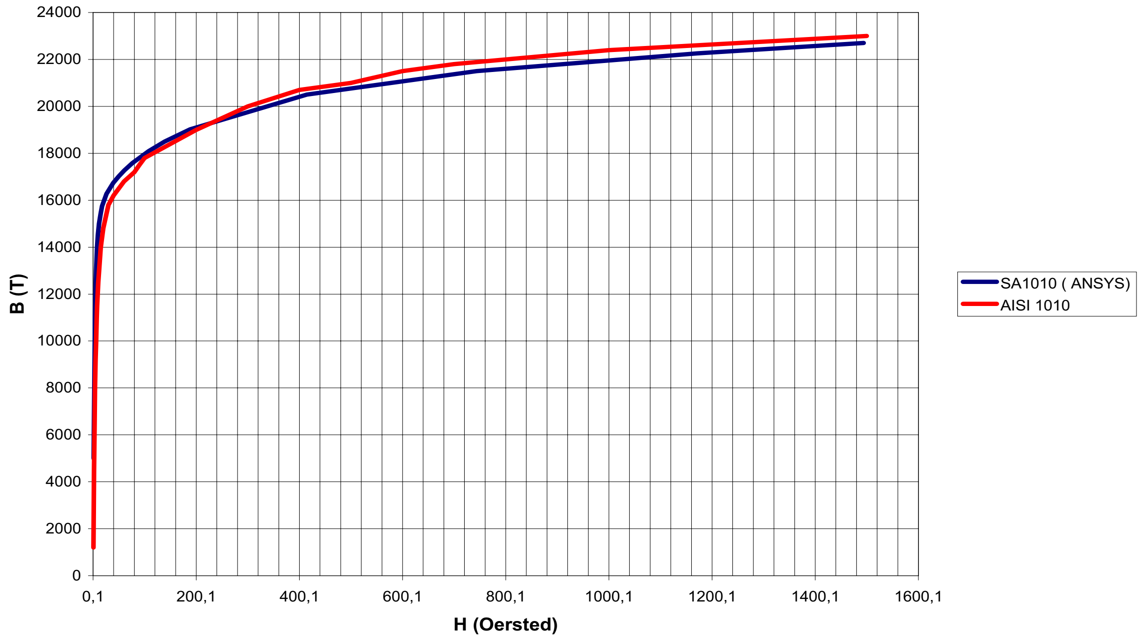


Figure 11.1 - Induction curve of 1010 steel

13. Electrical and cooling characteristics

A detailed list of the characteristics of the magnetic components is written in the reference drawings. Table 13.I shows the electrical characteristics of the magnetic components and the main requirements for the power supplies. Table 13.II shows the main cooling parameters of the magnets. It can be seen that wigglers require 85 % of both the total power and cooling flow rate.

Table 13.I - Electrical characteristics

	Magnet characteristics			Power supply characteristics (series connection)			Number of power supplies	N. of magnets	
	Tension (Volt)	Current (A)	Power (Kw)	Number of magnets	Total tension (Volt)	Total power (Kw)		Total number	Total power (Kw)
Quadrupoles									
QAM 1	4.56	138.4	0.631	**6**	**27.4**	**3.8**	**2**	**12**	**7.6**
QAM 2	4.56	138.4	0.631	**6**	**27.4**	**3.8**	**2**	**12**	**7.6**
QAM 3	2.62	98.5	0.258	**6**	**15.7**	**1.5**	**2**	**12**	**3.1**
QAM 4	2.62	98.5	0.258	**6**	**15.7**	**1.5**	**2**	**12**	**3.1**
QAM 5	2.62	98.5	0.258	**7**	**18.3**	**1.8**	**2**	**14**	**3.6**
QAF	4.56	138.4	0.631	**102**	**465.1**	**64.4**	**2**	**204**	**128.7**
QAD	4.56	138.4	0.631	**102**	**465.1**	**64.4**	**2**	**204**	**128.7**
QAD 1	4.56	138.4	0.631	**3**	**13.7**	**1.9**	**2**	**6**	**3.8**
QAD 2	4.56	138.4	0.631	**5**	**22.8**	**3.2**	**2**	**10**	**6.3**
QLF	4.84	224.2	1.085	**135**	**653.4**	**146.5**	**1**	**135**	**146.5**
QLD	4.84	224.2	1.085	**134**	**648.6**	**145.4**	**1**	**134**	**145.4**
QWF	1.6	76.3	0.122	**18**	**28.8**	**2.2**	**2**	**36**	**4.4**
QWD	1.6	76.3	0.122	**17**	**27.2**	**2.1**	**2**	**34**	**4.1**
QWA 1	4.59	141.6	0.650	**2**	**9.2**	**1.3**	**2**	**4**	**2.6**
QWA 2	4.59	141.6	0.650	**2**	**9.2**	**1.3**	**2**	**4**	**2.6**
QWA 3	4.59	141.6	0.650	**2**	**9.2**	**1.3**	**2**	**4**	**2.6**
QWA 4	4.59	141.6	0.650	**2**	**9.2**	**1.3**	**2**	**4**	**2.6**
QWA 5	4.59	141.6	0.650	**2**	**9.2**	**1.3**	**2**	**4**	**2.6**
Dipoles									
Dipole 4.5 m	3.31	772.5	2.557	**6**	**19.9**	**15.3**	**2**	**12**	**30.7**
Dipole 4.5 m	3.31	772.5	2.557	**102**	**337.6**	**260.8**	**2**	**204**	**521.6**
Sextupoles									
S1P	0.98	47.0	0.046	**102**	**99.8**	**4.7**	**2**	**204**	**9.4**
S2P(HALF)	1.62	48.1	0.078	**48**	**83.1**	**4.0**	**2**	**108**	**8.0**
S2P(FULL)	0.89	48.3	0.043	**6**					
Wigglers									
WIGGLER	134.57	683.3	91.956	**4**	**538.3**	**367.8**	**18**	**72**	**6620.8**

Total power (KW) 7796

Table 13.II - Cooling characteristics

Magnet	Cooling parameters: Water flow rate (Liter/min)	Inlet temperature (deg C)	Outlet temperature (deg C)	Number of circuits per magnet	Water flow rate per magnet (Liter/min)	Total: Number of magnets	Water flow rate (Liter/min)
Quadrupoles							
QAM 1	1.19	30	35.0	2	2.38	**12**	**28.6**
QAM 2	1.19	30	35.0	2	2.38	**12**	**28.6**
QAM 3	0.91	30	35.0	1	0.91	**12**	**10.9**
QAM 4	0.91	30	35.0	1	0.91	**12**	**10.9**
QAM 5	0.91	30	35.0	1	0.91	**14**	**12.7**
QAF	1.19	30	35.0	2	2.38	**204**	**485.5**
QAD	1.19	30	35.0	2	2.38	**204**	**485.5**
QAD 1	1.19	30	35.0	2	2.38	**6**	**14.3**
QAD 2	1.19	30	35.0	2	2.38	**10**	**23.8**
QLF	1.19	30	37.0	2	2.38	**135**	**321.3**
QLD	1.19	30	37.0	2	2.38	**134**	**318.9**
QWF	1.19	30	35.0	2	2.38	**36**	**85.7**
QWD	1.19	30	35.0	2	2.38	**34**	**80.9**
QWA 1	1.19	30	35.0	2	2.38	**4**	**9.5**
QWA 2	1.19	30	35.0	2	2.38	**4**	**9.5**
QWA 3	1.19	30	35.0	2	2.38	**4**	**9.5**
QWA 4	1.19	30	35.0	2	2.38	**4**	**9.5**
QWA 5	1.19	30	35.0	2	2.38	**4**	**9.5**
Dipoles							
Dipole 4.5 m	2.04	30	48.0	1	2.04	**12**	**24.5**
Dipole 4.5 m	2.04	30	48.0	1	2.04	**204**	**416.2**
Sextupoles							
S1P	0.78	30	32.0	1	0.78	**204**	**159.1**
S2P(HALF)	0.63	30	32.0	1	0.63	**108**	**68.0**
S2P(FULL)							
Wigglers							
WIGGLER	1.57	30	55.0	34	53.38	**72**	**3843.4**
					Total flow rate (liter/min)		**6466.4**

14. Costs

In this chapter the costs of all the magnets are summarized. The cost do not include spare parts and manpower for magnetic measurements and final alignment. All functional tests (electrical, hydraulic, etc.), transportation and installation on site are included. The cost includes the aluminum alloy supports while the girders to be fixed to the tunnel floor and the position adjustment equipped are excluded.

The whole supply can be split between three different companies and the time for the completion could be 24 months.

Table 14.I - Cost of magnets

MAGNETS	Total cost		Number of components	Cost / component	
	ITALIAN LIRE	EURO		ITALIAN LIRE	EURO
Dipoles	9,128,825,000	4,714,645	216	42,263,079	21,827
Quadrupoles QLF- QLD	5,250,915,000	2,711,871	269	19,520,130	10,081
Quadrupoles QAD-QAF-QAM1-2-QAD1-2-QWF-QWD	9,009,760,000	4,653,153	518	17,393,359	8,983
Quadrupoles QAM 3-4-5	714,180,000	368,843	38	18,794,211	9,706
Quadrupoles QWA 1-5	435,920,000	225,134	20	21,796,000	11,257
Sextupoles S1P-S1M	2,647,145,000	1,367,136	204	12,976,201	6,702
Sextupoles S2PA-S2MA	1,293,255,000	667,910	96	13,471,406	6,957
Sextupoles S2PB-S2MB	199,945,000	103,263	12	16,662,083	8,605
Wigglers	12,104,755,000	6,251,584	72	168,121,597	86,828
Steering magnets arc and wiggler sect.	2,114,905,000	1,092,257	360	5,874,736	3,034
Steering magnets long straight sect.	1,347,730,000	696,044	269	5,010,149	2,588
Grand total	**44,247,335,000**	**22,851,841**			

15. Annex 1 - Tasks to be completed (I.N.F.N) within 06/12/2000

Progressive Number					Main Item	Requested Job	
1	2	3	4	5		Des.	Mag/Therm Mechan/Ver.
1					TESLA 5 GeV Damping Rings		
1	1				Damping Ring Lattice	Not	
1	2				General Lay-out	Yes	
1	2	1			D.R. Arc Tunnel Lay-out	Yes	Not
1	2	2			D.R. 8 km Conn. Tunnel Lay-out	Yes	Not
1	3				Injection/Extraction Sections	Yes	Yes
1	4				Damping Rings		
1	4	1			Magnetic Components		
1	4	1	1		Bending Dipoles	Yes	Yes
1	4	1	2		Quadrupoles	Yes	Yes
1	4	1	3		Sextupoles	Yes	Yes
1	4	1	4		Magnetic Measurements	Not	Not
1	4	1	5		Magnet Assembly	Yes	Yes
1	4	1	6		H/V Correctors	Yes	Yes
1	4	1	7		Dipole Stands and Supports	Yes	Yes
1	4	1	8		Multipole Girders/Supports	Yes	Yes
1	4	1	9		Special Magnets (Electromagnetic Wigglers)	Yes	Yes
1	4	2			Power Supply System	Not	Yes
1	4	2	1		Mains Connections	Not	Not
1	4	2	2		Med/Low Voltage Breaker	Not	Not
1	4	2	3		Med/Low Voltage Cables and Trays	Not	Yes
1	4	2	4		Electromagnetic Wiggler Power Supplies	Not	Yes
1	4	3			RF System		
1	4	3	1		RF Cryo-modules	Not	Not
1	4	3	2		RF Power Surces	Not	Not
1	4	3	3		Waveguide network system	Not	Not
1	4	3	4		Cryogenic System	Not	Not
1	4	3	5		Cooling System	Not	Not
1	4	3	6		Others (electronics, controls, interlocks, etc.)	Not	Not
1	4	4			Vacuum System		
1	4	4	1		D. R. Vacuum Chamber	Yes	Yes
1	4	4	2		Conn. Tunnel Vacuum Chamber	Not	Not
1	4	4	3		Vacuum Chamber Supports	Yes	Yes
1	4	4	4		Pumps and Power Supplies	Not	Yes
1	4	4	5		Vacuum Diagnostics	Not	Yes
1	4	4	6		Manual and Automatic Valves	Not	Yes
1	4	4	7		Control Units	Not	Yes
1	4	4	8		Special Magnets Vacuum Chamber (Wigglers)	Yes	Yes
1	4	5			Beam Diagnostics		

1	4	5	1		Fluorescent Screens	Not	Yes
1	4	5	2		Toroidal Current Transformers	Not	Yes
1	4	5	3		Wall Current Monitors	Not	Yes
1	4	5	4		DC Current Transformers	Not	Yes
1	4	5	5		BPM Button/Strip Line Monitors	Not	Yes
1	4	5	6		Beam Diagnostics Electronics	Not	Not
1	4	5	7		Emittance Measurement System	Not	Not
1	5				Computer Control System		
1	5	1			Computer Control System Hardware	Not	Not
1	5	2			Computer Control System Software	Not	Not
1	6				Electrical Services		
1	6	1			Standard Line Voltage Sources	Not	Not
1	6	2			Main Power Distribution Boards	Not	Not
1	6	3			Medium/Low Voltage Transformers	Not	Not
1	6	4			Medium Voltage Breakers	Not	Not
1	6	5			Cables and Trays	Not	Not
1	6	6			Lightning System	Not	Not
1	6	7			Emergency Lightning System	Not	Not
1	7				Process Water Facilities		
1	7	1			Cooling Towers and Anc. Equip.	Not	Not
1	7	2			Pumps, Motors and Anc. Eqiuip.	Not	Not
1	7	3			Heat Exchangers	Not	Not
1	7	4			Piping	Not	Not
1	7	5			Filters	Not	Not
1	7	6			De-ionization Units	Not	Not
1	7	7			Tanks	Not	Not
1	8				Cooling and Ventilation System (only for Arcs)	Not	Not
1	9				Compressed Air Facilities (only for Arcs)	Not	Not
1	10				Handling Equipments and Cranes (only for Arcs)	Not	Not
1	11				Tunnel Transport System (only for Arcs)	Not	Not
1	12				Alignment Facilities (only for Arcs)	Not	Not
1	13				Installation Time Schedule and Manpower	Not	Not
1	14				Fire Detection System (only for Arcs)	Not	Not
1	15				Smoke extraction system (only for Arcs)	Not	Not
1	16				Tunnel TV Monitoring (only for Arcs)	Not	Not
1	17				Tests and Acceptance Tests	Not	Not
1	18				Commissioning (with no beam)	Not	Not
1	19				Engineering and Q.A.	Not	Not

ANSALDO

Ansaldo Ricerche s.r.l.

Progetto project	Identificativo document no.
TESLA DAMPING RING	File: 0s-decimo-1 S02995UX3000L

Cliente client	Comm.-s/comm. job. no.	Emittente issued by	Pagina page	Di of
I.N.F.N.	UX3.000	ARI/TME/MTM	1	13

Rag. disc. disc.code	Rif. str. prod. prod. str. no	Identificativo componente equipment identification code	Tipo doc. doc type	Cl. ris. class	Allegati enclosures
N/A	N/A	Damping Ring	Spec di Fabbr	L	n.2

Titolo title	Derivato da derived from
HANDLING EQUIPMENT AND CRANES	Candotti Specification
	Sostituisce substitutes

Stato validita`: **Issue 22/01/2001**
rev.scope

0	22/01/2001	Issue		Barbagelata Luigi	Grattarola Marco		Rosatelli Franco
Rev. rev.	**Data** date	**Descrizione** description	**Stato valid.** rev. scope	**Redazione** prepared by	**Controllo** checked by/	**approvazione** checked by/ approved by	**Autorizzazione emissione** issue authorization

Table of contents

1. AIM

The present Manufacturing Specification aims at detailed description of both the manufacturing criteria of the «Handling Equipments and Cranes», the working materials and procedures, the required number of Suppliers/Manufacturers, the time schedule agreed upon, the number of pieces to be delivered within schedule and the overall costs of the finished product.

2. REFERENCES

The present specification invokes the following documents:

1. List of deliverables, whose version dated 06/12/2000 has been provided by INFN, item 1.10 (see Attachment 1)
2. ARI Procedure n.P0111767000L dated 13/12/1999.
3. Drawings:
   - D02954UX3000L Damping Ring General Draw.
   - D02653UX3000L Damping Ring Lay-out 1
   - D02654UX3000L Damping Ring Lay-out 2
   - D02655UX3000L Damping Ring Lay-out 3
   - D02656UX3000L Damping Ring Lay-out 4
   - D02657UX3000L Damping Ring Lay-out 5

3. COMPONENTS

1. Monorail

N.° 1, 1354m-long for each Damping Ring Tesla Lobe

regions: all, excluding ±L2A MATCH e LONG CELL

2. Monorail Electric Trolleys

N.° 3 per pit (2) for each Damping Ring Tesla Lobe
(Total = 6/Lobo)

3. Shunting Electric Trolleys

N.° 1 per pit (2) for each Damping Ring Tesla Lobe
(Total = 2/Lobo)

4. External Bidge Cranes

N.° 1 per pit (2) for each Damping Ring Tesla Lobe
(Total = 2/Lobo)

5. Mobile Platforms

N.° 1 per pit (2) for each Damping Ring Tesla Lobe
(Total = 2/Lobo)

4. MACHINING PERFORMANCES

- Monorails are made of electro-welded bar. They are equipped with anchorage to the ceiling, as well as of (380/400 Vac) blindotrolly electric line.

- Monorail Trolleys are described in the Specification S02996UX3000L – Tunnel Transport System.

- Rail Electric Trolleys slide on 20m-long, ~2000mm-gauge rails with 6000x2500mm supporting plane and 50t capacity. Trolleys are equipped with 20m/min-speed gearmotors. Spring cable wheel power supply.

  50t-capacity, 12000mm-range, cab-controlled Bridge Cranes are positioned at pit openings. Runway length is 30m. Hook upstroke is 8m. above and 15m below runway plane respectively. Lifting speed, trolley traverse speed and crane sliding speed are 4/0,4 m/min., 20/5 m/min. and 20/5 m/min. respectively. A cable wheel is suitably positioned for both power supply and runways.

- Mobile Platform lay-out is shown in Attachment 2.. Mobile Platforms carry a «Monorail Trolley» with its load on the overhung «Monorail» in the tunnel. They provide also storage of the «Monorail Trolleys», when the tunnel is closed and the Damping Ring line is on duty.

5. MACHINING

5.1 MATERIALS

We envisage **FE430** steel as the manufacturing material of everything but the bar to be included in the the concrete casting, which is made of **HALFEN** steel. Screws and bolts are made of **Acc. 8.8.**.

5.2 STATE OF DELIVERY

«Turnkey» delivery of the fully equipped plant includes both transport, assembly and operation tests.

5.3. TESTS

We envisage testing of each component at Manifacturer's location for acceptance before shipping, according to ISO 9000

5.4. OTHERS

All ferrous surfaces will undergo «strong» burnishing in order to prevent oxydization.

6. LOCATION. QUANTITIES

Referring to both Specification no. S02996UX3000L and to Attachment 2, envisaged quantities are:

n°	**1354m.**	Monorail bar per Lobe
n°	**3**	Monorail Trolley per pit
n°	**1**	Rail Electric Trolley per pit
n°	**1**	Bridge Crane per pit
n°	**1**	Mobile Platform per pit

7. QUANTITIES TOTAL (+spare)

Both Lobes and Pits are two:

n°	**(1354x2x1.05)=**	**2843m.**	Complete Monorail bar
n°	**3x2x2=**	**12**	Monorail Trolley
n°	**1x2x2+1(sp)=**	**5**	Rail Electric Trolley
n°	**1x2x2=**	**4**	Bridge Crane
n°	**1x2x2=**	**4**	Mobile Platform

8. DELIVERY TIME and COST

«Time Schedule for the Constructions (Ref. To Spec. S02957UX3000L)» encompasses 18 months. The Constructor, one turn-key Supplier, guaranteed on-site final delivery in due time, as listed below:

HANDLING EQUIPMENTS AND CRANES

CONS. N.	# PLANNING (months) MONTHS	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	PIECES TOT.	COST (Mlire)	TOTAL (Euro)
	COMPONENT	(PIECES X MONTH)																					
1	Monorail	+				475		475		475		475		475		468					2.843		
	Shaped Monorail	+										2	2	2	2	2	2				12		
	Rail Elect.l Truck	+						1			1		1		1						5		
	Bridge Crane	+			2			2													4		
	Wolking Platform	+					2			2											4		
	Handling Equip-ment and Cranes																					5.150	2.659.753
	Order First Supply	(+) (#)																					
	GRAND TOTAL																					5.150	2.659.753

9. 1 ATTACHMENT 1

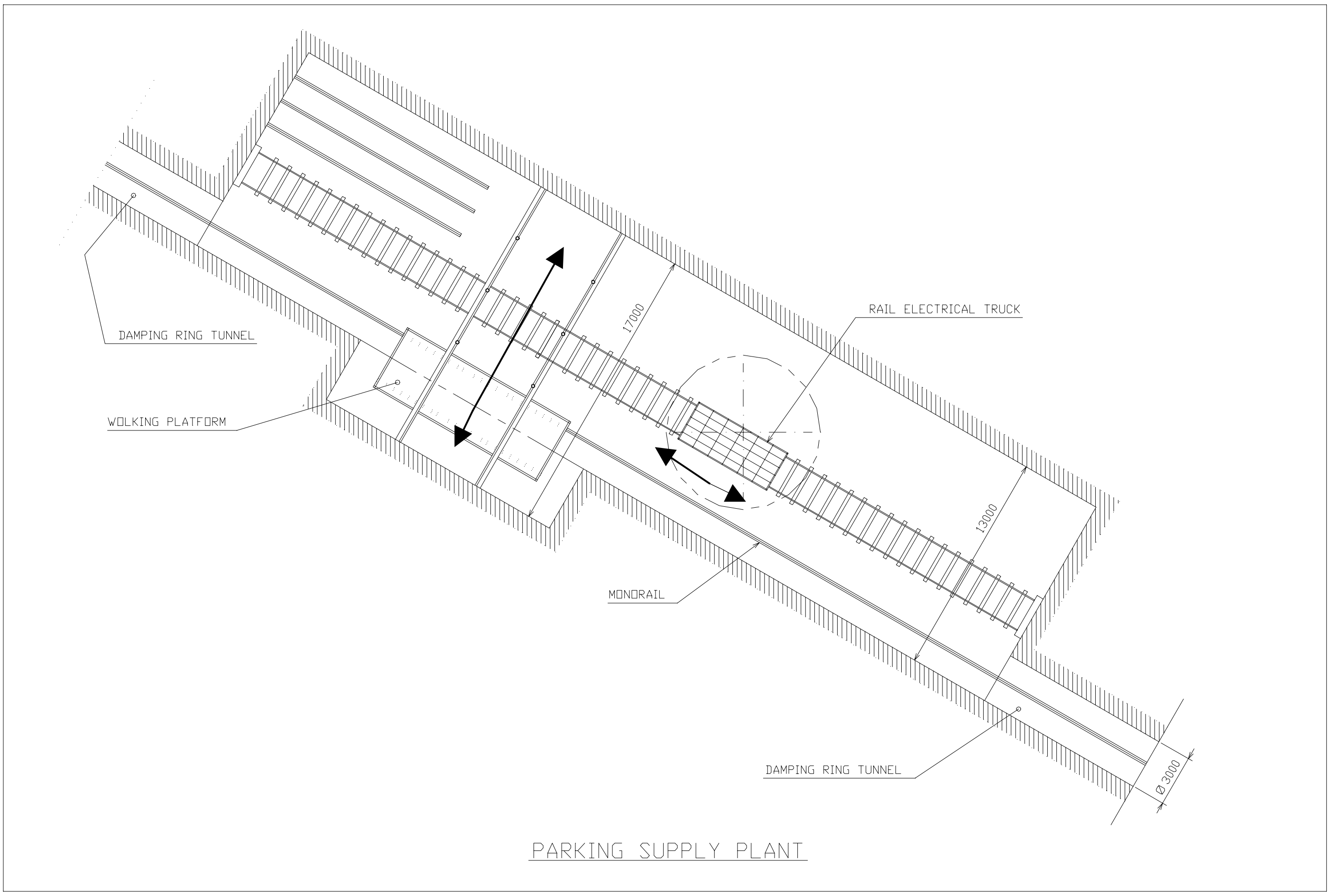
9.1 Attachment 1: Tasks to be completed (I.N.F.N.) within 06/12/2000

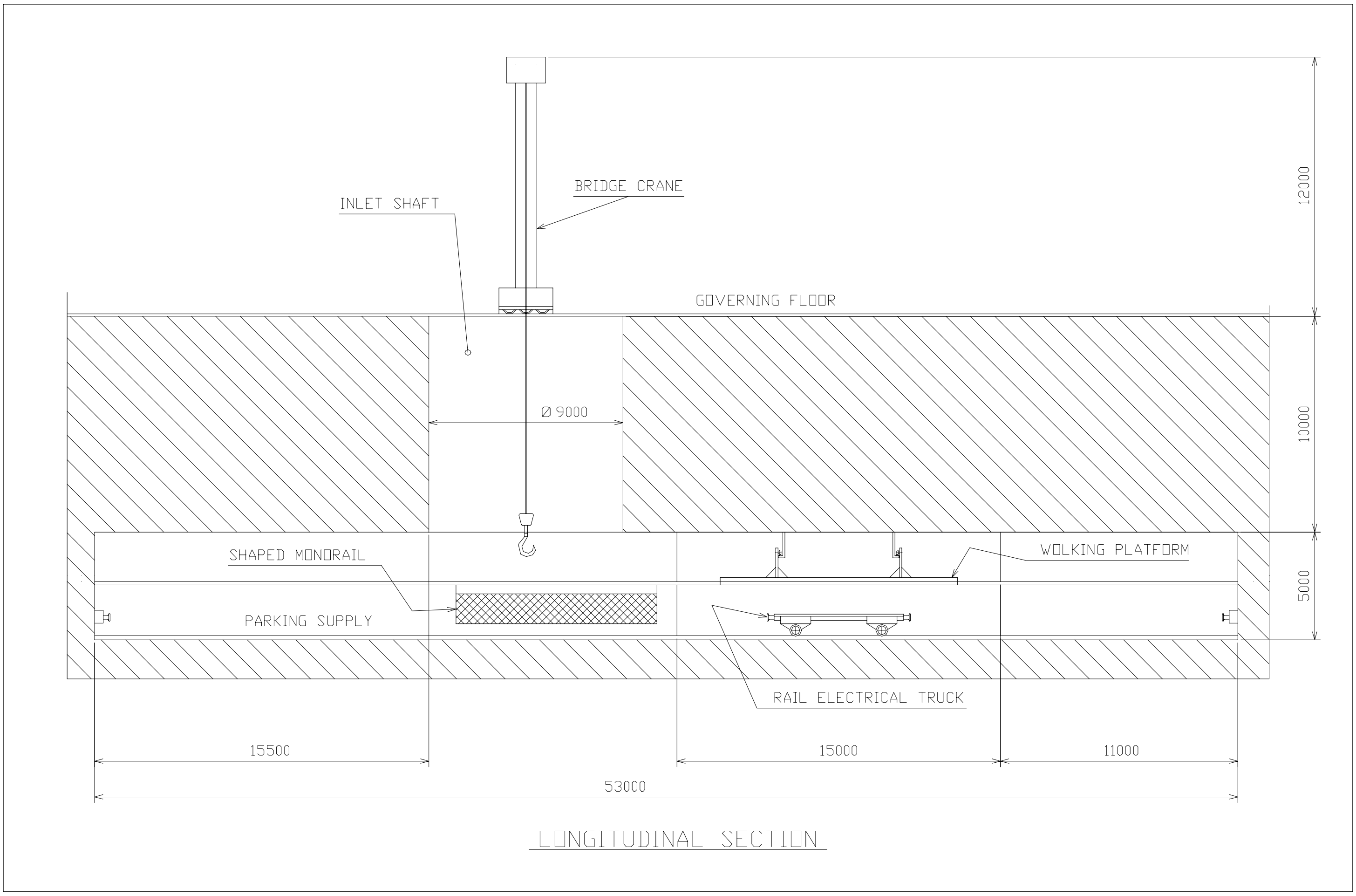
Progressive Number					Main Item	Requested Job	
1	2	3	4	5		Des.	Mag/Therm Mechan/Ver.
1					TESLA 5 GeV Damping Rings		
1	1				Damping Ring Lattice	Not	
1	2				General Lay-out	Yes	
1	2	1			D.R. Arc Tunnel Lay-out	Yes	Not
1	2	2			D.R. 8 km Conn. Tunnel Lay-out	Yes	Not
1	3				Injection/Extraction Sections	Yes	Yes
1	4				Damping Rings		
1	4	1			Magnetic Components		
1	4	1	1		Bending Dipoles	Yes	Yes
1	4	1	2		Quadrupoles	Yes	Yes
1	4	1	3		Sextupoles	Yes	Yes
1	4	1	4		Magnetic Measurements	Not	Not
1	4	1	5		Magnet Assembly	Yes	Yes
1	4	1	6		H/V Correctors	Yes	Yes
1	4	1	7		Dipole Stands and Supports	Yes	Yes
1	4	1	8		Multipole Girders/ Supports	Yes	Yes
1	4	1	9		Special Magnets (Electromagnetic Wigglers)	Yes	Yes
1	4	2			Power Supply System	Not	Yes
1	4	2	1		Mains Connections	Not	Not
1	4	2	2		Med/Low Voltage Breaker	Not	Not
1	4	2	3		Med/Low Voltage Cables and Trays	Not	Yes
1	4	2	4		Electromagnetic Wiggler Power Supplies	Not	Yes
1	4	3			RF System		
1	4	3	1		RF Cryo-modules	Not	Not
1	4	3	2		RF Power Surces	Not	Not
1	4	3	3		Waveguide network system	Not	Not
1	4	3	4		Cryogenic System	Not	Not
1	4	3	5		Cooling System	Not	Not
1	4	3	6		Others (electronics, controls, interlocks, etc.)	Not	Not
1	4	4			Vacuum System		
1	4	4	1		D. R. Vacuum Chamber	Yes	Yes
1	4	4	2		Conn. Tunnel Vacuum Chamber	Not	Not
1	4	4	3		Vacuum Chamber Supports	Yes	Yes
1	4	4	4		Pumps and Power Supplies	Not	Yes
1	4	4	5		Vacuum Diagnostics	Not	Yes

1	4	4	6		Manual and Automatic Valves	Not	Yes
1	4	4	7		Control Units	Not	Yes
1	4	4	8		Special Magnets Vacuum Chamber (Wigglers)	Yes	Yes
1	4	5			Beam Diagnostics		
1	4	5	1		Fluorescent Screens	Not	Yes
1	4	5	2		Toroidal Current Transformers	Not	Yes
1	4	5	3		Wall Current Monitors	Not	Yes
1	4	5	4		DC Current Transformers	Not	Yes
1	4	5	5		BPM Button/Strip Line Monitors	Not	Yes
1	4	5	6		Beam Diagnostics Electronics	Not	Not
1	4	5	7		Emittance Measurement System	Not	Not
1	5				Computer Control System		
1	5	1			Computer Control System Hardware	Not	Not
1	5	2			Computer Control System Software	Not	Not
1	6				Electrical Services		
1	6	1			Standard Line Voltage Sources	Not	Not
1	6	2			Main Power Distribution Boards	Not	Not
1	6	3			Medium/Low Voltage Transformers	Not	Not
1	6	4			Medium Voltage Breakers	Not	Not
1	6	5			Cables and Trays	Not	Not
1	6	6			Lightning System	Not	Not
1	6	7			Emergency Lightning System	Not	Not
1	7				Process Water Facilities		
1	7	1			Cooling Towers and Anc. Equip.	Not	Not
1	7	2			Pumps, Motors and Anc. Eqiuip.	Not	Not
1	7	3			Heat Exchangers	Not	Not
1	7	4			Piping	Not	Not
1	7	5			Filters	Not	Not
1	7	6			De-ionization Units	Not	Not
1	7	7			Tanks	Not	Not
1	8				Cooling and Ventilation System (only for Arcs)	Not	Not
1	9				Compressed Air Facilities (only for Arcs)	Not	Not
1	10				Handling Equipments and Cranes (only for Arcs)	Not	Not
1	11				Tunnel Transport System (only for Arcs)	Not	Not
1	12				Alignment Facilities (only for Arcs)	Not	Not
1	13				Installation Time Schedule and Manpower	Not	Not
1	14				Fire Detection System (only for Arcs)	Not	Not
1	15				Smoke extraction system (only for Arcs)	Not	Not
1	16				Tunnel TV Monitoring (only for Arcs)	Not	Not
1	17				Tests and Acceptance Tests	Not	Not
1	18				Commissioning (with no beam)	Not	Not
1	19				Engineering and Q.A.	Not	Not

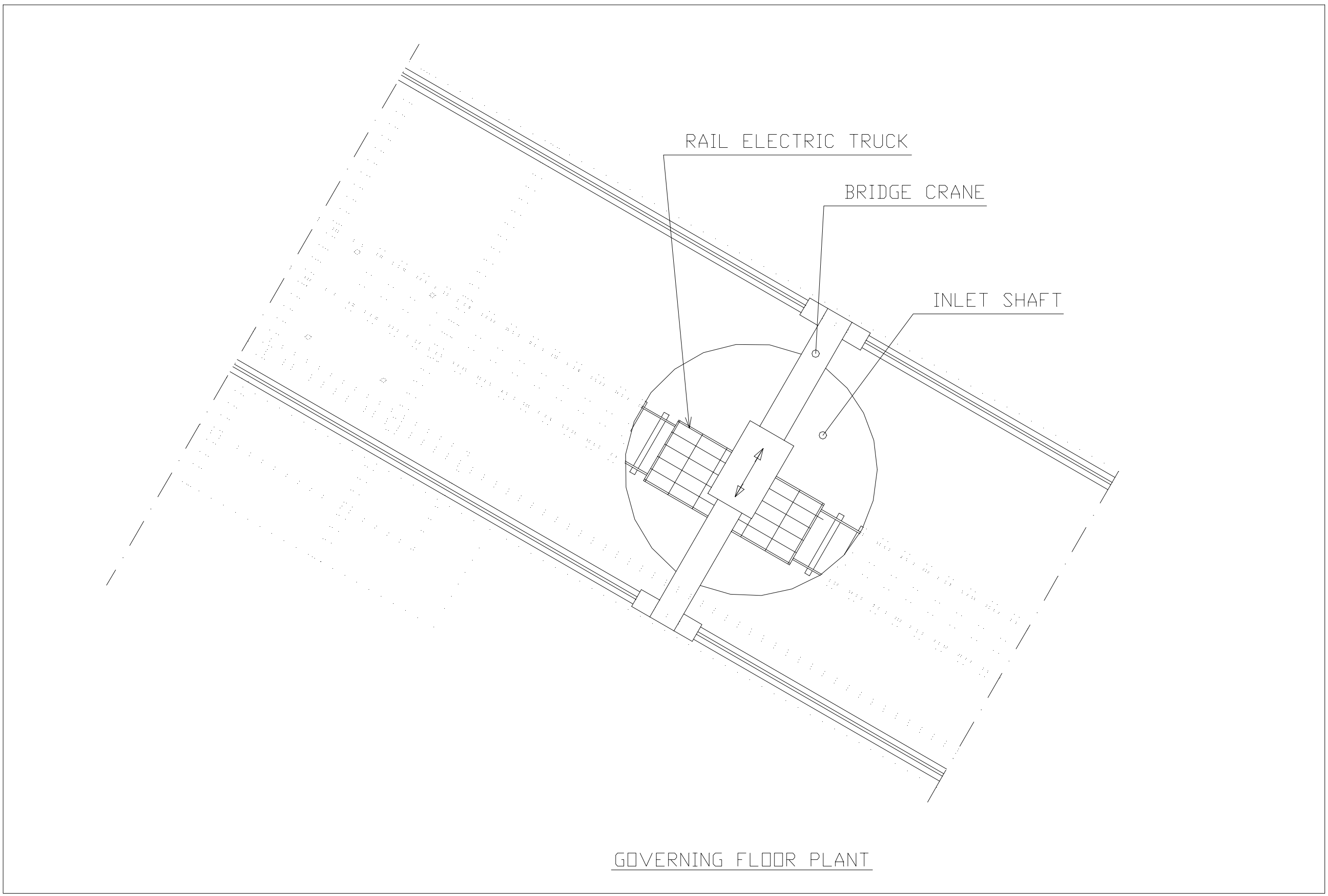
9. 2 ATTACHMENT 2

9.2 Attach. 2: Parking Supply Layout (Discharge, Sling and Material Handling)





BRIDGE CRANE
INLET SHAFT
GOVERNING FLOOR
Ø 9000
12000
10000
5000
SHAPED MONORAIL
WOLKING PLATFORM
PARKING SUPPLY
RAIL ELECTRICAL TRUCK
15500
15000
11000
53000
LONGITUDINAL SECTION



RAIL ELECTRIC TRUCK
BRIDGE CRANE
INLET SHAFT
GOVERNING FLOOR PLANT

ANSALDO

Ansaldo Ricerche s.r.l.

Progetto project	**Identificativo** document no.
TESLA DAMPING RING	File: 0s-undici-1 **S02996UX3000L**

Cliente client	**Comm.-s/comm.** job. no.	**Emittente** issued by	**Pagina** page	**Di** of
I.N.F.N.	**UX3.000**	**ARI/TME/MTM**	**1**	**12**

Rag. disc. disc.code	**Rif. str. prod.** prod. str. no	**Identificativo componente** equipment identification code	**Tipo doc.** doc type	**Cl. ris.** class	**Allegati** enclosures
N/A	**N/A**	**Damping Ring**	**Spec di Fabbr**	**L**	**n.2**

Titolo title	**Derivato da** derived from
TUNNEL TRANSPORT SYSTEM	Candotti Specification
	Sostituisce substitutes

Stato validita`: rev.scope **Issue 25/01/2001**

0	25/01/2001	Issue		Barbagelata Luigi	Grattarola Marco		Rosatelli Franco
Rev. rev.	**Data** date	**Descrizione** description	**Stato valid.** rev. scope	**Redazione** prepared by	**Controllo** checked by/	**approvazione** checked by/ approved by	**Autorizzazione emissione** issue authorization

Table of contents

1. AIM

The present Manufacturing Specification aims at detailed description of both the manufacturing criteria of the «Tunnel Transport System», the working materials and procedures, the required number of Suppliers/Manufacturers, the time schedule agreed upon, the number of pieces to be delivered within schedule and the overall costs of the finished product.

2. REFERENCES

The present specification invokes the following documents:

1. List of deliverables, whose version dated 06/12/2000 has been provided by INFN, item 1.11 (see Attachment 1)
2. ARI Procedure n.P0111767000L dated 13/12/1999.
3. ARI Delivery Specification no. S02995UX3000L
4. Drawings:
   - D02954UX3000L Damping Ring General Draw.
   - D02653UX3000L Damping Ring Lay-out 1
   - D02654UX3000L Damping Ring Lay-out 2
   - D02655UX3000L Damping Ring Lay-out 3
   - D02656UX3000L Damping Ring Lay-out 4
   - D02657UX3000L Damping Ring Lay-out 5
   - D02955UX3000L Damping Ring – Tunnel Trolley Particular -

3. COMPONENTS

1. Monorail Electric Trolleys

N.° 3 per pit (2) for each Damping Ring Tesla Lobe
(Total = 6/Lobe)

2. Damping Ring Tesla Tunnel

As for the Inner Tunnel Component Lay-out, see Fig.2 of Attachment 2 .

4. MACHINING PERFORMANCES

- Each Monorail Trolley is equipped with two electric 5000Kg-capacity tackle. In turn, the latter are equipped with remotely-fed push-button strip. Lifting speed is 1m/min. Trolleys are equipped with electric traverse mechanisms with adjustable 50-5m/min speed.
  Train-like anchorage of several platforms is allowed behind tackle support, for transport of both tools and people.
  The trolley itself carries its own control system; the latter allows manned control of the motion.
  Both autonomous lighting, side guards and a spring-lever assure in-motion safety; the lever is positioned on the trolley itself and allows speed adjustment. (see Attachment 2 pag.1)

5. MACHINING

5.1 MATERIALS

We envisage **FE430** steel as the manufacturing material of everything but screws and bolts, which are made of **Acc. 8.8.**.

5.2 STATE OF DELIVERY

«Turnkey» delivery of the fully equipped plant includes both transport, assembly and operation tests.

5.3. TESTS

We envisage testing of each component at Manifacturer's location for acceptance before shipping, according to ISO 9000

5.4. OTHERS

All ferrous surfaces will undergo «strong» burnishing in order to prevent oxydization. Painting requirements will be assessed on site.

6. LOCATION. QUANTITIES

Referring to both the Specification no.S02996UX3000L and the Attachment 2, envisaged quantities are:

n° **3** Monorail Trolleys per pit

7. TOTAL QUANTITIES (+spare)

Both Lobes and Pits are two:

n **3x2x2=12** Monorail Trolleys

8. DELIVERY TIME and COST

«Time Schedule for the Constructions (Ref. To Spec. S02957UX3000L)» encompasses 18 months (see Spec. S02957UX3000L). The Constructor, one turn-key Supplier, guaranteed final on-site delivery in due time, as listed below:

HANDLING EQUIPMENTS AND CRANES

CONS. N.	# PLANNING (months) MONTHS	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	PIECES TOT.	COST (Mlire)	TOTAL (Euro)
	COMPONENT	(PIECES X MONTH)																					
1	Monorail	+				475		475		475		475		475		468					2.843		
	Shaped Monorail	**+**										**2**	**2**	**2**	**2**	**2**	**2**				**12**		
	Rail Elect.l Truck	+						1			1		1		1						5		
	Bridge Crane	+			2			2													4		
	Wolking Platform	+					2			2											4		
	Handling Equip-ment and Cranes																				See Spec. S02995UX3000L		
	Order	(+)																					
	First Supply	(#)																					
	GRAND TOTAL																				See Spec. S02995UX3000L		

9. 1 ATTACHMENT 1

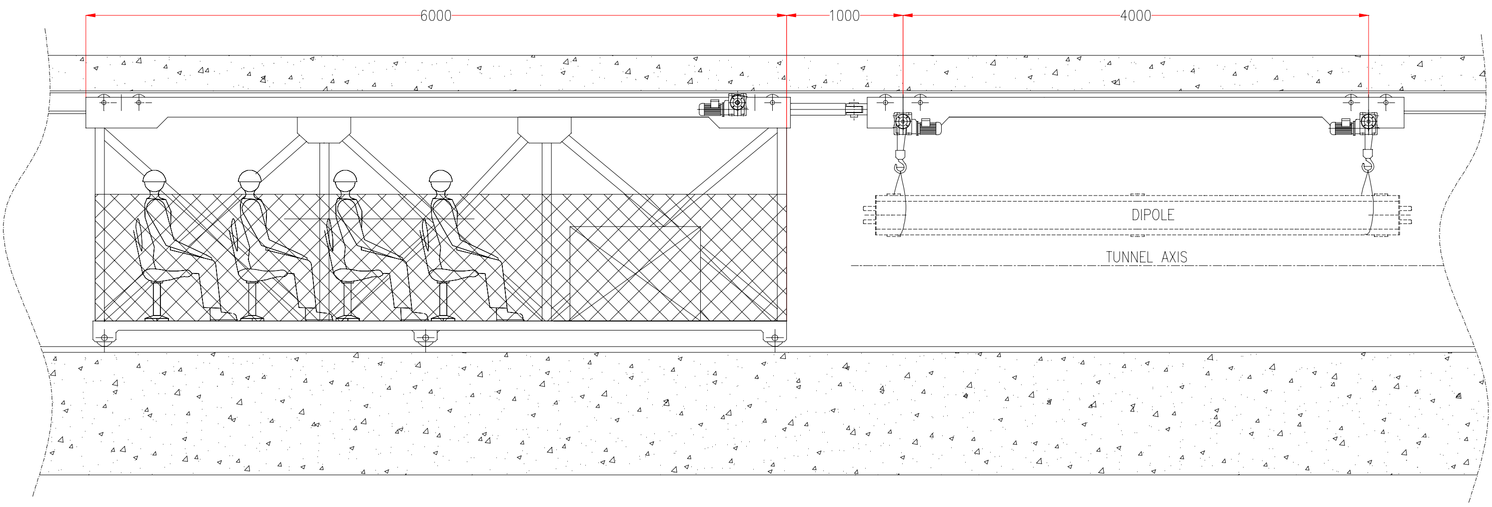
9.1 Attachment 1: Tasks to be completed (I.N.F.N.) within 06/12/2000

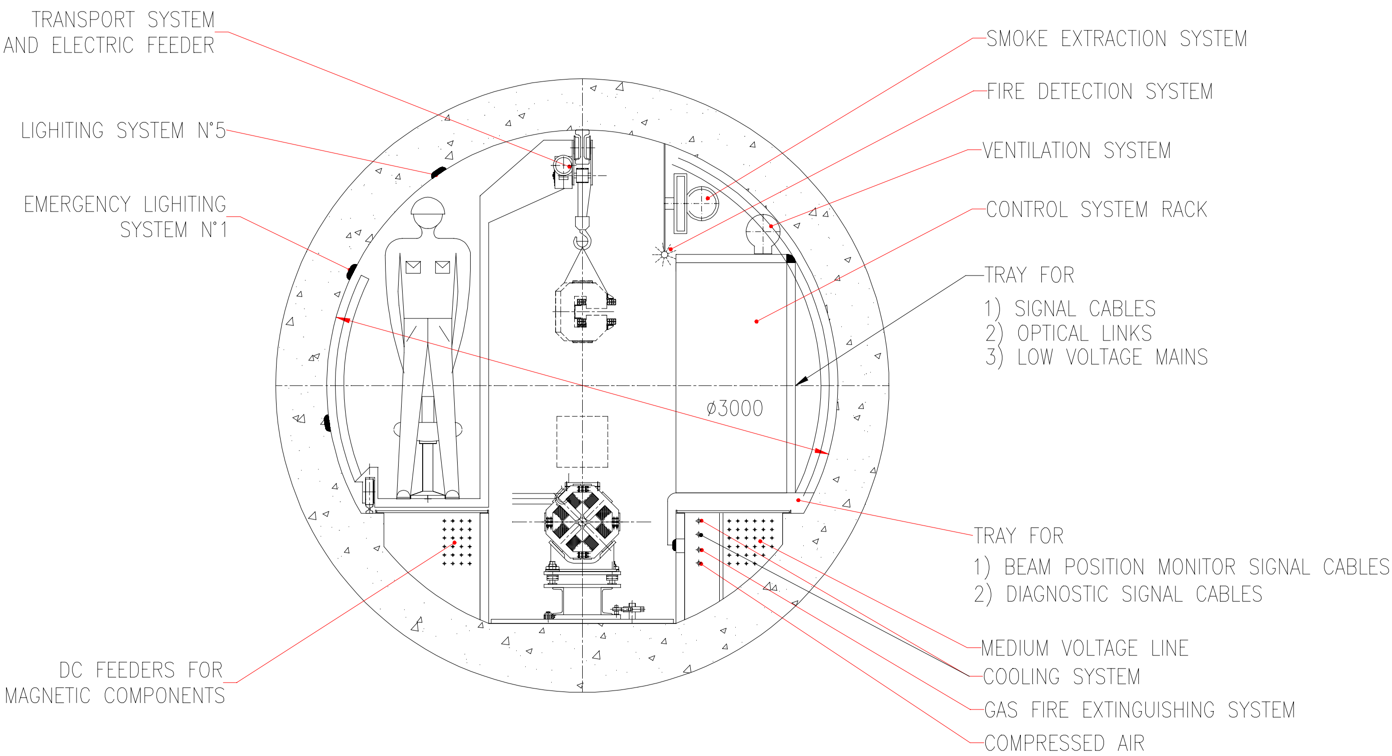
Progressive Number					Main Item	Requested Job	
1	2	3	4	5		Des.	Mag/Therm Mechan/Ver.
1					TESLA 5 GeV Damping Rings		
1	1				Damping Ring Lattice	Not	
1	2				General Lay-out	Yes	
1	2	1			D.R. Arc Tunnel Lay-out	Yes	Not
1	2	2			D.R. 8 km Conn. Tunnel Lay-out	Yes	Not
1	3				Injection/Extraction Sections	Yes	Yes
1	4				Damping Rings		
1	4	1			Magnetic Components		
1	4	1	1		Bending Dipoles	Yes	Yes
1	4	1	2		Quadrupoles	Yes	Yes
1	4	1	3		Sextupoles	Yes	Yes
1	4	1	4		Magnetic Measurements	Not	Not
1	4	1	5		Magnet Assembly	Yes	Yes
1	4	1	6		H/V Correctors	Yes	Yes
1	4	1	7		Dipole Stands and Supports	Yes	Yes
1	4	1	8		Multipole Girders/ Supports	Yes	Yes
1	4	1	9		Special Magnets (Electromagnetic Wigglers)	Yes	Yes
1	4	2			Power Supply System	Not	Yes
1	4	2	1		Mains Connections	Not	Not
1	4	2	2		Med/Low Voltage Breaker	Not	Not
1	4	2	3		Med/Low Voltage Cables and Trays	Not	Yes
1	4	2	4		Electromagnetic Wiggler Power Supplies	Not	Yes
1	4	3			RF System		
1	4	3	1		RF Cryo-modules	Not	Not
1	4	3	2		RF Power Surces	Not	Not
1	4	3	3		Waveguide network system	Not	Not
1	4	3	4		Cryogenic System	Not	Not
1	4	3	5		Cooling System	Not	Not
1	4	3	6		Others (electronics, controls, interlocks, etc.)	Not	Not
1	4	4			Vacuum System		
1	4	4	1		D. R. Vacuum Chamber	Yes	Yes
1	4	4	2		Conn. Tunnel Vacuum Chamber	Not	Not
1	4	4	3		Vacuum Chamber Supports	Yes	Yes
1	4	4	4		Pumps and Power Supplies	Not	Yes
1	4	4	5		Vacuum Diagnostics	Not	Yes

1	4	4	6		Manual and Automatic Valves	Not	Yes
1	4	4	7		Control Units	Not	Yes
1	4	4	8		Special Magnets Vacuum Chamber (Wigglers)	Yes	Yes
1	4	5			Beam Diagnostics		
1	4	5	1		Fluorescent Screens	Not	Yes
1	4	5	2		Toroidal Current Transformers	Not	Yes
1	4	5	3		Wall Current Monitors	Not	Yes
1	4	5	4		DC Current Transformers	Not	Yes
1	4	5	5		BPM Button/Strip Line Monitors	Not	Yes
1	4	5	6		Beam Diagnostics Electronics	Not	Not
1	4	5	7		Emittance Measurement System	Not	Not
1	5				Computer Control System		
1	5	1			Computer Control System Hardware	Not	Not
1	5	2			Computer Control System Software	Not	Not
1	6				Electrical Services		
1	6	1			Standard Line Voltage Sources	Not	Not
1	6	2			Main Power Distribution Boards	Not	Not
1	6	3			Medium/Low Voltage Transformers	Not	Not
1	6	4			Medium Voltage Breakers	Not	Not
1	6	5			Cables and Trays	Not	Not
1	6	6			Lightning System	Not	Not
1	6	7			Emergency Lightning System	Not	Not
1	7				Process Water Facilities		
1	7	1			Cooling Towers and Anc. Equip.	Not	Not
1	7	2			Pumps, Motors and Anc. Eqiuip.	Not	Not
1	7	3			Heat Exchangers	Not	Not
1	7	4			Piping	Not	Not
1	7	5			Filters	Not	Not
1	7	6			De-ionization Units	Not	Not
1	7	7			Tanks	Not	Not
1	8				Cooling and Ventilation System (only for Arcs)	Not	Not
1	9				Compressed Air Facilities (only for Arcs)	Not	Not
1	10				Handling Equipments and Cranes (only for Arcs)	Not	Not
1	11				Tunnel Transport System (only for Arcs)	Not	Not
1	12				Alignment Facilities (only for Arcs)	Not	Not
1	13				Installation Time Schedule and Manpower	Not	Not
1	14				Fire Detection System (only for Arcs)	Not	Not
1	15				Smoke extraction system (only for Arcs)	Not	Not
1	16				Tunnel TV Monitoring (only for Arcs)	Not	Not
1	17				Tests and Acceptance Tests	Not	Not
1	18				Commissioning (with no beam)	Not	Not
1	19				Engineering and Q.A.	Not	Not

9. 2 ATTACHMENT 2

9.2 Attach. 2: Shaped Monorail (Particulary) and Tunnel





TRANSPORT SYSTEM AND ELECTRIC FEEDER
LIGHTING SYSTEM N°5
EMERGENCY LIGHTING SYSTEM N°1
DC FEEDERS FOR MAGNETIC COMPONENTS
SMOKE EXTRACTION SYSTEM
FIRE DETECTION SYSTEM
VENTILATION SYSTEM
CONTROL SYSTEM RACK
TRAY FOR
1) SIGNAL CABLES
2) OPTICAL LINKS
3) LOW VOLTAGE MAINS
ø3000
TRAY FOR
1) BEAM POSITION MONITOR SIGNAL CABLES
2) DIAGNOSTIC SIGNAL CABLES
MEDIUM VOLTAGE LINE
COOLING SYSTEM
GAS FIRE EXTINGUISHING SYSTEM
COMPRESSED AIR

ANSALDO

Ansaldo Ricerche s.r.l.

Progetto project	Identificativo document no.
TESLA DAMPING RING	File: 0s-sedici-1 S03004UX3000L

Cliente client	Comm.-s/comm. job. no.	Emittente issued by	Pagina page	Di of
I.N.F.N.	UX3.000	ARI/TME/MTM	1	12

Rag. disc. disc.code	Rif. str. prod. prod. str. no	Identificativo componente equipment identification code	Tipo doc. doc type	Cl. ris. class	Allegati enclosures
N/A	N/A	Damping Ring	S	L	n.1

Titolo title	Derivato da derived from
- ENGINEERING AND Q.A. - - INSTALLATION TIME SCHEDULE AND MANPOWER -	Sostituisce substitutes

Stato validita`: rev.scope **Issue 19/02/2001**

Rev. rev.	Data date	Descrizione description	Stato valid. rev. scope	Redazione prepared by	Controllo checked by/	approvazione checked by/ approved by	Autorizzazione emissione issue authorization
0	19/02/2001	Issue		Barbagelata Luigi	Grattarola Marco		Rosatelli Franco

Table of contents

1. AIM

The present Manufacturing Specification aims at:

1. Detailed description of the Task Time Schedule agreed upon with the Customer, down to hour-by-hour level.

5. REFERENCES

The present specification invokes the following documents:

1. List of deliverables, whose version dated 22/11/99 has been provided by INFN. (Attachment 1)
2. Tesla Conceptual Design Report
3. ARI Procedure no.P0111767000L dated 13/12/99.
4. ARI Specification no. S02957UX3000L « Time Schedule for the Construction of Damping Ring Tesla»
5. ARI Manufacturing Specifications:
   n.° S02993UX3000L referring to « Magnets» ref.n. INFN 1.4.1
   n.°S02958UX3000L referring to « Multipole Girders/Support» ref.n. INFN 1.4.1.8
   n.° S02975UX3000L referring to « D.R. Vacuum Chambre» ref.n. INFN 1.4.4.1
   n.° S02977UX3000L referring to « Vacuum Chamber Supports» ref.n. INFN 1.4.4.3
   n.° S02982UX3000L referring to « Special Magnets V. C. (Wigglers)» ref.n. INFN 1.4.4.8
   n.° S02983UX3000L referring to « Beam Diagnostics» ref.n. INFN 1.4.5

6. Supply Specifications:
   n.° S03006UX3000L referring to « Magnet Power Supplies» ref.n. INFN 1.4.2
   n.° S02978UX3000L referring to « Pumps and Power Supplies» ref.n. INFN 1.4.4.4
   n.° S02979UX3000L referring to « Vacuum Diagnostic» ref.n. INFN 1.4.4.5
   n.° S02980UX3000L referring to « Manual and Automatic Valves» ref.n. INFN 1.4.4.6
   n.° S02981UX3000L referring to « Control Units» ref.n. INFN 1.4.4.7
   n.° S02991UX3000L referring to « General Services» ref.n. INFN 1.6÷1..9-1.14-1.15
   n.° S02995UX3000L referring to « Handling Equipment and Cranes» ref.n. INFN 1.10
   n.° S02996UX3000L referring to « Tunnel Transport System» ref.n. INFN 1.11
   n.° S03003UX3000L referring to « Alignement Facilities» ref.n. INFN 1.12
   n.° S03007UX3000L referring to « Test and Acceptance Tests» ref.n. INFN 1.17

7. Manpower Specifications:
   n.° S03004UX3000L referring to « Installation Time Schedule and Manpower / Engineering and Q.A .» ref.n. INFN 1.131.19

3. TASKS

3.1. As for item 1.19 (see Attachment 1), «**Engineering**» , Ari envisaged:

ENGINEERING				
		hours		
S02957UX3000L sheet 4 (Time Schedule)		Elect. Wigglers	Site	Lab. In Ge.
4	1242days (total) x 16h (2E)	19.872	x	x
5	390days x 24h (2E+1D)	9.360		x
6-7	262+284days x 16h (2d+1dE+1dH)	8.736		x
8	556days x 16h (2t)	8.896	x	x
Total		**46.864**		

3.2 As for item 1.13 (see Attachment 1), « **Manpower**» engaged in **Installation Time Schedule**, (we refer to Spec. S02957UX3000L), ARI envisaged:

Ref. to S02957UX3000L sheet 4 (Time Schedule)		Task	Envisaged engagement per task	TOT.
51		**TUNNEL DATA ALIGNMENT**	Estimations	(hours)
1		Satellite Collimations(GPS) with search of coordinates. Surface Marker Installation	(n°12x2Lobe) x10h /each	240
2		Optical and/or gravitational data transfer into the tunnel inner region	(n°12x2Lobe) x20h /each	480
3		In-tunnel Marker installation (120mt) – Reference rod clamping and measurement	(n°12x2Lobe) x8h /each	192
4		Clamping, Distinvar meaurements, Theodolite Collimations, various in-tunnel checks of line data (20mt)	(n°68x2Lobe) x12h /each	1632
5		Check of base plates (alternately positioned each per meter). Various checks and measurements	(n°677x2Lobe) x1h /each	1354
Grand Total				**3.898**

Ref. to S02957UX3000L sheet 4 (Time Schedule)		Task	Envisaged engagement per task	TOT.
52		**DIPOLES, WIGGLERS on SITE ASSEMBLY**	Estimations	(hours)
1		Alignment Board Sling and Transport (no°2 per time)	((216+72)/2) x3h	432
2		Sling and Transport of Dipoles and Wigglers	(216+72) x6h	1728
3		Assembly and Setting of the Electromagnet on the Girder and, then, on the Base Plate	(216+72) x12h	3456
4		Sling and Transport of Vacuum Chambers CVW and CVD (no°3 per time)	((216+72)/3 x3h	288
		Assembly of Vacuum Chambers CVW and CVD. Setting, orientation and alignment of Shims	(216+72) x8h	2304
		Grand Total		**8.208**

Ref. to S02957UX3000L sheet 4 (Time Schedule)		Task	Envisaged engagement per task	TOT.
53		**MULTIPOLES, VACUUM SYSTEM ASS.LY and ALIGNMENT on GIRDERS in LAB.RY**	Estimations	(hours)
Assembly	1	Magnets (excluding both Dipoles and Wigglers)	1161x2.5h	2902
	2	Vacuum Chambers (excluding both CVD and CVW)	3009x0.5h	1505
	3	Pumps	6405x1h	6405
	4	Supports (in the Arc region)	(1300x2)x0.5h	1300
		Total		**12.112**
Alignment	1	Magnets (Quadrupoles) (no.3 attempts)	(849x1.5h)x3	3820
	2	Magnets (Sextupoles) (no.3 attempts)	(312x1.5h)x3	1404
	3	Vacuum Chambers (Quadrupoles)	849x1h	849
	4	Vacuum Chambers (Sextupoles)	312x1h	312
	5	Vacuum Chambers (Generic)	1848x1h	1848
		Total		**8.233**
		Grand Total		**20.345**

Ref. to S02957UX3000L sheet 4 (Time Schedule)		Task	Envisaged engagement per task	TOT.
54		**MULTIPOLE GIRDERS on SITE ASSEMBLY**	Estimations	(hours)
1		On-plate assembled magnets D2808/09UX3000L (excluding «Long Cell» region)	(892/2)x2.5h	1115
2		On-plate assembled magnets D2808UX3000L sheet 2 (excluding «Arc Cell» regions)	(269)x2.5h	673
3		Sections D2693UX3000L (T7) with pumps and auxiliaries to be on-plate assembled D2808UX3000L sheet 2	1876x3h	5628
		Sections D2693UX3000L (T7) for on-plate assembly of inferior supports D2808UX3000L sheet 2	(1876x2)x1h	3752
Grand Total				**11.168**

Ref. to S02957UX3000L sheet 4 (Time Schedule)		Task	Whitout Electromagnetic Wigglers	With Electromagnetic Wigglers
55		**GENERIC ASSEMBLY**	(hours)	(hours)
	1.7.1	Cooling Towers and Anc. Equip.	1160	1624
	1.7.2	Pumps, Motors and Anc. Equip.	1720	2416
	1.7.3	Heat Exchangers	889	1457
	1.7.4	Piping	122392	134224
	1.7.5	Filters	300	436
	1.7.6	De-Ionization Units	240	240
	1.7.7	Tanks	284	444
1.7	**Tot.**	**Process Water Facilities**	**126.985**	**140.841**
1.8	**Tot.**	**Cooling and Ventilation Systems**	**5.856**	**8.416**
1.9	**Tot.**	**Compressed Air Facilities**	**3.628**	**3.628**
1.14	**Tot.**	**Fire Detection Systems**	**16.630**	**16.630**
1.15	**Tot**	**Smoke Extraction Systems**	**768**	**768**
Grand Total			**153.867**	**170.283**

Ref. to		Task	GE (General Electric) N.1 Constr.	SI (Siemens) N.1 Constr.	SI (Siemens) N.1 Constr.
S02957UX3000L sheet 4 (Time Schedule) **56**		**CONTROL UNITS - In the LABORATORY ASSEMBLY (P.L.C. Assembly, Cabling, SW, etc) -**	(hours)	(hours)	(hours)
1		Assembly of Net Masters	n.2x24h=48	n.2x24h=48	n.1x24h=24
2		P.L.C. Assembly and Commissioning	n.87x16h= 1392 n.1t x 0.6y=1020	n.87x16h= 1392 n.1t x 0.6y=1020	n.87x16h= 1392 n.1t x 0.6y=1020
3		Assembly of Boxes	n.87x2oc x 4h= 696	n.87x2oc x 4h= 696	n.85x2oc x 4h= 680
4		Assembly and Setting of electric Auxiliaries inside Boxes	n.87x2oc x 24h= 4176	n.87x2oc x 24h= 4176	n.85x2oc x 24h= 4080
5		Setting of both Wires and Cables	1oc x 0.5y=850	1oc x 0.5y=850	1oc x 0.5y=850
6		Software Setting and Check	1t x 0.7y=1190	1t x 0.5y=850	1t x 0.3y=510
Grand Total				**26.928**	

Ref. to	Task	GE (General Electric) N.1 Constr.	SI (Siemens) N.1 Constr.	SI (Siemens) N.1 Constr.
S02957UX3000L sheet 4 (Time Schedule) **57**	**P.L.C. CONTROL UNITS ASSEMBLY on the SITE**	(hours)	(hours)	(hours)
1	Setting of both Net Masters and Eternet line in the Control Room	n1T x n.2 x 24h= 48	n1T x n2 x 24h= 48	n.1T x n1 x 24h= 24
2	Connecting all input/output	2oc x n.87 x 120 x 2 x 0.125h= 5220	1oc x n.87 x 80 x 2 x 0.125h= 1740	1oc x n.85 x 80 x 2 x 0.125h= 1700
3	Functional Tests	n.1T x n.87 x 3 x 1h= 261	n.1T x n.87 x 3 x 1h= 261	n.1T x n.85 x 3 x 1h= 255
5	In-Tunnel Assembly of all Boxes (average transport time across the Tunnel = 2h)	2oc x n.516 x 2h x 3.5h= 7224		
	Setting of Anti-X-γ Shielding Panels (average transport time for 2 panels per time = 2h)	2oc x n.1547/2 x 2h x 1h= 3094		
6	Control Unit-dedicated Cable Commissioning (Ref. to Spec. S02981UX3000L -§7- Cables)	327000mt x 0.06h/mt = 19620h (6oc x 14 month)		
Grand Total			**39.495**	

Ref. to S02957UX3000L sheet 4 (Time Schedule)		Task		Without Electromagn. Wigglers	With Electromagn. Wigglers
58		**GENERIC CABLING**	manpower	(hours)	(hours)
	A	Pumps	n.6405 x 0.7h=		4484
	B	Vacuum Feedthroughs	n.238 x 0.5h=		119
	C	Power Supplies and Switching	n.10974 x 0.25h		2744
1.4.4.4	**Tot**	**Pumps and Power Supplies**		**7.346**	**7.346**
1.4.4.5	**Tot.**	**Vacuum Diagnostic Sensors,Controllers and Cables**	n.4467 x 0.75h	**3.350**	**3.350**
	A	Gate Valves	n.245 x 2h		490
	B	Power Supplies	n.245 x 1h		245
	C	«Odds and Ends»	n.500 x 1h		500
1.4.4.6	**Tot.**	**Manual and Automatic Valves**		**1.235**	**1.235**
1.4.5	**Tot.**	**Beam Diagnostics**	n.4T x 1 year	**8.000**	**8.000**
	1.6.1	Standard Line Voltage Sources		1008	1008
	1.6.2	Main Power Distribution Board		1328	2368
	1.6.3	Medium/Low Voltage Transformers		1792	3104
	1.6.4	Medium Voltage Breakers		992	1232
	1.6.5	Cable and Tray		28784	30434
	1.6.6	Lightning System		2148	2148
	1.6.7	Emergency Lightning System		208	208
1.6	**Tot.**	**Electrical Services**		**36.260**	**40.502**
1.8	**Tot.**	**Cooling and Ventilation Systems**		**400**	**400**
1.9	**Tot.**	**Compressed Air Facilities**		**160**	**160**
1.10	**Tot.**	**Cranes**	n.3oc x 1 year	**6.000**	**6.000**
1.11	**Tot.**	**Tunnel Transport System**	n.4oc x 1 year	**8.000**	**8.000**
1.14	**Tot.**	**Fire Detection Systems**		**500**	**500**
1.15	**Tot**	**Smoke Extraction Systems**		**400**	**400**
Grand Total				**71.651**	**75.893**

Ref. to S02957UX3000L sheet 4 (Time Schedule)		Task	Envisaged engagement per task	TOT.
59		**DIPOLES and WIGGLERS On SITE ALIGNMENT**	Estimations	(hours)
1		Alignment Dipoli sulla linea Damping Ring (no.3 attempts) prendendo come riferimento i Markes (20mt) gia' piazzati nel Tunnel	n.216 x 12h x 3ct=	7776
2		Alignment Wigglers sulla linea Damping Ring (no.3 attempts) prendendo come riferimento i Markes (20mt) gia' piazzati nel Tunnel	n.72 x 12h x 3ct=	2592
Grand Total				**10.368**

Ref. to S02957UX3000L sheet 4 (Time Schedule)		Task	Envisaged engagement per task	TOT.
60		**MAGNETS ALIGNMENT on SITE**	Estimations	(hours)
1		Alignment (no.3 attempts) of the boards supporting Quadrupoles/Sextupoles (D02811UX3000L and D2812UX3000L)	n.228 x 3h x 3ct=	2052
2		Alignment (no.3 attempts) of the boards supporting Dipoles (D02813UX3000L)	n.216 x 3h x 3ct=	1944
3		Alignment (no.3 attempts) of the boards supporting Wigglers (D02809UX3000L)	n.72 x 3h x 3ct=	648
4		Alignment (no.3 attempts) of the boards supporting Quadrupoles Long Straight (D02808UX3000L sheet 2)	n.332 x 3h x 3ct=	2988
Grand Total				**7.632**

Ref. to S02957UX3000L sheet 4 (Time Schedule)		Task	Envisaged engagement per task	TOT.
61		**ACCEPTANCE TESTS**	Estimations	(hours)
1		Functional tests of all electrical and mechanical devices. Seal tests in all regions. Dedicated tests aimed at functional check of all sensors. Issue af both test certificates and reports.	12 people x 250 days	29880
Grand Total				**29.880**

Ref. to S02957UX3000L sheet 4 (Time Schedule)		Task	Envisaged engagement per task	TOT.
62		**ACCEPTANCE TESTS**	Estimations	(hours)
1		Beam-line alignment test. Setting of all alignment sensors and components. Issue of test reports	8people x 90 days	7200
Grand Total				**7.200**

3.3 MANPOWER Overview

MANPOWER					
Ref.	Task	Time	Elect. Wigglers (hours)	Site	Lab. Ge.
51	Tunnel Referents Alignment	66days x 60h/d (6 people)	3.898	x	
52	Dipoles and Wigglers on Site Assembly	51days x 160h/d (16 people)	8.208	x	
53	Multipoles and Vacuum System Assembly and Alignment on Girders in Laboratory	315days x 64h/d (8 people)	20.345		x
54	Multipoles Girders on Site Assembly	69days x 160h/d (16 people)	11.168	x	
55	Generic Assembly	883 days x 160h/d (16 people)	170.283	x	
56	In Laboratory Assembly of Control Units	281days x 96h/d (4 people) x 3 Constr.	26.928		x
57	On Site Assembly of Control Units	300days x 120h/d (4 people) x 3 Constr.	39.495	x	
58	Generic Cabling	646days x120h/d (12 people)	75.893	x	
59	Dipoles and Wigglers on Site Alignment	87days x120h/d (12 people)	10.368	x	
60	Magnets Alignment on Site	60days x 120h/d (12 people)	7.632	x	
		Total	**374218**		
61	Acceptance Tests	249days x 120h/d (12 people)	29.880	x	x
62	Commissioning	90days x 80h/d (8 people)	7.200	x	

3.4 Reference List

E= Graduate Engineer
D= Physicist
d= Draughtstman
dE= Draughtstman (electric System)
dH= Draughtstman (Hydraulic System)
os= Skilled Workman
t= Tecniciam
oc= Fitter
Constr.= Constructor
L= Lobe
T= Shift
ct= Cut-and-try method
d= day
y= year
h= hour

9. ATTACHMENTS

9.1 Attachment 1: Tasks to be completed (I.N.F.N.) within 06/12/2000

Progressive Number					Main Item	Requested Job	
1	2	3	4	5		Des.	Mag/Therm Mechan/Ver.
1					TESLA 5 GeV Damping Rings		
1	1				Damping Ring Lattice	Not	
1	2				General Lay-out	Yes	
1	2	1			D.R. Arc Tunnel Lay-out	Yes	Not
1	2	2			D.R. 8 km Conn. Tunnel Lay-out	Yes	Not
1	3				Injection/Extraction Sections	Yes	Yes
1	4				Damping Rings		
1	4	1			Magnetic Components		
1	4	1	1		Bending Dipoles	Yes	Yes
1	4	1	2		Quadrupoles	Yes	Yes
1	4	1	3		Sextupoles	Yes	Yes
1	4	1	4		Magnetic Measurements	Not	Not
1	4	1	5		Magnet Assembly	Yes	Yes
1	4	1	6		H/V Correctors	Yes	Yes
1	4	1	7		Dipole Stands and Supports	Yes	Yes
1	4	1	8		Multipole Girders/Supports	Yes	Yes
1	4	1	9		Special Magnets (Electromagnetic Wigglers)	Yes	Yes
1	4	2			Power Supply System	Not	Yes
1	4	2	1		Mains Connections	Not	Not
1	4	2	2		Med/Low Voltage Breaker	Not	Not
1	4	2	3		Med/Low Voltage Cables and Trays	Not	Yes
1	4	2	4		Electromagnetic Wiggler Power Supplies	Not	Yes
1	4	3			RF System		
1	4	3	1		RF Cryo-modules	Not	Not
1	4	3	2		RF Power Surces	Not	Not
1	4	3	3		Waveguide network system	Not	Not
1	4	3	4		Cryogenic System	Not	Not
1	4	3	5		Cooling System	Not	Not
1	4	3	6		Others (electronics, controls, interlocks, etc.)	Not	Not
1	4	4			Vacuum System		
1	4	4	1		D. R. Vacuum Chamber	Yes	Yes
1	4	4	2		Conn. Tunnel Vacuum Chamber	Not	Not
1	4	4	3		Vacuum Chamber Supports	Yes	Yes
1	4	4	4		Pumps and Power Supplies	Not	Yes
1	4	4	5		Vacuum Diagnostics	Not	Yes
1	4	4	6		Manual and Automatic Valves	Not	Yes

1	4	4	7		Control Units	Not	Yes
1	4	4	8		Special Magnets Vacuum Chamber (Wigglers)	Yes	Yes
1	4	5			Beam Diagnostics		
1	4	5	1		Fluorescent Screens	Not	Yes
1	4	5	2		Toroidal Current Transformers	Not	Yes
1	4	5	3		Wall Current Monitors	Not	Yes
1	4	5	4		DC Current Transformers	Not	Yes
1	4	5	5		BPM Button/Strip Line Monitors	Not	Yes
1	4	5	6		Beam Diagnostics Electronics	Not	Not
1	4	5	7		Emittance Measurement System	Not	Not
1	5				Computer Control System		
1	5	1			Computer Control System Hardware	Not	Not
1	5	2			Computer Control System Software	Not	Not
1	6				Electrical Services		
1	6	1			Standard Line Voltage Sources	Not	Not
1	6	2			Main Power Distribution Boards	Not	Not
1	6	3			Medium/Low Voltage Transformers	Not	Not
1	6	4			Medium Voltage Breakers	Not	Not
1	6	5			Cables and Trays	Not	Not
1	6	6			Lightning System	Not	Not
1	6	7			Emergency Lightning System	Not	Not
1	7				Process Water Facilities		
1	7	1			Cooling Towers and Anc. Equip.	Not	Not
1	7	2			Pumps, Motors and Anc. Eqiuip.	Not	Not
1	7	3			Heat Exchangers	Not	Not
1	7	4			Piping	Not	Not
1	7	5			Filters	Not	Not
1	7	6			De-ionization Units	Not	Not
1	7	7			Tanks	Not	Not
1	8				Cooling and Ventilation System (only for Arcs)	Not	Not
1	9				Compressed Air Facilities (only for Arcs)	Not	Not
1	10				Handling Equipments and Cranes (only for Arcs)	Not	Not
1	11				Tunnel Transport System (only for Arcs)	Not	Not
1	12				Alignment Facilities (only for Arcs)	Not	Not
1	13				Installation Time Schedule and Manpower	Not	Not
1	14				Fire Detection System (only for Arcs)	Not	Not
1	15				Smoke extraction system (only for Arcs)	Not	Not
1	16				Tunnel TV Monitoring (only for Arcs)	Not	Not
1	17				Tests and Acceptance Tests	Not	Not
1	18				Commissioning (with no beam)	Not	Not
1	19				Engineering and Q.A.	Not	Not

ANSALDO

Ansaldo Ricerche s.r.l.

Progetto / project				Identificativo / document no.			
TESLA DAMPING RING				File: 0s-quinto-1 — S03006UX3000L			

Cliente / client	Comm.-s/comm. / job. no.	Emittente / issued by	Pagina / page	Di / of
I.N.F.N.	UX3.000	ARI/TME/MTM	1	9

Rag. disc. / disc.code	Rif. str. prod. / prod. str. no	Identificativo componente / equipment identification code	Tipo doc. / doc type	Cl. ris. / class	Allegati / enclosures
N/A	N/A	Damping Ring	S	L	

Titolo / title	Derivato da / derived from
MAGNET POWER SUPPLIES	Sostituisce / substitutes

Stato validita`:
rev.scope

Rev. / rev.	Data / date	Descrizione / description	Stato valid. / rev. scope	Redazione / prepared by	Controllo / checked by/	approvazione / checked by/ approved by	Autorizzazione emissione / issue authorization
0	30/11/20000	Issue		Canepa Giuseppe	Grattarola Marco	Grattarola Marco	Rosatelli Franc

1. Introduction

In this document the number of power supplies necessary to feed the main magnetic system of the Tesla Damping Ring and their cost are estimated. Power supplies for steering magnets are not been taken into consideration in this document but they are described and quoted in document S02981UX3000L " Control units".

2. References

The present document invokes the following documents:

- List of deliverables, whose version dated 22/11/1999 has been provided by INFN, "Magnetic components", items 1.4.2 and 1.4.2.4 (annex 1).
- ARI Procedure n. P0111767000L dated 13/12/1999.

3. Main characteristics of the magnets

The main characteristics of the magnets are listed in Table 3.I.

4. Nominal characteristics of power supplies

The magnets are divided in families. The magnets belonging to a family are connected in series to a single power supply. Table 4.I shows the electrical characteristics of the magnets and how the families are composed. The same table shows also the minimum requirements, in terms of voltage and current, of the power supplies.

Table 3.I - Main characteristics of the Damping Ring Magnets

Bending magnets	*Quantity*	*Magnetic length [m]*	*Defl. angle [deg]*	*Mag. field [T]*	*Gap [mm]*	*Ampere turns [A]*	Power / magnet [W]
	216	4.5	3	0.194	40	6176	2557

Quadrupoles	*Quantity*	*Magnetic length [m]*	*Maximum Gradient [T/m]*	*Bore radius [mm]*	*Ampere turns/pole [A]*	*Power per quad. [W]*
Arc	456	0.2	21.7	24	4973	631
Arc match	38	0.3	10.3	24	2361	258
Wiggler	70	0.2	14.2	24	3254	270
Wiggler match	16	0.4	10.9	28	3400	270
Long straight	269	0.2	7.5	52	8070	1085

Sextupoles	*Quantity*	*Magnetic length [m]*	*Maximum gradient [T/m2]*	*Bore radius [mm]*	*Ampere turns/pole [A]*	*Power per quad. [W]*
SF	204	0.3	101.7	24	187	46
SDA	96	0.4	130.1	24	240	78
SDB	12	0.2	130.1	24	240	43

Electromagnetic wigglers	*Quantity*	*Period length [mm]*	*Number of periods*	*Nominal field [T]*	*Nominal gap [mm]*	*Ampere turns/pole [A]*	*Power per wiggler [W]*
	72	550	8	1.8	25	20500	94000

Steering magnets	*Quantity*	*Magnetic length [m]*	*Nominal field [Gauss]*	*Bore aperture [mm]*	*Ampere turns [A]*	*Power per quad. [W]*
Arc & wiggler section	360	0.1	833	120	8620	190
Long straight section	269	0.1	33	105	288	2

Table 4.I - Electrical characteristics of magnets and power supplies

	Magnet characteristics			Power supply characteristics (series connection)			Number of power supplies	N. of magnets	
	Tension (Volt)	Current (A)	Power (Kw)	Number of magnets	Total tension (Volt)	Total power (Kw)		Total number	Total power (Kw)
Quadrupoles									
QAM 1	4.56	138.4	0.631	**6**	**27.4**	**3.8**	**2**	**12**	**7.6**
QAM 2	4.56	138.4	0.631	**6**	**27.4**	**3.8**	**2**	**12**	**7.6**
QAM 3	2.62	98.5	0.258	**6**	**15.7**	**1.5**	**2**	**12**	**3.1**
QAM 4	2.62	98.5	0.258	**6**	**15.7**	**1.5**	**2**	**12**	**3.1**
QAM 5	2.62	98.5	0.258	**7**	**18.3**	**1.8**	**2**	**14**	**3.6**
QAF	4.56	138.4	0.631	**102**	**465.1**	**64.4**	**2**	**204**	**128.7**
QAD	4.56	138.4	0.631	**102**	**465.1**	**64.4**	**2**	**204**	**128.7**
QAD 1	4.56	138.4	0.631	**3**	**13.7**	**1.9**	**2**	**6**	**3.8**
QAD 2	4.56	138.4	0.631	**5**	**22.8**	**3.2**	**2**	**10**	**6.3**
QLF	4.84	224.2	1.085	**135**	**653.4**	**146.5**	**1**	**135**	**146.5**
QLD	4.84	224.2	1.085	**134**	**648.6**	**145.4**	**1**	**134**	**145.4**
QWF	1.6	76.3	0.122	**18**	**28.8**	**2.2**	**2**	**36**	**4.4**
QWD	1.6	76.3	0.122	**17**	**27.2**	**2.1**	**2**	**34**	**4.1**
QWA 1	4.59	141.6	0.650	**2**	**9.2**	**1.3**	**2**	**4**	**2.6**
QWA 2	4.59	141.6	0.650	**2**	**9.2**	**1.3**	**2**	**4**	**2.6**
QWA 3	4.59	141.6	0.650	**2**	**9.2**	**1.3**	**2**	**4**	**2.6**
QWA 4	4.59	141.6	0.650	**2**	**9.2**	**1.3**	**2**	**4**	**2.6**
QWA 5	4.59	141.6	0.650	**2**	**9.2**	**1.3**	**2**	**4**	**2.6**
Dipoles									
Dipole 4.5 m	3.31	772.5	2.557	**6**	**19.9**	**15.3**	**2**	**12**	**30.7**
Dipole 4.5 m	3.31	772.5	2.557	**102**	**337.6**	**260.8**	**2**	**204**	**521.6**
Sextupoles									
S1P	0.98	47.0	0.046	**102**	**99.8**	**4.7**	**2**	**204**	**9.4**
S2P(HALF)	1.62	48.1	0.078	**48**	**83.1**	**4.0**	**2**	**108**	**8.0**
S2P(FULL)	0.89	48.3	0.043	**6**					
Wigglers									
WIGGLER	134.57	683.3	91.956	**4**	**538.3**	**367.8**	**18**	**72**	**6620.8**

Total power (KW) 7796

5. Specification of the power supplies

The power supplies should fulfill the following requirements:

Stability

Dipoles e wigglers	2.50E-05
Quadrupoles	5.00E-05
Sextupoles	1.00E-04

Resolution and repeteability

Dipoli e wigglers	18 bit
Quadrupoles	16 bit
Sestupoles	16 bit

Service temperature

Nominal	40 deg C
Maximum	60 dec C

Radiation

500 krads integrated on 10 years

Interface

Serial type

Other

Electronic control

The power supply will be located on the surface near one of the main tunnel accesses.

6. Cost

In order to reduce costs, the same type of power supply has been chosen for magnet families having similar electrical characteristics. Table 6.I shows the number of power supplies, their characteristics, the families of magnet they feed and their cost.

Table 6.I - Power supply cost

Type of magnets	N. power suplies	Volt	Ampere	Tecnology	Unit cost (kEuro)	Total cost (kEuro)	%
QAM1 & 2	4	30	140	S.D.R.	10.69	42.76	1.7%
QAM3, 4 & 5	6	20	100	S.D.R.	9.21	55.24	2.2%
QAF & QAD	2	470	140	P.T.	40.98	81.96	3.2%
QAD1	2	15	140	S.D.R.	9.50	19.01	0.8%
QAD2	2	24	140	S.D.R.	10.39	20.79	0.8%
QLF & QLD	2	655	225	D.P.	76.02	152.04	6.0%
QWA1,2,3,4 & 5	10	10	145	S.D.R.	8.31	83.15	3.3%
DIPOLI A	2	20	775	P.T.(S.D.R.)	33.26	66.52	2.6%
DIPOLI B	2	340	775	D.P. (A)	84.93	169.86	6.7%
S1P & S2P	4	100	50	S.D.R.	10.10	40.39	1.6%
WIGGLERS	18	540	685	D.P. (A)	99.78	1,796.03	71.1%
			Total cost power supplies			**2,527.75**	100.0%
			Installation and testing			**30.99**	
						2,558.73	

SDR = Switching double resonant
PT = Simple bridge tyristore
DPT = Double bridge (12 SCR) tyristore
(A) = Cooling required

7. Acknowledgment

We thanks OCEM s.p.a., Italy for the support in the frame of this cost evaluation.

8. Annex 1 - Tasks to be completed (I.N.F.N) within 06/12/2000

Progressive Number					Main Item	Requested Job	
1	2	3	4	5		Des.	Mag/Therm Mechan/Ver.
1					TESLA 5 GeV Damping Rings		
1	1				Damping Ring Lattice	Not	
1	2				General Lay-out	Yes	
1	2	1			D.R. Arc Tunnel Lay-out	Yes	Not
1	2	2			D.R. 8 km Conn. Tunnel Lay-out	Yes	Not
1	3				Injection/Extraction Sections	Yes	Yes
1	4				Damping Rings		
1	4	1			Magnetic Components		
1	4	1	1		Bending Dipoles	Yes	Yes
1	4	1	2		Quadrupoles	Yes	Yes
1	4	1	3		Sextupoles	Yes	Yes
1	4	1	4		Magnetic Measurements	Not	Not
1	4	1	5		Magnet Assembly	Yes	Yes
1	4	1	6		H/V Correctors	Yes	Yes
1	4	1	7		Dipole Stands and Supports	Yes	Yes
1	4	1	8		Multipole Girders/Supports	Yes	Yes
1	4	1	9		Special Magnets (Electromagnetic Wigglers)	Yes	Yes
1	4	2			Power Supply System	Not	Yes
1	4	2	1		Mains Connections	Not	Not
1	4	2	2		Med/Low Voltage Breaker	Not	Not
1	4	2	3		Med/Low Voltage Cables and Trays	Not	Yes
1	4	2	4		Electromagnetic Wiggler Power Supplies	Not	Yes
1	4	3			RF System		
1	4	3	1		RF Cryo-modules	Not	Not
1	4	3	2		RF Power Surces	Not	Not
1	4	3	3		Waveguide network system	Not	Not
1	4	3	4		Cryogenic System	Not	Not
1	4	3	5		Cooling System	Not	Not
1	4	3	6		Others (electronics, controls, interlocks, etc.)	Not	Not
1	4	4			Vacuum System		
1	4	4	1		D. R. Vacuum Chamber	Yes	Yes
1	4	4	2		Conn. Tunnel Vacuum Chamber	Not	Not
1	4	4	3		Vacuum Chamber Supports	Yes	Yes
1	4	4	4		Pumps and Power Supplies	Not	Yes
1	4	4	5		Vacuum Diagnostics	Not	Yes
1	4	4	6		Manual and Automatic Valves	Not	Yes
1	4	4	7		Control Units	Not	Yes

1	4	4	8		Special Magnets Vacuum Chamber (Wigglers)	Yes	Yes
1	4	5			Beam Diagnostics		
1	4	5	1		Fluorescent Screens	Not	Yes
1	4	5	2		Toroidal Current Transformers	Not	Yes
1	4	5	3		Wall Current Monitors	Not	Yes
1	4	5	4		DC Current Transformers	Not	Yes
1	4	5	5		BPM Button/Strip Line Monitors	Not	Yes
1	4	5	6		Beam Diagnostics Electronics	Not	Not
1	4	5	7		Emittance Measurement System	Not	Not
1	5				Computer Control System		
1	5	1			Computer Control System Hardware	Not	Not
1	5	2			Computer Control System Software	Not	Not
1	6				Electrical Services		
1	6	1			Standard Line Voltage Sources	Not	Not
1	6	2			Main Power Distribution Boards	Not	Not
1	6	3			Medium/Low Voltage Transformers	Not	Not
1	6	4			Medium Voltage Breakers	Not	Not
1	6	5			Cables and Trays	Not	Not
1	6	6			Lightning System	Not	Not
1	6	7			Emergency Lightning System	Not	Not
1	7				Process Water Facilities		
1	7	1			Cooling Towers and Anc. Equip.	Not	Not
1	7	2			Pumps, Motors and Anc. Eqiuip.	Not	Not
1	7	3			Heat Exchangers	Not	Not
1	7	4			Piping	Not	Not
1	7	5			Filters	Not	Not
1	7	6			De-ionization Units	Not	Not
1	7	7			Tanks	Not	Not
1	8				Cooling and Ventilation System (only for Arcs)	Not	Not
1	9				Compressed Air Facilities (only for Arcs)	Not	Not
1	10				Handling Equipments and Cranes (only for Arcs)	Not	Not
1	11				Tunnel Transport System (only for Arcs)	Not	Not
1	12				Alignment Facilities (only for Arcs)	Not	Not
1	13				Installation Time Schedule and Manpower	Not	Not
1	14				Fire Detection System (only for Arcs)	Not	Not
1	15				Smoke extraction system (only for Arcs)	Not	Not
1	16				Tunnel TV Monitoring (only for Arcs)	Not	Not
1	17				Tests and Acceptance Tests	Not	Not
1	18				Commissioning (with no beam)	Not	Not
1	19				Engineering and Q.A.	Not	Not

ANSALDO

Ansaldo Ricerche s.r.l.

Progetto / project				Identificativo / document no.			
TESLA DAMPING RING				File: 0s-quinto-1 — S03006UX3000L			
Cliente / client				Comm.-s/comm. / job. no.	Emittente / issued by	Pagina / page	Di / of
I.N.F.N.				UX3.000	ARI/TME/MTM	1	9
Rag. disc. / disc.code	Rif. str. prod. / prod. str. no	Identificativo componente / equipment identification code		Tipo doc. / doc type	Cl. ris. / class	Allegati / enclosures	
N/A	N/A	Damping Ring		S	L		
Titolo / title				Derivato da / derived from			
MAGNET POWER SUPPLIES				Sostituisce / substitutes			

Stato validita`:
rev.scope

Rev. / rev.	Data / date	Descrizione / description	Stato valid. / rev. scope	Redazione / prepared by	Controllo / checked by/	approvazione / checked by/ approved by	Autorizzazione emissione / issue authorization
0	30/11/20000	Issue		Canepa Giuseppe	Grattarola Marco	Grattarola Marco	Rosatelli Franc

1. Introduction

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- ARI Procedure n. P0111767000L dated 13/12/1999.

3. Main characteristics of the magnets

The main characteristics of the magnets are listed in Table 3.I.

4. Nominal characteristics of power supplies

The magnets are divided in families. The magnets belonging to a family are connected in series to a single power supply. Table 4.I shows the electrical characteristics of the magnets and how the families are composed. The same table shows also the minimum requirements, in terms of voltage and current, of the power supplies.

Table 3.I - Main characteristics of the Damping Ring Magnets

Bending magnets	*Quantity*	*Magnetic length [m]*	*Defl. angle [deg]*	*Mag. field [T]*	*Gap [mm]*	*Ampere turns [A]*	Power / magnet [W]
	216	4.5	3	0.194	40	6176	2557

Quadrupoles	*Quantity*	*Magnetic length [m]*	*Maximum Gradient [T/m]*	*Bore radius [mm]*	*Ampere turns/pole [A]*	*Power per quad. [W]*
Arc	456	0.2	21.7	24	4973	631
Arc match	38	0.3	10.3	24	2361	258
Wiggler	70	0.2	14.2	24	3254	270
Wiggler match	16	0.4	10.9	28	3400	270
Long straight	269	0.2	7.5	52	8070	1085

Sextupoles	*Quantity*	*Magnetic length [m]*	*Maximum gradient [T/m2]*	*Bore radius [mm]*	*Ampere turns/pole [A]*	*Power per quad. [W]*
SF	204	0.3	101.7	24	187	46
SDA	96	0.4	130.1	24	240	78
SDB	12	0.2	130.1	24	240	43

Electromagnetic wigglers	*Quantity*	*Period length [mm]*	*Number of periods*	*Nominal field [T]*	*Nominal gap [mm]*	*Ampere turns/pole [A]*	*Power per wiggler [W]*
	72	550	8	1.8	25	20500	94000

Steering magnets	*Quantity*	*Magnetic length [m]*	*Nominal field [Gauss]*	*Bore aperture [mm]*	*Ampere turns [A]*	*Power per quad. [W]*
Arc & wiggler section	360	0.1	833	120	8620	190
Long straight section	269	0.1	33	105	288	2

Table 4.I - Electrical characteristics of magnets and power supplies

	Magnet characteristics			Power supply characteristics (series connection)			Number of power supplies	N. of magnets	
	Tension (Volt)	Current (A)	Power (Kw)	Number of magnets	Total tension (Volt)	Total power (Kw)		Total number	Total power (Kw)
Quadrupoles									
QAM 1	4.56	138.4	0.631	**6**	**27.4**	**3.8**	**2**	**12**	**7.6**
QAM 2	4.56	138.4	0.631	**6**	**27.4**	**3.8**	**2**	**12**	**7.6**
QAM 3	2.62	98.5	0.258	**6**	**15.7**	**1.5**	**2**	**12**	**3.1**
QAM 4	2.62	98.5	0.258	**6**	**15.7**	**1.5**	**2**	**12**	**3.1**
QAM 5	2.62	98.5	0.258	**7**	**18.3**	**1.8**	**2**	**14**	**3.6**
QAF	4.56	138.4	0.631	**102**	**465.1**	**64.4**	**2**	**204**	**128.7**
QAD	4.56	138.4	0.631	**102**	**465.1**	**64.4**	**2**	**204**	**128.7**
QAD 1	4.56	138.4	0.631	**3**	**13.7**	**1.9**	**2**	**6**	**3.8**
QAD 2	4.56	138.4	0.631	**5**	**22.8**	**3.2**	**2**	**10**	**6.3**
QLF	4.84	224.2	1.085	**135**	**653.4**	**146.5**	**1**	**135**	**146.5**
QLD	4.84	224.2	1.085	**134**	**648.6**	**145.4**	**1**	**134**	**145.4**
QWF	1.6	76.3	0.122	**18**	**28.8**	**2.2**	**2**	**36**	**4.4**
QWD	1.6	76.3	0.122	**17**	**27.2**	**2.1**	**2**	**34**	**4.1**
QWA 1	4.59	141.6	0.650	**2**	**9.2**	**1.3**	**2**	**4**	**2.6**
QWA 2	4.59	141.6	0.650	**2**	**9.2**	**1.3**	**2**	**4**	**2.6**
QWA 3	4.59	141.6	0.650	**2**	**9.2**	**1.3**	**2**	**4**	**2.6**
QWA 4	4.59	141.6	0.650	**2**	**9.2**	**1.3**	**2**	**4**	**2.6**
QWA 5	4.59	141.6	0.650	**2**	**9.2**	**1.3**	**2**	**4**	**2.6**
Dipoles									
Dipole 4.5 m	3.31	772.5	2.557	**6**	**19.9**	**15.3**	**2**	**12**	**30.7**
Dipole 4.5 m	3.31	772.5	2.557	**102**	**337.6**	**260.8**	**2**	**204**	**521.6**
Sextupoles									
S1P	0.98	47.0	0.046	**102**	**99.8**	**4.7**	**2**	**204**	**9.4**
S2P(HALF)	1.62	48.1	0.078	**48**	**83.1**	**4.0**	**2**	**108**	**8.0**
S2P(FULL)	0.89	48.3	0.043	**6**					
Wigglers									
WIGGLER	134.57	683.3	91.956	**4**	**538.3**	**367.8**	**18**	**72**	**6620.8**

Total power (KW) 7796

5. Specification of the power supplies

The power supplies should fulfill the following requirements:

Stability

Dipoles e wigglers	2.50E-05
Quadrupoles	5.00E-05
Sextupoles	1.00E-04

Resolution and repeteability

Dipoli e wigglers	18 bit
Quadrupoles	16 bit
Sestupoles	16 bit

Service temperature

Nominal	40 deg C
Maximum	60 dec C

Radiation

500 krads integrated on 10 years

Interface

Serial type

Other

Electronic control

The power supply will be located on the surface near one of the main tunnel accesses.

6. Cost

In order to reduce costs, the same type of power supply has been chosen for magnet families having similar electrical characteristics. Table 6.I shows the number of power supplies, their characteristics, the families of magnet they feed and their cost.

Table 6.I - Power supply cost

Type of magnets	N. power suplies	Volt	Ampere	Tecnology	Unit cost (kEuro)	Total cost (kEuro)	%
QAM1 & 2	4	30	140	S.D.R.	10.69	42.76	1.7%
QAM3, 4 & 5	6	20	100	S.D.R.	9.21	55.24	2.2%
QAF & QAD	2	470	140	P.T.	40.98	81.96	3.2%
QAD1	2	15	140	S.D.R.	9.50	19.01	0.8%
QAD2	2	24	140	S.D.R.	10.39	20.79	0.8%
QLF & QLD	2	655	225	D.P.	76.02	152.04	6.0%
QWA1,2,3,4 & 5	10	10	145	S.D.R.	8.31	83.15	3.3%
DIPOLI A	2	20	775	P.T.(S.D.R.)	33.26	66.52	2.6%
DIPOLI B	2	340	775	D.P. (A)	84.93	169.86	6.7%
S1P & S2P	4	100	50	S.D.R.	10.10	40.39	1.6%
WIGGLERS	18	540	685	D.P. (A)	99.78	1,796.03	71.1%
			Total cost power supplies			**2,527.75**	100.0%
			Installation and testing			**30.99**	
						2,558.73	

SDR = Switching double resonant
PT = Simple bridge tyristore
DPT = Double bridge (12 SCR) tyristore
(A) = Cooling required

7. Acknowledgment

We thanks OCEM s.p.a., Italy for the support in the frame of this cost evaluation.

8. Annex 1 - Tasks to be completed (I.N.F.N) within 06/12/2000

Progressive Number					Main Item	Requested Job	
1	2	3	4	5		Des.	Mag/Therm Mechan/Ver.
1					TESLA 5 GeV Damping Rings		
1	1				Damping Ring Lattice	Not	
1	2				General Lay-out	Yes	
1	2	1			D.R. Arc Tunnel Lay-out	Yes	Not
1	2	2			D.R. 8 km Conn. Tunnel Lay-out	Yes	Not
1	3				Injection/Extraction Sections	Yes	Yes
1	4				Damping Rings		
1	4	1			Magnetic Components		
1	4	1	1		Bending Dipoles	Yes	Yes
1	4	1	2		Quadrupoles	Yes	Yes
1	4	1	3		Sextupoles	Yes	Yes
1	4	1	4		Magnetic Measurements	Not	Not
1	4	1	5		Magnet Assembly	Yes	Yes
1	4	1	6		H/V Correctors	Yes	Yes
1	4	1	7		Dipole Stands and Supports	Yes	Yes
1	4	1	8		Multipole Girders/Supports	Yes	Yes
1	4	1	9		Special Magnets (Electromagnetic Wigglers)	Yes	Yes
1	4	2			Power Supply System	Not	Yes
1	4	2	1		Mains Connections	Not	Not
1	4	2	2		Med/Low Voltage Breaker	Not	Not
1	4	2	3		Med/Low Voltage Cables and Trays	Not	Yes
1	4	2	4		Electromagnetic Wiggler Power Supplies	Not	Yes
1	4	3			RF System		
1	4	3	1		RF Cryo-modules	Not	Not
1	4	3	2		RF Power Surces	Not	Not
1	4	3	3		Waveguide network system	Not	Not
1	4	3	4		Cryogenic System	Not	Not
1	4	3	5		Cooling System	Not	Not
1	4	3	6		Others (electronics, controls, interlocks, etc.)	Not	Not
1	4	4			Vacuum System		
1	4	4	1		D. R. Vacuum Chamber	Yes	Yes
1	4	4	2		Conn. Tunnel Vacuum Chamber	Not	Not
1	4	4	3		Vacuum Chamber Supports	Yes	Yes
1	4	4	4		Pumps and Power Supplies	Not	Yes
1	4	4	5		Vacuum Diagnostics	Not	Yes
1	4	4	6		Manual and Automatic Valves	Not	Yes
1	4	4	7		Control Units	Not	Yes

1	4	4	8		Special Magnets Vacuum Chamber (Wigglers)	Yes	Yes
1	4	5			Beam Diagnostics		
1	4	5	1		Fluorescent Screens	Not	Yes
1	4	5	2		Toroidal Current Transformers	Not	Yes
1	4	5	3		Wall Current Monitors	Not	Yes
1	4	5	4		DC Current Transformers	Not	Yes
1	4	5	5		BPM Button/Strip Line Monitors	Not	Yes
1	4	5	6		Beam Diagnostics Electronics	Not	Not
1	4	5	7		Emittance Measurement System	Not	Not
1	5				Computer Control System		
1	5	1			Computer Control System Hardware	Not	Not
1	5	2			Computer Control System Software	Not	Not
1	6				Electrical Services		
1	6	1			Standard Line Voltage Sources	Not	Not
1	6	2			Main Power Distribution Boards	Not	Not
1	6	3			Medium/Low Voltage Transformers	Not	Not
1	6	4			Medium Voltage Breakers	Not	Not
1	6	5			Cables and Trays	Not	Not
1	6	6			Lightning System	Not	Not
1	6	7			Emergency Lightning System	Not	Not
1	7				Process Water Facilities		
1	7	1			Cooling Towers and Anc. Equip.	Not	Not
1	7	2			Pumps, Motors and Anc. Eqiuip.	Not	Not
1	7	3			Heat Exchangers	Not	Not
1	7	4			Piping	Not	Not
1	7	5			Filters	Not	Not
1	7	6			De-ionization Units	Not	Not
1	7	7			Tanks	Not	Not
1	8				Cooling and Ventilation System (only for Arcs)	Not	Not
1	9				Compressed Air Facilities (only for Arcs)	Not	Not
1	10				Handling Equipments and Cranes (only for Arcs)	Not	Not
1	11				Tunnel Transport System (only for Arcs)	Not	Not
1	12				Alignment Facilities (only for Arcs)	Not	Not
1	13				Installation Time Schedule and Manpower	Not	Not
1	14				Fire Detection System (only for Arcs)	Not	Not
1	15				Smoke extraction system (only for Arcs)	Not	Not
1	16				Tunnel TV Monitoring (only for Arcs)	Not	Not
1	17				Tests and Acceptance Tests	Not	Not
1	18				Commissioning (with no beam)	Not	Not
1	19				Engineering and Q.A.	Not	Not

ANSALDO

Ansaldo Ricerche s.r.l.

Progetto project	TESLA DAMPING RING			**Identificativo** document no. File: 0s-terzo-1	S02958UX3000L			
Cliente client	I.N.F.N.			**Comm.-s/comm.** job. no. UX3.000	**Emittente** issued by ARI/TME/MTM	**Pagina** page 1	**Di** of 11	
Rag. disc. disc.code N/A	**Rif. str. prod.** prod. str. no N/A	**Identificativo componente** equipment identification code Damping Ring			**Tipo doc.** doc type Spec di Fabbr	**Cl. ris.** class L	**Allegati** enclosures 1	
Titolo title	MULTIPOLE GIRDERS/SUPPORTS				**Derivato da** derived from			
					Sostituisce substitutes			

Stato validita`: rev.scope **Issue 13/11/2000**

Rev. rev.	Data date	Descrizione description	Stato valid. rev. scope	Redazione prepared by	Controllo checked by/	approvazione checked by/ approved by	Autorizzazione emissione issue authorization
1	20/02/2001	Sheets 7 and 8 (§6-7) modified.		Ottonello G.B.	Barbagelata Luigi	Grattarola Marco	Rosatelli Franco
0	13/11/20000	Issue		Ottonello G.B.	Barbagelata Luigi	Grattarola Marco	Rosatelli Franco

TABLE OF CONTENTS

1. AIM

The present Manufacturing Specification aims at detailed description of both the manufacturing criteria, the working materials and procedures, the Suppliers takeninto account, the time schedule agreed upon, the number of pieces and the overall costs of the delivered product.

2. REFERENCES

The present specification invokes the following documents:

1. List of deliverables, whose version dated 06/12/2000 has been provided by INFN, item 1.4.1.8. (see Attachment 1)
2. ARI Procedure n.P0111767000L dated 13/12/1999.
3. Drawings:
   - D02954UX3000L Damping Ring General Draw.
   - D02653UX3000L Damping Ring Lay-out 1
   - D02654UX3000L Damping Ring Lay-out 2
   - D02655UX3000L Damping Ring Lay-out 3
   - D02656UX3000L Damping Ring Lay-out 4
   - D02657UX3000L Damping Ring Lay-out 5
   - D02808UX3000L Damping Ring Quadrupole QDW/QFW Support (Sheet 1 and 2)
   - D02809UX3000L Damping Ring Wiggler Support
   - D02810UX3000L Damping Ring Quadrupole, Sextupole upper Support
   - D02811UX3000L Damping Ring Quadrupole, Sextupole Sx lower Support
   - D02812UX3000L Damping Ring Quadrupole, Sextupole Rx lower Support
   - D02813UX3000L Damping Ring Dipole Support
   - D02814UX3000L Damping Ring Sextupole Support
   - D02815UX3000L Damping Ring Vertical Register Support
   - D02816UX3000L Damping Ring Register Support
   - D02893UX3000L Damping Ring Dipole, Quadrupole, Sextupole Detail
   - D02894UX3000L Damping Ring Wiggler, Quadrupole Particular
   - D02895UX3000L Damping Ring Wiggler, Quadrupole Section Detail

3. COMPONENTS

1. Alignment beds regions: ±ARC PNOD, ARC PCELL, ±ARC MNOD and ARC MCELL.

Four models:

Dwg. D02813UX3000L supporting Dipoles ~ 7000 Kg.
Dwg. D02812UX3000L supporting two full Quadrupoles, two Sextupoles and various Vacuum Line components.
Dwg. D02811UX3000L supporting two full Quadrupoles, one Sextupole and various Vacuum Line components.
Dwg. D02810UX3000L supporting one Quadrupole.

2. Alignment beds regions: WIG CEL

Two models:

Dwg. D02809UX3000L supporting Wigglers ~ 5000 Kg.
Dwg. D02808UX3000L (sheet 1) supporting one Quadrupole and various Vacuum Line components.

3. Alignment bed regions: ±ARC MATCH, ±W2A MATCH, ARC DRIFT and LONG CELL

Only one model:

Dwg. D02808UX3000L (sheet 2) supporting one Quadrupole and various Vacuum Line components.

4. MANIFACTURING PERFORMANCES

Such Planes allow integral mechanical anchorage of Damping Ring Line componets, even if fine alignment adjustment is allowed. It turns out that D.R.-plane- and axis-height-alignment ranges are ± 25 mm and ±20mm respectively. The plane adjustment angle is 7 degrees. Insertion of spherical-seat washers assures angular locking.

According to dwg. D02894UX3000L e D02893UX3000L, we envisage laboratory assembly of various components on the Planes. Firstly, we will create a »Plane Reference Axis»; the latter allows further assembly and in-situ alignment of all assembled parts. Manifacturing procedures envisage in-situ alignment adjustment from upper side with the help of special keys.

5. MACHINING

5.1 MATERIALS

As for the manifacturing material, we envisage **FE430** steel for the alignment planes on one side and **C40** carbon steel for both the «Vertical Register Supports» and the «Registers of Support» on the other side. We envisage also utilization of cylindrical roller axial bearings **SKF** (81102), as well as of treated-steel-made «skew bearing ball joints» (GX17F SKF) and «articulated terminals» (SAKAC16M SKF). «Sextupole Support» aluminium is ANTICORODAL 6060.

5.2 STATE OF DELIVERY

The state of deliveries is as follows:

- D02808UX3000L (sheet 1 and 2) Damping Ring Quadrupole QDW/QFW Support
  Sheet 25mm-thick, Channel UPN160
- D02809UX3000L Damping Ring Wiggler Support
  Sheet 25mm-thick, I-beam IPE120
- D02810UX3000L Damping Ring Quadrupole, Sextupole upper Support
  Sheet 25mm-thick
- D02811UX3000L Damping Ring Quadrupole, Sextupole Sx lower Support
  Sheet 25mm-thick, Channel UPN80
- D02812UX3000L Damping Ring Quadrupole, Sextupole Rx lower Support
  Sheet 25mm-thick, Channel UPN80
- D02813UX3000L Damping Ring Dipole Support
  Sheet 25mm-thick, Channel UPN160
- D02814UX3000L Damping Ring Sextupole Support
  Sheet 10mm-thick, Sheet 15mm-thick
- D02815UX3000L Damping Ring Vertical Register Support
  Round ϕ=80mm., Details : see catalogue
- D02816UX3000L Damping Ring Register Support
  Sheet 50mm-thick, Details : see catalogue

NB. Weldability fastening requires annealing of all delivered sheets.

5.3. TESTS

We envisage both functional and dimensional tests of all finished parts at Manifacturer's location for acceptance before shipping, according to ISO 9000.

5.4. OTHERS

An agreement with the Constructor upon a relieving treatment to be performed before finishing and after welding is required, in order to assure time stability.

All ferrous surfaces will undergo «strong» burnishing in order to prevent oxydization.

6. LOCATION. QUANTITIES

Referring to

- D02954UX3000L Damping Ring General Draw.
- D02653UX3000L Damping Ring **Lay-out 1**

It turns out that the quantities are:

n° **36** D02808UX3000L (sheet 1) Damping Ring Quadrupole QDW/QFW Support
n° **14** D02808UX3000L (sheet 2) Damping Ring Quadrupole QDW/QFW Support
n° **36** D02809UX3000L Damping Ring Wiggler Support
n° **13** D02810UX3000L Damping Ring Quadrupole, Sextupole upper Support
n° **3** D02811UX3000L Damping Ring Quadrupole, Sextupole Lx lower Support
n° **2** D02812UX3000L Damping Ring Quadrupole, Sextupole Rx lower Support
n° **4** D02813UX3000L Damping Ring Dipole Support
n° **4** D02814UX3000L Damping Ring Sextupole Support

Referring to

- D02954UX3000L Damping Ring General Draw.
- D02654UX3000L Damping Ring **Lay-out 2**

It turns out that the quantities are:
n° **3** D02808UX3000L (sheet 2)Damping Ring Quadrupole QDW/QFW Support
n°**139** D02810UX3000L Damping Ring Quadrupole, Sextupole upper Support
n° **3** D02811UX3000L Damping Ring Quadrupole, Sextupole Lx lower Support
n° **2** D02812UX3000L Damping Ring Quadrupole, Sextupole Rx lower Support
n° **4** D02813UX3000L Damping Ring Dipole Support
n° **4** D02814UX3000L Damping Ring Sextupole Support

Referring to

- D02954UX3000L Damping Ring General Draw.

- D02655UX3000L Damping Ring **Lay-out 3**

It turns out that the quantities are:

n° **3** D02808UX3000L (sheet 2) Damping Ring Quadrupole QDW/QFW Support
n° **139** D02810UX3000L Damping Ring Quadrupole, Sextupole upper Support
n° **20** D02811UX3000L Damping Ring Quadrupole, Sextupole Lx lower Support
n° **20** D02812UX3000L Damping Ring Quadrupole, Sextupole Rx lower Support
n° **39** D02813UX3000L Damping Ring Dipole Support
n° **59** D02814UX3000L Damping Ring Sextupole Support

Referring to

- D02954UX3000L Damping Ring General Draw.
- D02656UX3000L Damping Ring **Lay-out 4**

It turns out that the quantities are:
n° **10** D02808UX3000L (sheet 2) Damping Ring Quadrupole QDW/QFW Support
n° **82** D02810UX3000L Damping Ring Quadrupole, Sextupole upper Support
n° **12** D02811UX3000L Damping Ring Quadrupole, Sextupole Lx lower Support
n° **12** D02812UX3000L Damping Ring Quadrupole, Sextupole Rx lower Support
n° **24** D02813UX3000L Damping Ring Dipole Support
n° **34** D02814UX3000L Damping Ring Sextupole Support

Referring to

- D02954UX3000L Damping Ring General Draw.
- D02657UX3000L Damping Ring **Lay-out 5**

It turns out that the quantities are:
n° **137** del D02808UX3000L (sheet 2) Damping Ring Quadrupole QDW/QFW Support

7. TOTAL QUANTITIES (spare=5%)

n° **36x2x1.05= 77** dwg D02808UX3000L (sheet 1) D. R. Quadrupole QDW/QFW Support
n° **166x2x1.05=348** dwg D02808UX3000L (sheet 2) D. R. Quadrupole QDW/QFW Support
n° **36x2x1.05= 76** dwg D02809UX3000L Damping Ring Wiggler Support
n° **373x2x1.05=783** dwg D02810UX3000L Damping Ring Quadrupole, Sext.le upper Support
n° **55x2x1.05= 116** dwg D02811UX3000L D.R. Quadrupole, Sext.le Lx lower Support
n° **54x2x1.05=113** dwg D02812UX3000L D.R. Quadrupole, Sext.le Rx lower Support
n° **108x2x1.05=227** dwg D02813UX3000L Damping Ring Dipole Support
n° **154x2x1.05=324** dwg D02814UX3000L Damping Ring Sextupole Support
n° **2862** dwg. D02815UX3000L Damping Ring Vertical Register Support
n° **2862** dwg.D02816UX3000L Damping Ring Register Support

8. DELIVERY TIME and COST

«Time Schedule for the Constructions (Rif. Spec. S02957UX3000L)» encompasses 24 months.
Manifacturing of several components is required.
Accordingly, we are bound to envisage utilization of three different Manifacturers, as listed below:

Alignment Girders

CONSTR. NUMBER	MONTHS	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	PIECES TOT.	COST (Mlire)	TOTAL (Euro)
					#							PLANNING (months)																	
	COMPONENT											(PIECES X MONTH)																	
	D02810UX3000L	+			36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	27	783		
	D02811UX3000L	+			6	5	6	5	6	5	6	5	6	5	6	5	6	5	6	5	6	5	6	5	6		116		
	D02812UX3000L	+			5	6	5	5	5	5	5	6	5	5	5	5	6	5	5	5	5	5	5	5	5	5	113		
1	D02814UX3000L	+			15	14	15	15	15	14	15	15	15	14	15	15	15	14	15	15	15	14	15	15	15	14	324	797	411.616
	D02808UX3000L	+			20	20	20	20	20	20	20	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	425		
2	D02809UX3000L	+			4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	78	1.055	544.862
3	D02813UX3000L	+			11	11	11	11	10	11	11	11	10	10	10	10	10	10	10	10	10	10	10	10	10	10	227	993	512.841
	Order	(+)																											
	First Supply	(#)																											
	GRAND TOTAL																										2.063	2.845	1.469.319

9. ATTACHMENTS

9.1 Attachment 1: Tasks to be completed (I.N.F.N.) within 06/12/2000

Progressive Number					Main Item	Requested Job	
1	2	3	4	5		Des.	Mag/Therm Mechan/Ver.
1					TESLA 5 GeV Damping Rings		
1	1				Damping Ring Lattice	Not	
1	2				General Lay-out	Yes	
1	2	1			D.R. Arc Tunnel Lay-out	Yes	Not
1	2	2			D.R. 8 km Conn. Tunnel Lay-out	Yes	Not
1	3				Injection/Extraction Sections	Yes	Yes
1	4				Damping Rings		
1	4	1			Magnetic Components		
1	4	1	1		Bending Dipoles	Yes	Yes
1	4	1	2		Quadrupoles	Yes	Yes
1	4	1	3		Sextupoles	Yes	Yes
1	4	1	4		Magnetic Measurements	Not	Not
1	4	1	5		Magnet Assembly	Yes	Yes
1	4	1	6		H/V Correctors	Yes	Yes
1	4	1	7		Dipole Stands and Supports	Yes	Yes
1	4	1	8		Multipole Girders/Supports	Yes	Yes
1	4	1	9		Special Magnets (Electromagnetic Wigglers)	Yes	Yes
1	4	2			Power Supply System	Not	Yes
1	4	2	1		Mains Connections	Not	Not
1	4	2	2		Med/Low Voltage Breaker	Not	Not
1	4	2	3		Med/Low Voltage Cables and Trays	Not	Yes
1	4	2	4		Electromagnetic Wiggler Power Supplies	Not	Yes
1	4	3			RF System		
1	4	3	1		RF Cryo-modules	Not	Not
1	4	3	2		RF Power Surces	Not	Not
1	4	3	3		Waveguide network system	Not	Not
1	4	3	4		Cryogenic System	Not	Not
1	4	3	5		Cooling System	Not	Not
1	4	3	6		Others (electronics, controls, interlocks, etc.)	Not	Not
1	4	4			Vacuum System		
1	4	4	1		D. R. Vacuum Chamber	Yes	Yes
1	4	4	2		Conn. Tunnel Vacuum Chamber	Not	Not
1	4	4	3		Vacuum Chamber Supports	Yes	Yes
1	4	4	4		Pumps and Power Supplies	Not	Yes
1	4	4	5		Vacuum Diagnostics	Not	Yes
1	4	4	6		Manual and Automatic Valves	Not	Yes
1	4	4	7		Control Units	Not	Yes

1	4	4	8		Special Magnets Vacuum Chamber (Wigglers)	Yes	Yes
1	4	5			Beam Diagnostics		
1	4	5	1		Fluorescent Screens	Not	Yes
1	4	5	2		Toroidal Current Transformers	Not	Yes
1	4	5	3		Wall Current Monitors	Not	Yes
1	4	5	4		DC Current Transformers	Not	Yes
1	4	5	5		BPM Button/Strip Line Monitors	Not	Yes
1	4	5	6		Beam Diagnostics Electronics	Not	Not
1	4	5	7		Emittance Measurement System	Not	Not
1	5				Computer Control System		
1	5	1			Computer Control System Hardware	Not	Not
1	5	2			Computer Control System Software	Not	Not
1	6				Electrical Services		
1	6	1			Standard Line Voltage Sources	Not	Not
1	6	2			Main Power Distribution Boards	Not	Not
1	6	3			Medium/Low Voltage Transformers	Not	Not
1	6	4			Medium Voltage Breakers	Not	Not
1	6	5			Cables and Trays	Not	Not
1	6	6			Lightning System	Not	Not
1	6	7			Emergency Lightning System	Not	Not
1	7				Process Water Facilities		
1	7	1			Cooling Towers and Anc. Equip.	Not	Not
1	7	2			Pumps, Motors and Anc. Eqiuip.	Not	Not
1	7	3			Heat Exchangers	Not	Not
1	7	4			Piping	Not	Not
1	7	5			Filters	Not	Not
1	7	6			De-ionization Units	Not	Not
1	7	7			Tanks	Not	Not
1	8				Cooling and Ventilation System (only for Arcs)	Not	Not
1	9				Compressed Air Facilities (only for Arcs)	Not	Not
1	10				Handling Equipments and Cranes (only for Arcs)	Not	Not
1	11				Tunnel Transport System (only for Arcs)	Not	Not
1	12				Alignment Facilities (only for Arcs)	Not	Not
1	13				Installation Time Schedule and Manpower	Not	Not
1	14				Fire Detection System (only for Arcs)	Not	Not
1	15				Smoke extraction system (only for Arcs)	Not	Not
1	16				Tunnel TV Monitoring (only for Arcs)	Not	Not
1	17				Tests and Acceptance Tests	Not	Not
1	18				Commissioning (with no beam)	Not	Not
1	19				Engineering and Q.A.	Not	Not

Spec. n. S02992UX3000L

DAMPING RING TESLA

DRAWING LIST

Rev.	Data	Descrizione	Emesso Issued	Controllato Controlled	Approvato Approved
0	02/02/2001	Drawing List	Patrone Sandro	Barbagelata Luigi	Rosatelli F.

NUMBER	TITLE	Rev.
	1. LAY-OUT DRAWINGS	
1. **D02954UX3000L**	Lay-out 0 (Damping Ring Line)	0
2. **D02653UX3000L**	Lay-out1 (Detail Damping Ring Line sheet 001÷030)	0
3. **D02654UX3000L**	Lay-out2 (Detail Damping Ring Line sheet 031÷053)	0
4. **D02655UX3000L**	Lay-out3 (Detail Damping Ring Line sheet 054÷076)	0
5. **D02656UX3000L**	Lay-out4 (Detail Damping Ring Line sheet 077÷109)	0
6. **D02657UX3000L**	Lay-out5 (Detail Damping Ring Line sheet 110÷112)	0
	2. COMPONENT DRAWINGS	
7. **D02658UX3000L**	Quadrupole vacuum chamber assembly - CV43 MOD.1/1-	0
8. **D02659UX3000L**	Bellow-Mod.1/2-	0
9. **D02660UX3000L**	Quadrupole vacuum chamber assembly - CV43 MOD.1/3-	0
10. **D02661UX3000L**	Vacuum pump connection -Mod.2-	0
11. **D02662UX3000L**	Vacuum pump connection -Mod.3-	0
12. **D02679UX3000L**	Quadrupole vacuum chamber assembly - CW80 MOD.4 -	0
13. **D02680UX3000L**	Bellow -MOD.4/3-	0
14. **D02681UX3000L**	Bellow -MOD.6-	0
15. **D02682UX3000L**	Quadrupole vacuum chamber assembly - CV100 MOD.6/1 -	0
16. **D02683UX3000L**	Vacuum pump connection -ø43 T1-	0
17. **D02684UX3000L**	Vacuum pump connection -ø43 T2-	0
18. **D02685UX3000L**	Vacuum pump connection -ø43 T3-	0
19. **D02690UX3000L**	Flange joint DN100/200 –CW80 T4-	0
20. **D02691UX3000L**	F.3 Wiggler sect. Syncrotron radiation -CVW/CW80 T5-	0
21. **D02692UX3000L**	Flange joint DN100/200 -CW80 T6-	0
22. **D02693UX3000L**	Vacuum pump connection -CV100 T7-	0
23. **D02694UX3000L**	Flange joint DN63/100 -ø43 T8-	0

24. **D02695UX3000L** Flange joint DN100/200 -CW80 T9-	0
25. **D02696UX3000L** Conical flange joint DN63/200 -ø43/RFø200 T10-	0
26. **D02778UX3000L** Ceramic flag/otr indicator plate positioner -ø43 T11-	0
27. **D02779UX3000L** Slit/Scraper positioner -ø43 T12-	0
28. **D02780UX3000L** Toroidal current monitor -ø43 T13-	0
29. **D02781UX3000L** DC current monitor (DCCT) -ø43 T14-	0
30. **D02782UX3000L** Transversal kicker stripline -ø43 T15-	0
31. **D02783UX3000L** Transversal kicker stripline -ø43 T16-	0
32. **D02784UX3000L** Wall current monitor -T17-	0
33. **D02785UX3000L** Vacuum pump connection -RFø200 T18-	0
34. **D02786UX3000L** Radio frequency cavity -RFø200 T19-	0
35. **D02787UX3000L** Support beam loss monitor -T20-	0
36. **D02788UX3000L** Wiggler vacuum chamber -CVW-	0
37. **D02789UX3000L** Long straight section vacuum chamber -CV100-	0
38. **D02790UX3000L** Dipole vacuum chamber -CVD-	0
39. **D02791UX3000L** Quadrupole vacuum chamber -CV43-	0
40. **D02792UX3000L** Wiggler sect. Quadrupole vacuum chamber -CW80-	0
41. **D02793UX3000L** Beam position monitor -CV100/MOD .6-2-	0
42. **D02794UX3000L** Beam position monitor -CW80/5-	0
43. **D02795UX3000L** Beam position monitor -CW80/4-	0
44. **D02796UX3000L** Beam position monitor -CV43/1-3-	0
45. **D02797UX3000L** B.P.M. support -CV43/CV100/CW80-	0
46. **D02798UX3000L** Vacuum chamber support -CV43/CV100/CW80-	0
47. **D02799UX3000L** Sextupole vacuum chamber -Sxxx CVW-	0
48. **D02008UX3000L** Wiggler sect. Quadrupole vacuum chamber -CW80 MOD.5-	0
49. **D02808UX3000L** Quadrupole QDW,QFW support	0

50.	**D02809UX3000L** Wiggler support	0
51.	**D02810UX3000L** Arc pcel line quadrupole sextupole upper support	0
52.	**D02811UX3000L** Arc pcel line quadrupole sextupole left-hand side lower support	0
53.	**D02812UX3000L** Arc pcel line quadrupole, sextupole right-hand side lower support	0
54.	**D02813UX3000L** Arc pcel line dipole support	0
55.	**D02814UX3000L** Arc pcel line sextupole support	0
56.	**D02815UX3000L** Vertical register support	0
57.	**D02816UX3000L** Register support	0
58.	**D02893UX3000L** Arc pcel line dipole, quadrupole, sextupole particular	0
59.	**D02894UX3000L** Wiggler line "wiggler, quadrupole, particular"	0
60.	**D02895UX3000L** Wiggler line "wiggler, quadrupole, section particular"	0
61.	**D02955UX3000L** D.R.T. Tunnel	0
62.	**D03029UX3000L** Typical flange CFs 100 section	0
63.	**D03030UX3000L** Typical gasket CFs 100 section	0
64.	**D03031UX3000L** Dipole vacuum chamber –A1,A2,A3,-	0
65.	**D03032UX3000L** Vacuum chamber –B1/B2,C1-	0
66.	**D03033UX3000L** Wiggler vacuum chamber section	0
67.	**D03034UX3000L** Wiggler quadrupole vacuum chamber	0
68.	**D03035UX3000L** CW80 vacuum chamber machining for welding	0
69.	**D03036UX3000L** Dipole vacuum chamber machining for welding	0
70.	**D03037UX3000L** Wiggler vacuum chamber machining for welding	0
71.	**D03038UX3000L** Round vacuum chamber machining for chamber	0
	2. MAGNET DRAWINGS	
72.	**D01623UX3000C** Dipole assembly	0
73.	**D01624UX3000C** Dipole lamination	0

74. **D01633UX3000C** QAD/QAF/QAM1,2/QAD1,1 Quadrupole assembly	0
75. **D01670UX3000C** QAD/QAF/QAM1,2/QAD1,1 Quadrupole yoke assembly	0
76. **D01639UX3000C** QAD/QAF/QAM1,2/QAD1,1/QWF/QWD Quadrupole lamination	0
77. **D01634UX3000C** QAD/QAF/QAM/QWA/QWF/QWD Quadrupole support	0
78. **D01636UX3000C** QAM 3, 4, 5 Quadrupole assembly	0
79. **D01667UX3000C** QAM 3, 4, 5 Quadrupole yoke assembly	0
80. **D01638UX3000C** QWF, QWD Quadrupole assembly	0
81. **D01637UX3000C** QWA 1, 2, 3, 4, 5 Quadrupole assembly	0
82. **D01669UX3000C** QWA 1, 2, 3, 4, 5 Quadrupole yoke assembly	0
83. **D01640UX3000C** QWA 1, 2, 3, 4, 5 Quadrupole lamination	0
84. **D01629UX3000C** QLF, QLD Quadrupole assembly	0
85. **D01666UX3000C** QLF, QLD Quadrupole yoke assembly	0
86. **D01631UX3000C** QLF, QLD Quadrupole lamination	0
87. **D01630UX3000C** QLF, QLD Quadrupole support	0
88. **D01626UX3000C** S1P, S1M Sextupole assembly	0
89. **D01672UX3000C** S1P, S1M Sextupole yoke assembly	0
90. **D01625UX3000C** S2PA, S2MA Sextupole assembly	0
91. **D01673UX3000C** S2PA, S2MA Sextupole yoke assembly	0
92. **D01627UX3000C** S2PB, S2MB Sextupole assembly	0
93. **D01671UX3000C** S2PB, S2MB Sextupole yoke assembly	0
94. **D01628UX3000C** S1P, S1M, S2PA, S2MA, S2PB, S2MB Sextupole lamination	0
95. **D01614UX3000C** S1P, S1M, S2PA, S2MA, S2PB, S2MB Sextupole support	0
96. **D02603UX3000C** ARC_CELL and Wiggler section corrector	0
97. **D02604UX3000C** Long straight section corrector	0
98. **D01620UX3000C** Electromagnetic wiggler assembly	0
99. **D02837UX3000C** Electromagnetic wiggler support	0

- News drawings

** Revisions drawings

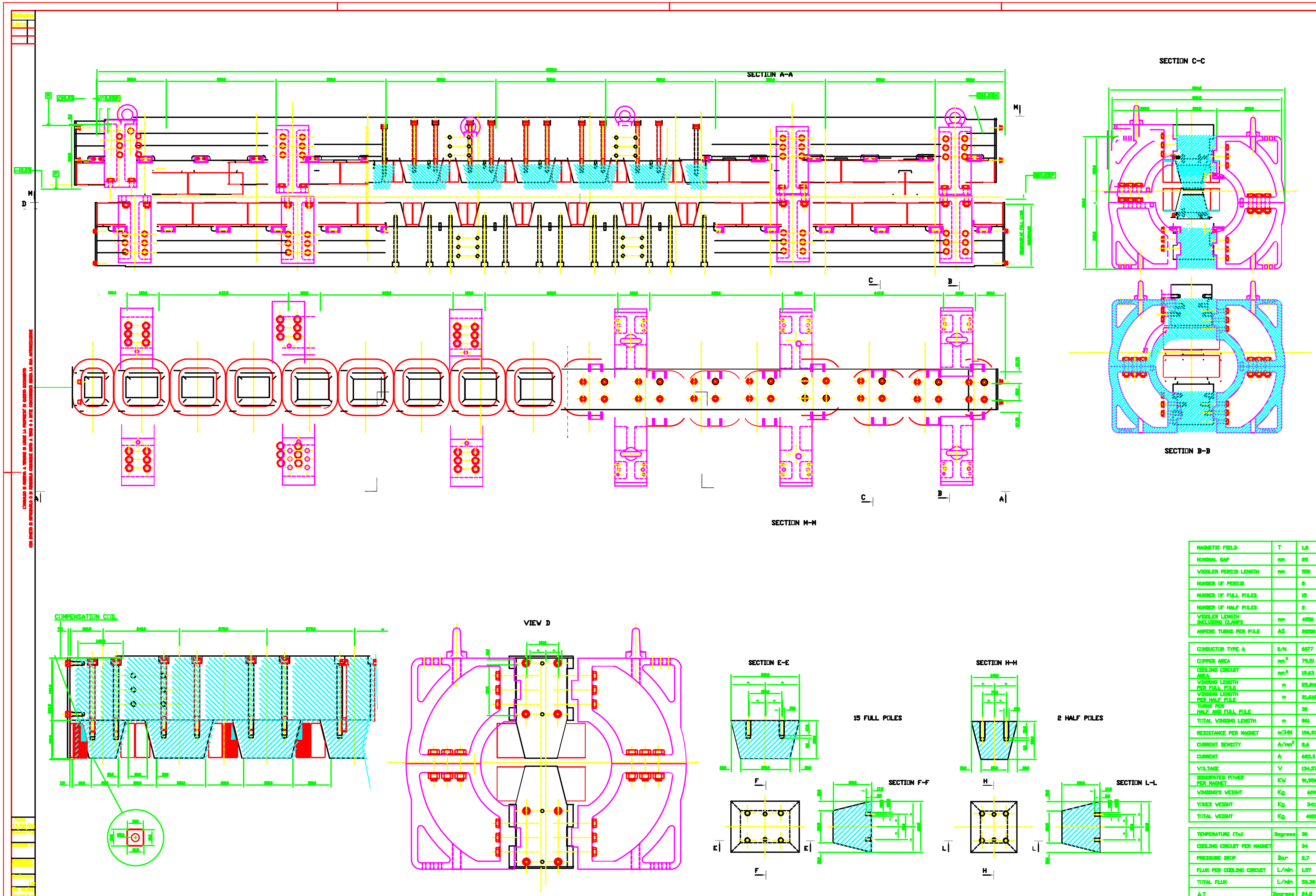
Spec. n. S02994UX3000L

DAMPING RING TESLA

REPORT LIST

Rev.	Data	Descrizione	Emesso Issued	Controllato Controlled	Approvato Approved
0	02/02/2001	Report List	Barbagelata Luigi	Grattarola Marco	Rosatelli F.
1	28/02/2001	Report List	Barbagelata Luigi	Grattarola Marco	Rosatelli F.

NUMBER	TITLE	Rev.
1. **S02956UX3000L**	Economic and sinking plan of " Tesla Damping Ring"	1
2. **S02957UX3000L**	Time schedule for the construction of "Tesla Damping Ring"	1
3. **S02958UX3000L**	Multipole girders and supports	1
4. **S02975UX3000L**	Damping Ring vacuum chamber	0
5. **S02977UX3000L**	Vacuum chamber supports	0
6. **S02978UX3000L**	Pumps and power supplies	0
7. **S02979UX3000L**	Vacuum diagnostics	0
8. **S02980UX3000L**	Manual and automatic valves	0
9. **S02981UX3000L**	Control units	1
10. **S02982UX3000L**	Special magnet vacuum chambers (wigglers)	0
11. **S02983UX3000L**	Beam diagnostics	0
12. **S02991UX3000L**	General Services	0
13. **S02992UX3000L**	Drawing list	0
14. **S02993UX3000L**	Magnets	0
15. **S02994UX3000L**	Report list	1
16. **S02995UX3000L**	Handling equipment and cranes	0
17. **S02996UX3000L**	Tunnel transport system	0
18. **S03003UX3000L**	Alignment facilities (in progress)	0
19. **S03004UX3000L**	-Installation time schedule and manpower- - Engineering and QA -	0
20. **S03006UX3000L**	Magnet power supplies	0
21. **S03007UX3000L**	Tests and acceptance tests (in progress)	0



MAGNETIC FIELD	T	1,8
NOMINAL GAP	mm	25
WIGGLER PERIOD LENGTH	mm	550
NUMBER OF PERIOD		8
NUMBER OF FULL POLES		15
NUMBER OF HALF POLES		2
WIGGLER LENGTH INCLUDING CLAMPS	mm	4550
AMPERE TURNS PER POLE	AS	20500

CONDUCTOR TYPE A	S/N	6077
COPPER AREA	mm^2	79,51
COOLING CIRCUIT AREA	mm^2	19,63
WINDING LENGTH PER FULL POLE	m	25,816
WINDING LENGTH PER HALF POLE	m	21,616
TURNS PER HALF AND FULL POLE		30
TOTAL WINDING LENGTH	m	861
RESISTANCE PER MAGNET	mOHM	196,93
CURRENT DENSITY	A/mm^2	8,6
CURRENT	A	683,3
VOLTAGE	V	134,57
DISSIPATED POWER PER MAGNET	KW	91,956
WINDING'S WEIGHT	Kg	609
YOKES WEIGHT	Kg	3411
TOTAL WEIGHT	Kg	4020

TEMPERATURE [To]	Degrees	30
COOLING CIRCUIT PER MAGNET		34
PRESSURE DROP	Bar	2,7
FLUX PER COOLING CIRCUIT	L/min	1,57
TOTAL FLUX	L/min	53,38
ΔT	Degrees	24,8

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768-K

MATERIALE

FINITURA

ANSALDO
Ansaldo Ricerche s.r.l.

TESLA DAMPING RING
WIGGLER ASSEMBLY

Rev. 0 | Scala

D01620UX3000C

Segue F. 1 F. 1

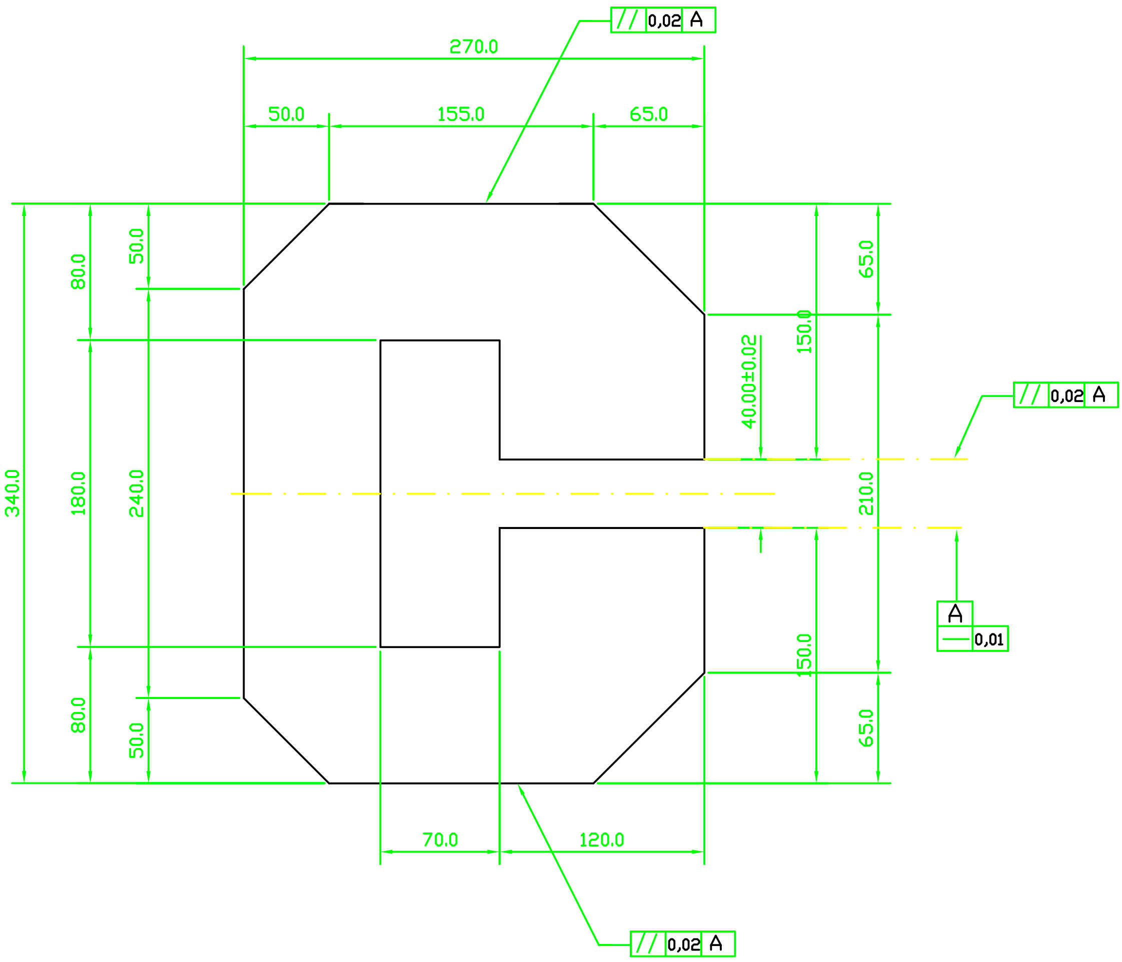
Distribuzione

Lista 13

ANSALDO

Ansaldo Ricerche s.r.l.

L'ANSALDO SI RISERVA A TERMINE DI LEGGE LA PROPRIETA' DI QUESTO DOCUMENTO CON DIVIETO DI RIPRODURLO O DI RENDERLO COMUNQUE NOTO A TERZI O A DITTE CONCORRENTI SENZA LA SUA AUTORIZZAZIONE



THICKNESS SHEET 1-1,5 mm

TOTAL SHEETS = 646488

MATERIAL: SA1010

Data	13/06/00
Redatto	CANEPA
Controllo e Approvazione	CANEPA
Autorizzazione Emissione	GRATTAROLA
Software	CAD 12
File: xxx.dwg	D01623.DWG

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–c K

REV.	DESCRIZIONE	Data	Redatto	Controllo Approvaz.	Autorizz. Emissione

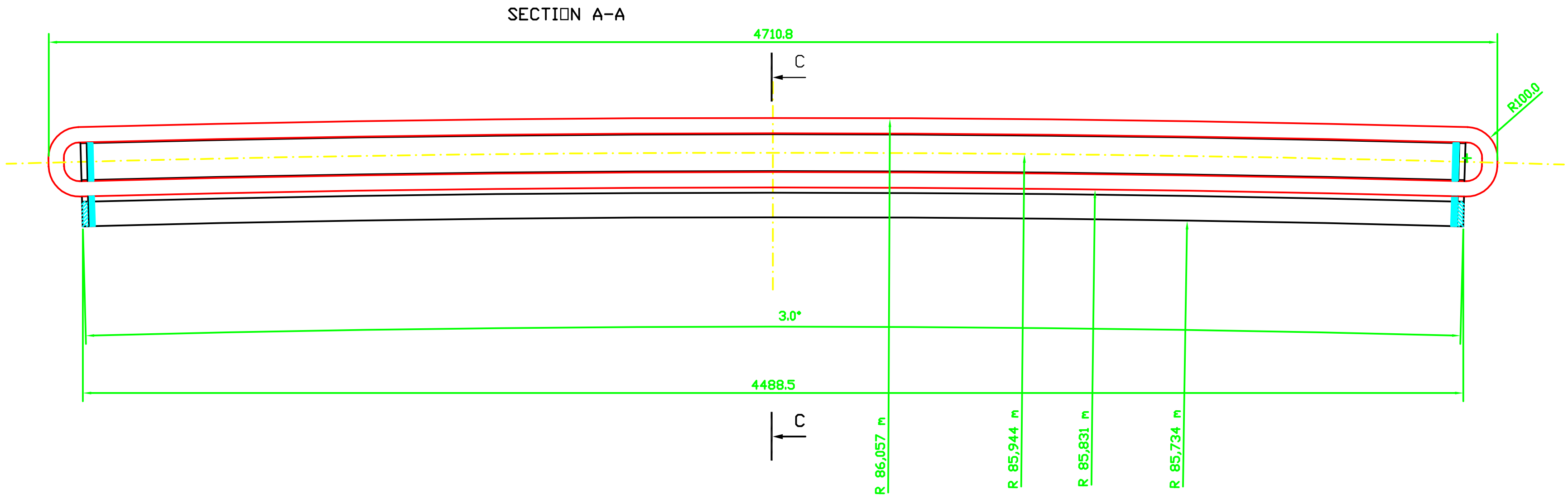
TESLA DAMPING RING

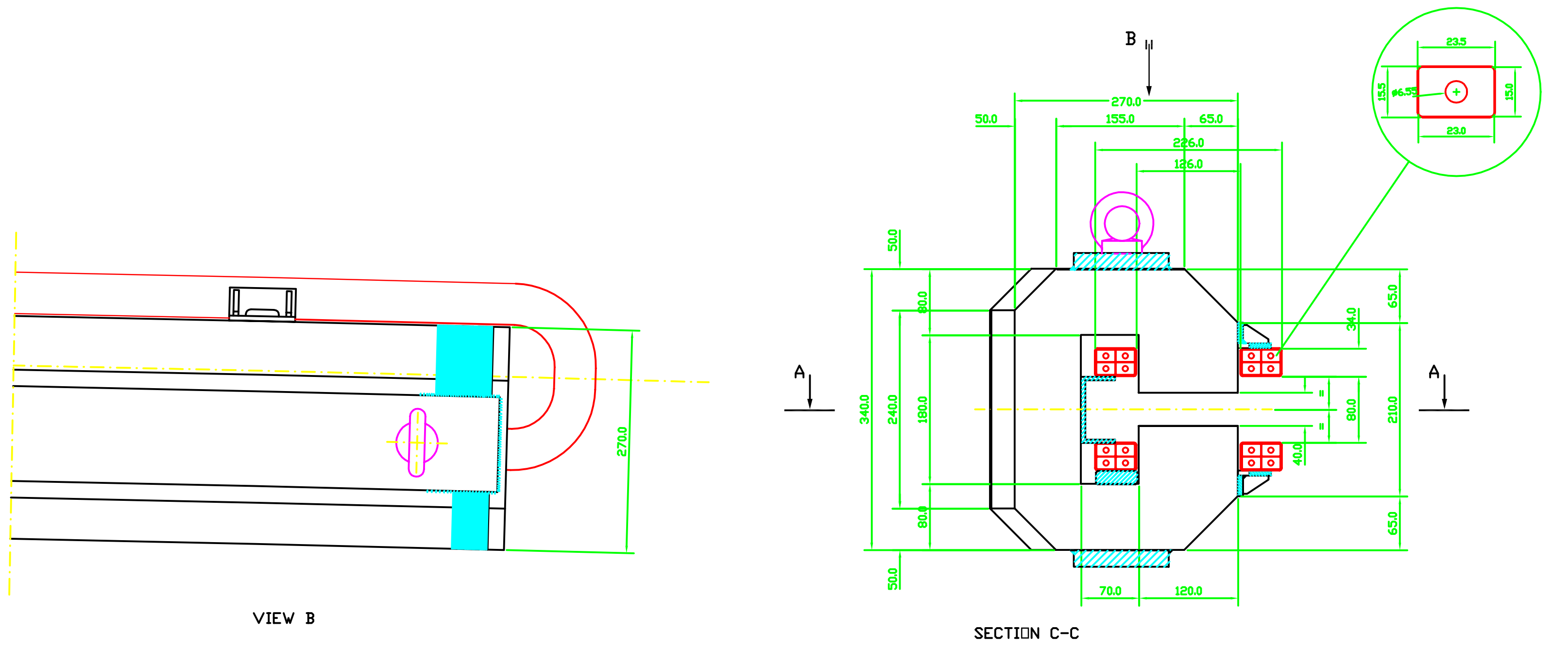
DIPOLE LAMINATION

Rev. 0 Scala

D01624UX3000C

Segue F. 1 F. 1





MAGNETIC LENGTH	mm	4500
MAGNETIC GAP	mm	40
BENDING RADIUS	m	85,944
MAGNETIC FIELD	T	0,19346
TOTAL AMPERE TURNS	As	6176

CONDUCTOR TYPE A	S/N	8198
COPPER AREA	mm^2	310,068
COOLING CIRCUIT AREA	mm^2	33,696
AVERAGE LENGTH PER TURN	m	9,394
NUMBER OF TURNS		4
WINDING LENGTH PER COIL	m	37,576
TOTAL WINDING LENGTH	m	75,152
RESISTANCE PER MAGNET	mOHM	4,29
CURRENT DENSITY	A/mm^2	2,49
CURRENT	A	772,1
VOLTAGE	V	3,31
DISSIPATED POWER PER MAGNET	KW	2,557
WINDING'S WEIGHT	Kg	207,4
YOKES WEIGHT	Kg	2385
TOTAL WEIGHT	Kg	2592,4

TEMPERATURE [To]	Degrees	30
COOLING CIRCUIT PER MAGNET		1
PRESSURE DROP	Bar	2,1
FLUX PER COOLING CIRCUIT	L/min	2,04
TOTAL FLUX	L/min	2,04
ΔT	Degrees	18

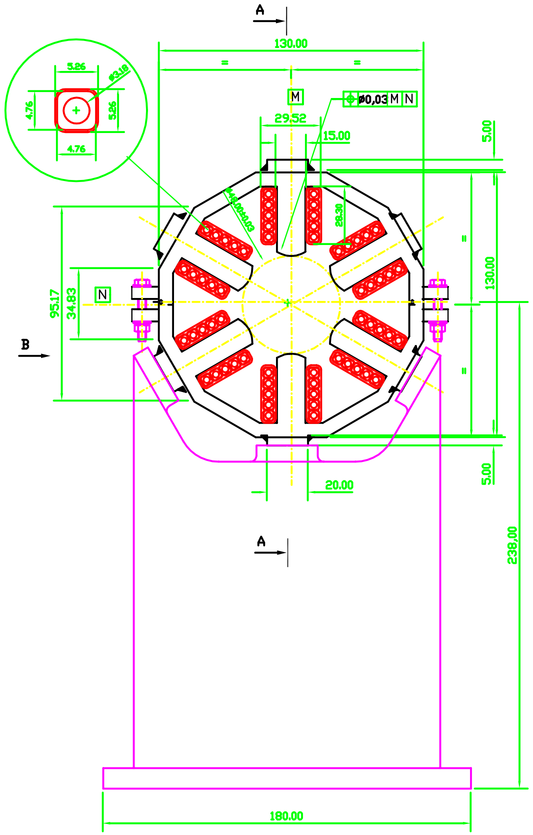
Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768

ANSALDO
Ansaldo Ricerche s.r.l.

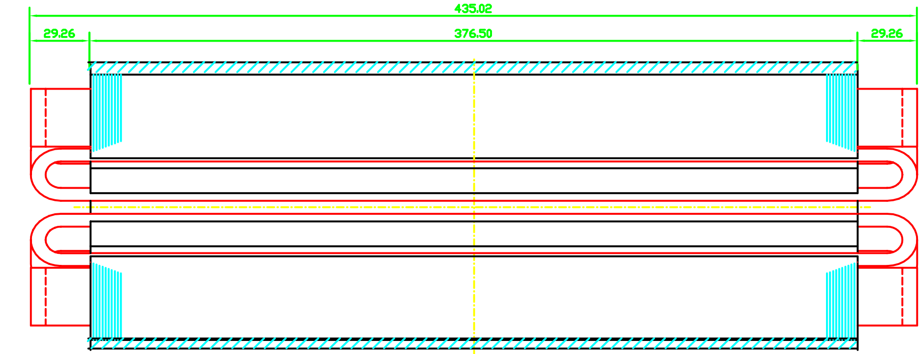
TESLA DAMPING RING
DIPOLE ASSEMBLY

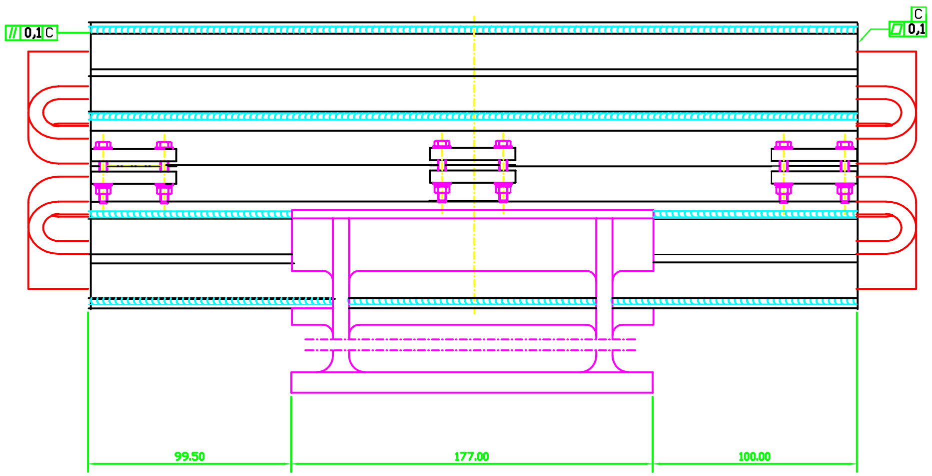
Rev. 0 Scala

D01623UX3000C



SECTION A-A





VIEW B

MAGNETIC LENGTH	mm	400
APERTURE RADIUS	mm	24
MAX GRADIENT	T/m2	65,05
AMPERE TURNS	As	240

CONDUCTOR TYPE A	S/N	8150
COPPER AREA	mm^2	13,857
COOLING CIRCUIT AREA	mm^2	7,942
AVERAGE LENGTH PER TURN	m	0,882
NUMBER OF TURNS		5
WINDING LENGTH PER COIL	m	4,41
TOTAL WINDING LENGTH	m	26,46
RESISTANCE PER MAGNET	mOHM	33,796
CURRENT DENSITY	A/mm^2	3,464
CURRENT	A	48
VOLTAGE	V	1,62
DISSIPATED POWER PER MAGNET	KW	0,078
WINDING'S WEIGHT	Kg	3,26
YOKES WEIGHT	Kg	16,45
TOTAL WEIGHT	Kg	19,71

TEMPERATURE [To]	Degrees	30
COOLING CIRCUIT PER MAGNET		1
PRESSURE DROP	Bar	2,8
FLUX PER COOLING CIRCUIT	L/min	0,60
TOTAL FLUX	L/min	0,60
ΔT	Degrees	2

Data 13/06/00
Redatto CANEPA
Controllo e Approvazione CANEPA
Autorizzazione Emissione GRATTAROLA
Software CAD 12
File: xxx.dwg D01625.DWG

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768-K

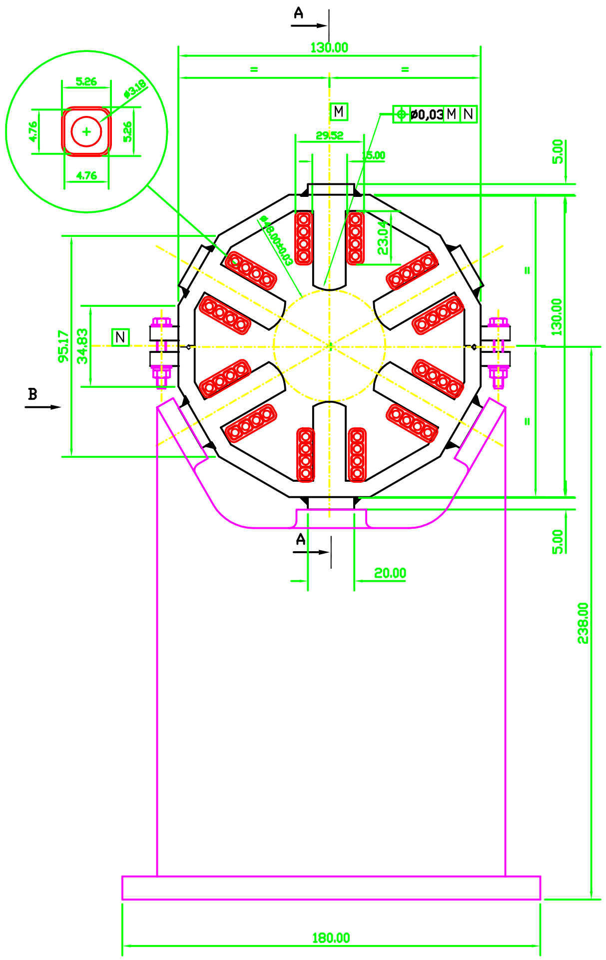
REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione	MATERIALE
						FINITURA

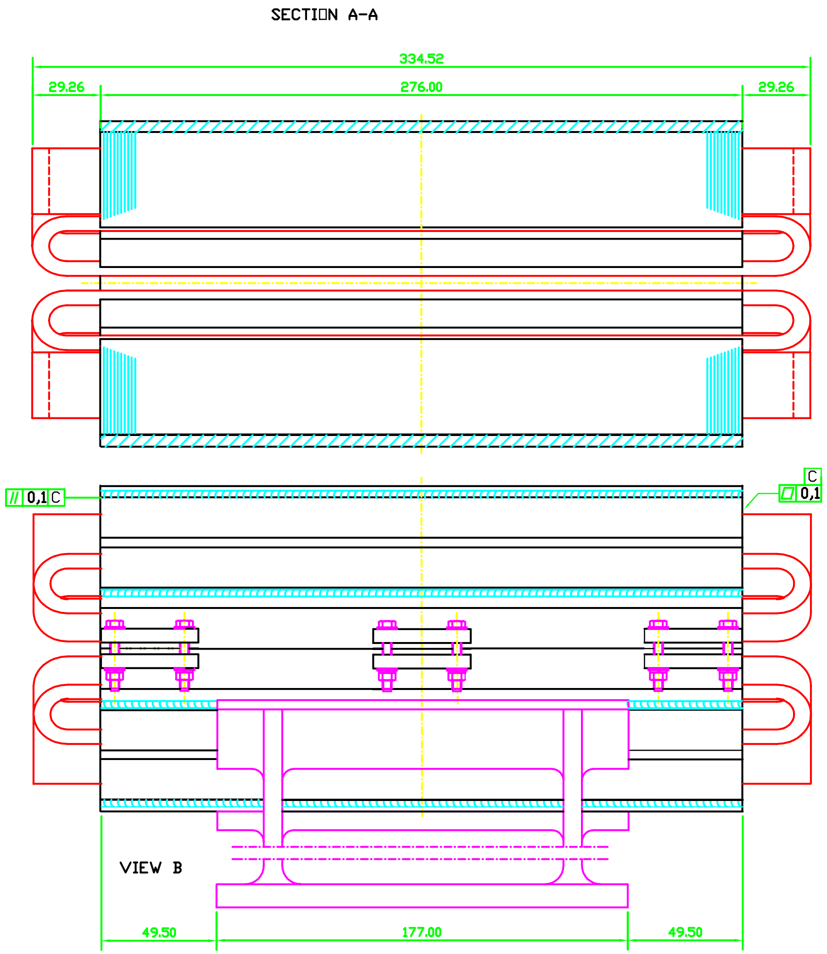
ANSALDO
Ansaldo Ricerche s.r.l.

TESLA DAMPING RING
S2PA–S2MA SEXTUPOLE ASSEMBLY

Rev. 0 Scala
D01625UX3000C
Segue F. 1 F. 1

Distribuzione	
Lista	13





MAGNETIC LENGTH	mm	300
APERTURE RADIUS	mm	24
MAX GRADIENT	T/m2	50,85
AMPERE TURNS	As	187

CONDUCTOR TYPE A	S/N	8150
COPPER AREA	mm^2	13,857
COOLING CIRCUIT AREA	mm^2	7,942
AVERAGE LENGTH PER TURN	m	0,682
NUMBER OF TURNS		4
WINDING LENGTH PER COIL	m	2,728
TOTAL WINDING LENGTH	m	16,37
RESISTANCE PER MAGNET	mOHM	20,905
CURRENT DENSITY	A/mm^2	3,374
CURRENT	A	46,75
VOLTAGE	V	0,98
DISSIPATED POWER PER MAGNET	KW	0,046
WINDING'S WEIGHT	Kg	2,02
YOKES WEIGHT	Kg	12,06
TOTAL WEIGHT	Kg	14,08

TEMPERATURE [To]	Degrees	30
COOLING CIRCUIT PER MAGNET		1
PRESSURE DROP	Bar	2,8
FLUX PER COOLING CIRCUIT	L/min	0,78
TOTAL FLUX	L/min	0,78
ΔT	Degrees	2

Data 13/06/00
Redatto CANEPA
Controllo e Approvazione CANEPA
Autorizzazione Emissione GRATTAROLA
Software CAD 12
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Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768-K

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione	MATERIALE
						FINITURA

ANSALDO
Ansaldo Ricerche s.r.l.

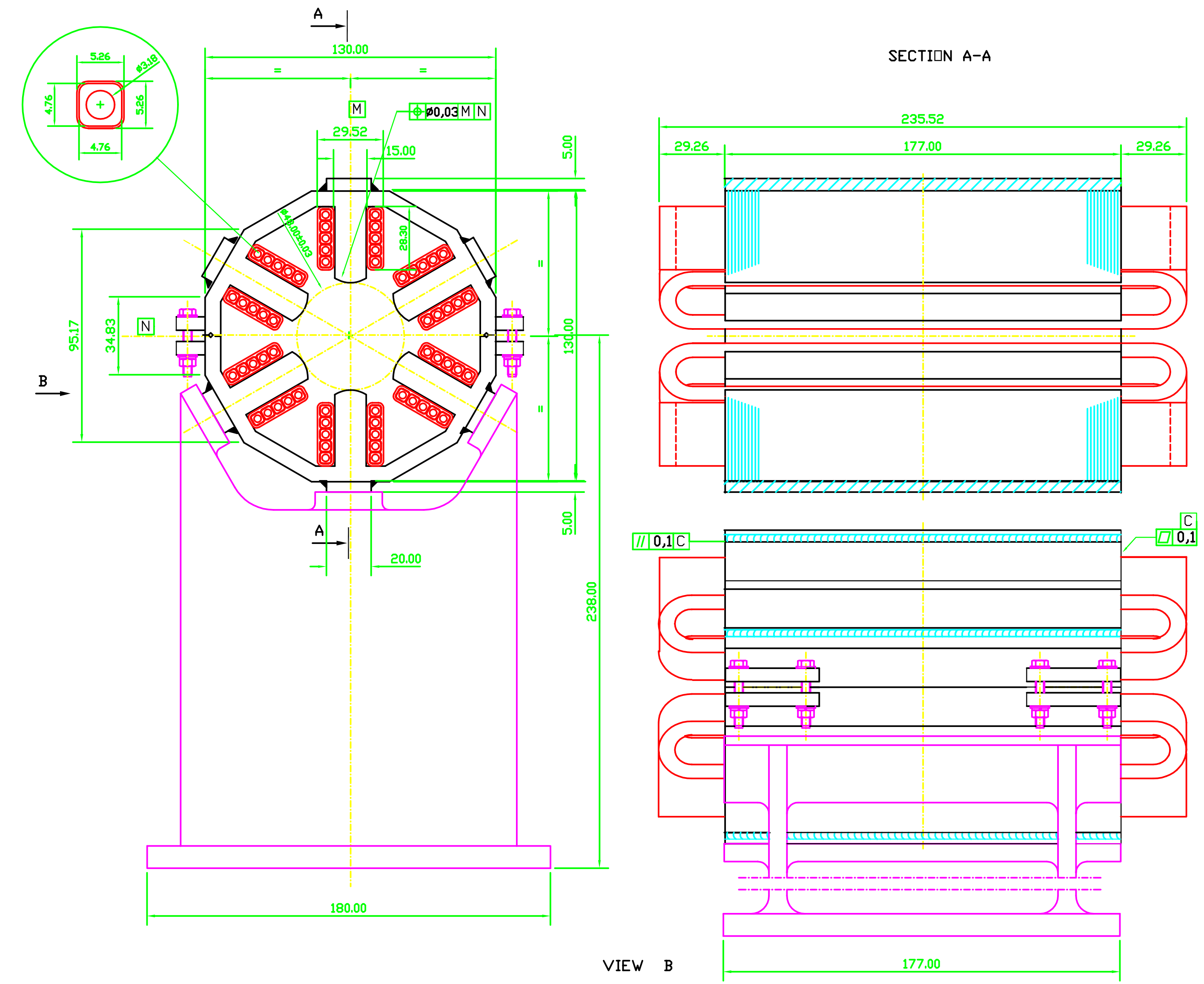
TESLA DAMPING RING

S1P-S1M SEXTUPOLE ASSEMBLY

Rev. 0 Scala

D01626UX3000C

Segue F. 1 F. 1



Distribuzione
Lista 13

L'ANSALDO SI RISERVA A TERMINE DI LEGGE LA PROPRIETA' DI QUESTO DOCUMENTO CON DIVIETO DI RIPRODURLO O DI RENDERLO COMUNQUE NOTO A TERZI O A DITTE CONCORRENTI SENZA LA SUA AUTORIZZAZIONE

MAGNETIC LENGTH	mm	200
APERTURE RADIUS	mm	24
MAX GRADIENT	T/m2	65,05
AMPERE TURNS	As	240

CONDUCTOR TYPE A	S/N	8150
COPPER AREA	mm^2	13,857
COOLING CIRCUIT AREA	mm^2	7,942
AVERAGE LENGTH PER TURN	m	0,482
NUMBER OF TURNS		5
WINDING LENGTH PER COIL	m	2,41
TOTAL WINDING LENGTH	m	14,46
RESISTANCE PER MAGNET	mOHM	18,468
CURRENT DENSITY	A/mm^2	3,464
CURRENT	A	48
VOLTAGE	V	0,89
DISSIPATED POWER PER MAGNET	KW	0,043
WINDING'S WEIGHT	Kg	1,78
YOKES WEIGHT	Kg	7,73
TOTAL WEIGHT	Kg	9,51

TEMPERATURE [To]	Degrees	30
COOLING CIRCUIT PER MAGNET		1
PRESSURE DROP	Bar	2,8
FLUX PER COOLING CIRCUIT	L/min	0,84
TOTAL FLUX	L/min	0,84
ΔT	Degrees	1

Data 13/06/00
Redatto CANEPA
Controllo e Approvazione CANEPA
Autorizzazione Emissione GRATTAROLA
Software CAD 12
File: xxx.dwg D01627.DWG

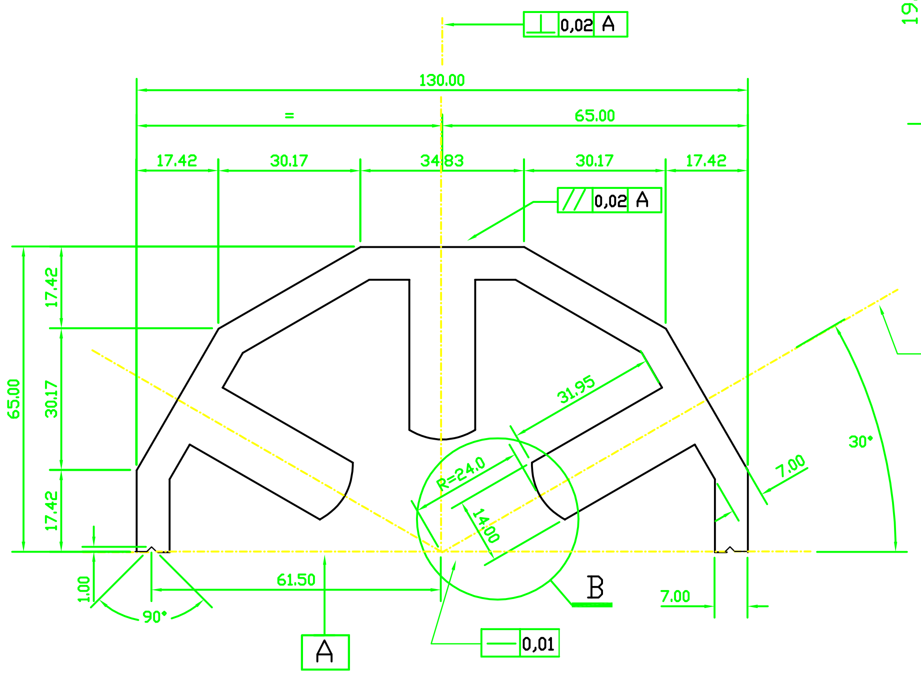
Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768-K

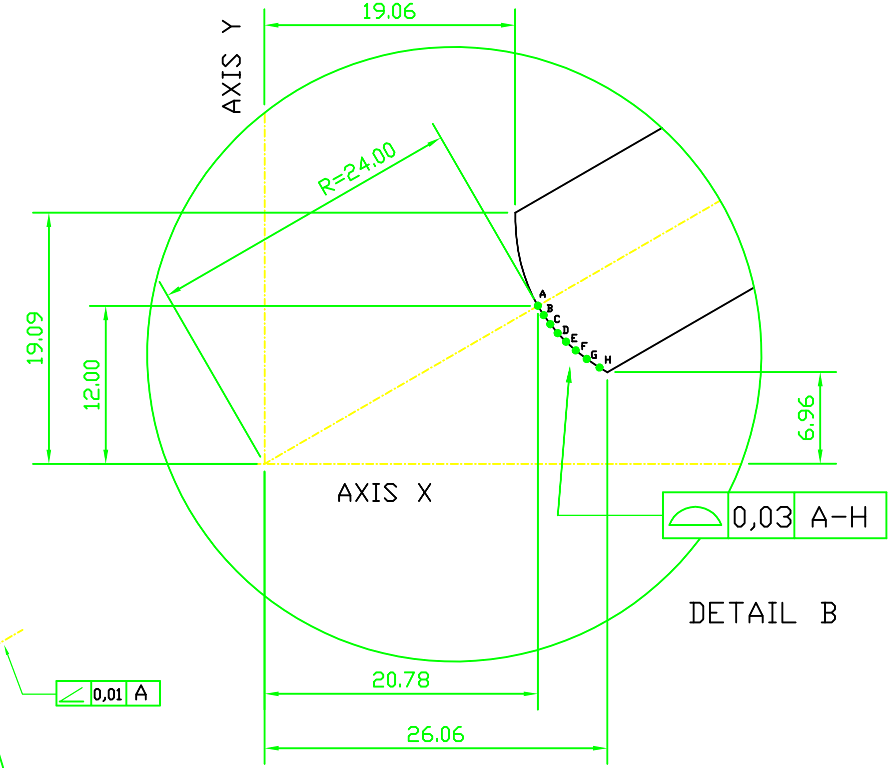
REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizz. emissione	MATERIALE
						FINITURA

ANSALDO
Ansaldo Ricerche s.r.l.

TESLA DAMPING RING
S2PB-S2MB SEXTUPOLE ASSEMBLY

Rev. 0 Scala
D01627UX3000C
Segue F. 1 F. 1





POINT	Axis X	Axis Y
A	20.78	12.00
B	21.23	11.29
C	21.73	10.60
D	22.29	9,93
E	22.93	9.27
F	23.66	8.61
G	24.50	7.96
H	25.47	7.30

THICKNESS SHEET 1-1,5 mm

TOTAL SHEETS =126096

Distribuzione
Lista 13

Data 13/06/00
Redatto CANEPA
Controllo e Approvazione CANEPA
Autorizzazione Emissione GRATTAROLA
Software CAD 12
File: xxx.dwg D01628.DWG

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768-K

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione

MATERIALE SA1010

FINITURA

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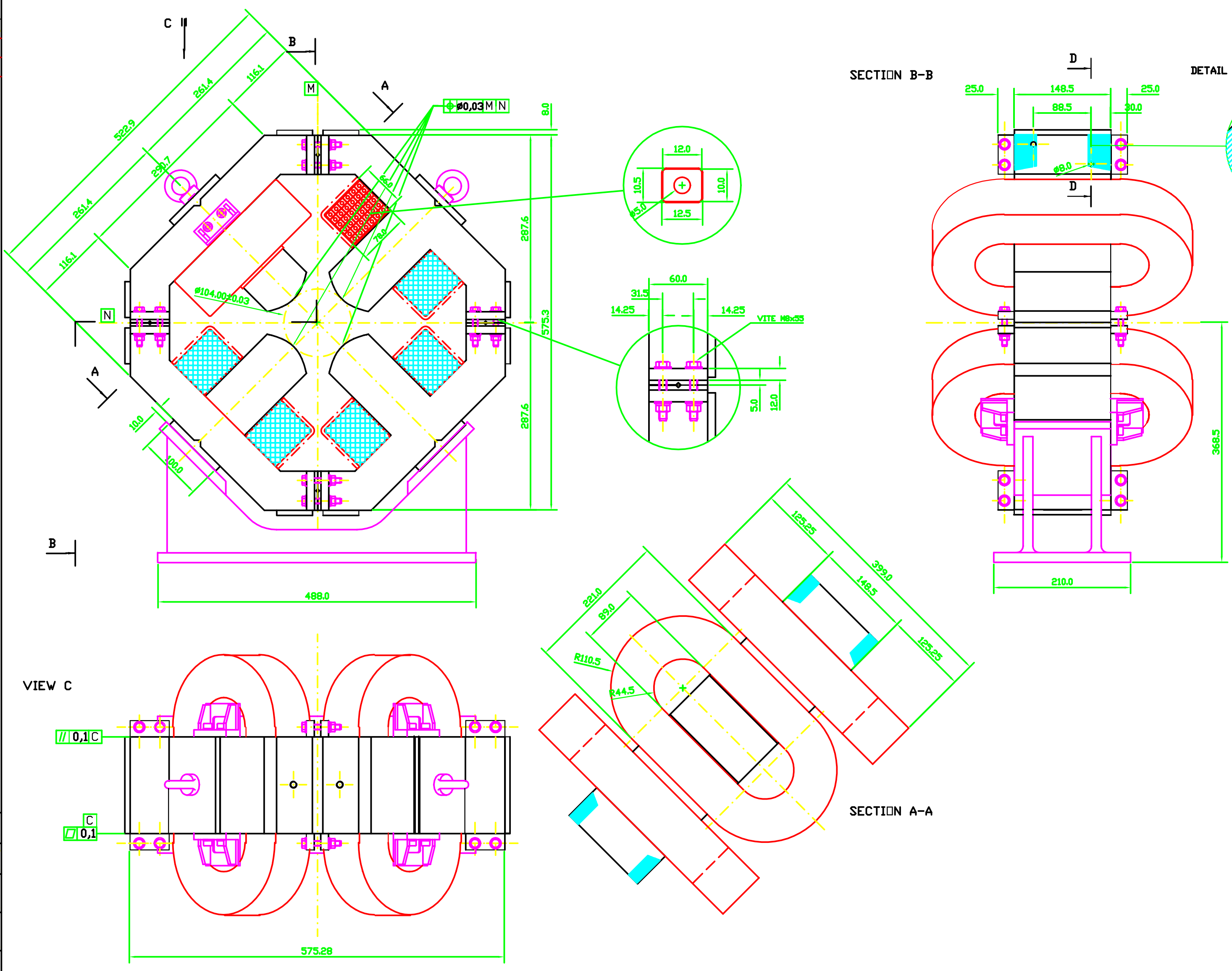
Ansaldo Ricerche s.r.l.

TESLA DAMPING RING
S1P-S1M-S2PA-S2MA-S2PB-S2MB SEXTUPOLE LAMINATION

Rev. 0
Scala

D01628UX3000C

Segue F. 1
F. 1



MAGNETIC LENGTH	mm	200
APERTURE RADIUS	mm	52
MAX GRADIENT	T/m	7,5
AMPERE TURNS	As	8070

CONDUCTOR TYPE A	S/N	6893
COPPER AREA	mm^2	99,507
COOLING CIRCUIT AREA	mm^2	19,63
AVERAGE LENGTH PER TURN	m	0,8429
NUMBER OF TURNS		36
WINDING LENGTH PER COIL	m	30,344
TOTAL WINDING LENGTH	m	121,38
RESISTANCE PER MAGNET	mOHM	21,6
CURRENT DENSITY	A/mm^2	2,253
CURRENT	A	224,17
VOLTAGE	V	4,85
DISSIPATED POWER PER MAGNET	KW	1,086
WINDING'S WEIGHT	Kg	107,5
YOKES WEIGHT	Kg	146,9
TOTAL WEIGHT	Kg	254,4

TEMPERATURE [To]	Degrees	30
COOLING CIRCUIT PER MAGNET		2
PRESSURE DROP	Bar	2,2
FLUX PER COOLING CIRCUIT	L/min	1,19
TOTAL FLUX	L/min	2,38
ΔT	Degrees	7

Distribuzione
Lista 13

Data 13/06/00
Redatto CANEPA
Controllo e Approvazione CANEPA
Autorizzazione Emissione GRATTAROLA
Software CAD 12
File: xxx.dwg D01629.DWG

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768-K

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizz. emissione

MATERIALE

FINITURA

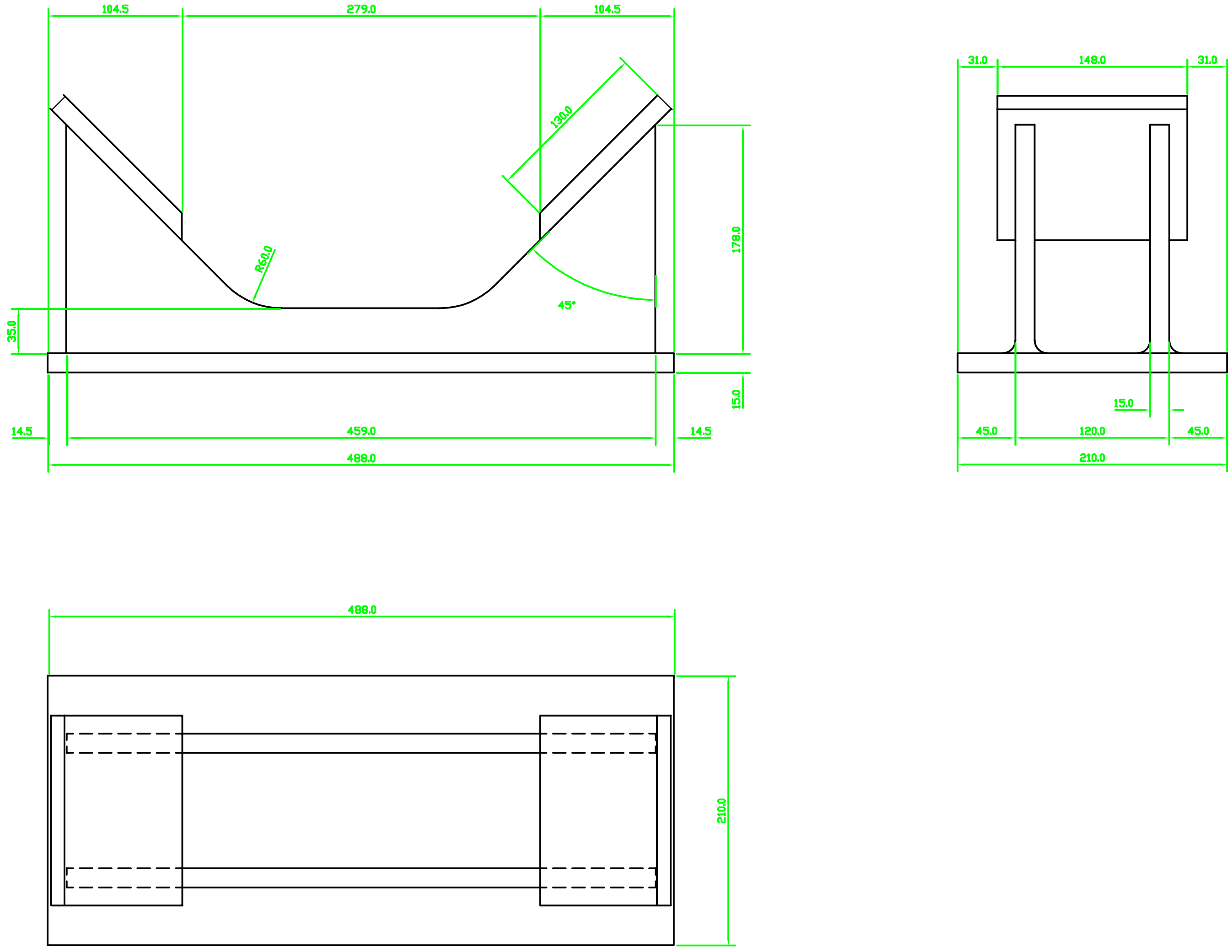
ANSALDO
Ansaldo Ricerche s.r.l.

TESLA DAMPING RING
QLF - QLD QUADRUPOLE ASSEMBLY

Rev. 0 Scala

D01629UX3000C

Segue F. 1 F. 1



Distribuzione
Lista 13

Data 13/06/00
Redatto CANEPA
Controllo e Approvazione CANEPA
Autorizzazione Emissione GRATTAROLA
Software CAD 12
File: xxx.dwg D01630.DWG

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768-K

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzaz. emissione

MATERIALE G-Al Si7 Mg Mn UNI 3599

FINITURA

ANSALDO
Ansaldo Ricerche s.r.l.

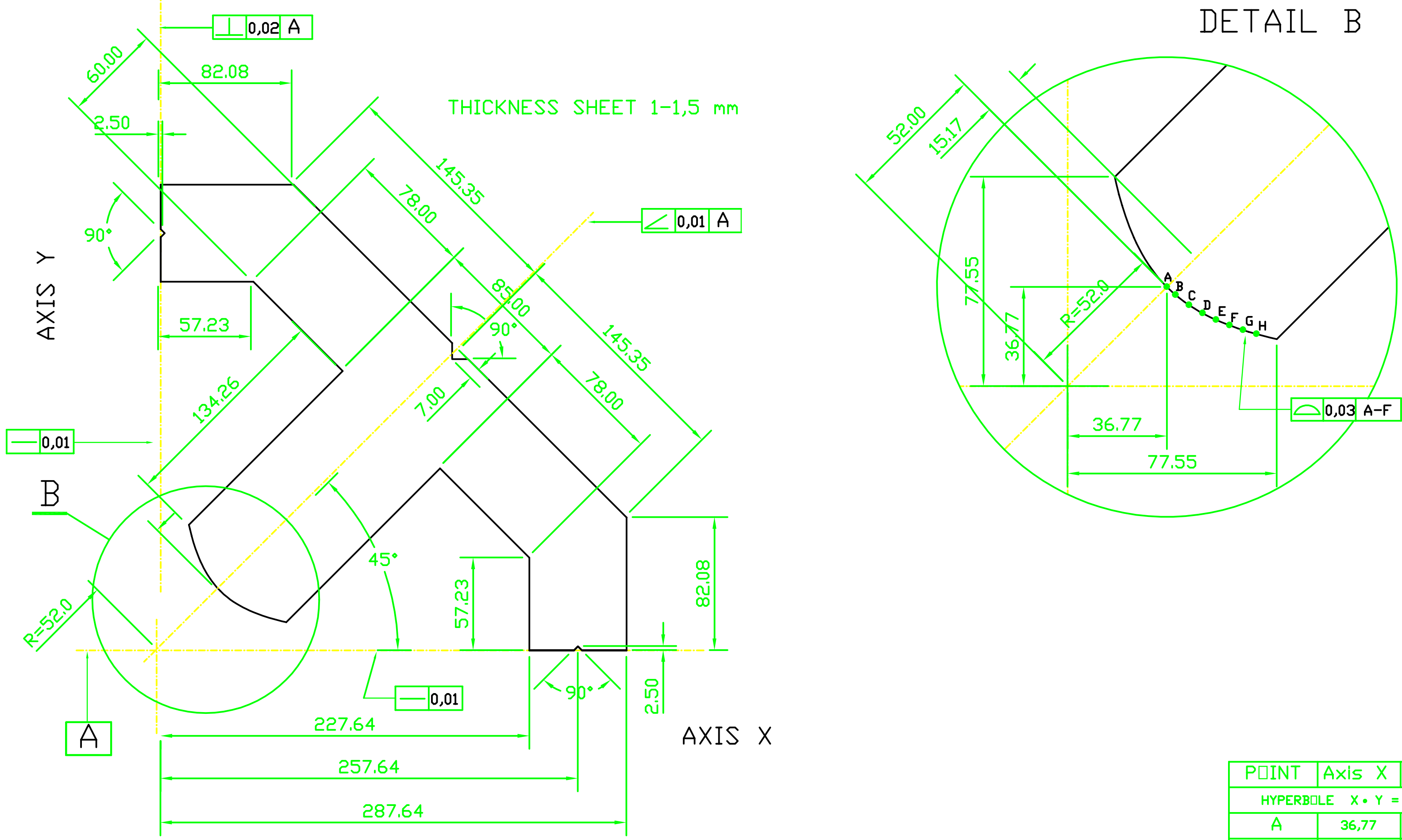
TESLA DAMPING RING

QLF – QLD QUADRUPOLE SUPPORT

Rev. 0
Scala

D01630UX3000C

Segue F. 1 F. 1



POINT	Axis X	Axis Y
HYPERBOLE	X • Y = 52²/ 2	
A	36,77	36,77
B	40,00	33,80
C	45,00	30,04
D	50,00	27,04
E	55,00	24,58
F	60,00	22,53
G	65,00	20,08
H	70,00	19,31

TOTAL SHEETS = 106524

Distribuzione
Lista 13

Data 13/06/00
Redatto CANEPA
Controllo e Approvazione CANEPA
Autorizzazione Emissione GRATTAROLA
Software CAD 12
File: xxx.dwg D01631.DWG

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768-K

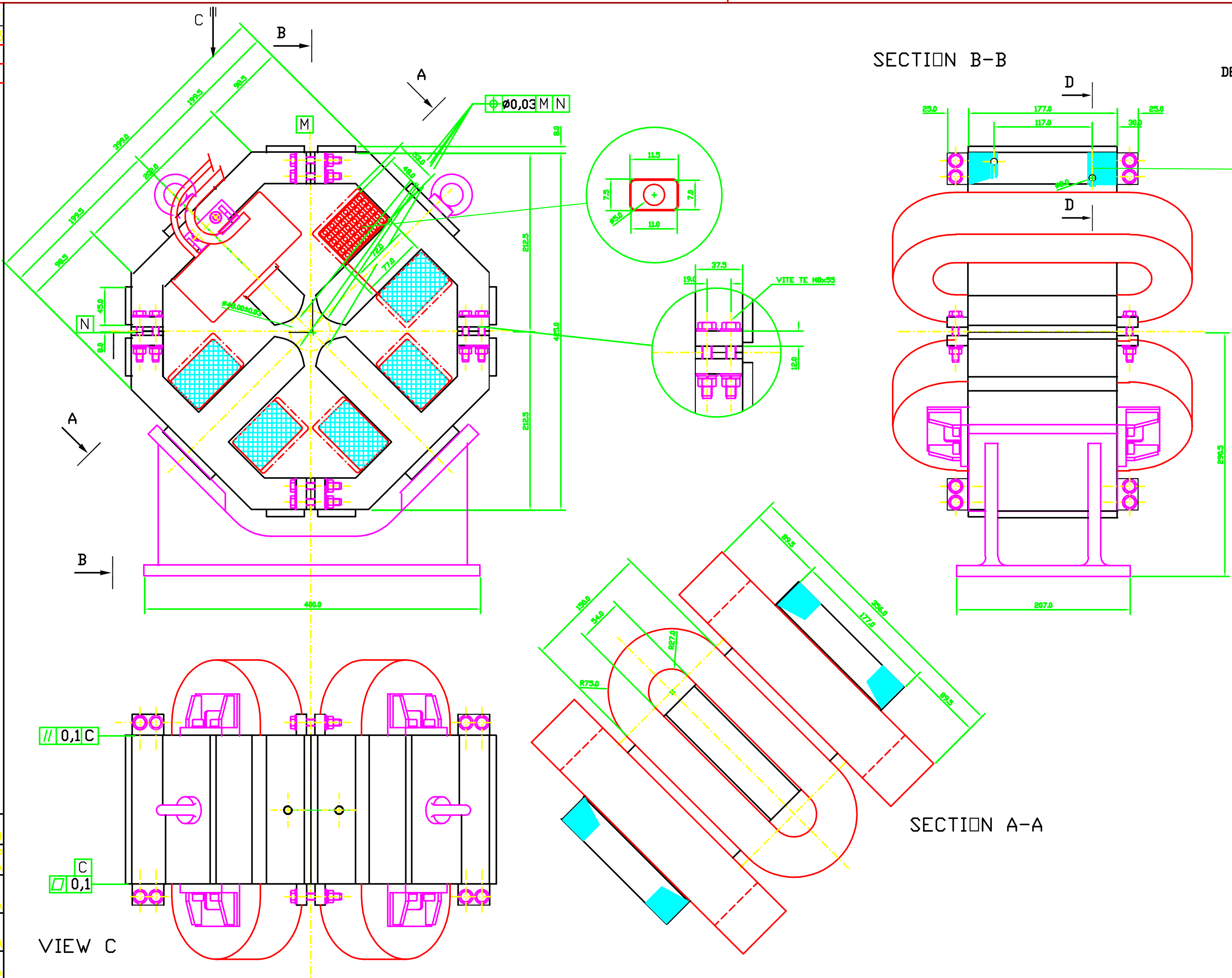
REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzaz. emissione

MATERIALE SA1010
FINITURA

ANSALDO
Ansaldo Ricerche s.r.l.

TESLA DAMPING RING
QLF – QLD QUADRUPOLE LAMINATION

Rev. 0
Scala
D01631UX3000C
Segue F. 1 F. 1



MAGNETIC LENGTH	mm	200
APERTURE RADIUS	mm	24
MAX GRADIENT	T/m	21,7
AMPERE TURNS	As	4973
CONDUCTOR TYPE A	S/N	8166
COPPER AREA	mm^2	56,507
COOLING CIRCUIT AREA	mm^2	19,63
AVERAGE LENGTH PER TURN	m	0,7324
NUMBER OF TURNS		36
WINDING LENGTH PER COIL	m	26,366
TOTAL WINDING LENGTH	m	105,46
RESISTANCE PER MAGNET	mOHM	33,1
CURRENT DENSITY	A/mm^2	2,445
CURRENT	A	138,14
VOLTAGE	V	4,57
DISSIPATED POWER PER MAGNET	KW	0,631
WINDING'S WEIGHT	Kg	53
YOKES WEIGHT	Kg	102
TOTAL WEIGHT	Kg	155
TEMPERATURE [To]	Degrees	30
COOLING CIRCUIT PER MAGNET		2
PRESSURE DROP	Bar	2,2
FLUX PER COOLING CIRCUIT	L/min	1,19
TOTAL FLUX	L/min	2,38
Δ T	Degrees	5

Distribuzione
Lista 13

Data 13/06/00
Redatto CANEPA
Controllo e Approvazione CANEPA
Autorizzazione Emissione GRATTAROLA
Software CAD 12
File: xxx.dwg D01633.DWG

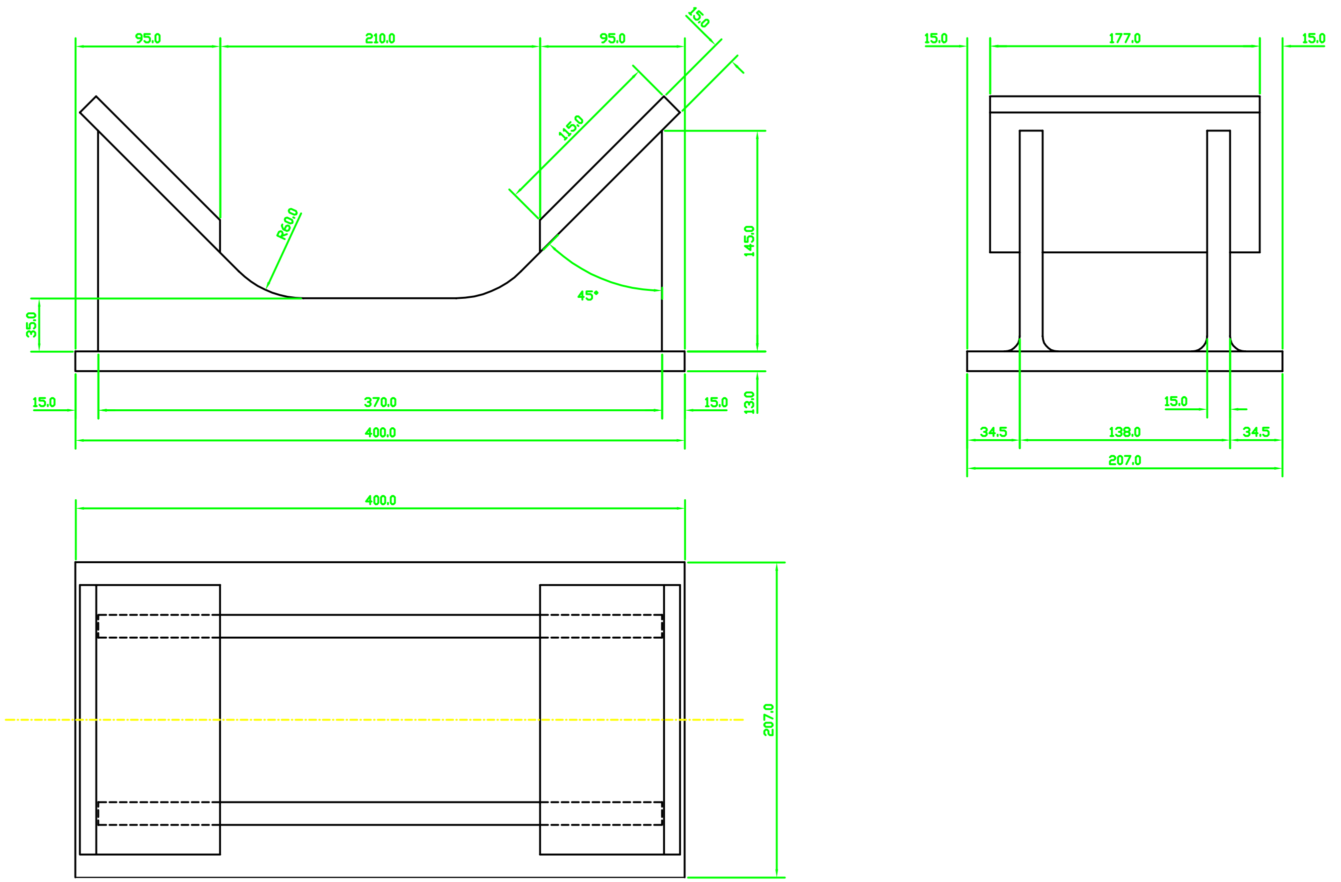
Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768-K

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizz. emissione	MATERIALE
						FINITURA

ANSALDO
Ansaldo Ricerche s.r.l.

TESLA DAMPING RING
QAD/QAF/QAM1,2/QAD1,2 QUADRUPOLE ASSEMBLY

Rev. 0 Scala
D01633UX3000C
Segue F. 1 F. 1



Distribuzione
Lista 13

Data 13/06/00
Redatto CANEPA
Controllo e Approvazione CANEPA
Autorizzazione Emissione GRATTAROLA
Software CAD12
File: xxx.dwg D01634.DWG

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768-K

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizz. emissione

MATERIALE G-Al Si7 Mg Mn UNI 3599

FINITURA

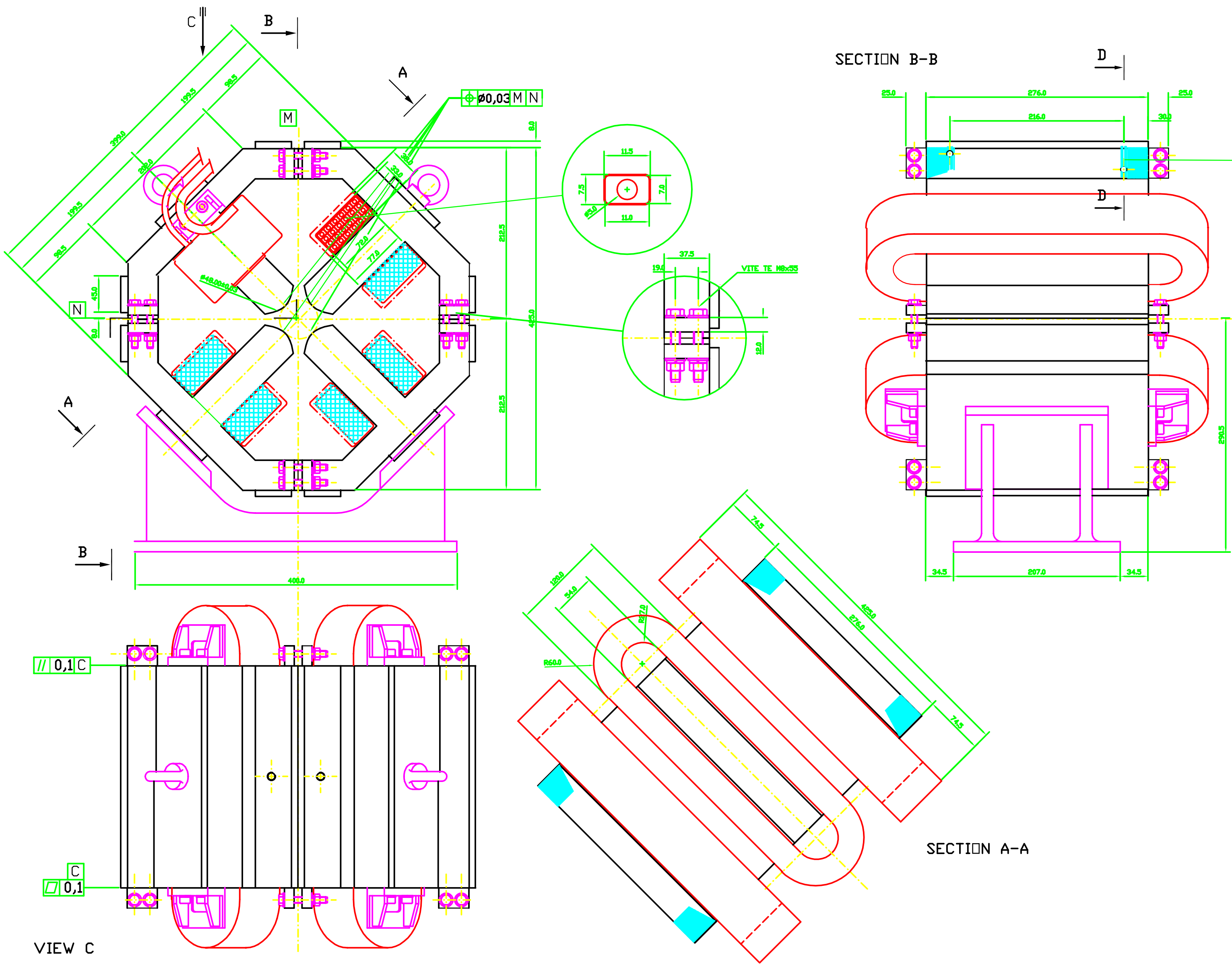
ANSALDO
Ansaldo Ricerche s.r.l.

TESLA DAMPING RING
QAD-QAF-QAM-QWA-QWF-QWD QUADRUPOLE SUPPORT

Rev. 0
Scala

D01634UX3000C

Segue F. 1
F. 1



MAGNETIC LENGTH	mm	300
APERTURE RADIUS	mm	24
MAX GRADIENT	T/m	10,3
AMPERE TURNS	As	2361

CONDUCTOR TYPE A	S/N	8166
COPPER AREA	mm^2	56,507
COOLING CIRCUIT AREA	mm^2	19,63
AVERAGE LENGTH PER TURN	m	0,8853
NUMBER OF TURNS		24
WINDING LENGTH PER COIL	m	21,247
TOTAL WINDING LENGTH	m	84,99
RESISTANCE PER MAGNET	mOHM	26,7
CURRENT DENSITY	A/mm^2	1,741
CURRENT	A	98,38
VOLTAGE	V	2,62
DISSIPATED POWER PER MAGNET	KW	0,258
WINDING'S WEIGHT	Kg	42,74
YOKES WEIGHT	Kg	159
TOTAL WEIGHT	Kg	201.8

TEMPERATURE [To]	Degrees	30
COOLING CIRCUIT PER MAGNET		1
PRESSURE DROP	Bar	2,2
FLUX PER COOLING CIRCUIT	L/min	0,91
TOTAL FLUX	L/min	0,91
ΔT	Degrees	5

Distribuzione
Lista 13

Data 13/06/00
Redatto CANEPA
Controllo e Approvazione CANEPA
Autorizzazione Emissione GRATTAROLA
Software CAD 12
File: xxx.dwg D01636.DWG

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768-K

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzaz. emissione

MATERIALE

FINITURA

ANSALDO
Ansaldo Ricerche s.r.l.

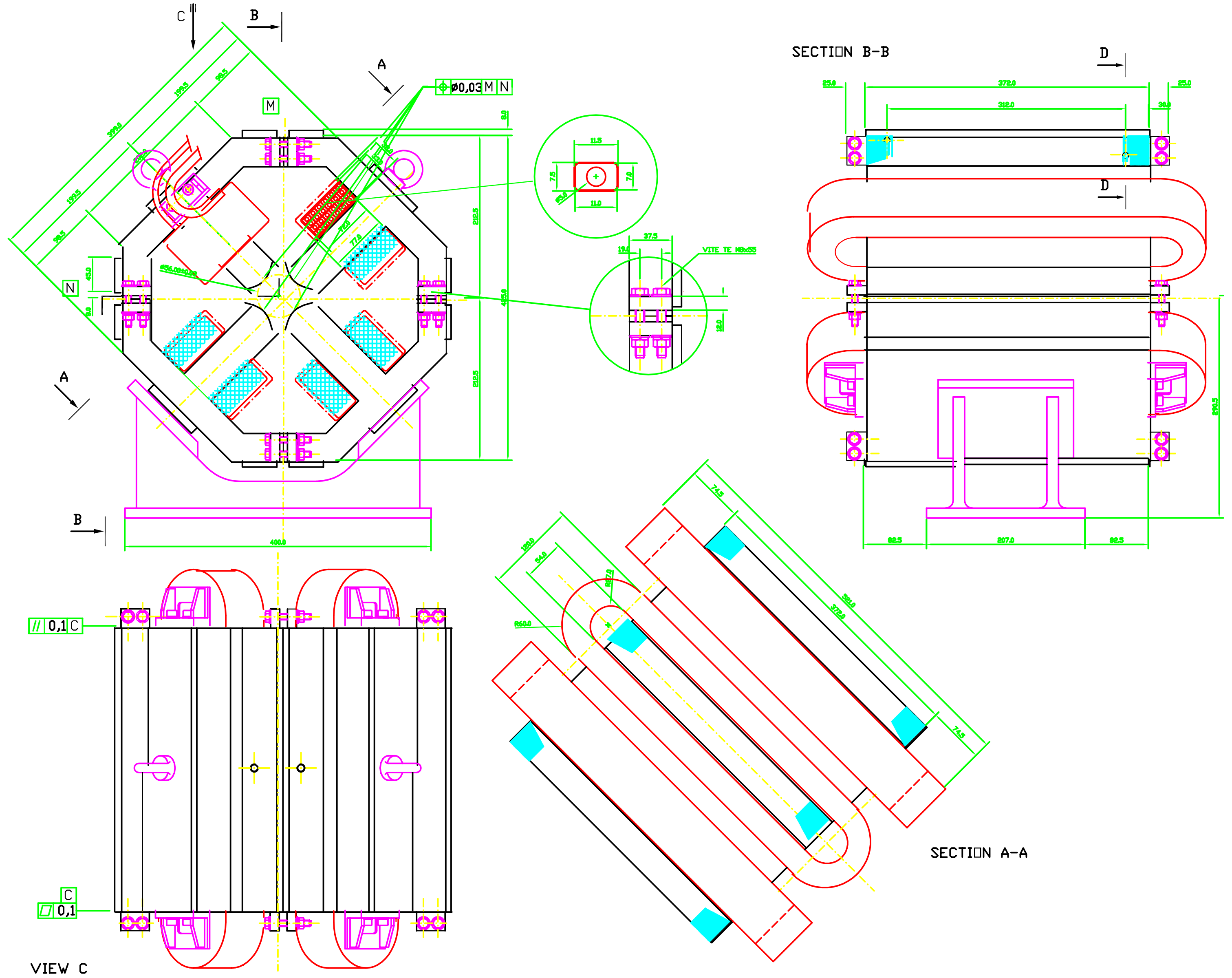
TESLA DAMPING RING

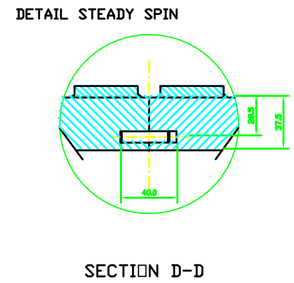
QAM 3-4-5 QUADRUPOLE ASSEMBLY

Rev. 0 | Scala

D01636UX3000C

Segue F. 1 F. 1





MAGNETIC LENGTH	mm	400
APERTURE RADIUS	mm	28
MAX GRADIENT	T/m	10,9
AMPERE TURNS	As	3400

CONDUCTOR TYPE A	S/N	8166
COPPER AREA	mm^2	56,507
COOLING CIRCUIT AREA	mm^2	19,63
AVERAGE LENGTH PER TURN	m	1,0773
NUMBER OF TURNS		24
WINDING LENGTH PER COIL	m	25,855
TOTAL WINDING LENGTH	m	103,42
RESISTANCE PER MAGNET	mOHM	32,4
CURRENT DENSITY	A/mm^2	2,507
CURRENT	A	141,66
VOLTAGE	V	4,59
DISSIPATED POWER PER MAGNET	KW	0,650
WINDING'S WEIGHT	Kg	52
YOKES WEIGHT	Kg	212
TOTAL WEIGHT	Kg	264

TEMPERATURE [To]	Degrees	30
COOLING CIRCUIT PER MAGNET		2
PRESSURE DROP	Bar	2,2
FLUX PER COOLING CIRCUIT	L/min	1,19
TOTAL FLUX	L/min	2,38
ΔT	Degrees	5

Distribuzione
Lista 13

Data 13/06/00
Redatto CANEPA
Controllo e Approvazione CANEPA
Autorizzazione Emissione GRATTAROLA
Software CAD 12
File: xxx.dwg D01637.DWG

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768-K

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione	MATERIALE
						FINITURA

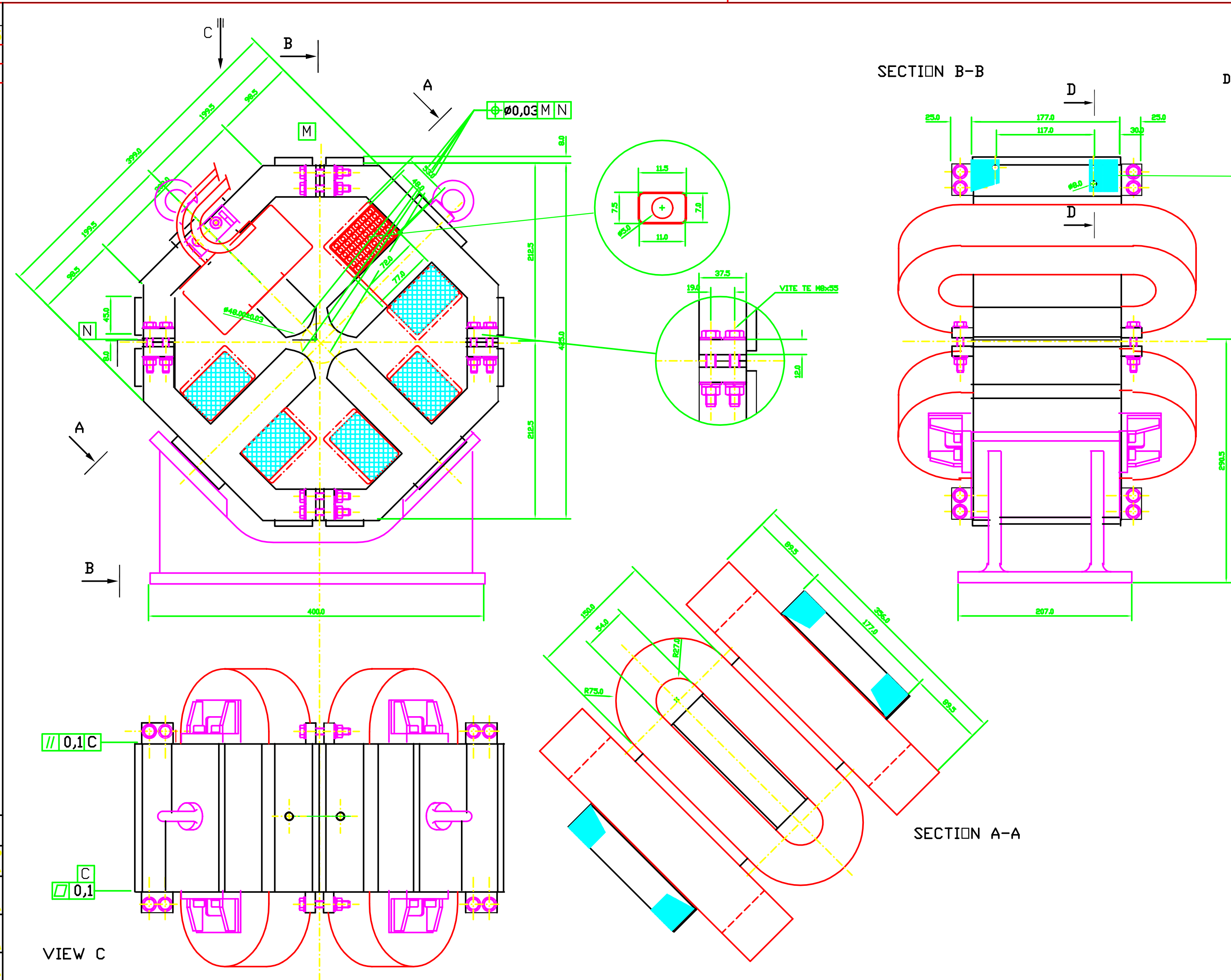
ANSALDO
Ansaldo Ricerche s.r.l.

TESLA DAMPING RING
QWA 1-2-3-4-5 QUADRUPOLE ASSEMBLY

Rev. 0 Scala

D01637UX3000C

Segue F. 1 F. 1



MAGNETIC LENGTH	mm	200
APERTURE RADIUS	mm	24
MAX GRADIENT	T/m	14,2
AMPERE TURNS	As	3254
CONDUCTOR TYPE A	S/N	8166
COPPER AREA	mm^2	56,507
COOLING CIRCUIT AREA	mm^2	19,63
AVERAGE LENGTH PER TURN	m	0,7324
NUMBER OF TURNS		36
WINDING LENGTH PER COIL	m	26,366
TOTAL WINDING LENGTH	m	105,46
RESISTANCE PER MAGNET	mOHM	33,1
CURRENT DENSITY	A/mm^2	1,600
CURRENT	A	90,39
VOLTAGE	V	2,99
DISSIPATED POWER PER MAGNET	KW	0,270
WINDING'S WEIGHT	Kg	53
YOKES WEIGHT	Kg	102
TOTAL WEIGHT	Kg	155
TEMPERATURE [To]	Degrees	30
COOLING CIRCUIT PER MAGNET		2
PRESSURE DROP	Bar	2,2
FLUX PER COOLING CIRCUIT	L/min	1,19
TOTAL FLUX	L/min	2,38
ΔT	Degrees	1

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768-K

REV. | DESCRIZIONE | Data | Redatto | Controllo Approv. | Autorizzazione emissione | MATERIALE

FINITURA

ANSALDO

Ansaldo Ricerche s.r.l.

TESLA DAMPING RING

QWF – QWD QUADRUPOLE ASSEMBLY

Rev. 0 Scala

D01638UX3000C

Segue F. 1 F. 1

Distribuzione

Lista 13

Data 13/06/00

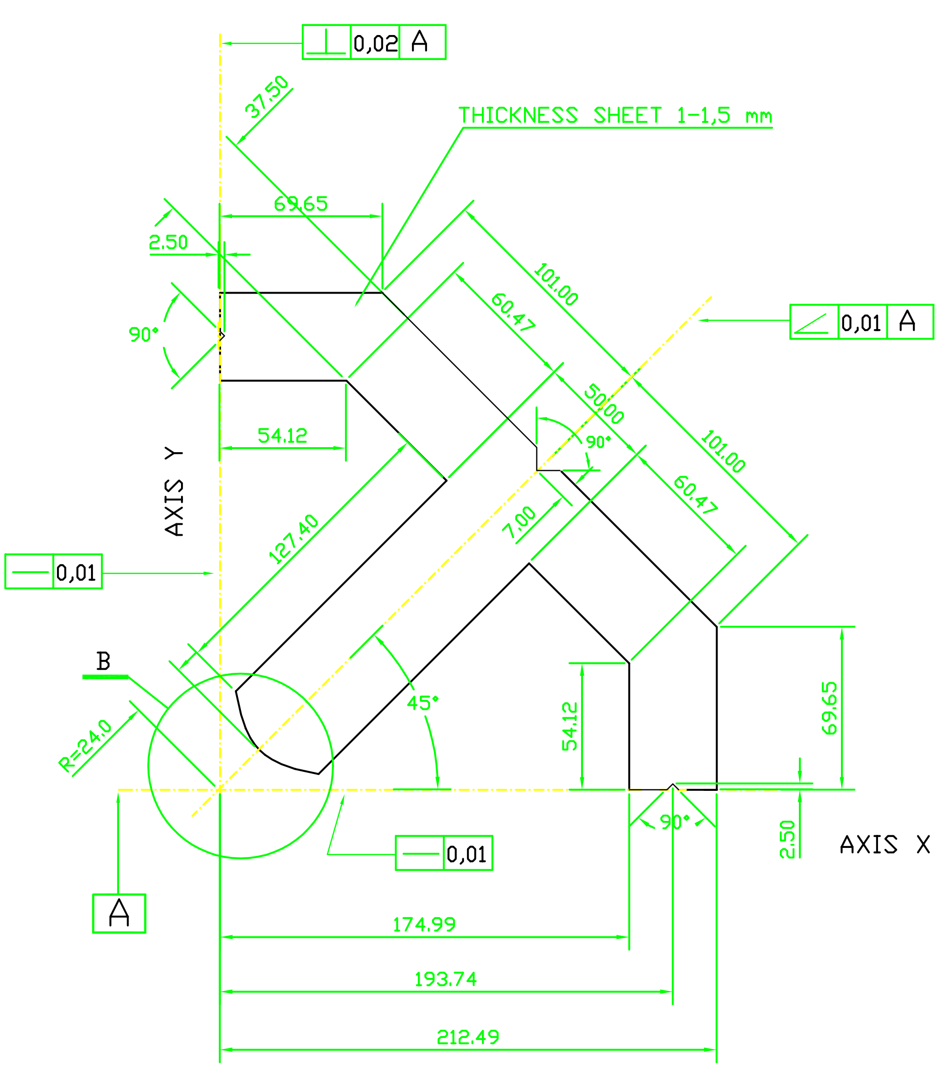
Redatto CANEPA

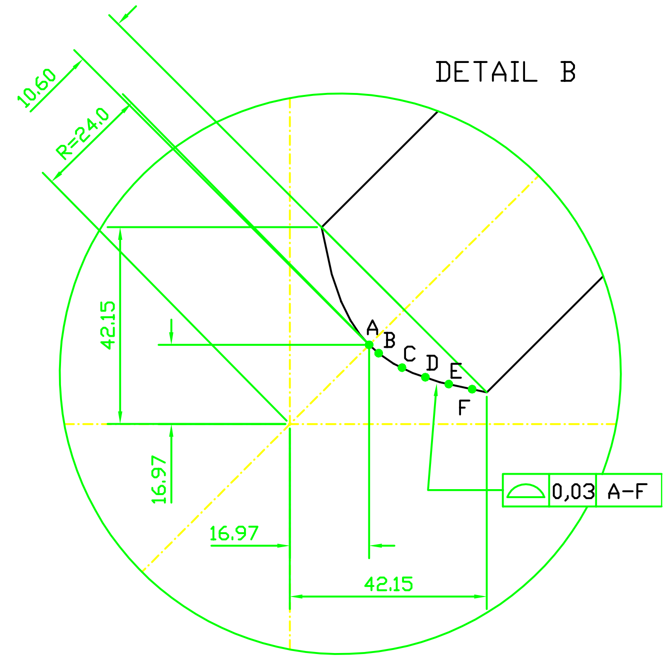
Controllo e Approvazione CANEPA

Autorizzazione Emissione GRATTAROLA

Software CAD 12

File: xxx.dwg D01638.DWG





POINT	Axis X	Axis Y
HYPERBOLE	X • Y = 24² / 2	
A	16,97	16,97
B	19,00	15,16
C	24,00	12,00
D	29,00	9,93
E	34,00	8,47
F	39,00	7,38

TOTAL SHEETS = 272464

Distribuzione
Lista 13

Data 13/06/00
Redatto CANEPA
Controllo e Approvazione CANEPA
Autorizzazione Emissione GRATTAROLA
Software CAD 12
File: xxx.dwg D01639.DWG

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768-K

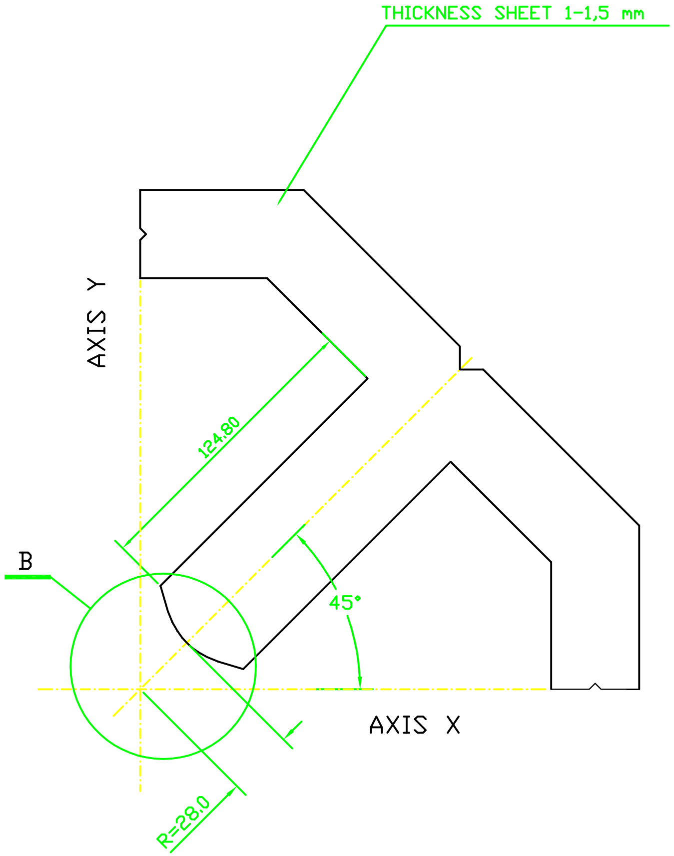
REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizz. emissione

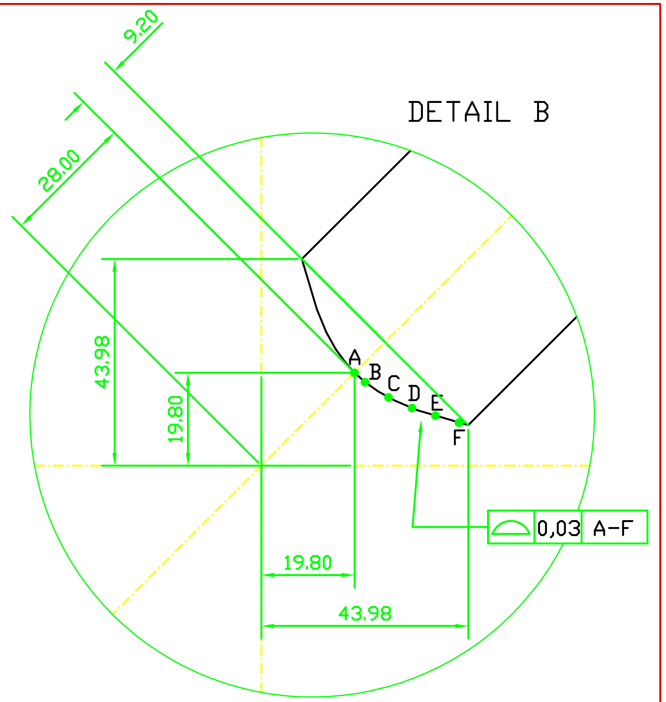
MATERIALE SA1010
FINITURA

ANSALDO
Ansaldo Ricerche s.r.l.

TESLA DAMPING RING
QAD/QAF/QAM1,2,3,4,5/QAD1,2,QWF/QWD LAMINATION

Rev. 0
Scala
D01639UX3000C
Segue F. 1
F. 1





POINT	Axis X	Axis Y
HYPERBOLE	X • Y = 28² / 2	
A	19,80	19,80
B	22,00	17,18
C	27,00	14,52
D	32,00	12,25
E	37,00	10,59
F	42,00	9,33

TOTAL SHEETS = 19840

FACE MOLD AS DRAWING D01639UX3000C WITH EXCEPTION OF CENTRAL HYPERBOLE

Distribuzione
Lista 13

Data 13/06/00
Redatto CANEPA
Controllo e Approvazione CANEPA
Autorizzazione Emissione GRATTAROLA
Software CAD 12
File: xxx.dwg D01640.DWG

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768-K

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizz. emissione

MATERIALE SA1010
FINITURA

ANSALDO
Ansaldo Ricerche s.r.l.

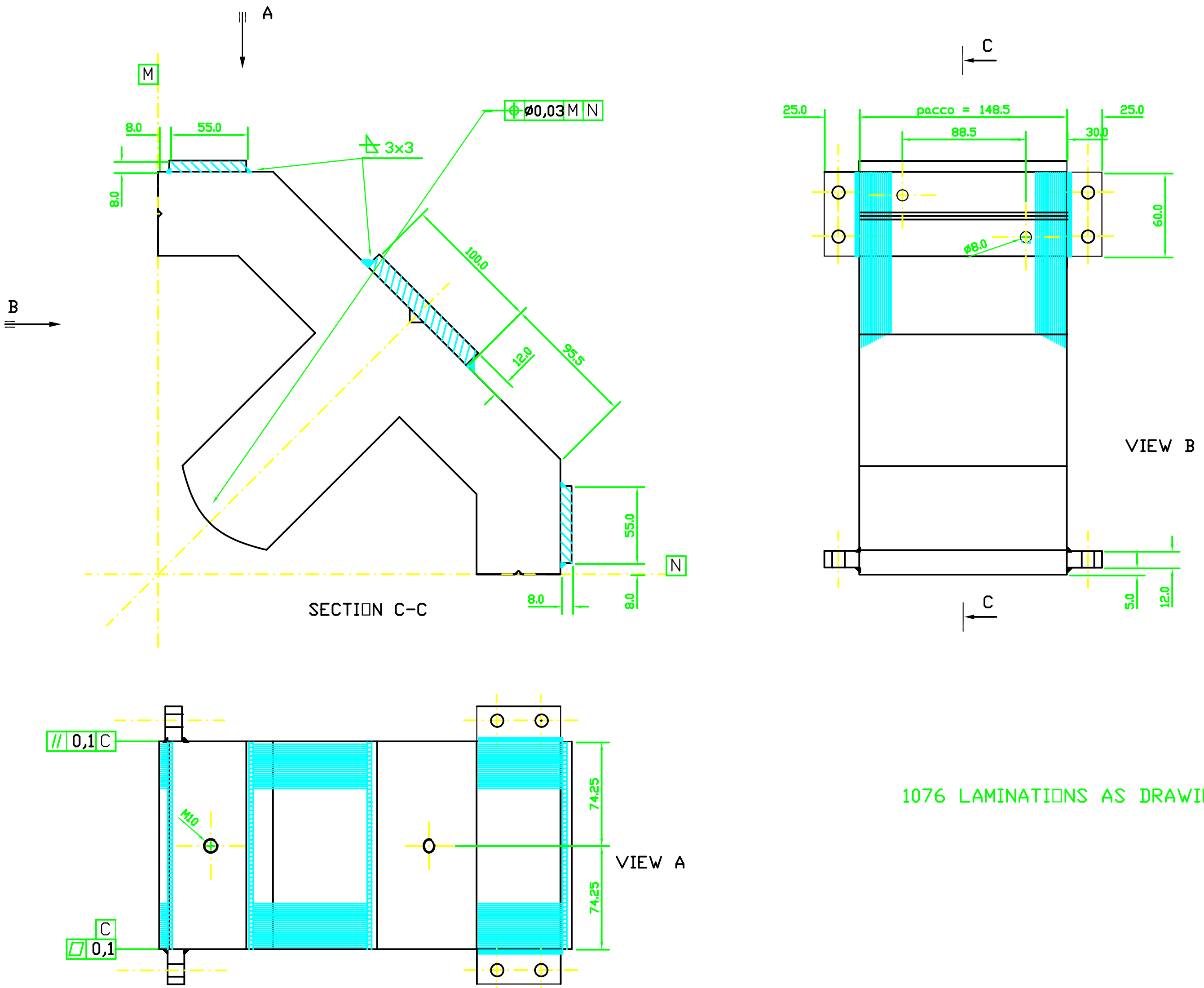
TESLA DAMPING RING
QWA 1-2-3-4-5 QUADRUPOLE LAMINATION

Rev. 0
Scala

D01640UX3000C

Segue F. 1
F. 1

Distribuzione
Lista 13



1076 LAMINATIONS AS DRAWING D01631UX3000C

Data	13/06/00
Redatto	CANEPA
Controllo e Approvazione	CANEPA
Autorizzazione Emissione	GRATTAROLA
Software	CAD 12
File: xxx.dwg	D01666.DWG

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768-K

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizz. emissione

MATERIALE

FINITURA

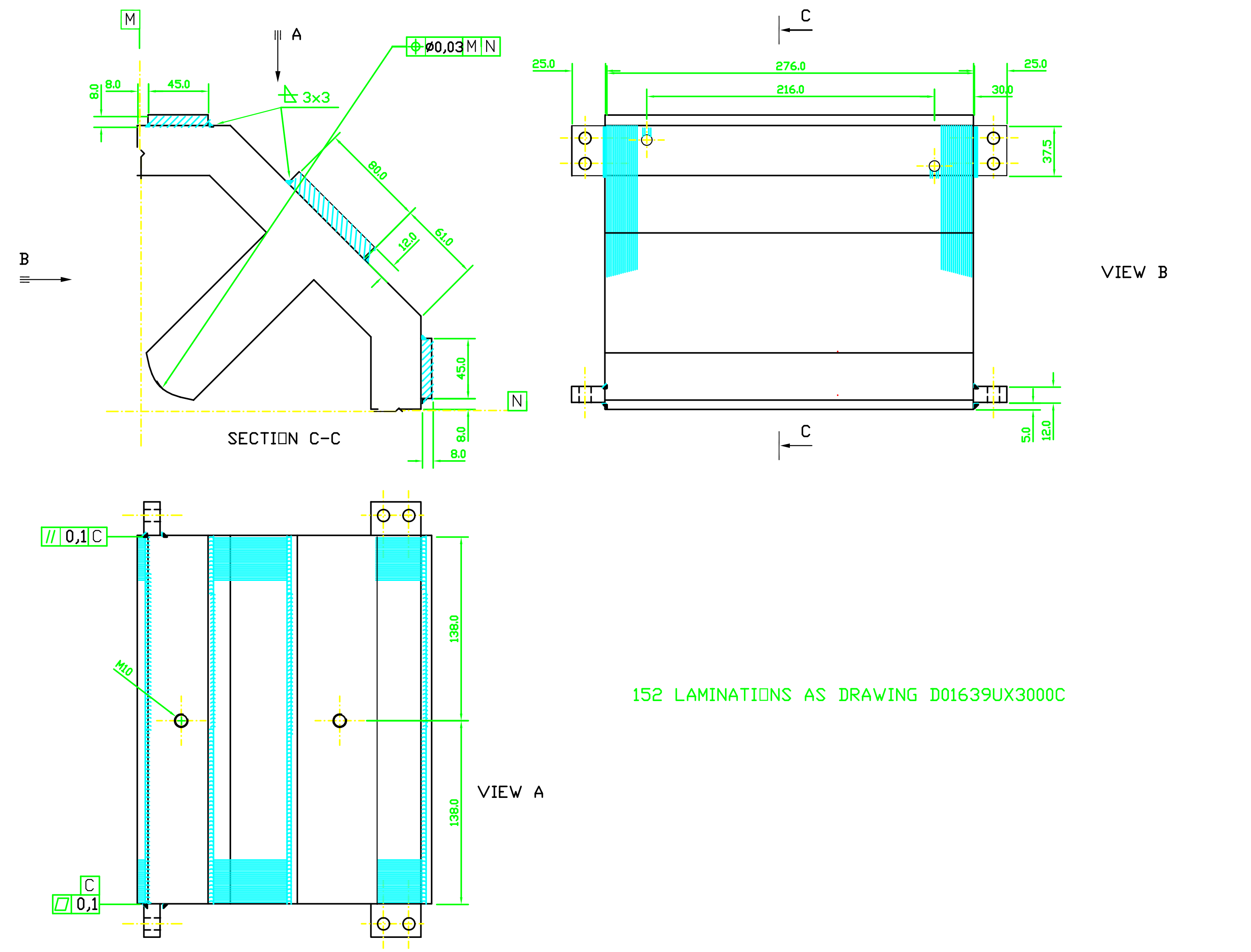
ANSALDO
Ansaldo Ricerche s.r.l.

TESLA DAMPING RING
QLF – QLD YOKE ASSEMBLY

Rev. 0 Scala

D01666UX3000C

Segue F. 1 F. 1



Distribuzione: Lista 13

Data: 13/06/00
Redatto: CANEPA
Controllo e Approvazione: CANEPA
Autorizzazione Emissione: GRATTAROLA
Software: CAD 12
File: D01667.DWG

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768-K

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione	MATERIALE
						FINITURA

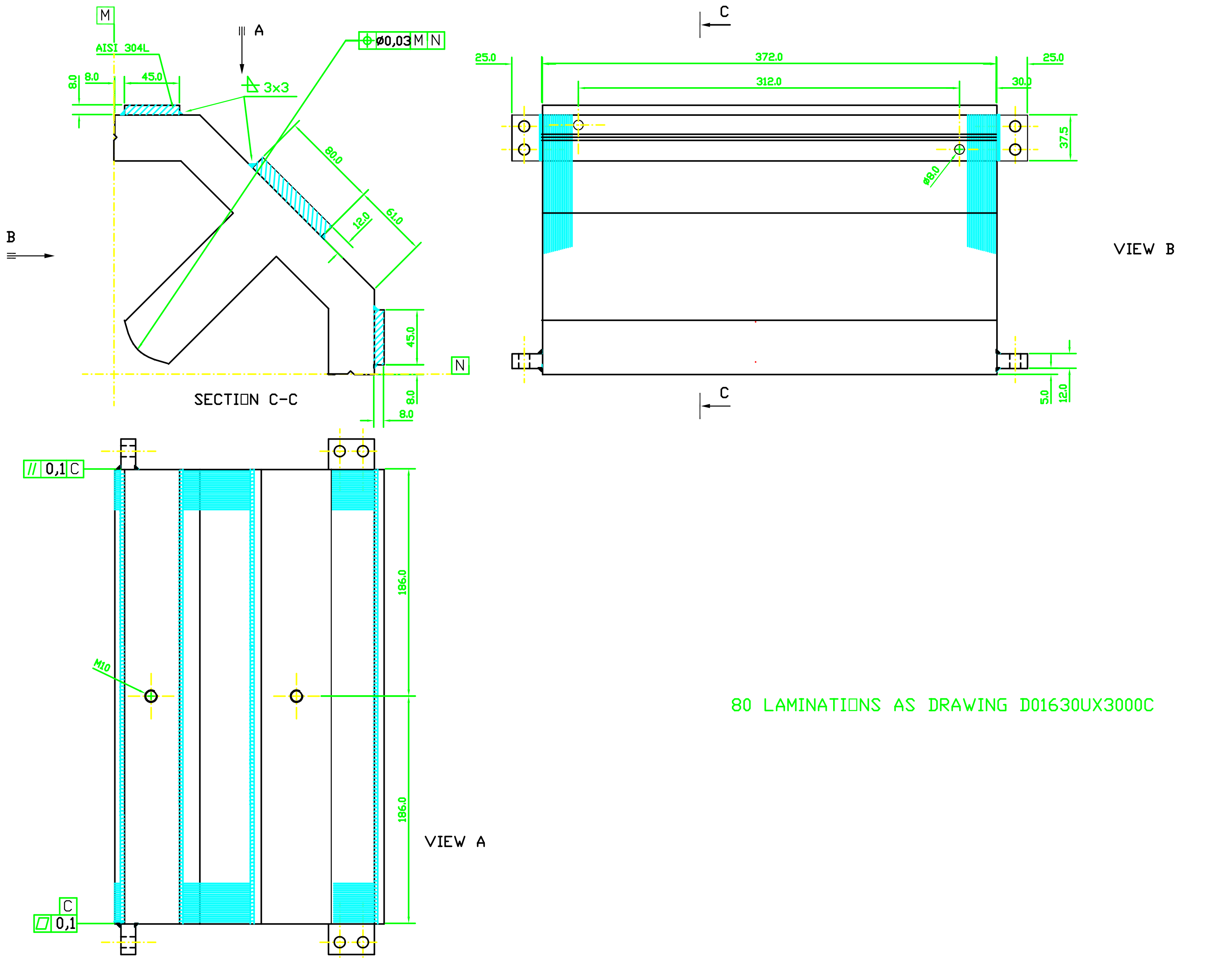
ANSALDO
Ansaldo Ricerche s.r.l.

TESLA DAMPING RING
QAM 3-4-5 YOKE ASSEMBLY

Rev. 0
Scala

D01667UX3000C

Segue F. 1 F. 1



80 LAMINATIONS AS DRAWING D01630UX3000C

Distribuzione
Lista 13

Data 13/06/00
Redatto CANEPA
Controllo e Approvazione CANEPA
Autorizzazione Emissione GRATTAROLA
Software CAD 12
File: xxx.dwg D01669.DWG

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768-K

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzaz. emissione

MATERIALE

FINITURA

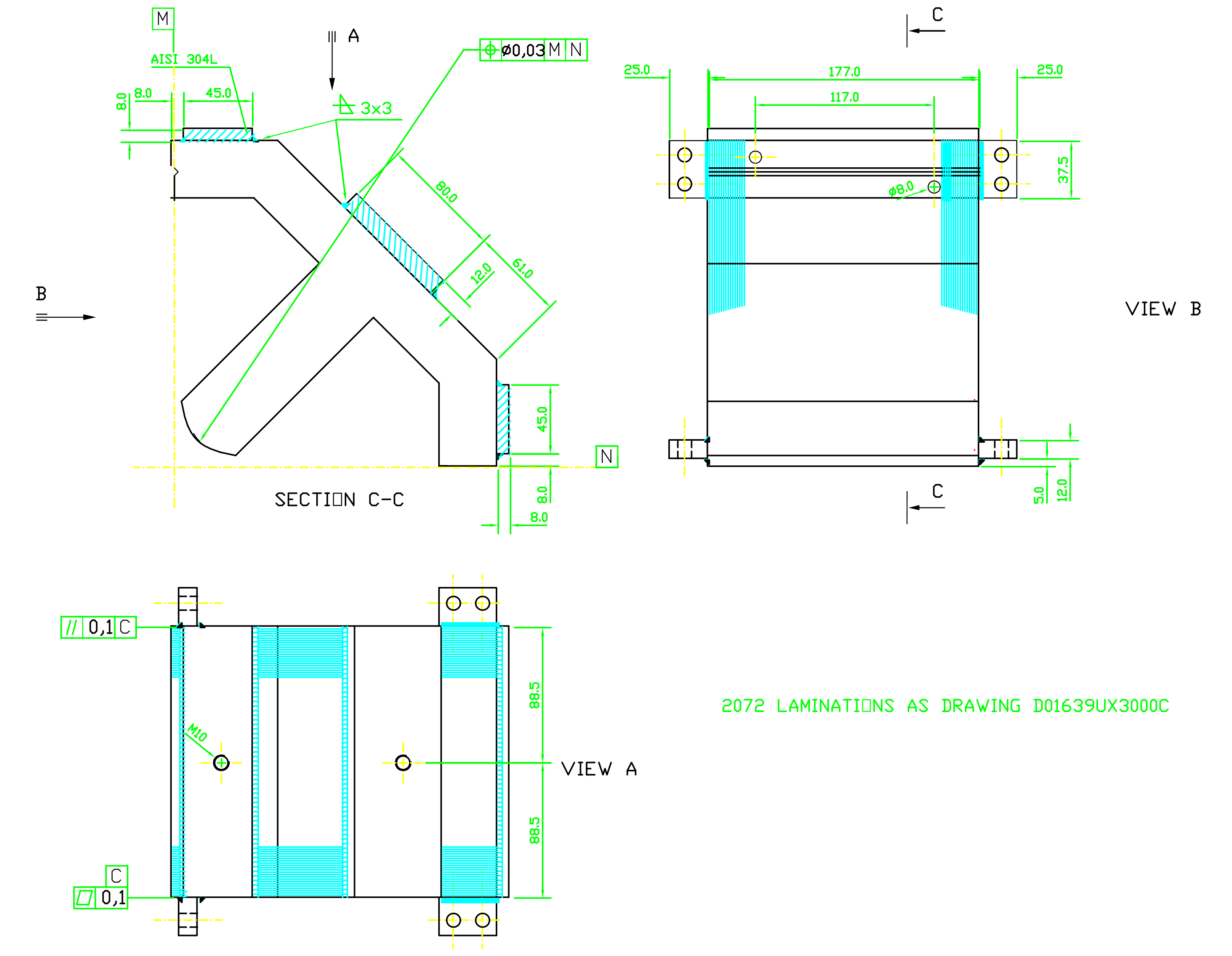
ANSALDO
Ansaldo Ricerche s.r.l.

TESLA DAMPING RING
QWA 1-2-3-4-5 YOKE ASSEMBLY

Rev. 0 Scala

D01669UX3000C

Segue F. 1 F. 1



Distribuzione
Lista 13

L'ANSALDO SI RISERVA A TERMINE DI LEGGE LA PROPRIETA' DI QUESTO DOCUMENTO CON DIVIETO DI RIPRODURLO O DI RENDERLO COMUNQUE NOTO A TERZI O A DITTE CONCORRENTI SENZA LA SUA AUTORIZZAZIONE

Data 13/06/00
Redatto CANEPA
Controllo e Approvazione CANEPA
Autorizzazione Emissione GRATTAROLA
Software CAD 12
File: xxx.dwg D01670.DWG

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768-K

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione

MATERIALE

FINITURA

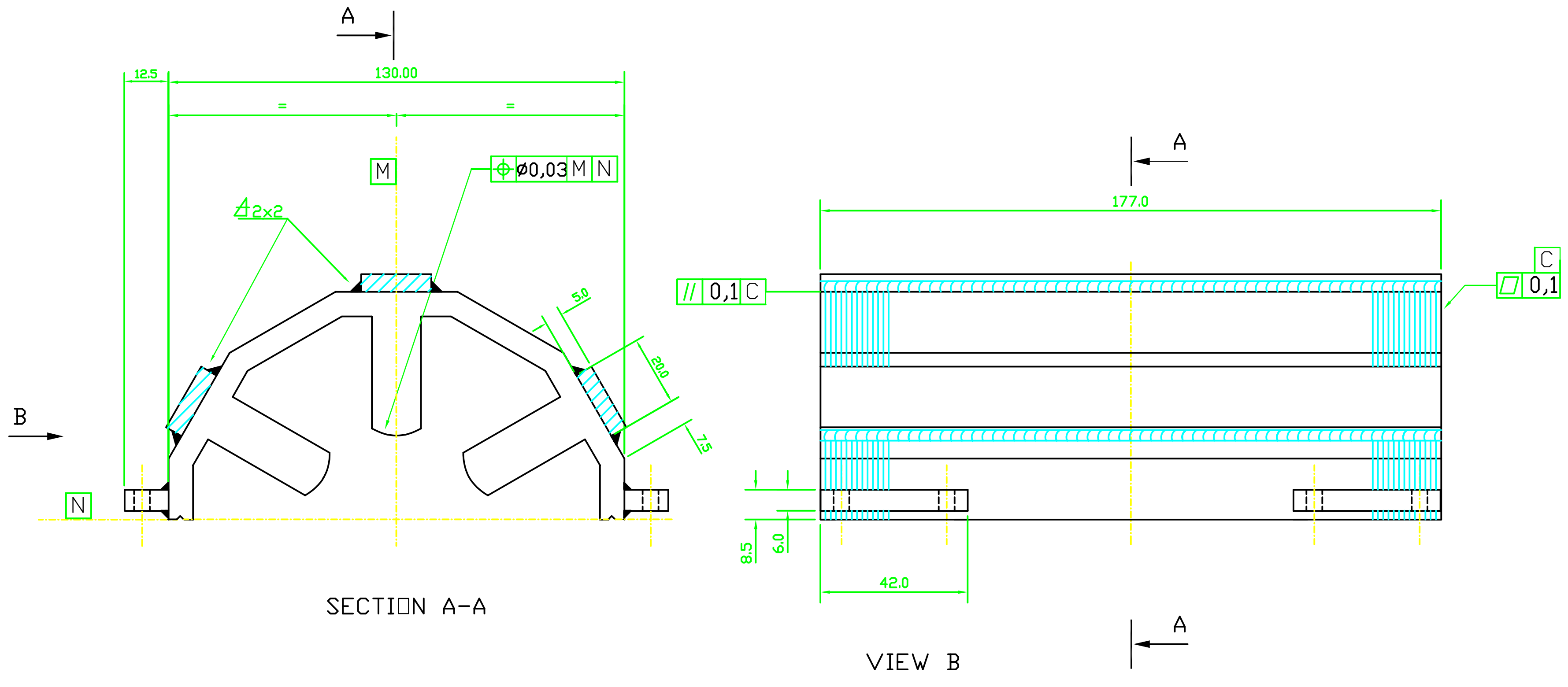
ANSALDO
Ansaldo Ricerche s.r.l.

TESLA DAMPING RING
QAD/QAF/QAM1,2/QWF/QWD YOKE ASSEMBLY

Rev. 0 Scala

D01670UX3000C

Segue F. 1 F. 1



24 LAMINATIONS AS DRAWING D01628UX3000C

Distribuzione
Lista 13

Data 13/06/00
Redatto CANEPA
Controllo e Approvazione CANEPA
Autorizzazione Emissione GRATTAROLA
Software CAD 12
File: xxx.dwg D01671.DWG

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768-K

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzaz. emissione

MATERIALE

FINITURA

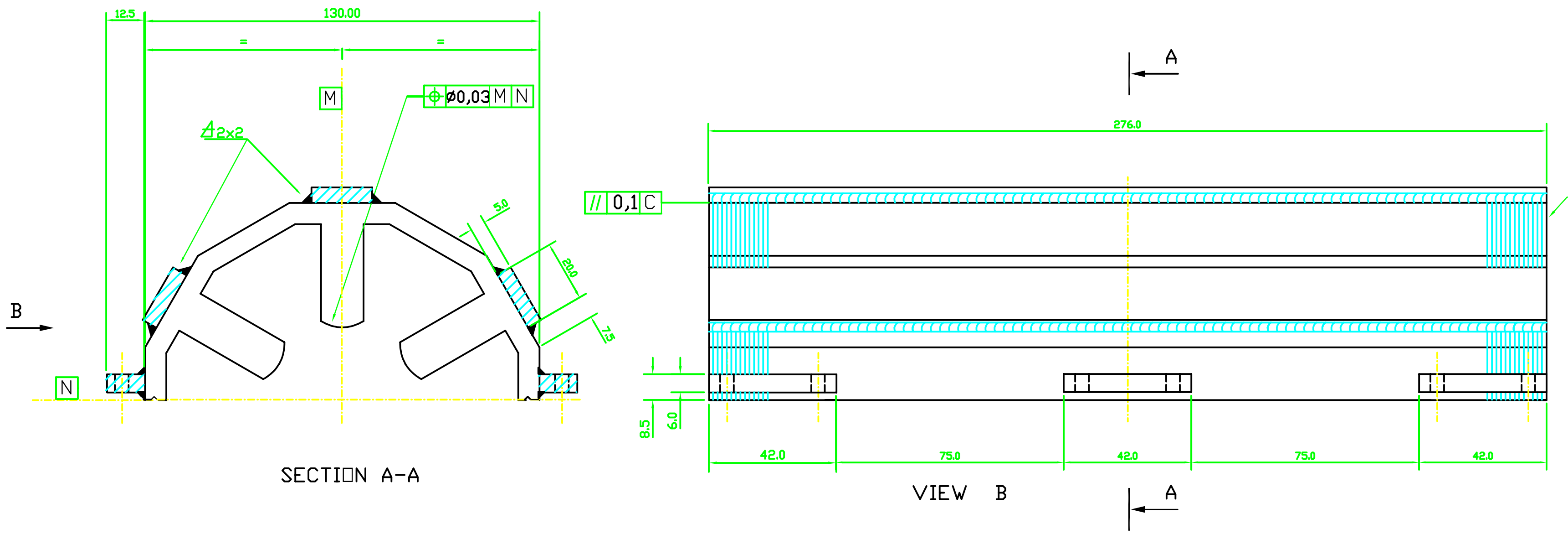
ANSALDO
Ansaldo Ricerche s.r.l.

TESLA DAMPING RING
S2PB-S2MB YOKE ASSEMBLY

Rev. 0 Scala

D01671UX3000C

Segue F. 1 F. 1



408 LAMINATIONS AS DRAWING D01628UX3000C

L'ANSALDO SI RISERVA A TERMINE DI LEGGE LA PROPRIETA' DI QUESTO DOCUMENTO CON DIVIETO DI RIPRODURLO O DI RENDERLO COMUNQUE NOTO A TERZI O A DITTE CONCORRENTI SENZA LA SUA AUTORIZZAZIONE

Distribuzione	
Lista	13
Data	13/06/00
Redatto	CANEPA
Controllo e Approvazione	CANEPA
Autorizzazione Emissione	GRATTAROLA
Software	CAD 12
File: xxx.dwg	D01672.DWG

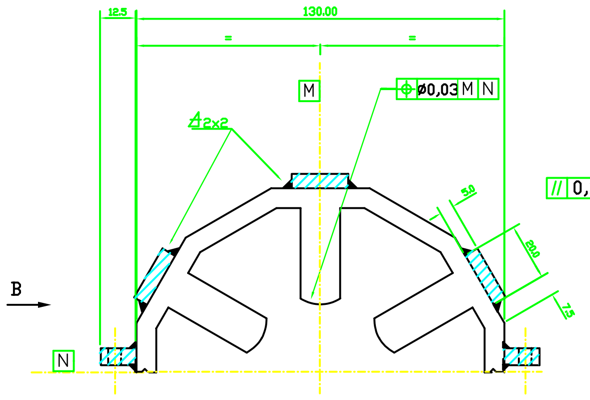
Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768-K

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizz. emissione	MATERIALE
						FINITURA

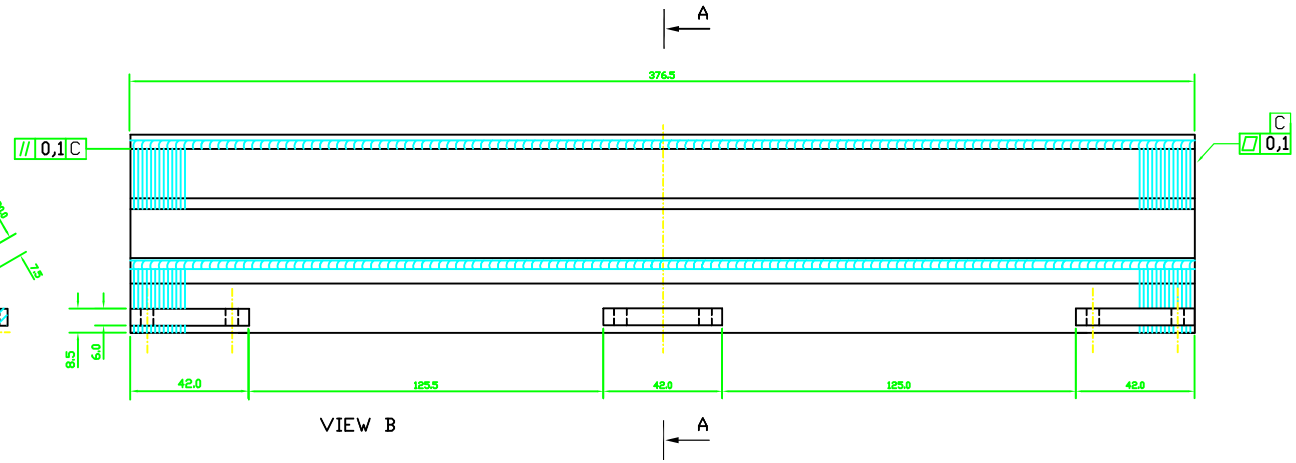
ANSALDO
Ansaldo Ricerche s.r.l.

TESLA DAMPING RING
S1P-S1M YOKE ASSEMBLY

Rev. 0	Scala
D01672UX3000C	
Segue F. 1	F. 1



SECTION A-A



VIEW B

192 LAMINATIONS AS DRAWING D01628UX3000C

Distribuzione
Lista 13

Data 13/06/00
Redatto CANEPA
Controllo e Approvazione CANEPA
Autorizzazione Emissione GRATTAROLA
Software CAD 12
File: xxx.dwg D01673.DWG

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768-K

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione

MATERIALE

FINITURA

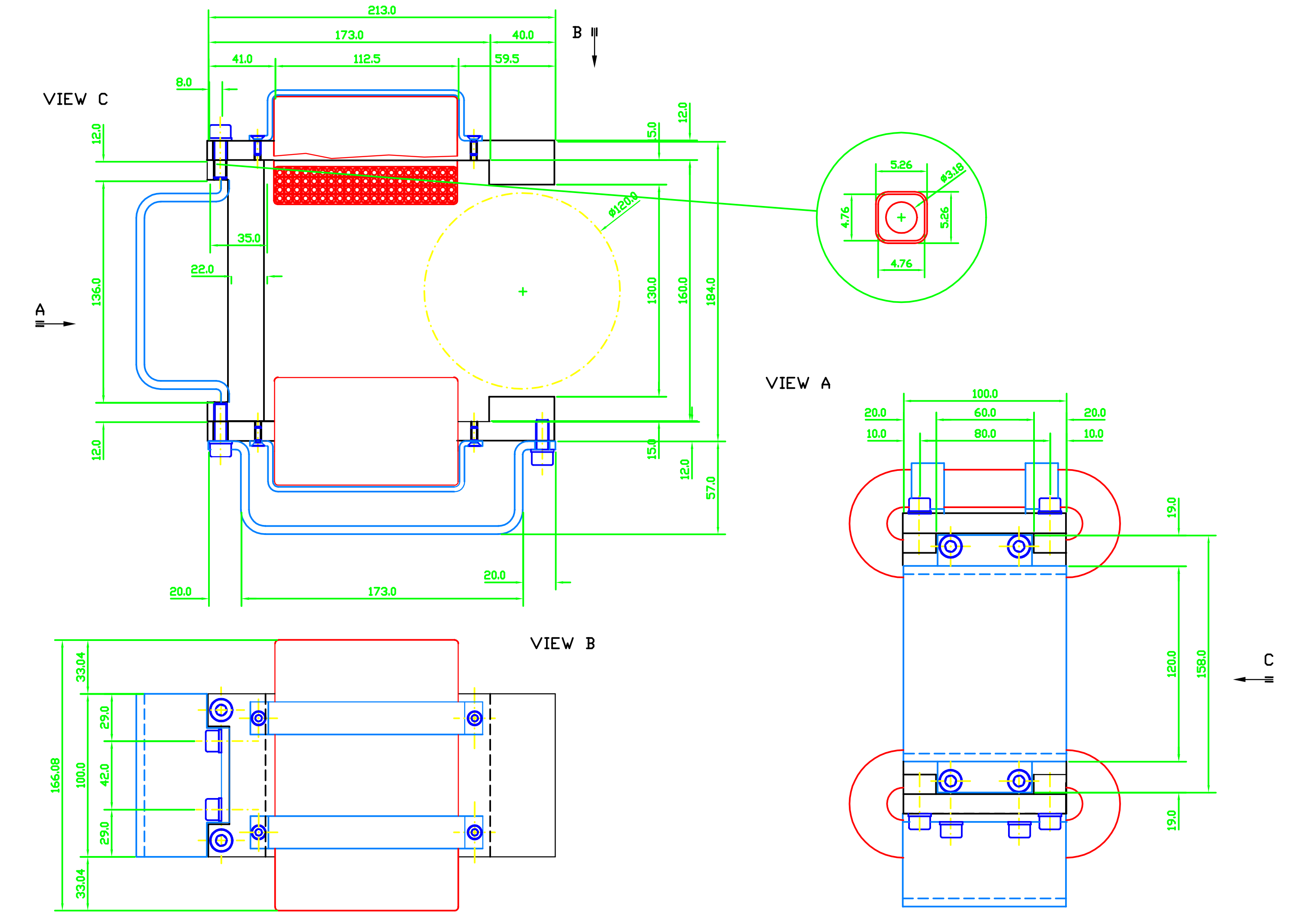
ANSALDO
Ansaldo Ricerche s.r.l.

TESLA DAMPING RING
S2PA-S2MA YOKE ASSEMBLY

Rev. 0
Scala

D01673UX3000C

Segue F. 1
F. 1



MAGNETIC LENGTH	mm	≤ 100
MAGNET GAP	mm	130
NOMINAL MAGNET FIELD	T	0,0833
DEFLECTION ANGLE	Rad	5x10e-4
AMPERE TURN	AS	4310

CONDUCTOR TYPE A	S/N	8150
COPPER AREA	mm^2	13,86
COOLING CIRCUIT AREA	mm^2	7,94
AVERAGE LENGTH PER TURN	m	0,335
NUMBER OF TURNS		84
WINDING LENGTH PER COIL	m	28,16
TOTAL WINDING LENGTH	m	56,32
RESISTANCE PER MAGNET	mOHM	71,935
CURRENT DENSITY	A/mm^2	3,703
CURRENT	A	51,31
VOLTAGE	V	3,69
DISSIPATED POWER PER MAGNET	KW	0,189
WINDING'S WEIGHT	Kg	7
YOKES WEIGHT	Kg	7,8
TOTAL WEIGHT	Kg	14,8

TEMPERATURE [To]	Degrees	30
COOLING CIRCUIT PER MAGNET		2
PRESSURE DROP	Bar	2,8
FLUX PER COOLING CIRCUIT	L/min	0,33
TOTAL FLUX	L/min	0,33
ΔT	Degrees	8

Distribuzione
Lista 13

L'ANSALDO SI RISERVA A TERMINE DI LEGGE LA PROPRIETA' DI QUESTO DOCUMENTO CON DIVIETO DI RIPRODURLO O DI RENDERLO COMUNQUE NOTO A TERZI O A DITTE CONCORRENTI SENZA LA SUA AUTORIZZAZIONE

Data 04/10/00
Redatto CANEPA
Controllo e Approvazione CANEPA
Autorizzazione Emissione GRATTAROLA
Software CAD 12
File xxx.dwg D02603.DWG

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768-K

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzaz. emissione	MATERIALE

FINITURA

ANSALDO
Ansaldo Ricerche s.r.l.

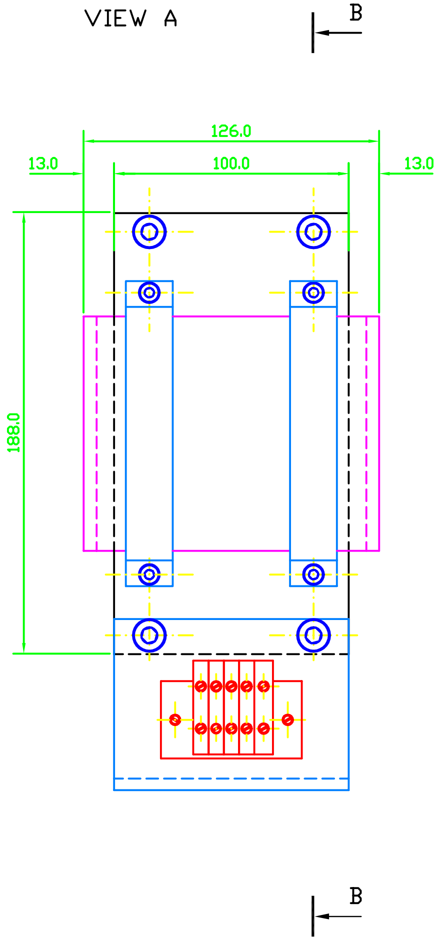
TESLA DAMPING RING
ARC CELL AND WIGGLER SECTION CORRECTOR

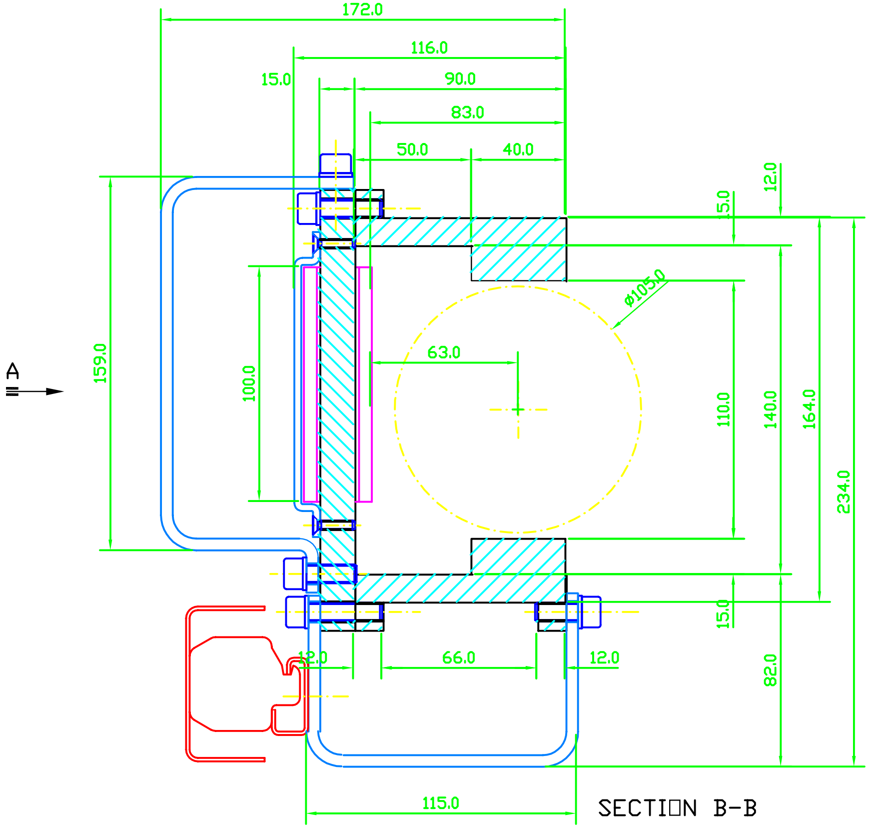
Rev. 0 Scala

D02603UX3000C

Segue F. 1 F. 1

VIEW A





SECTION B-B

MAGNETIC LENGTH	mm	≤ 100
MAGNET GAP	mm	110
NOMINAL MAGNET FIELD	T	0,0033
DEFLECTION ANGLE	Rad	2x10e-5
AMPERE TURN	AS	288

CONDUCTOR DIAMETER	mm	2,5
COPPER AREA	mm^2	4,909
NUMBER OF TURNS	#	72
TOTAL WINDING LENGTH	m	19,03
RESISTANCE	mOHM	68
CURRENT DENSITY	A/mm^2	0,815
CURRENT	A	4,0
VOLTAGE	V	0,272
DISSIPATED POWER	KW	0,0011
WINDING'S WEIGHT	Kg	0,83
YOKES WEIGHT	Kg	4,0
TOTAL WEIGHT	Kg	4,83

Distribuzione
Lista 13

Data 04/10/00
Redatto CANEPA
Controllo e Approvazione CANEPA
Autorizzazione Emissione GRATTAROLA
Software CAD 12
File: xxx.dwg D02604.DWG

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768-K

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzaz. emissione

MATERIALE

FINITURA

ANSALDO
Ansaldo Ricerche s.r.l.

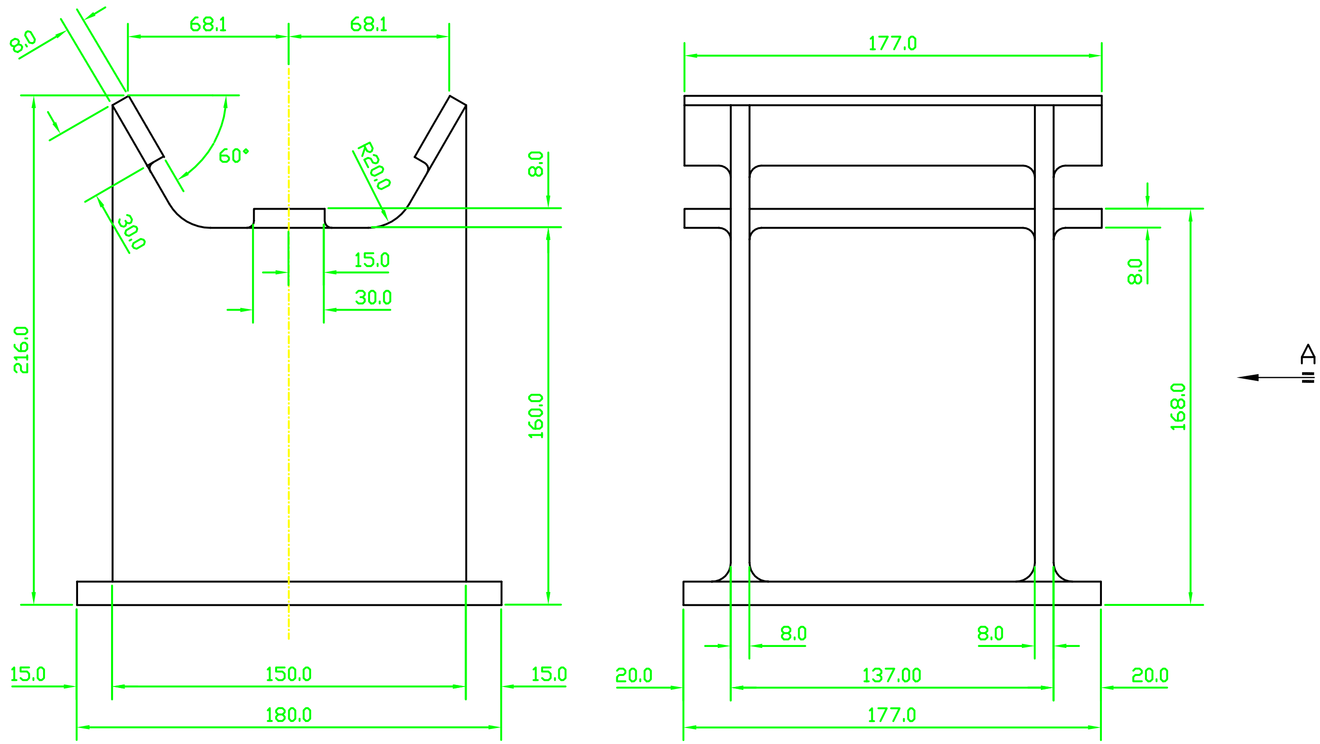
TESLA DAMPING RING

LONG STRAIGTH SECTION CORRECTOR

Rev. 0 Scala

D02604UX3000C

Segue F. 1 F. 1



VIEW A

Distribuzione	
Lista	13
Data	13/06/00
Redatto	CANEPA
Controllo e Approvazione	CANEPA
Autorizzazione Emissione	GRATTAROLA
Software	CAD12
File: xxx.dwg	D02814.DWG

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768-K

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione

MATERIALE G–Al Si7 Mg Mn UNI 3599

FINITURA

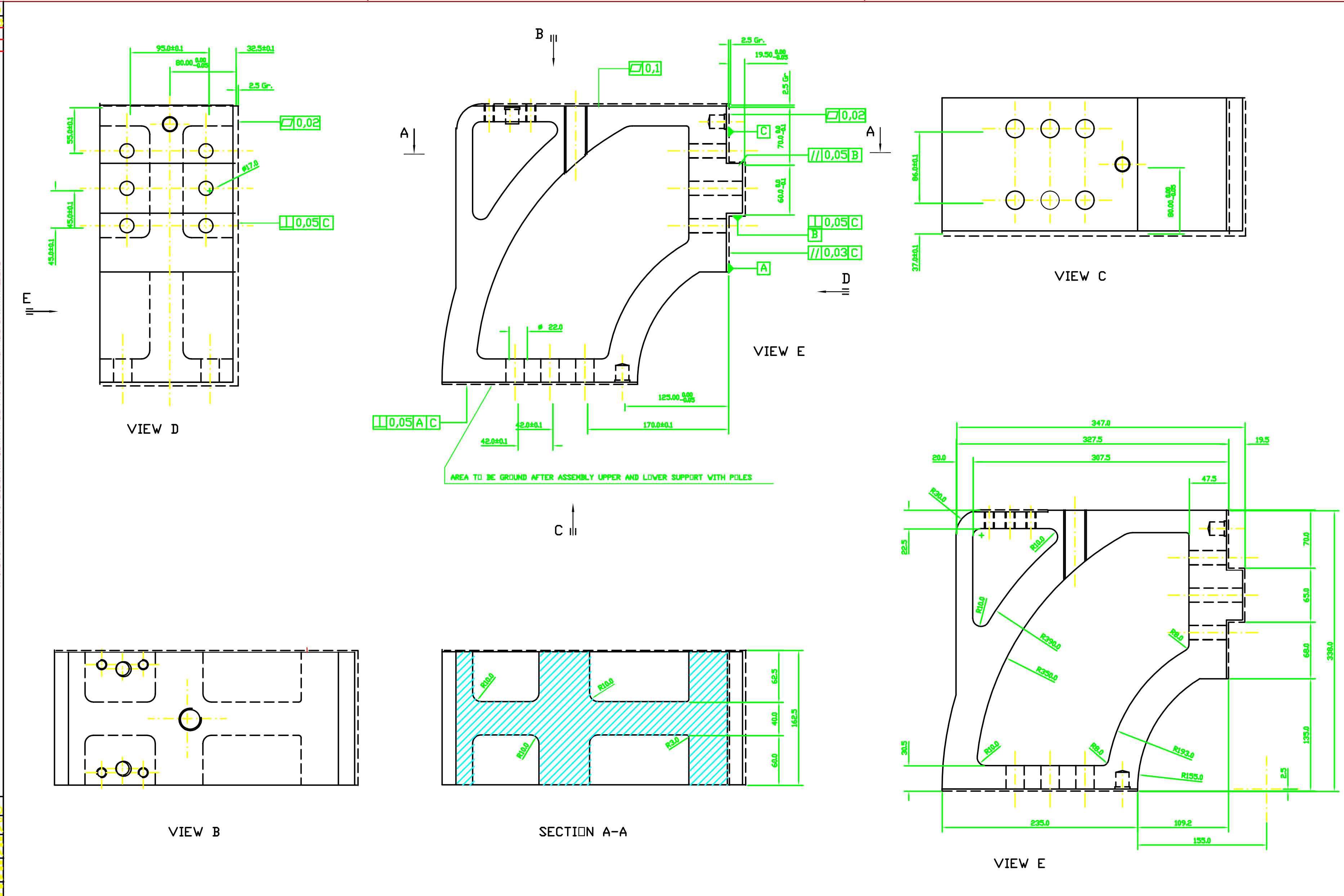
ANSALDO
Ansaldo Ricerche s.r.l.

TESLA DAMPING RING
SEXTUPOLE SUPPORT

Rev. 0 Scala

D02814UX3000L

Segue F. 1 F. 1



Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768-K

REV.	DESCRIZIONE	Data	Redatto	Controllo	Approvazione	REV.	DESCRIZIONE	Data	Redatto	Controllo	Approvazione

MATERIALE

FINITURA

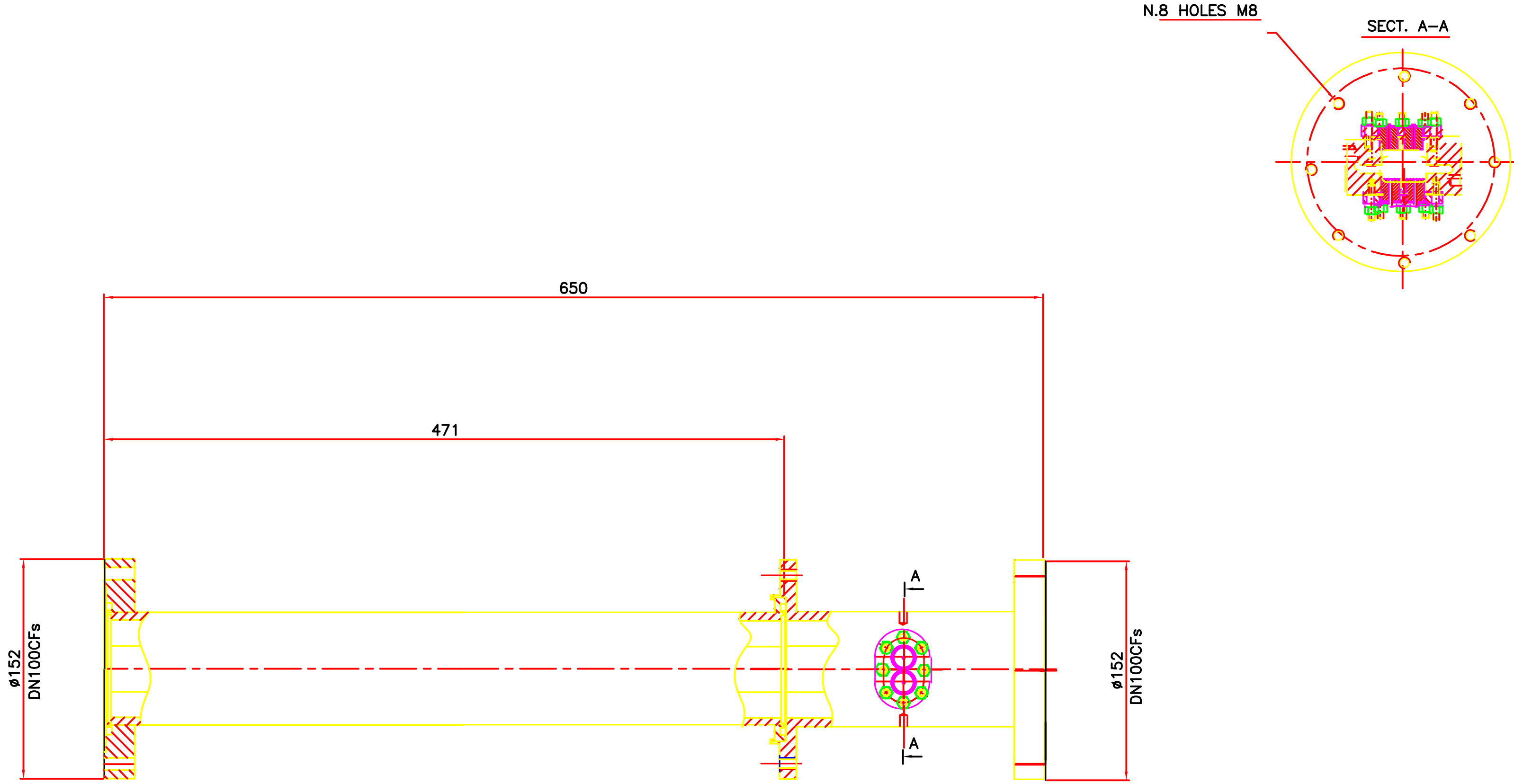
ANSALDO
Ansaldo Ricerche s.r.l.

TESLA DAMPING RING
WIGGLER SUPPORT

Rev. 0 Scala

D02837UX3000C

Segue F. 1 F. 1



Distribuzione

Data 25/01/01

Redatto

Controllo e Approvazione

Autorizzazione Emissione

Software AUTOCAD 14

File: xxx.dwg D02008

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione
0	FIRST EMISSION	25/01/01			

MATERIALE

FINITURA

ANSALDO

Ansaldo Ricerche s.r.l.

DAMPING RING TESLA

WIGGLER SECTION QUADRUPOLE
VACUUM CHAMBER ASSEMBLY
– CW80 MOD.5 –

Rev. 0

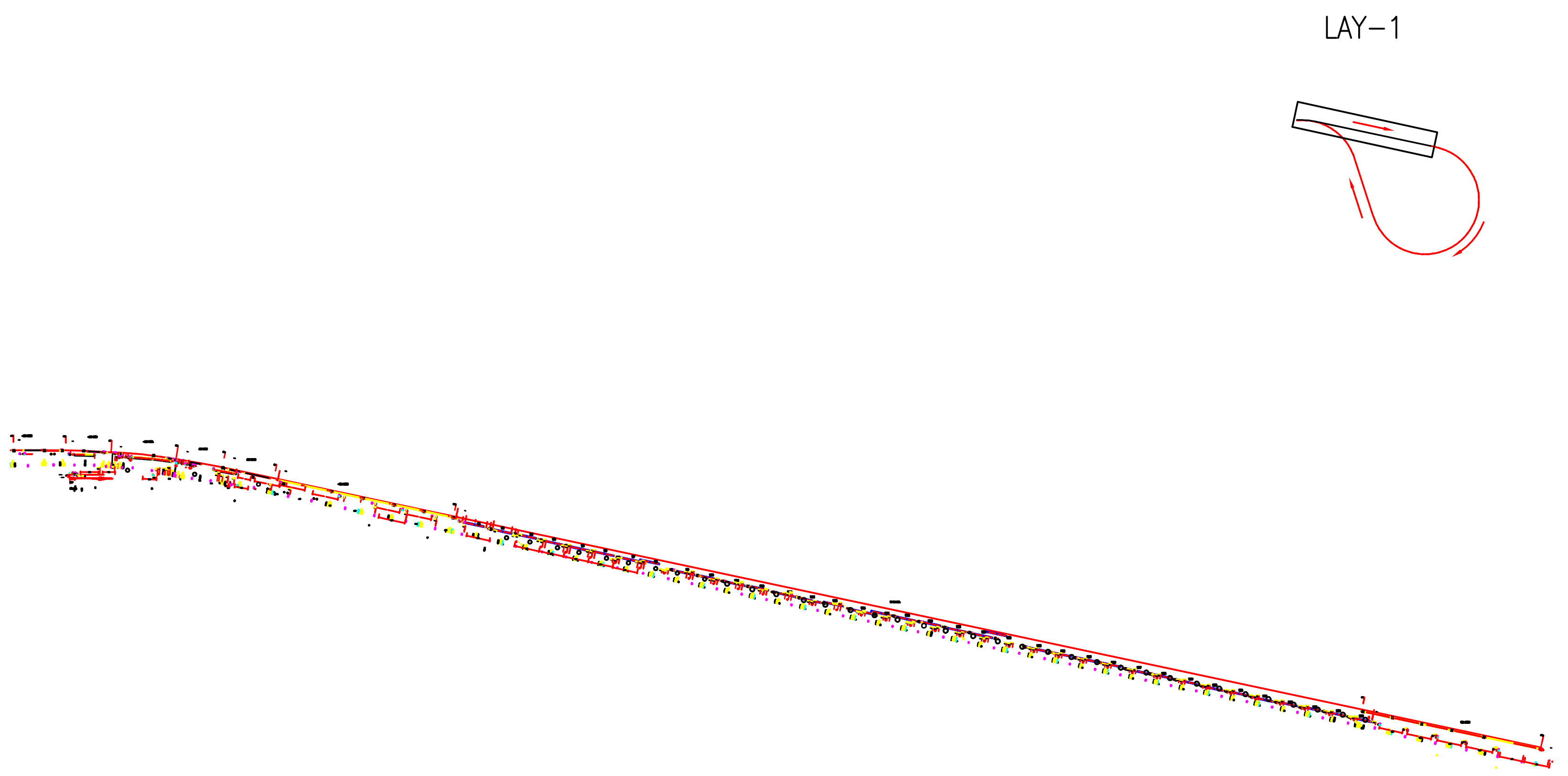
Scala

D02008UX3000L

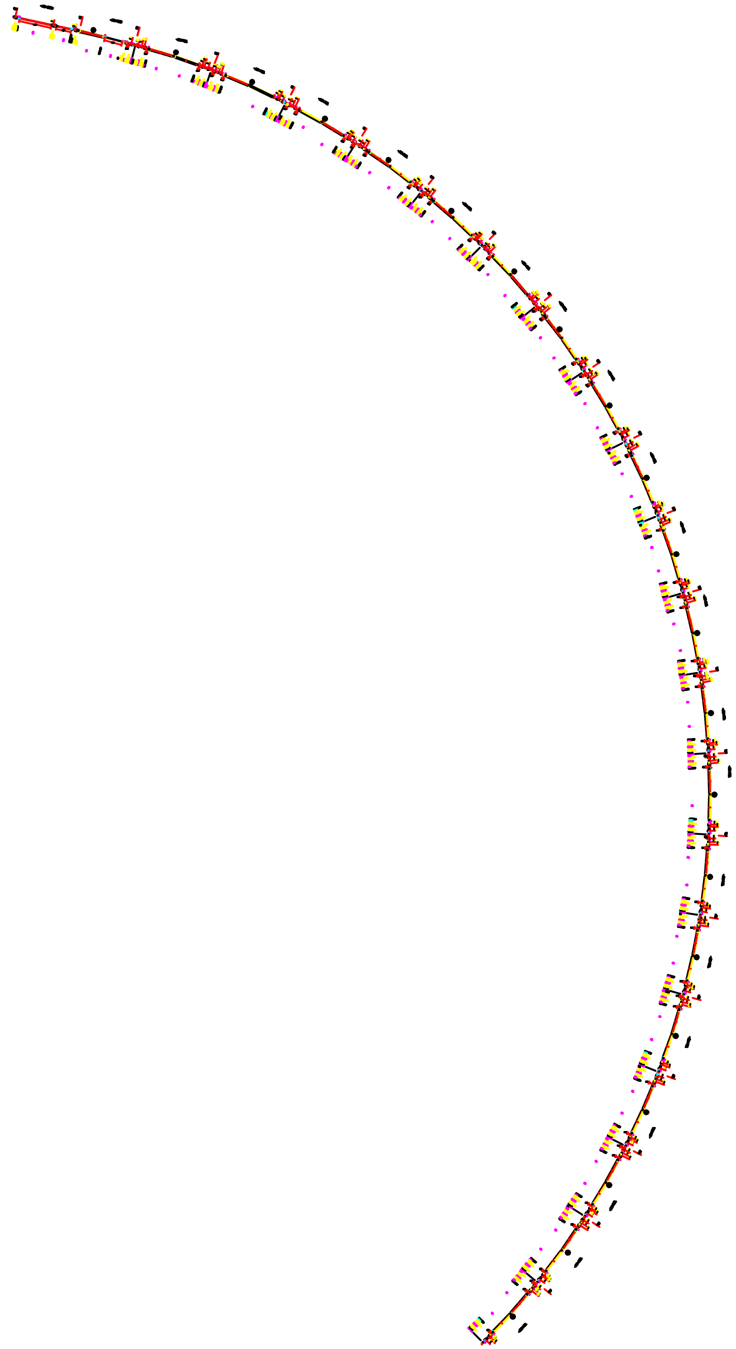
Segue F. /

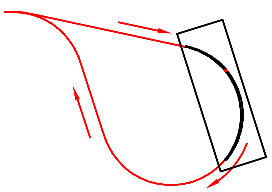
F. 1

SHEET A1- SCALE-1:2



ANSALDO	LAY-1
D02653UX3000L	





SHEET A1- SCALE-1:2

REV.	DESCRIZIONE	Data	Redatto	Controllo e Approvazione	Autorizzazione Emissione	REV.	DESCRIZIONE	Data	Redatto	Controllo e Approvazione	Autorizzazione Emissione

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768-

MATERIALE

FINITURA

ANSALDO
Ansaldo Ricerche s.r.l.

LAY-2

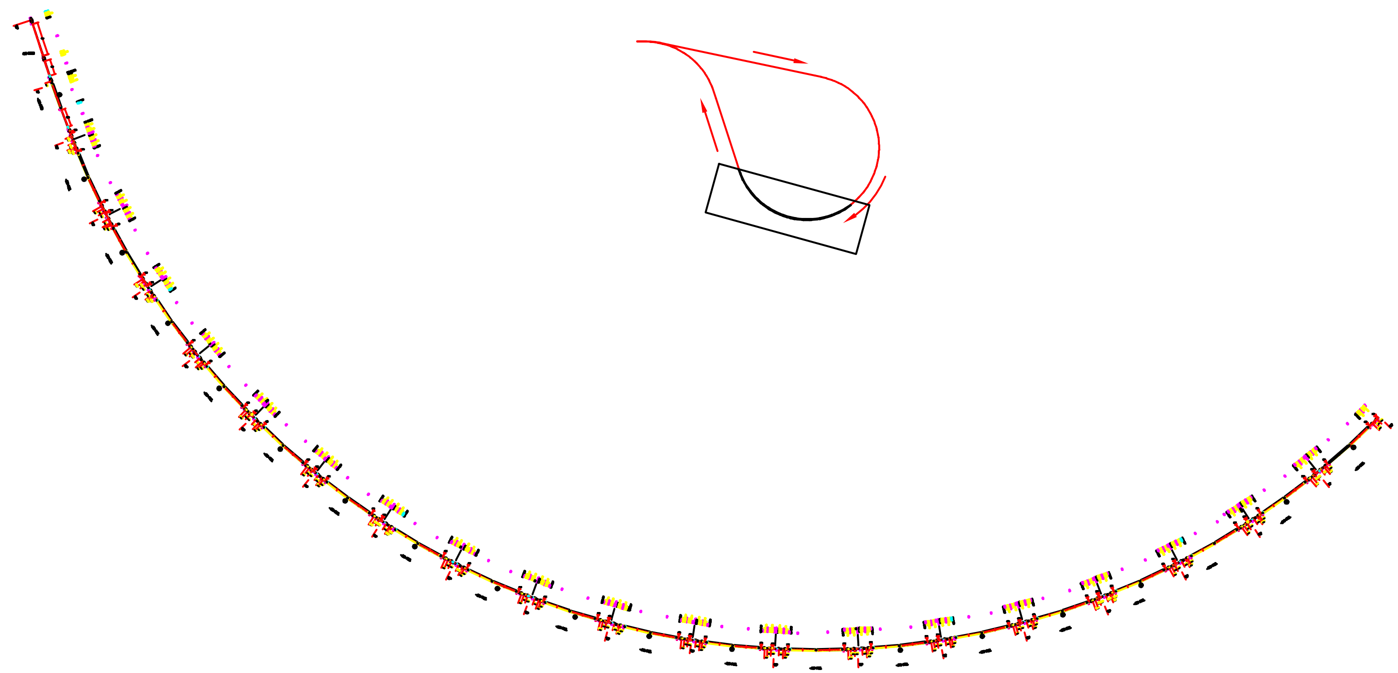
Rev. | Scala

D02654UX3000L

Segue F. 31d53 F. 1A

SHEET A1- SCALE-1:2

LAY-3



REV.	DESCRIZIONE	Data				REV.	DESCRIZIONE	Data			

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

MATERIALE

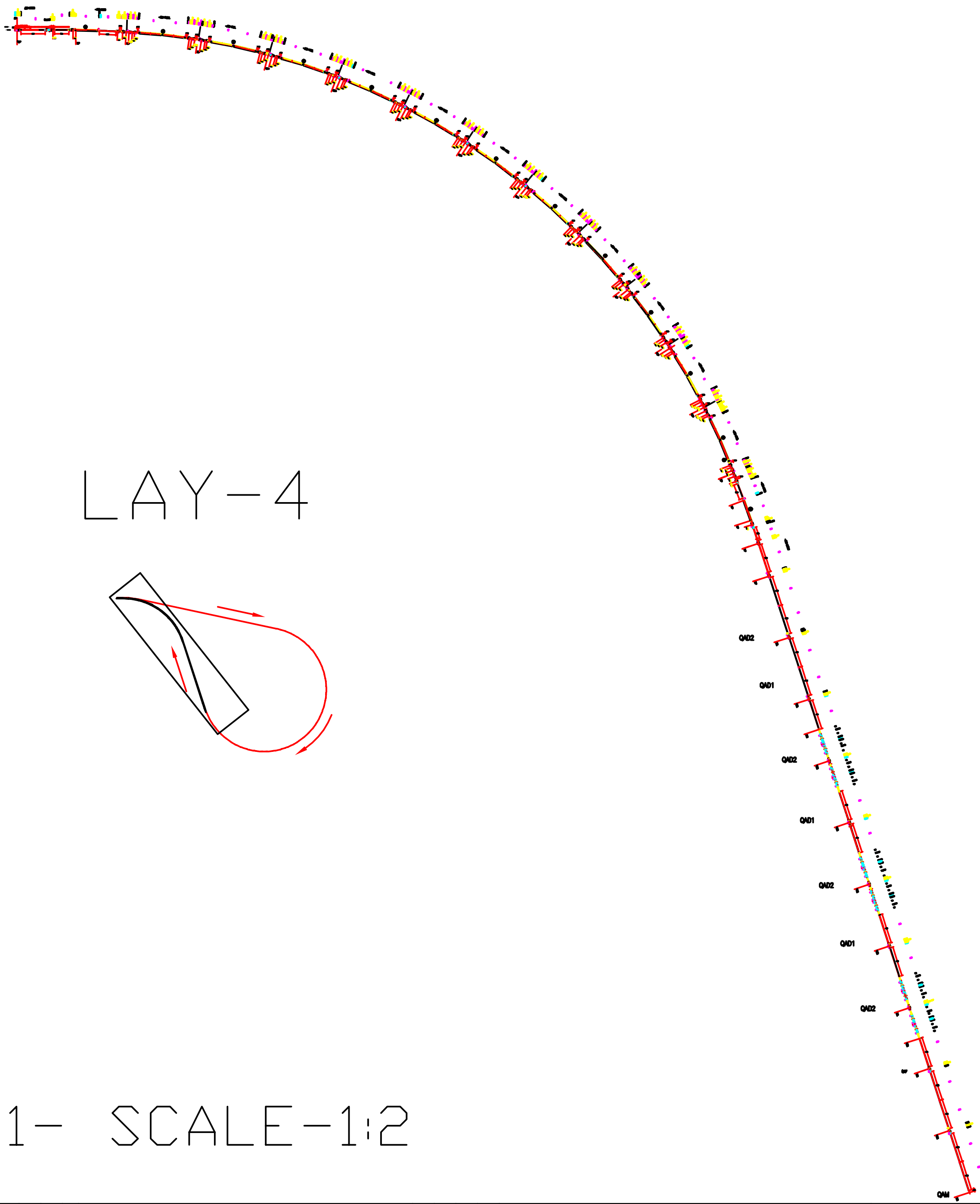
FINITURA

ANSALDO
Ansaldo Ricerche s.r.l.

LAY–3

Rev. | Scala

D02655UX3000L



LAY-4

SHEET A1- SCALE-1:2

REV.	DESCRIZIONE	Data	Redatto	Controllo e Approvazione	Emissione	REV.	DESCRIZIONE	Data	Redatto	Controllo e Approvazione	Emissione

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768-

MATERIALE

FINITURA

ANSALDO
Ansaldo Ricerche s.r.l.

LAY-4

Rev. | Scala

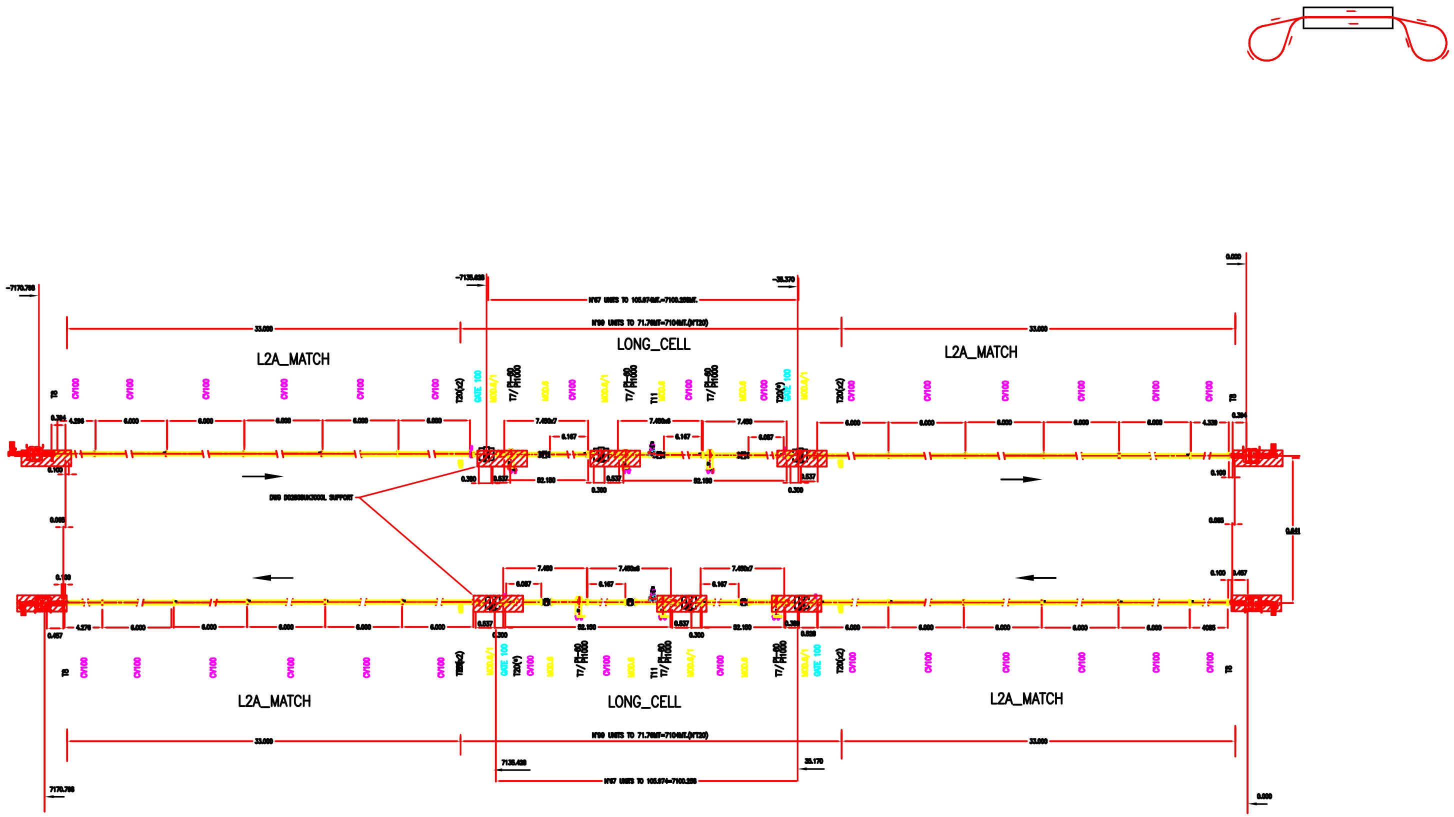
D02656UX3000L

Segue F.77 di 109 F.1A

SHEET A3- SCALE-1:8

Distribuzione

L'ANSALDO SI RISERVA A TERMINE DI LEGGE LA PROPRIETA' DI QUESTO DOCUMENTO CON DIVIETO DI RIPRODURLO O DI RENDERLO COMUNQUE NOTO A TERZI O A DITTE CONCORRENTI SENZA LA SUA AUTORIZZAZIONE



Data

Redatto

Controllo e Approvazione

Autorizzazione Emissione

Software

File: xxx.dwg
D02657

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768-

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione

MATERIALE

FINITURA

ANSALDO
Ansaldo Ricerche s.r.l.

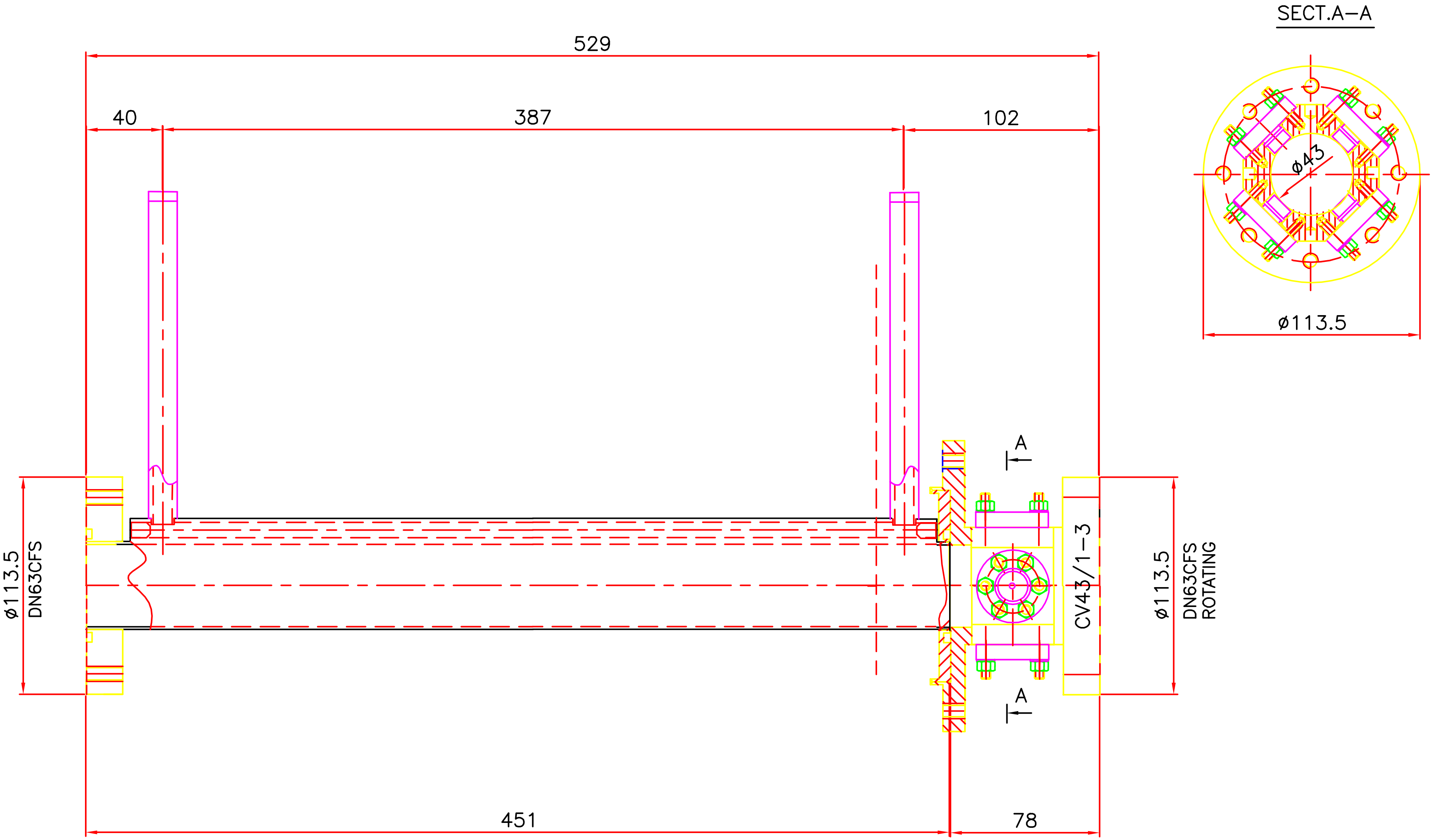
LAY-5

Rev. Scala

D02657UX3000L

Segue F. 110di112 F. 1A

L'ANSALDO SI RISERVA A TERMINE DI LEGGE LA PROPRIETA' DI QUESTO DOCUMENTO
CON DIVIETO DI RIPRODURLO O DI RENDERLO COMUNQUE NOTO A TERZI O A DITTE CONCORRENTI SENZA LA SUA AUTORIZZAZIONE



Distribuzione	
Data	25/01/01
Redatto	
Controllo e Approvazione	
Autorizzazione Emissione	
Software	AUTOCAD 14
File: xxx.dwg	D02658

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione	MATERIALE
0	FIRST EMISSION	25/01/01				FINITURA

ANSALDO
Ansaldo Ricerche s.r.l.

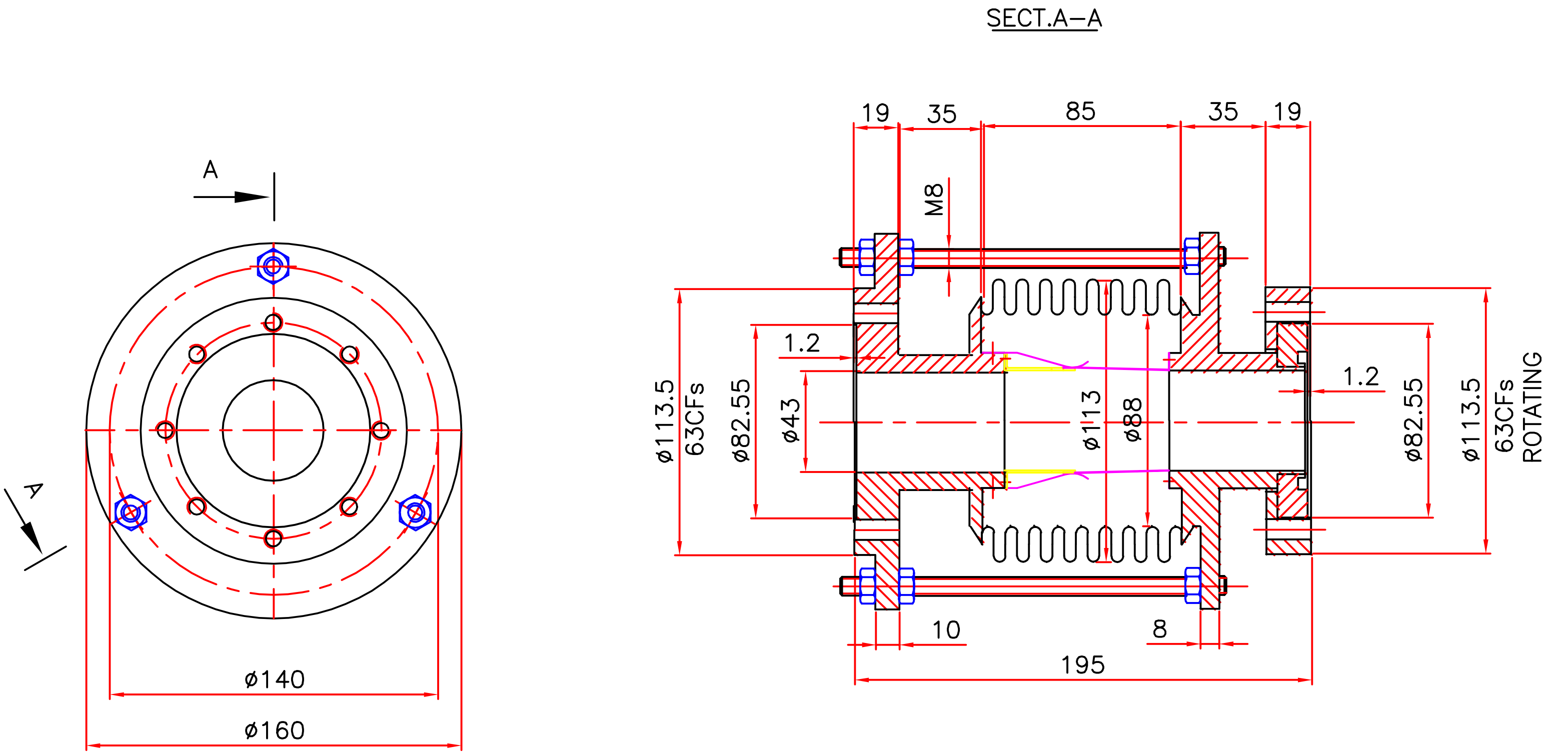
DAMPING RING TESLA
QUADRUPOLE
VACUUM CHAMBER ASSEMBLY
– CV43 MOD.1/1 –

Rev. 0 | Scala

D02658UX3000L

Segue F. / F. 1

Distribuzione



Data 25/01/01

Redatto

Controllo e Approvazione

Autorizzazione Emissione

Software AUTOCAD 14

File: xxx.dwg D02659

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione
0	FIRST EMISSION	25/01/01			

MATERIALE

FINITURA

ANSALDO

Ansaldo Ricerche s.r.l.

DAMPING RING TESLA

BELLOW

– MOD.1/2 –

Rev. 0

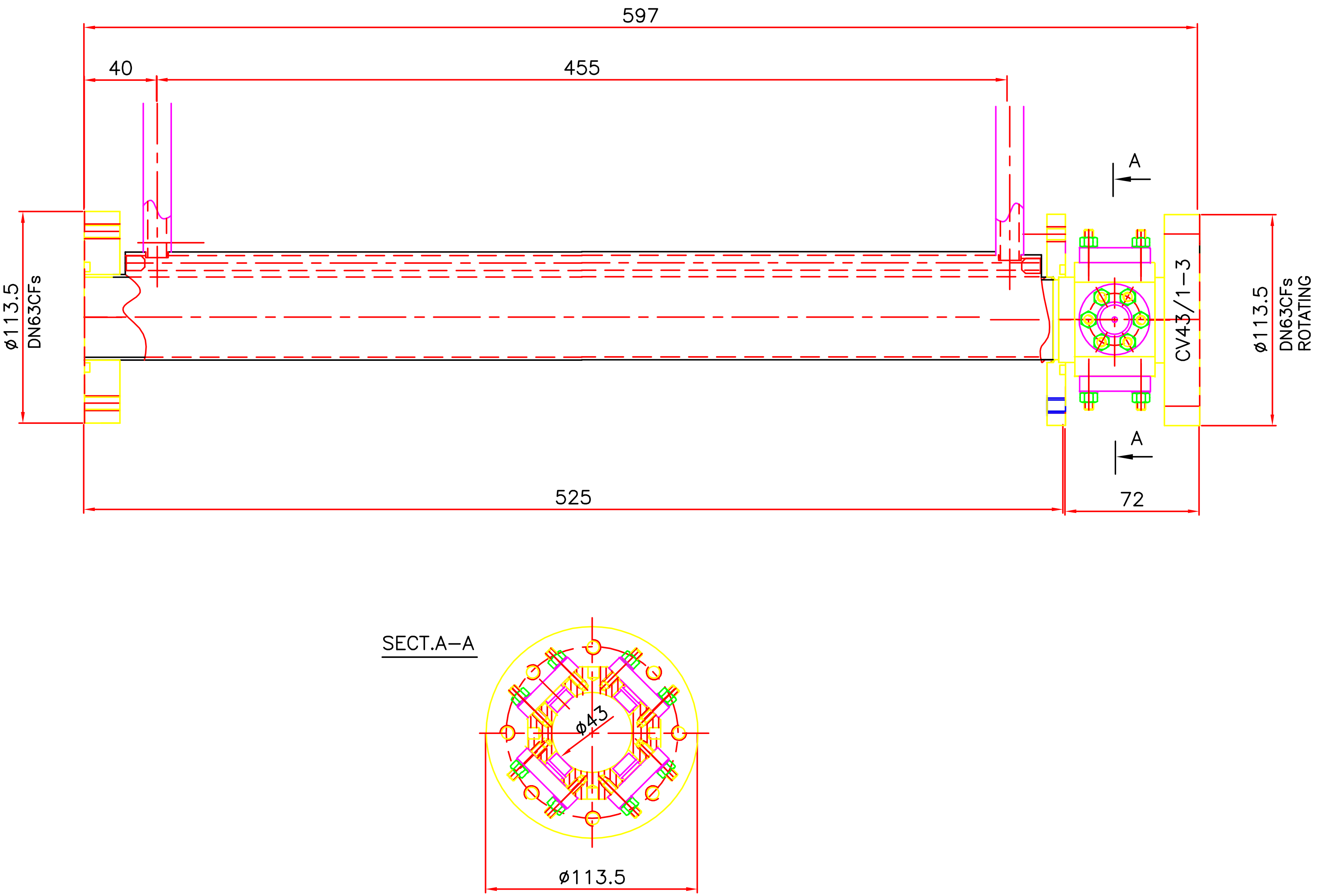
Scala

D02659UX3000L

Segue F. /

F. 1

Distribuzione



Data 25/01/01
Redatto
Controllo e Approvazione
Autorizzazione Emissione
Software AUTOCAD 14
File: xxx.dwg D02660

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione
0	FIRST EMISSION	25/01/01			

MATERIALE

FINITURA

ANSALDO
Ansaldo Ricerche s.r.l.

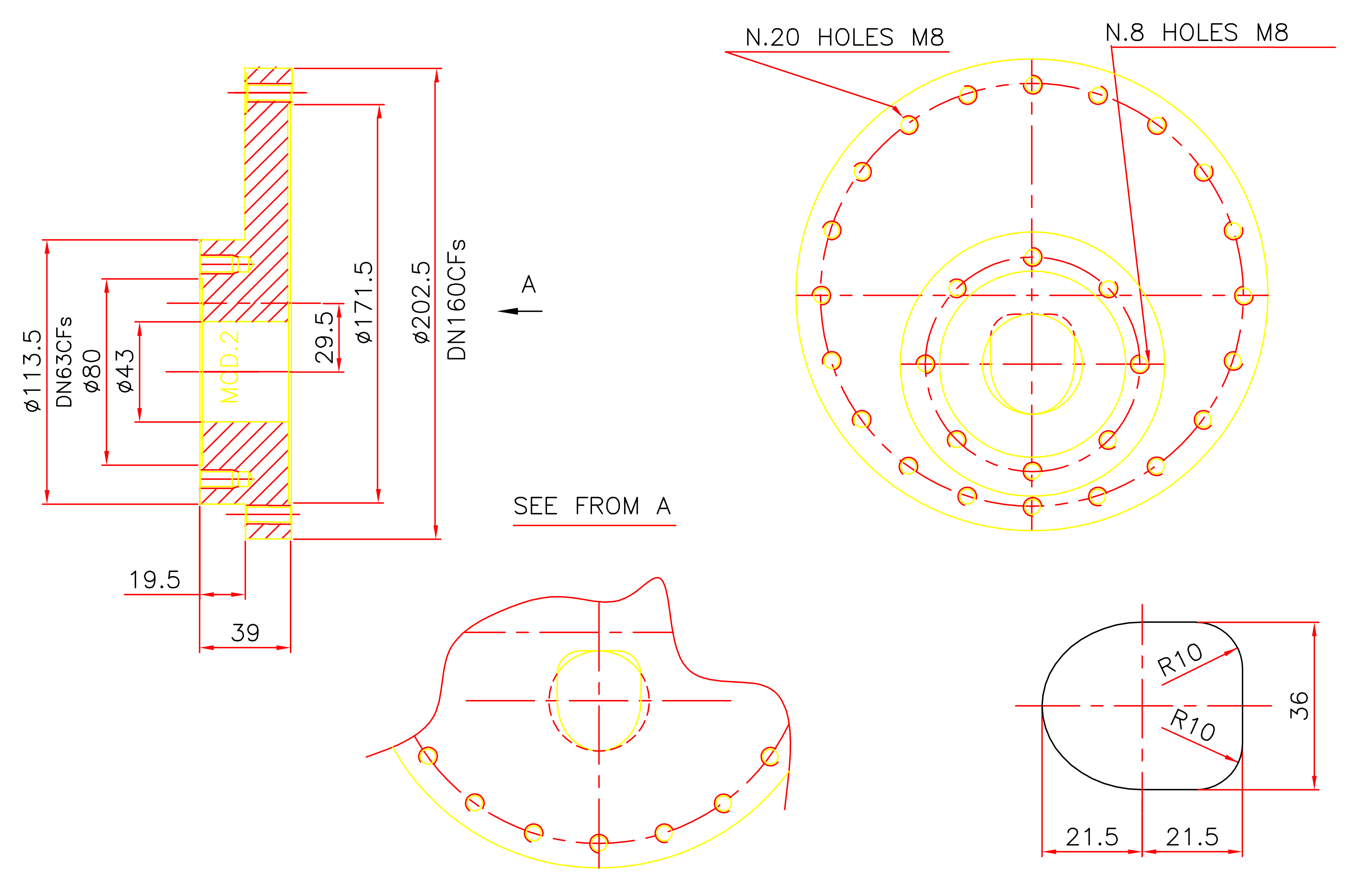
DAMPING RING TESLA
QUADRUPOLE
VACUUM CHAMBER ASSEMBLY
– CV43 MOD.1/3 –

Rev. 0
Scala

D02660UX3000L

Segue F. /
F. 1

Distribuzione



Data 25/01/01
Redatto
Controllo e Approvazione
Autorizzazione Emissione
Software AUTOCAD 14
File: xxx.dwg D02661

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione
0	FIRST EMISSION	25/01/01			

MATERIALE

FINITURA

ANSALDO
Ansaldo Ricerche s.r.l.

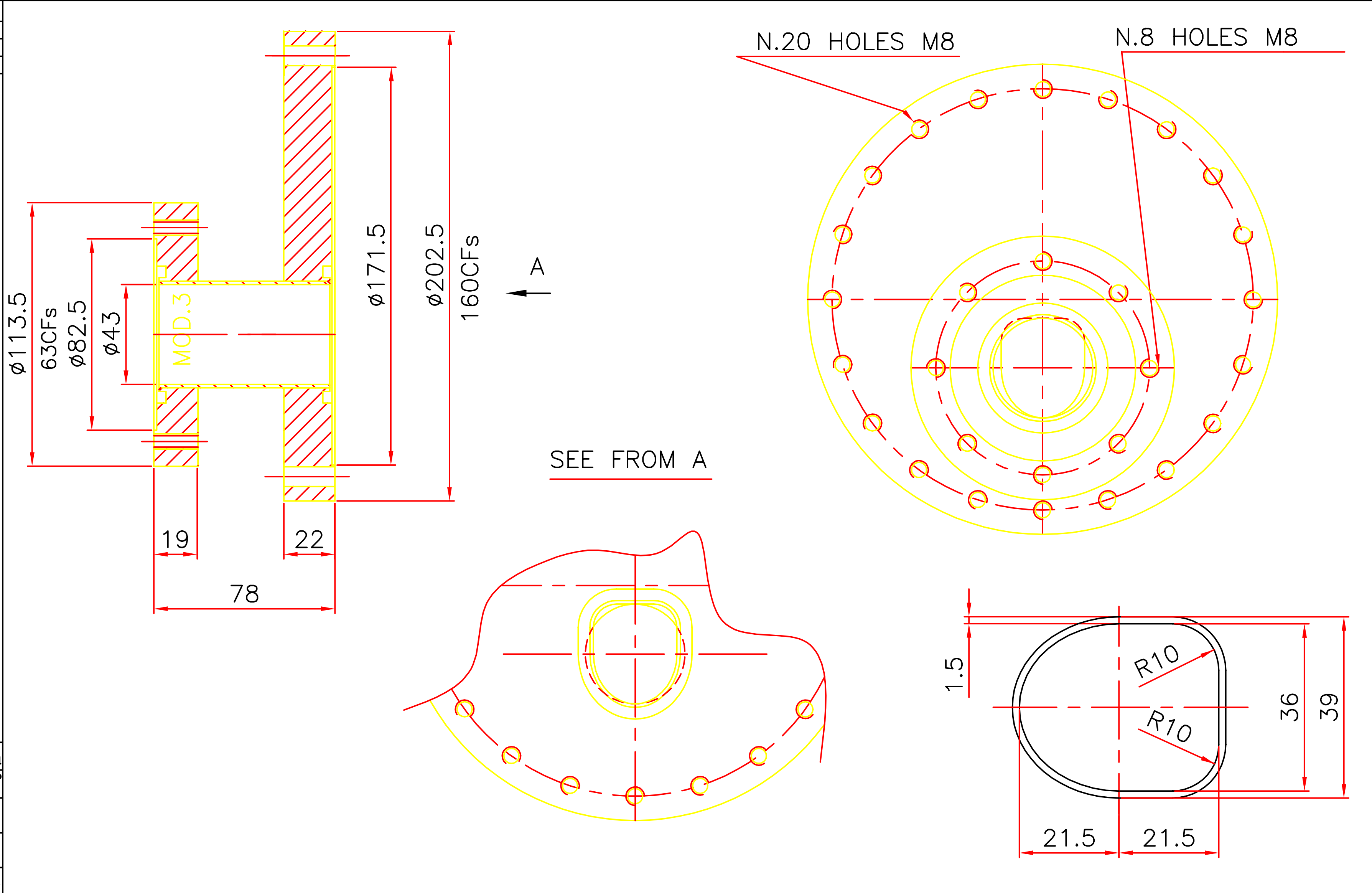
DAMPING RING TESLA

VACUUM PUMP CONNECTION
– MOD.2 –

Rev. 0 Scala

D02661UX3000L

Segue F. / F. 1



Distribuzione	
Data	25/01/01
Redatto	
Controllo e Approvazione	
Autorizzazione Emissione	
Software	AUTOCAD 14
File: xxx.dwg	D02662

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione
0	FIRST EMISSION	25/01/01			

MATERIALE

FINITURA

ANSALDO

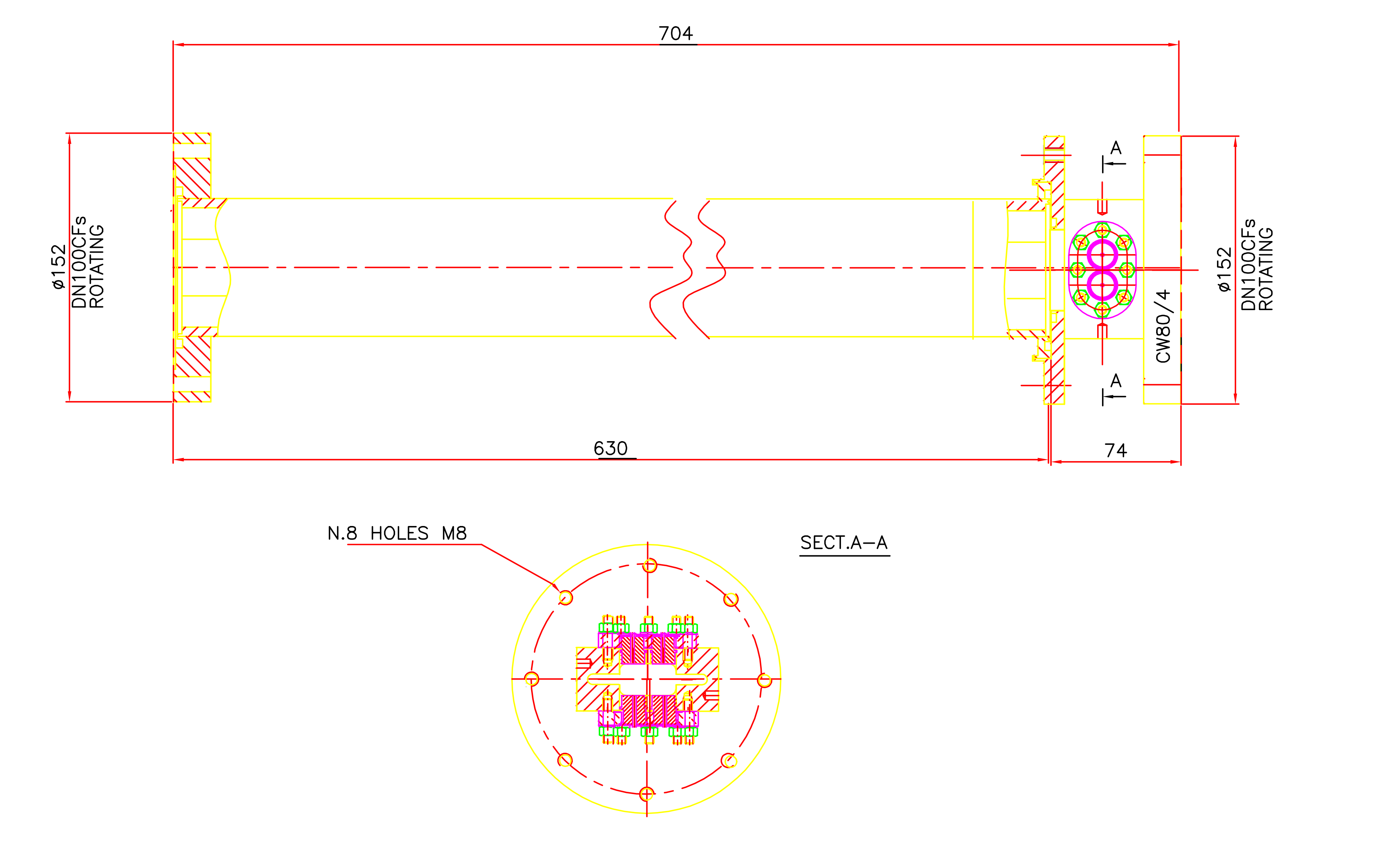
Ansaldo Ricerche s.r.l.

DAMPING RING TESLA

VACUUM PUMP CONNECTION

– MOD.3 –

Rev. 0	Scala
D02662UX3000L	
Segue F. /	F. 1



Distribuzione

Data 25/01/01
Redatto
Controllo e Approvazione
Autorizzazione Emissione
Software AUTOCAD 14
File: xxx.dwg D02679

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione
0	FIRST EMISSION	25/01/01			

MATERIALE

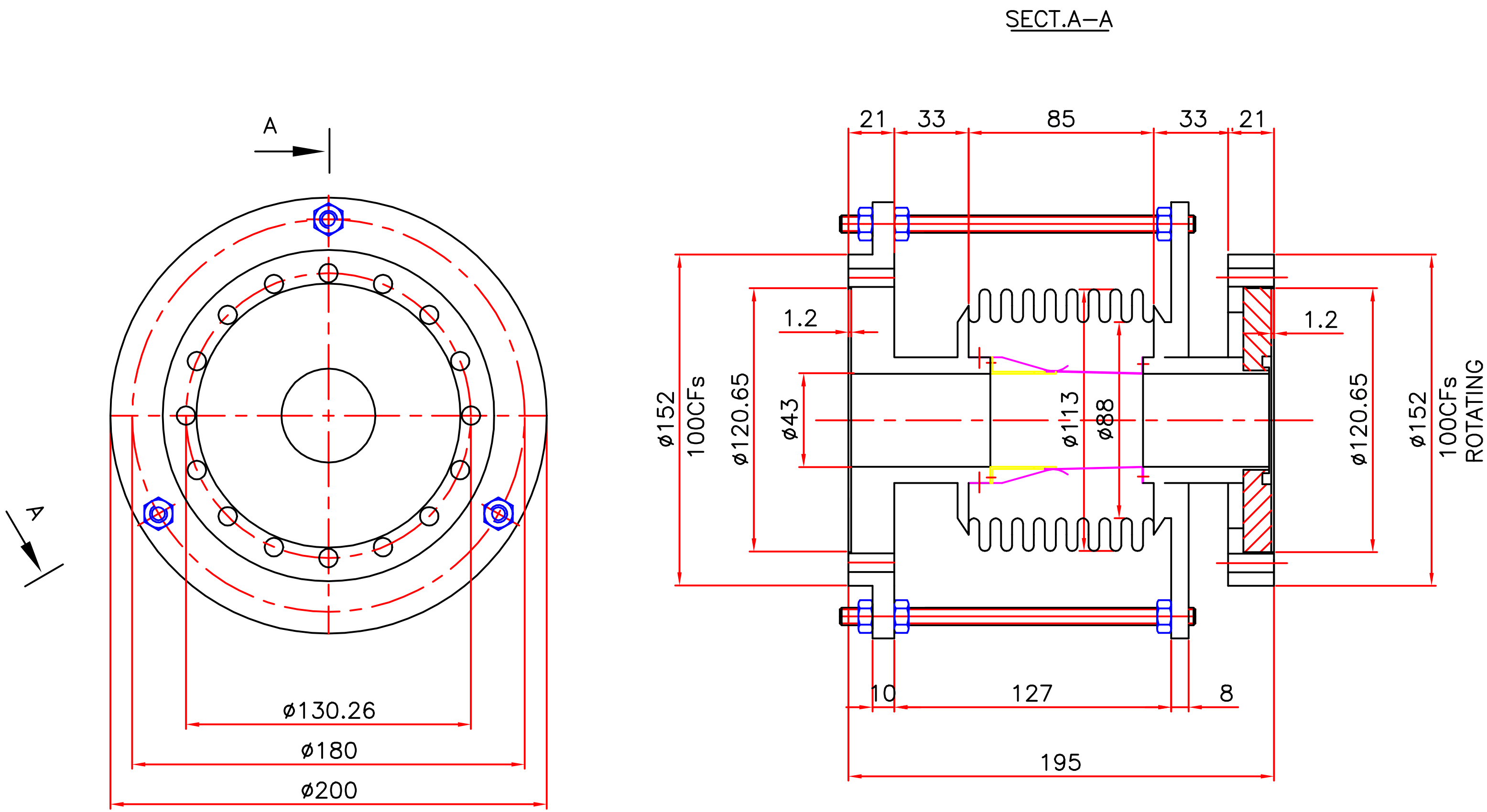
FINITURA

ANSALDO
Ansaldo Ricerche s.r.l.

DAMPING RING TESLA
QUADRUPOLE
VACUUM CHAMBER ASSEMBLY
– CW80 MOD.4 –

Rev. 0
Scala
D02679UX3000L
Segue F. /
F. 1

Distribuzione



Data 25/01/01
Redatto
Controllo e Approvazione
Autorizzazione Emissione
Software AUTOCAD 14
File: xxx.dwg D02680

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione
0	FIRST EMISSION	25/01/01			

MATERIALE

FINITURA

ANSALDO
Ansaldo Ricerche s.r.l.

DAMPING RING TESLA

BELLOW
– MOD.4/3 –

Rev. 0

Scala

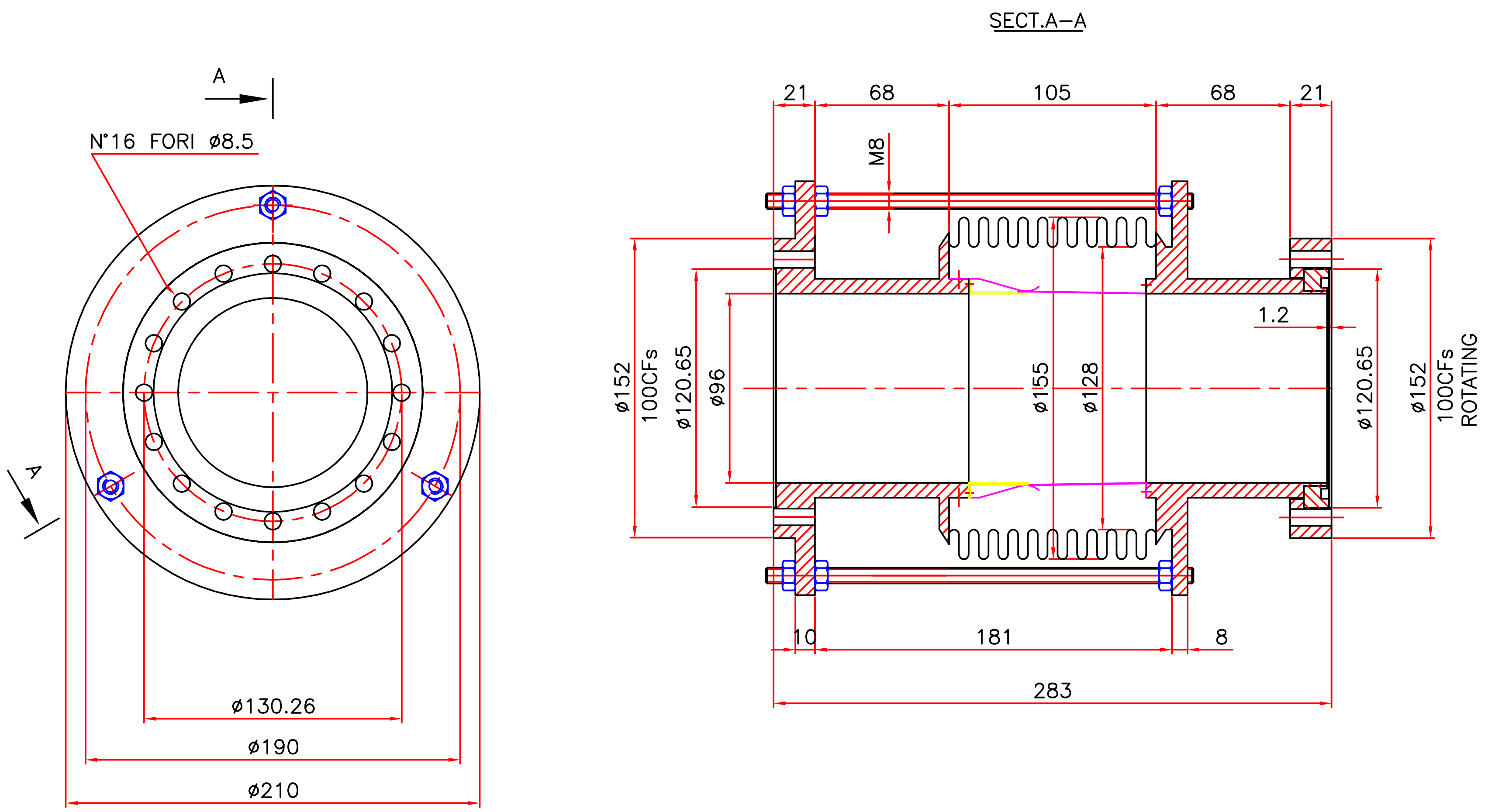
D02680UX3000L

Segue F. /

F. 1

Distribuzione

L'ANSALDO SI RISERVA A TERMINE DI LEGGE LA PROPRIETA' DI QUESTO DOCUMENTO
CON DIVIETO DI RIPRODURLO O DI RENDERLO COMUNQUE NOTO A TERZI O A DITTE CONCORRENTI SENZA LA SUA AUTORIZZAZIONE



Data 25/01/01
Redatto
Controllo e Approvazione
Autorizzazione Emissione
Software AUTOCAD 14
File: xxx.dwg D02681

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione
0	FIRST EMISSION	25/01/01			

MATERIALE

FINITURA

ANSALDO
Ansaldo Ricerche s.r.l.

DAMPING RING TESLA

BELLOW
– MOD.6 –

Rev. 0

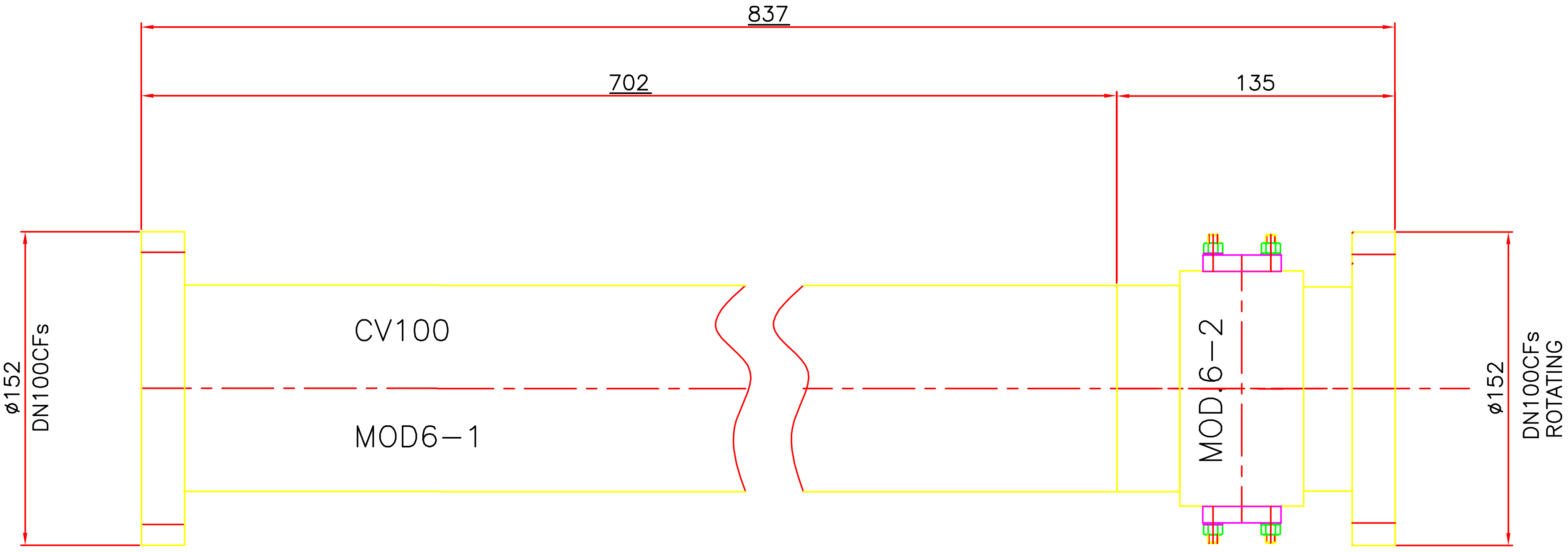
Scala

D02681UX3000L

Segue F. /

F. 1

Distribuzione



Data 25/01/01
Redatto
Controllo e Approvazione
Autorizzazione Emissione
Software AUTOCAD 14
File: xxx.dwg D02682

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768−

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione
0	FIRST EMISSION	25/01/01			

MATERIALE

FINITURA

ANSALDO

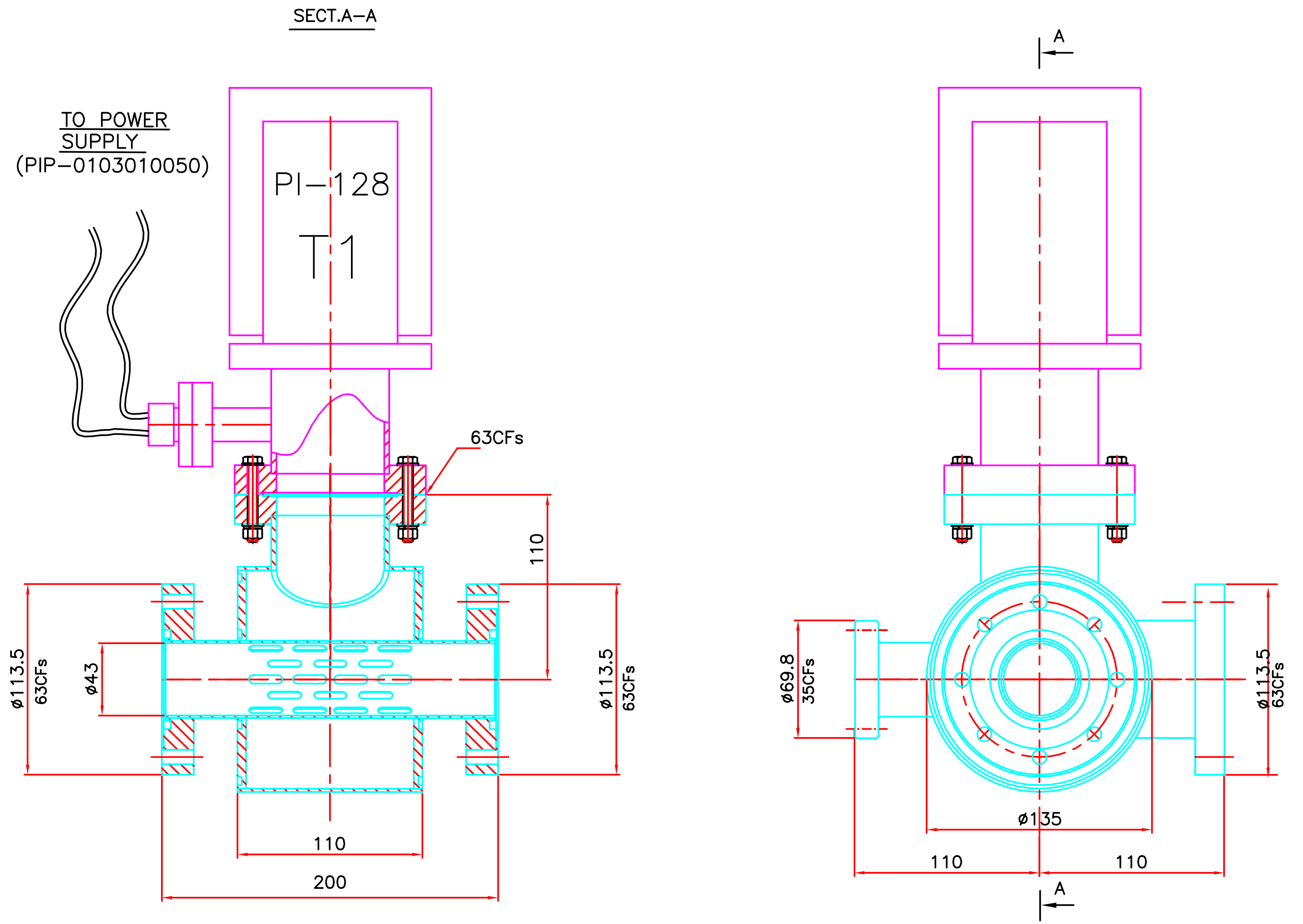
Ansaldo Ricerche s.r.l.

DAMPING RING TESLA
QUADRUPOLE
VACUUM CHAMBER ASSEMBLY
− CV100 MOD6/1 −

Rev. 0 Scala

D02682UX3000L

Segue F. / F. 1



Distribuzione

Data 25/01/01
Redatto
Controllo e Approvazione
Autorizzazione Emissione
Software AUTOCAD 14
File: xxx.dwg D02683

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione
0	FIRST EMISSION	25/01/01			

MATERIALE

FINITURA

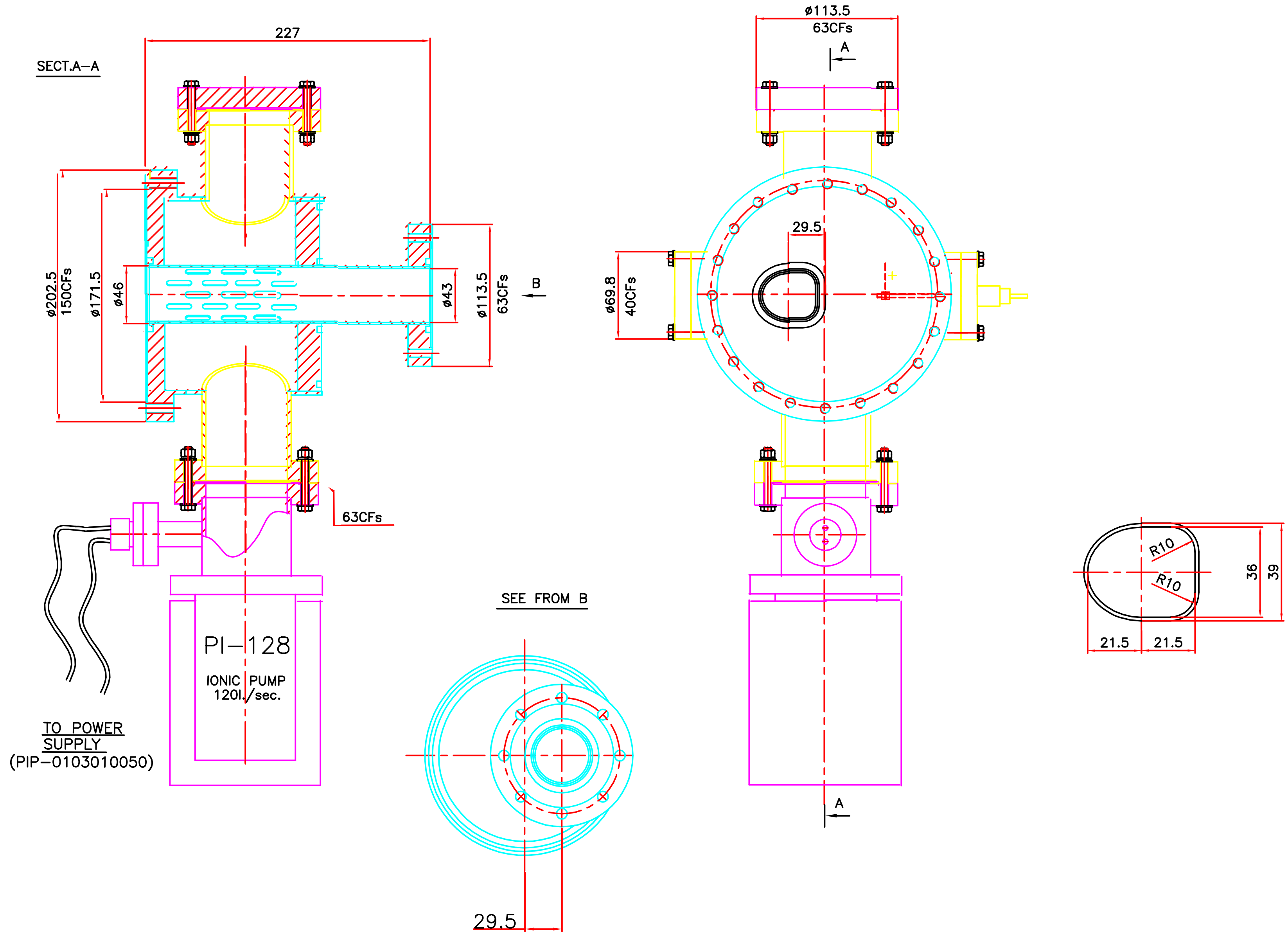
ANSALDO
Ansaldo Ricerche s.r.l.

DAMPING RING TESLA
VACUUM PUMP CONNECTION
– ø43 T1 –

Rev. 0 | Scala

D02683UX3000L

Segue F. / F. 1



Distribuzione

Data 25/01/01
Redatto
Controllo e Approvazione
Autorizzazione Emissione
Software AUTOCAD 14
File: xxx.dwg D02684

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione
0	FIRST EMISSION	25/01/01			

MATERIALE

FINITURA

ANSALDO
Ansaldo Ricerche s.r.l.

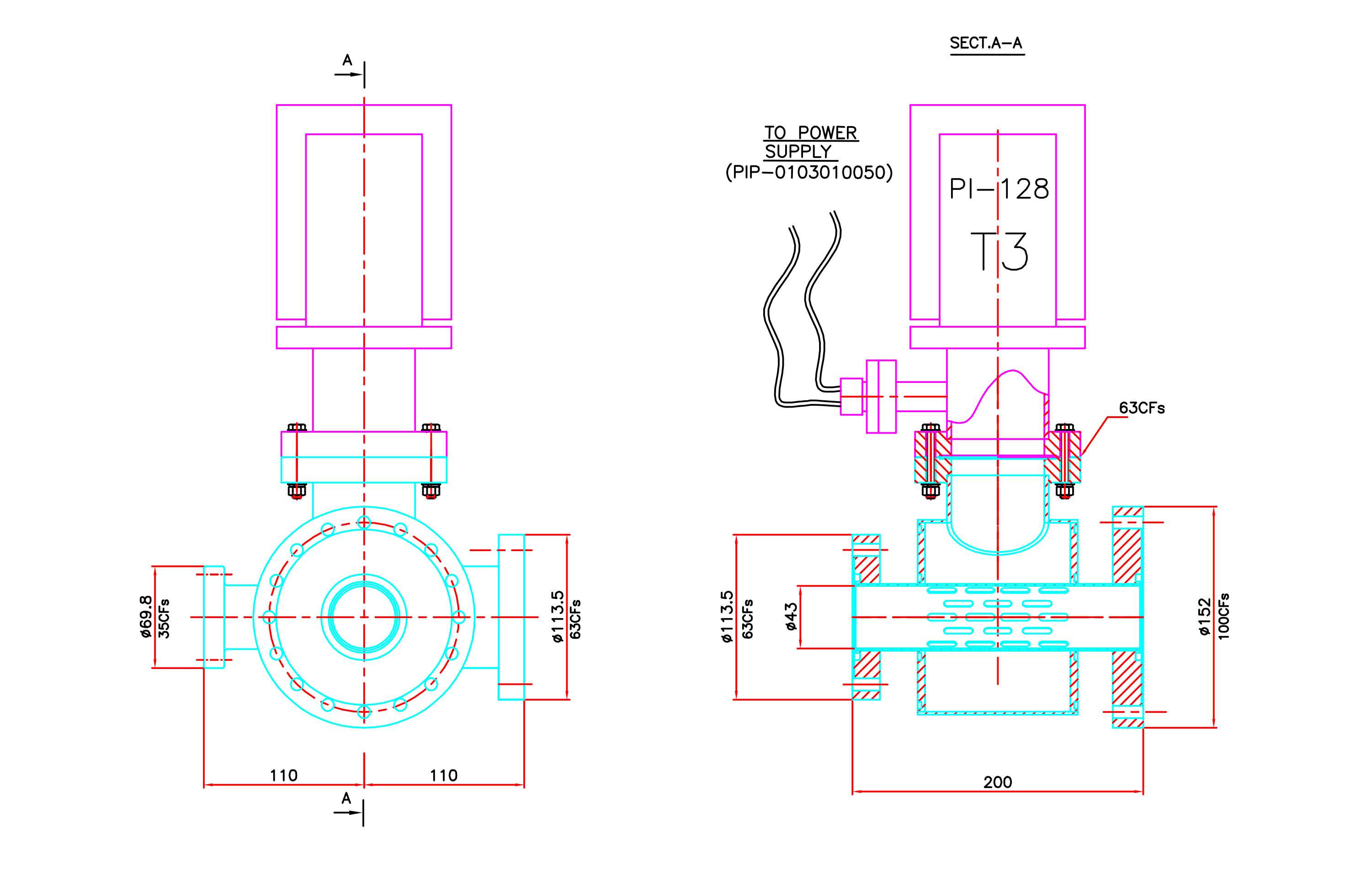
DAMPING RING TESLA
VACUUM PUMP CONNECTION
– CV43 T2 –

Rev. 0
Scala

D02684UX3000L

Segue F. / F. 1

Distribuzione



Data
25/01/01
Redatto
Controllo e Approvazione
Autorizzazione Emissione
Software
AUTOCAD 14
File: xxx.dwg
D02685

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione
0	FIRST EMISSION	25/01/01			

MATERIALE

FINITURA

ANSALDO
Ansaldo Ricerche s.r.l.

DAMPING RING TESLA
VACUUM PUMP CONNECTION
– ø43 T3 –

Rev. 0
Scala

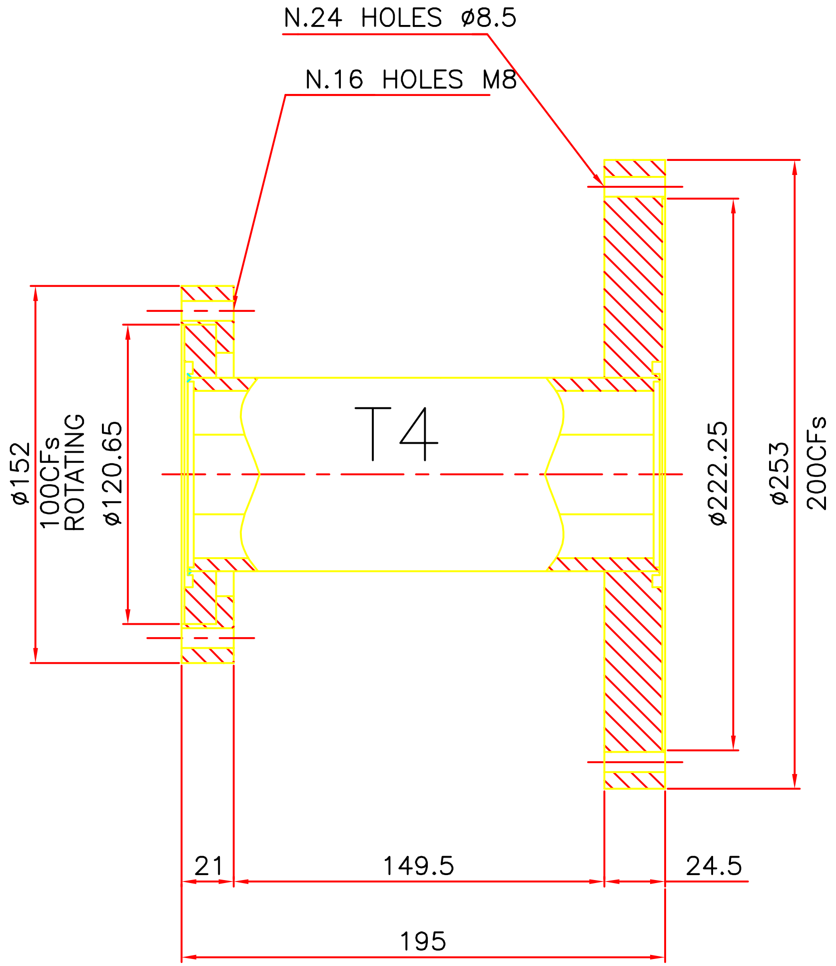
D02685UX3000L

Segue F. /
F. 1

Distribuzione

ANSALDO

Ansaldo Ricerche s.r.l.



Data 25/01/01

Redatto

Controllo e Approvazione

Autorizzazione Emissione

Software AUTOCAD14

File: xxx.dwg D02690

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo Approvaz.	Autorizz. Emissione
0	FIRST EMISSION	25/01/01			

DAMPING RING TESLA

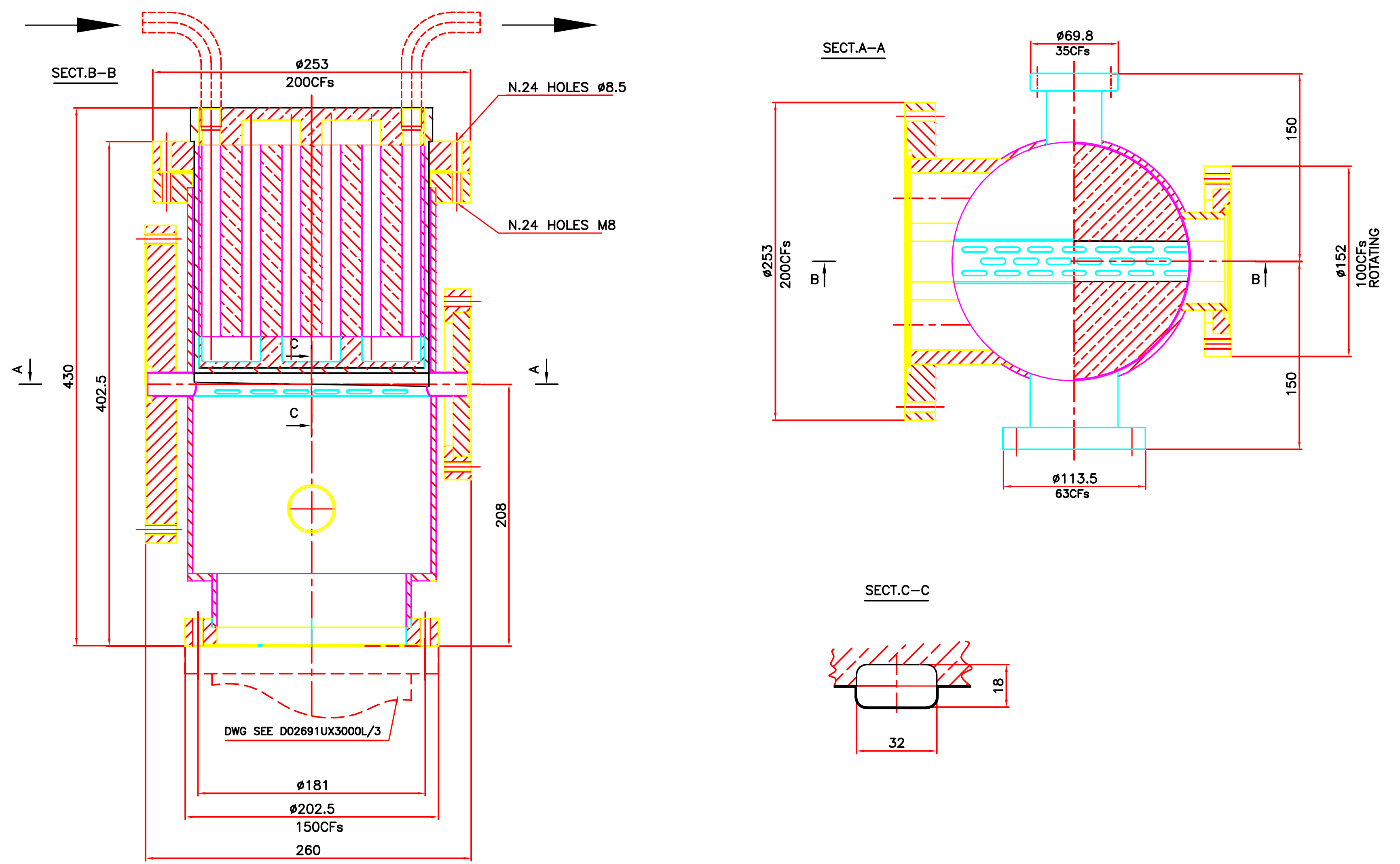
FLANGE JOINT DN100/200

– CW80 T4 –

Rev. 0 Scala

D02690UX3000L

Segue F. / F. 1



Distribuzione

L'ANSALDO SI RISERVA A TERMINE DI LEGGE LA PROPRIETA' DI QUESTO DOCUMENTO CON DIVIETO DI RIPRODURLO O DI RENDERLO COMUNQUE NOTO A TERZI O A DITTE CONCORRENTI SENZA LA SUA AUTORIZZAZIONE

Data 25/01/01
Redatto
Controllo e Approvazione
Autorizzazione Emissione
Software AUTOCAD 14
File: xxx.dwg D02691/1

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione
0	FIRST EMISSION	25/01/01			

MATERIALE

FINITURA

ANSALDO
Ansaldo Ricerche s.r.l.

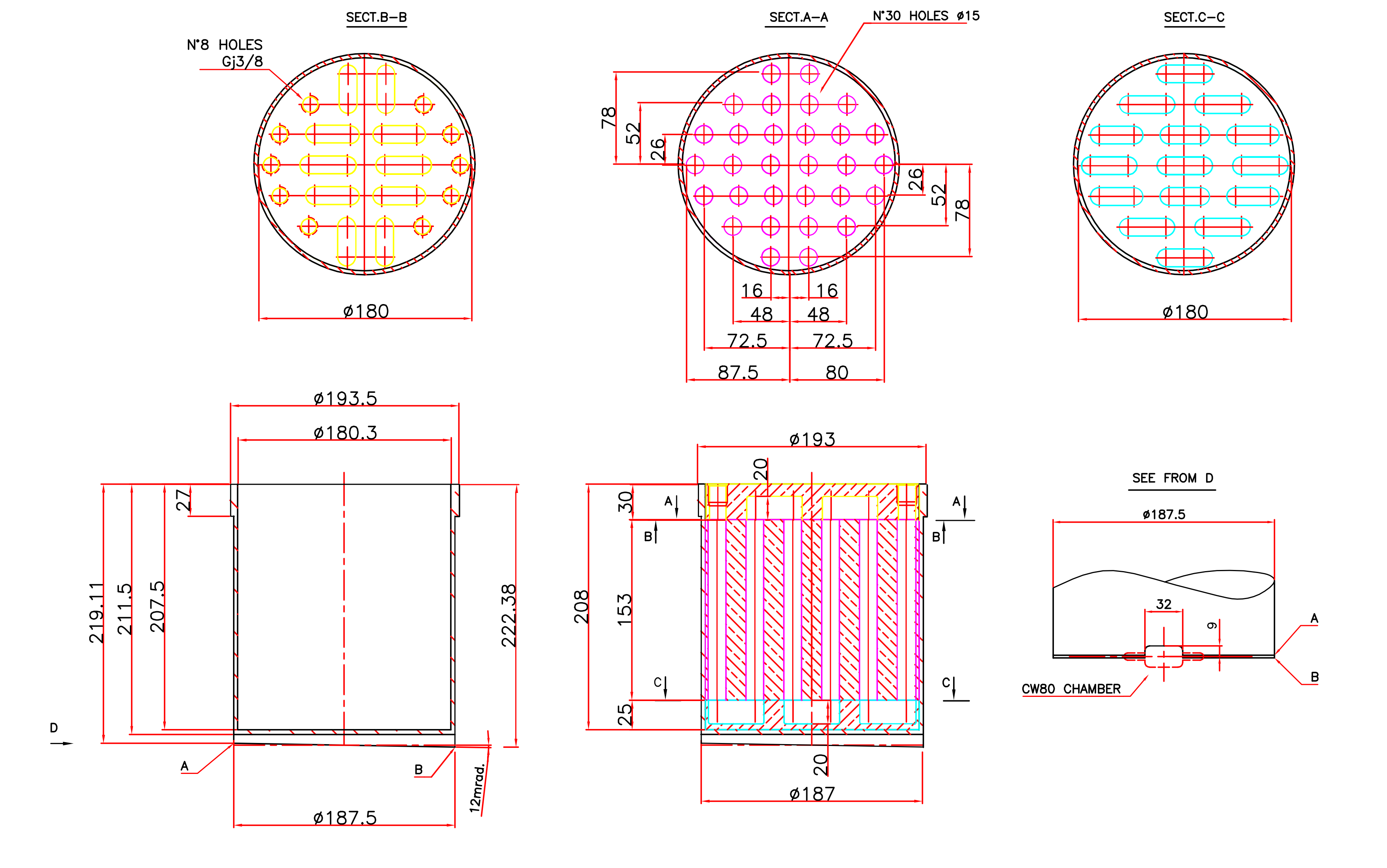
DAMPING RING TESLA
WIGGLER SECTION
SYNCROTRON RADIATION
ABSORBER CHAMBER
– CVW/CW80 T5 –

Rev. 0
Scala

D02691UX3000L

Segue F. 2
F. 1

Distribuzione



Data 25/01/01
Redatto
Controllo e Approvazione
Autorizzazione Emissione
Software AUTOCAD 14
File: xxx.dwg D02691/2

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione
0	FIRST EMISSION	25/01/01			

MATERIALE

FINITURA

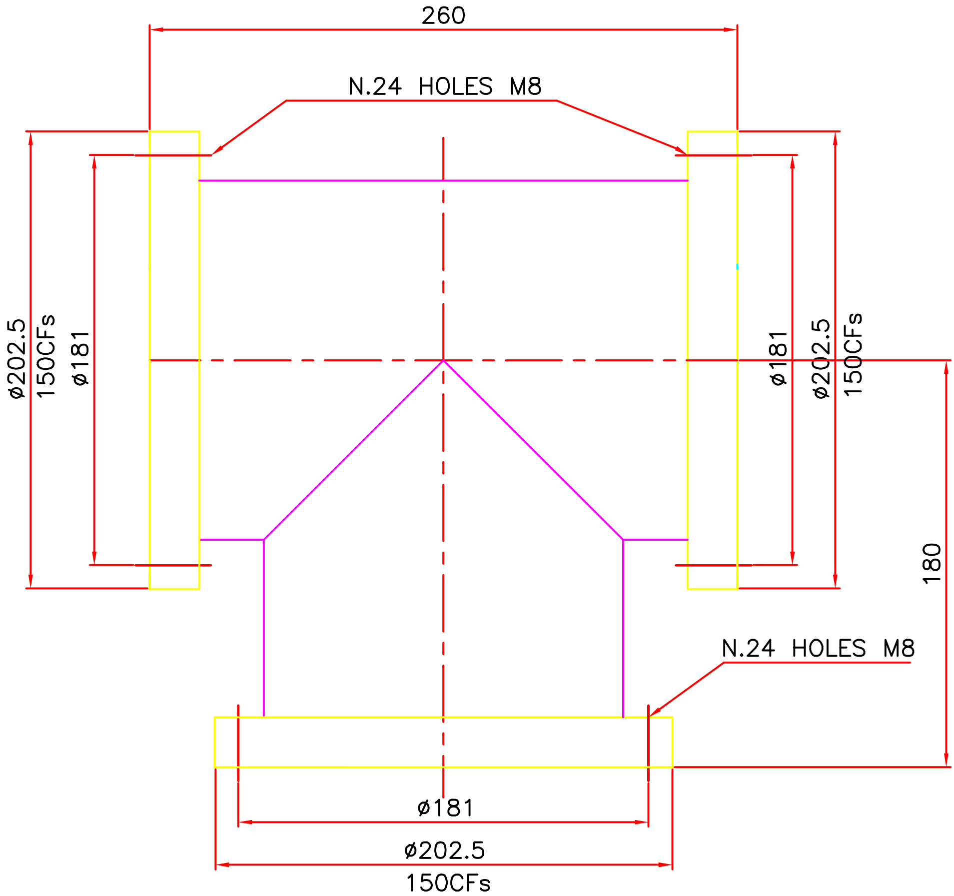
ANSALDO
Ansaldo Ricerche s.r.l.

DAMPING RING TESLA
WIGGLER SECTION
SYNCROTRON RADIATION
ABSORBER CHAMBER
– CVW/CW80 T5 –

Rev. 0 | Scala

D02691UX3000L

Segue F. 3 F. 2



ANSALDO
Ansaldo Ricerche s.r.l.

Distribuzione

Data 25/01/01
Redatto
Controllo e Approvazione
Autorizzazione Emissione
Software AUTOCAD14
File: xxx.dwg D02691/3

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo Approvaz.	Autorizz. Emissione
0	FIRST EMISSION	25/01/01			

DAMPING RING TESLA

90° TEE

– T17 –

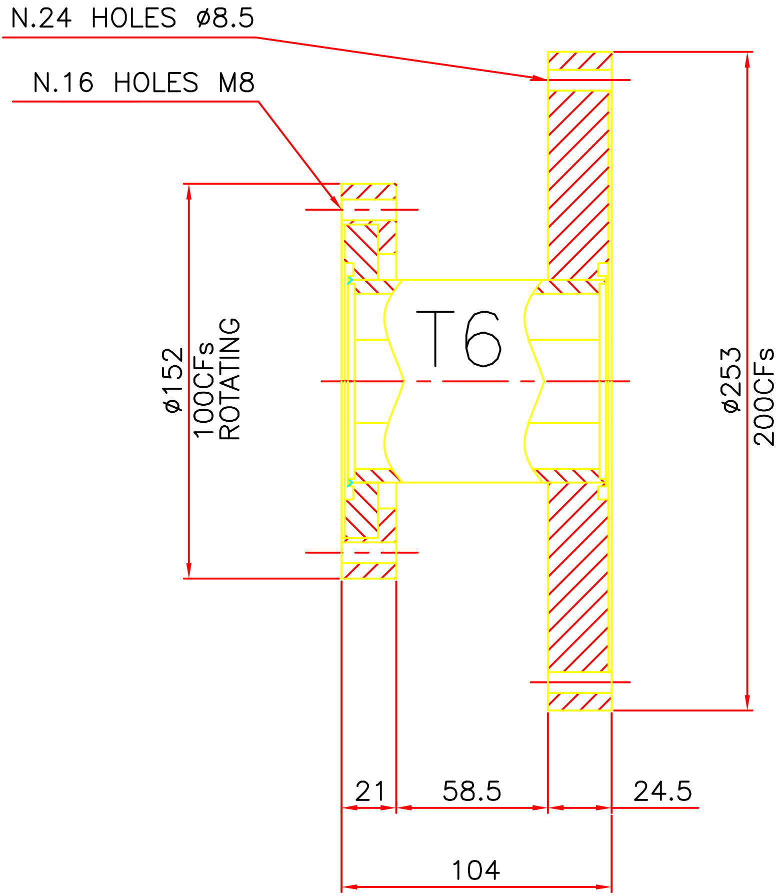
Rev. 0 Scala

D02691UX3000L

Segue F. / F. 3

Distribuzione

ANSALDO
Ansaldo Ricerche s.r.l.



Data 25/01/01
Redatto
Controllo e Approvazione
Autorizzazione Emissione
Software AUTOCAD14
File: xxx.dwg D02692

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo Approvaz.	Autorizz. Emissione
0	FIRST EMISSION	25/01/01			

DAMPING RING TESLA

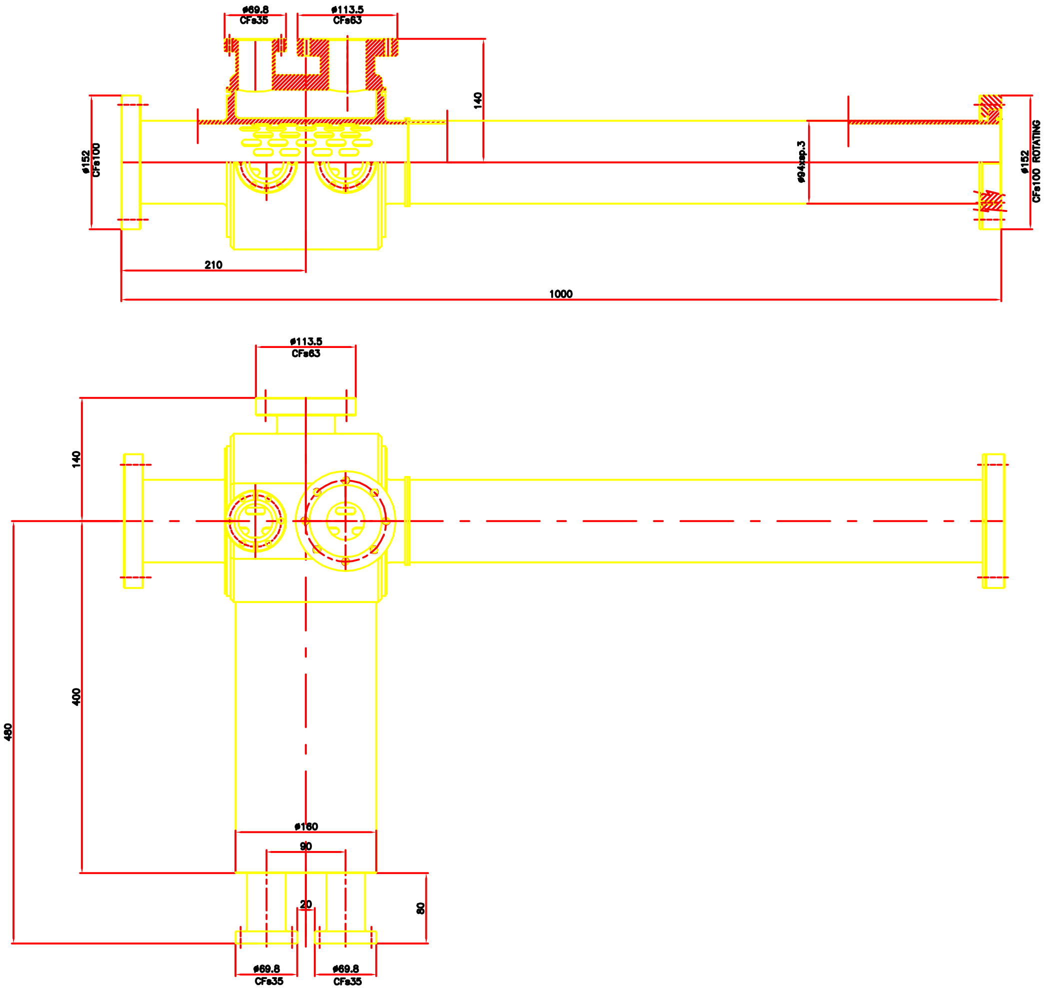
FLANGE JOINT DN100/200
– CW80 T6 –

Rev. 0 Scala

D02692UX3000L

Segue F. / F. 1

Distribuzione



Data
25/01/01
Redatto
Controllo e Approvazione
Autorizzazione Emissione
Software
AUTOCAD 14
File: xxx.dwg
D02693

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione
0	FIRST EMISSION	25/01/01			

MATERIALE

FINITURA

ANSALDO
Ansaldo Ricerche s.r.l.

DAMPING RING TESLA

VACUUM PUMP CONNECTION
– CV100 T7 –

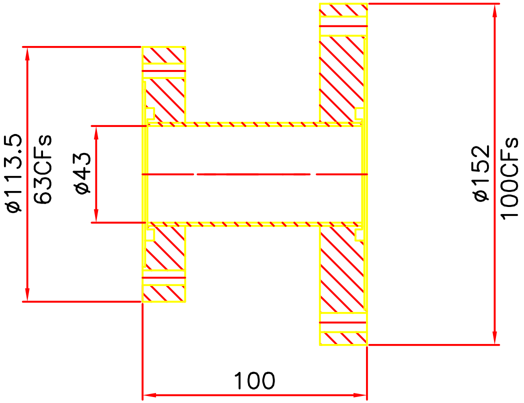
Rev. 0

Scala

D02693UX3000L

Segue F. /

F. 1



Distribuzione

ANSALDO
Ansaldo Ricerche s.r.l.

Data 25/01/01
Redatto
Controllo e Approvazione
Autorizzazione Emissione
Software AUTOCAD14
File: xxx.dwg D02694

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo Approvaz.	Autorizz. Emissione
0	FIRST EMISSION	25/01/01			

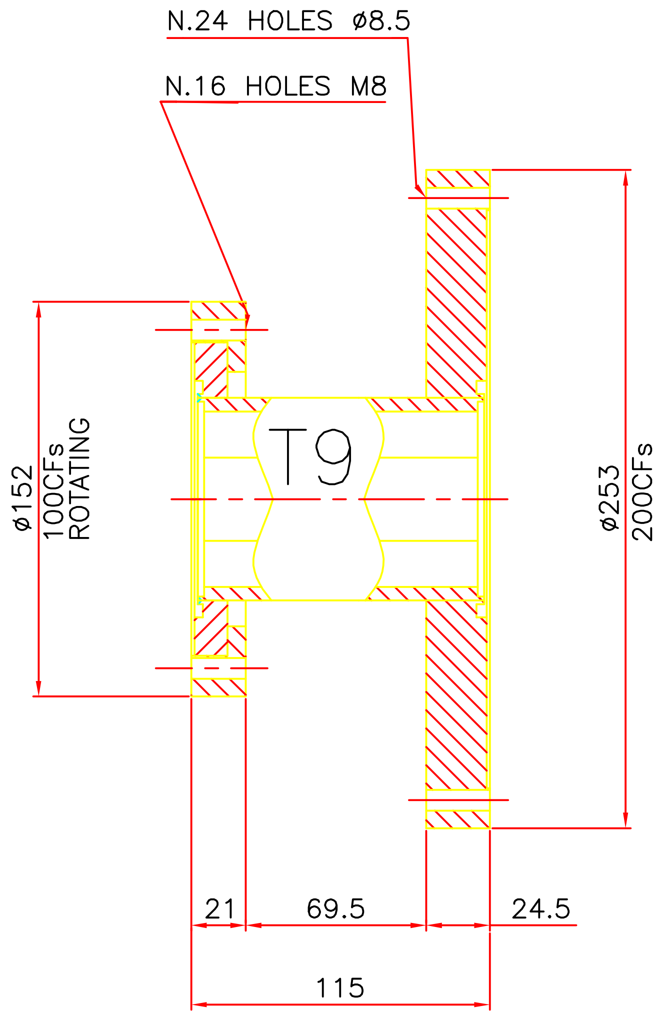
DAMPING RING TESLA

FLANGE JOINT DN63/100
– ø43 T8 –

Rev. 0 Scala

D02694UX3000L

Segue F. / F. 1



Distribuzione

Data 25/01/01
Redatto
Controllo e Approvazione
Autorizzazione Emissione
Software AUTOCAD14
File: xxx.dwg D02695

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo Approvaz.	Autorizz. Emissione
0	FIRST EMISSION	25/01/01			

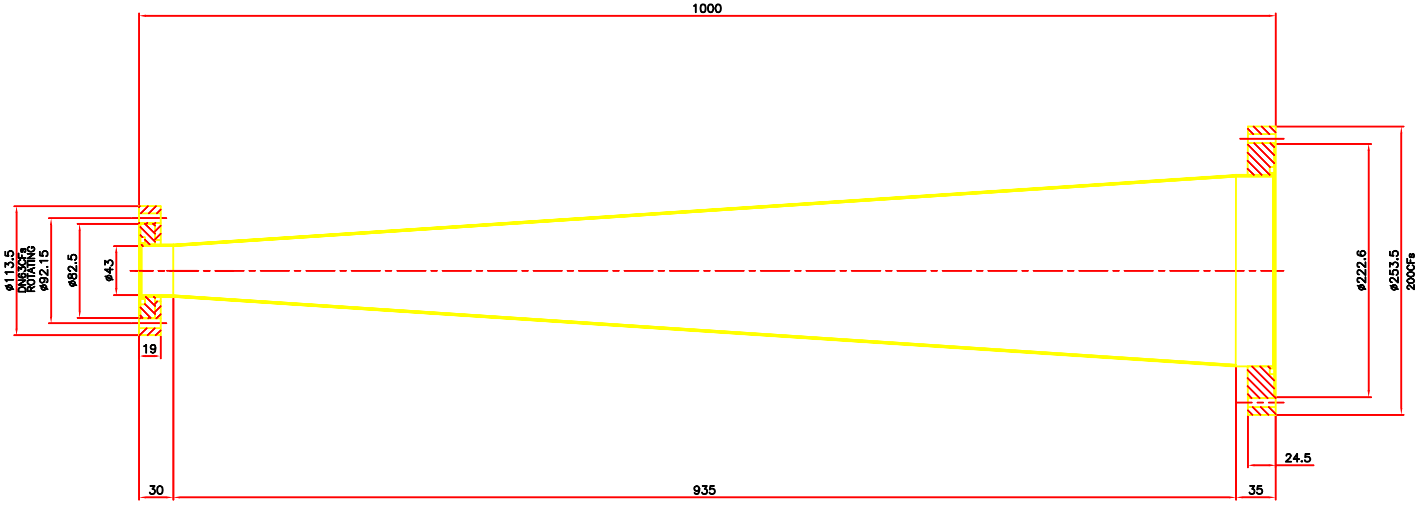
DAMPING RING TESLA

FLANGE JOINT DN100/200
– CW80 T9 –

Rev. 0 Scala

D02695UX3000L

Segue F. / F. 1



Distribuzione

Data 25/01/01
Redatto
Controllo e Approvazione
Autorizzazione Emissione
Software AUTOCAD 14
File: xxx.dwg D02696

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione
0	FIRST EMISSION	25/01/01			

MATERIALE

FINITURA

ANSALDO
Ansaldo Ricerche s.r.l.

DAMPING RING TESLA

CONICAL FLANGE
JOINT DN63/200
– ø43/RFø200 T10 –

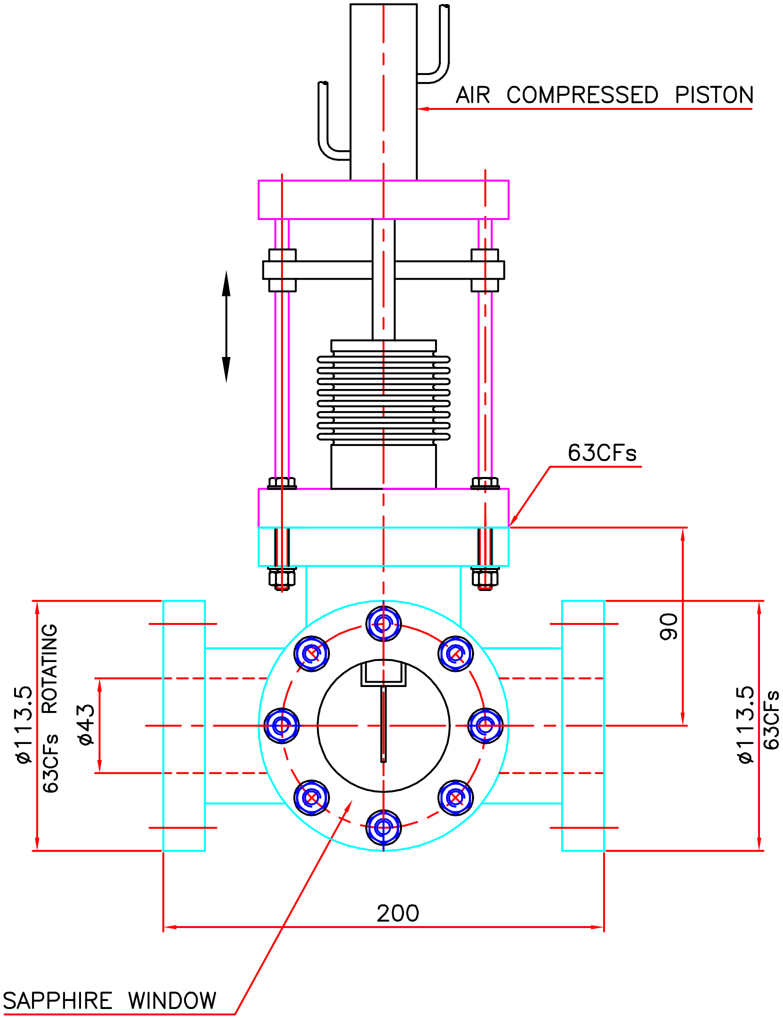
Rev. 0 | Scala

D02696UX3000L

Segue F. / F. 1

Distribuzione

ANSALDO
Ansaldo Ricerche s.r.l.



Data 25/01/01
Redatto
Controllo e Approvazione
Autorizzazione Emissione
Software AUTOCAD14
File: xxx.dwg D02778

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo Approvaz.	Autorizz. Emissione
0	FIRST EMISSION	25/01/01			

DAMPING RING TESLA
CERAMIC FLAG/OTR
INDICATOR PLATE POSITIONER
– ø43 T11 –

Rev. 0 Scala

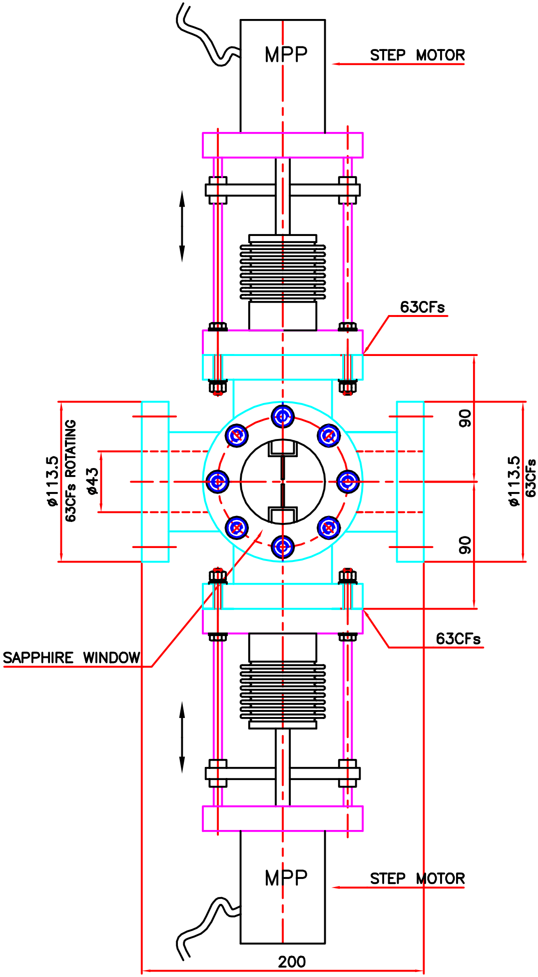
D02778UX3000L

Segue F. / F. 1

Distribuzione

ANSALDO

Ansaldo Ricerche s.r.l.



Data 25/01/01

Redatto

Controllo e Approvazione

Autorizzazione Emissione

Software AUTOCAD14

File: xxx.dwg D02779

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo Approvaz.	Autorizz. Emissione
0	FIRST EMISSION	25/01/01			

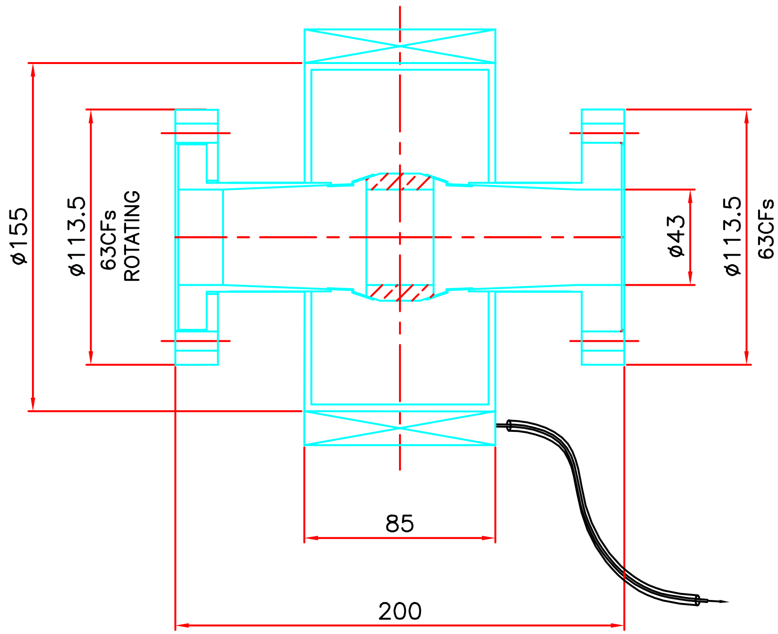
DAMPING RING TESLA

SLIT/SCRAPER POSITIONER
– ø43 T12 –

Rev. 0 Scala

D02779UX3000L

Segue F. / F. 1



Distribuzione

ANSALDO
Ansaldo Ricerche s.r.l.

Data 25/01/01
Redatto
Controllo, e Approvazione
Autorizzazione Emissione
Software AUTOCAD14
File: xxx.dwg D02780

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo Approvaz.	Autorizz. Emissione
0	FIRST EMISSION	25/01/01			

DAMPING RING TESLA

TOROID CURRENT MONITOR
– ø43 T13 –

Rev. 0 Scala

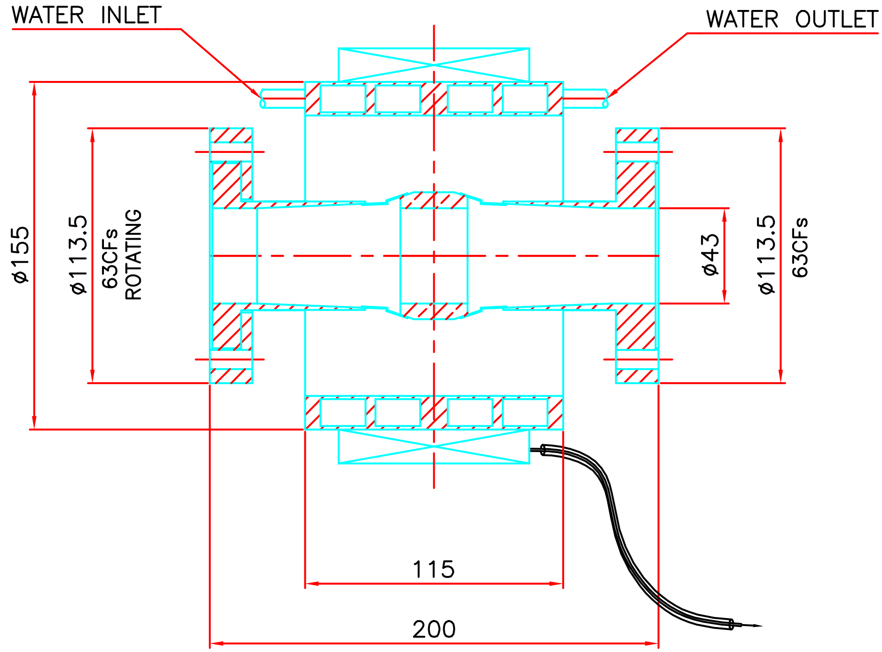
D02780UX3000L

Segue F. / F. 1

Distribuzione

ANSALDO

Ansaldo Ricerche s.r.l.



Data 25/01/01

Redatto

Controllo, e Approvazione

Autorizzazione Emissione

Software AUTOCAD14

File: xxx.dwg D02781

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo Approvaz.	Autorizz. Emissione
0	FIRST EMISSION	25/01/01			

DAMPING RING TESLA

DC CURRENT MONITOR
(DCCT)
– ø43 T14 –

Rev. 0

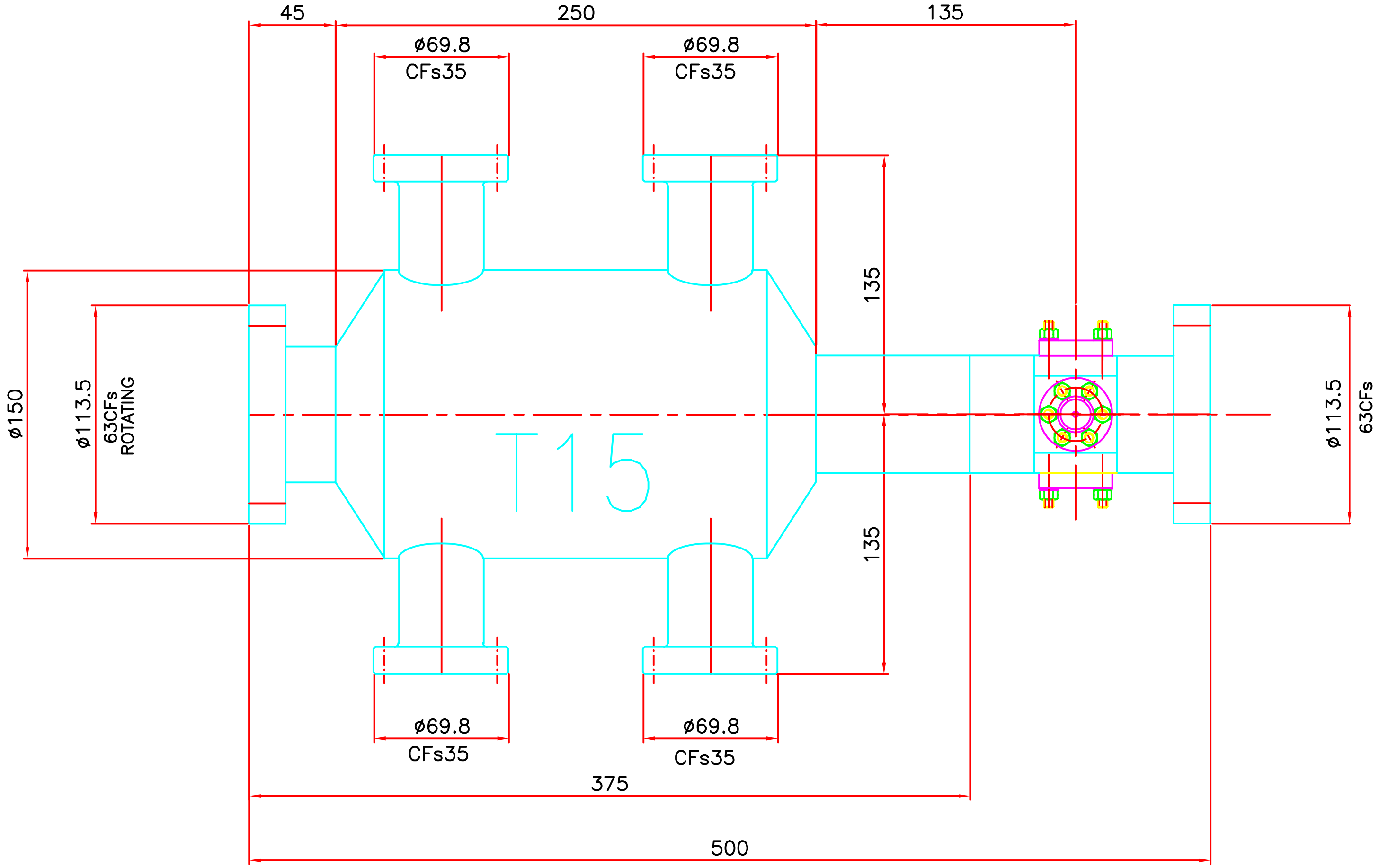
Scala

D02781UX3000L

Segue F. /

F. 1

Distribuzione



Data 25/01/01
Redatto
Controllo e Approvazione
Autorizzazione Emissione
Software AUTOCAD 14
File: xxx.dwg D02782

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione
0	FIRST EMISSION	25/01/01			

MATERIALE

FINITURA

ANSALDO

Ansaldo Ricerche s.r.l.

DAMPING RING TESLA

TRANSVERSAL KICKER STRIPLINE
– ø43 T15 –

Rev. 0

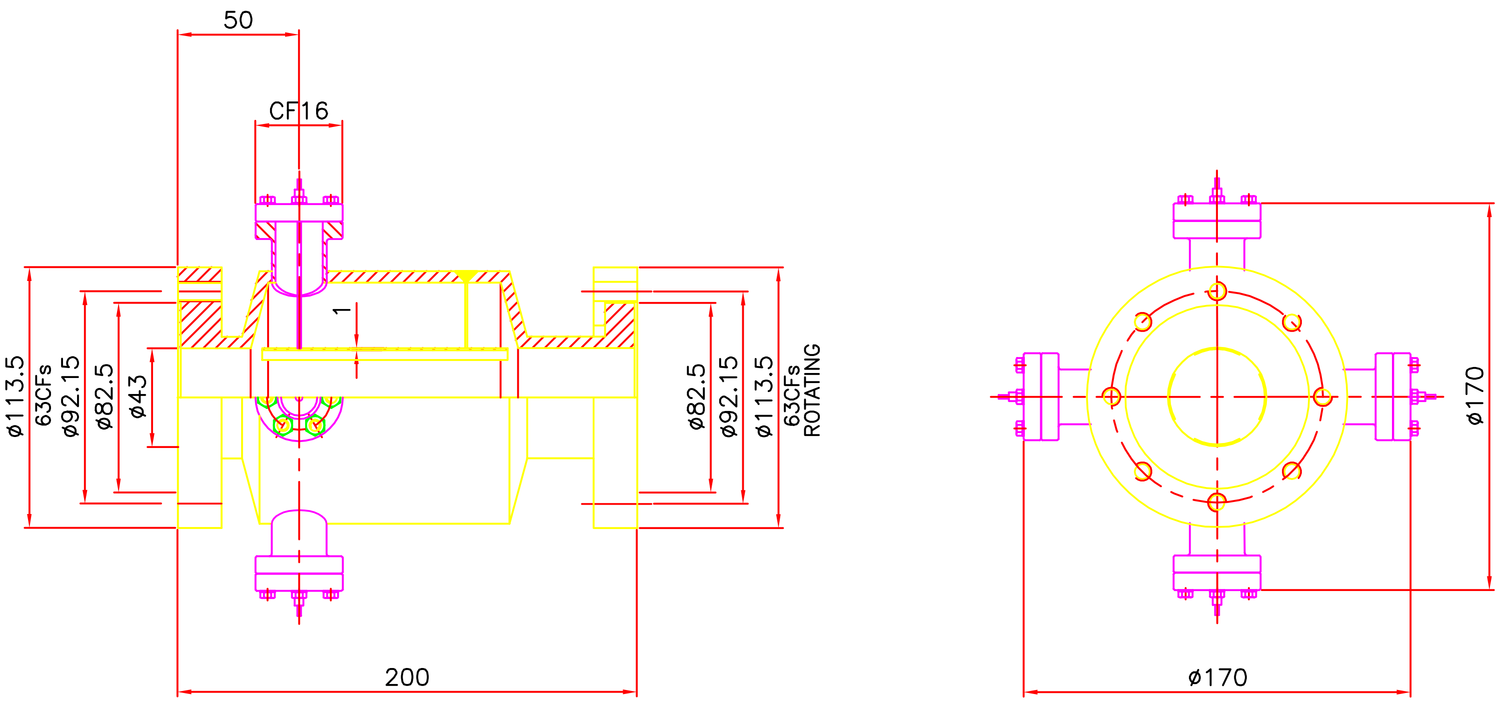
Scala

D02782UX3000L

Segue F. /

F. 1

Distribuzione



Data 25/01/01
Redatto
Controllo e Approvazione
Autorizzazione Emissione
Software AUTOCAD 14
File: xxx.dwg
D02783

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione
0	FIRST EMISSION	25/01/01			

MATERIALE

FINITURA

ANSALDO
Ansaldo RIcerche s.r.l.

DAMPING RING TESLA

TRASVERSAL KICKER STRIPLINE
– ø43 T16 –

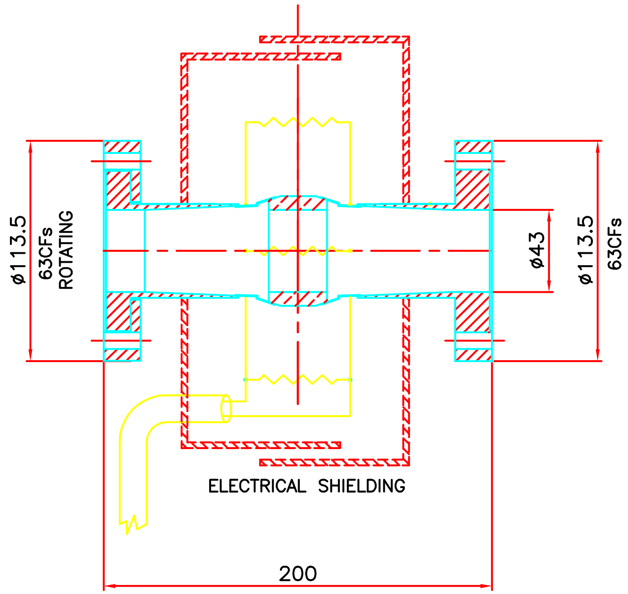
Rev. 0 | Scala

D02783UX3000L

Segue F. / F. 1

Distribuzione

ANSALDO
Ansaldo Ricerche s.r.l.



Data
25/01/01
Redatto
Controllo. e Approvazione
Autorizzazione Emissione
Software
AUTOCAD14
File: xxx.dwg
D02784

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo Approvaz.	Autorizz. Emissione
0	FIRST EMISSION	25/01/01			

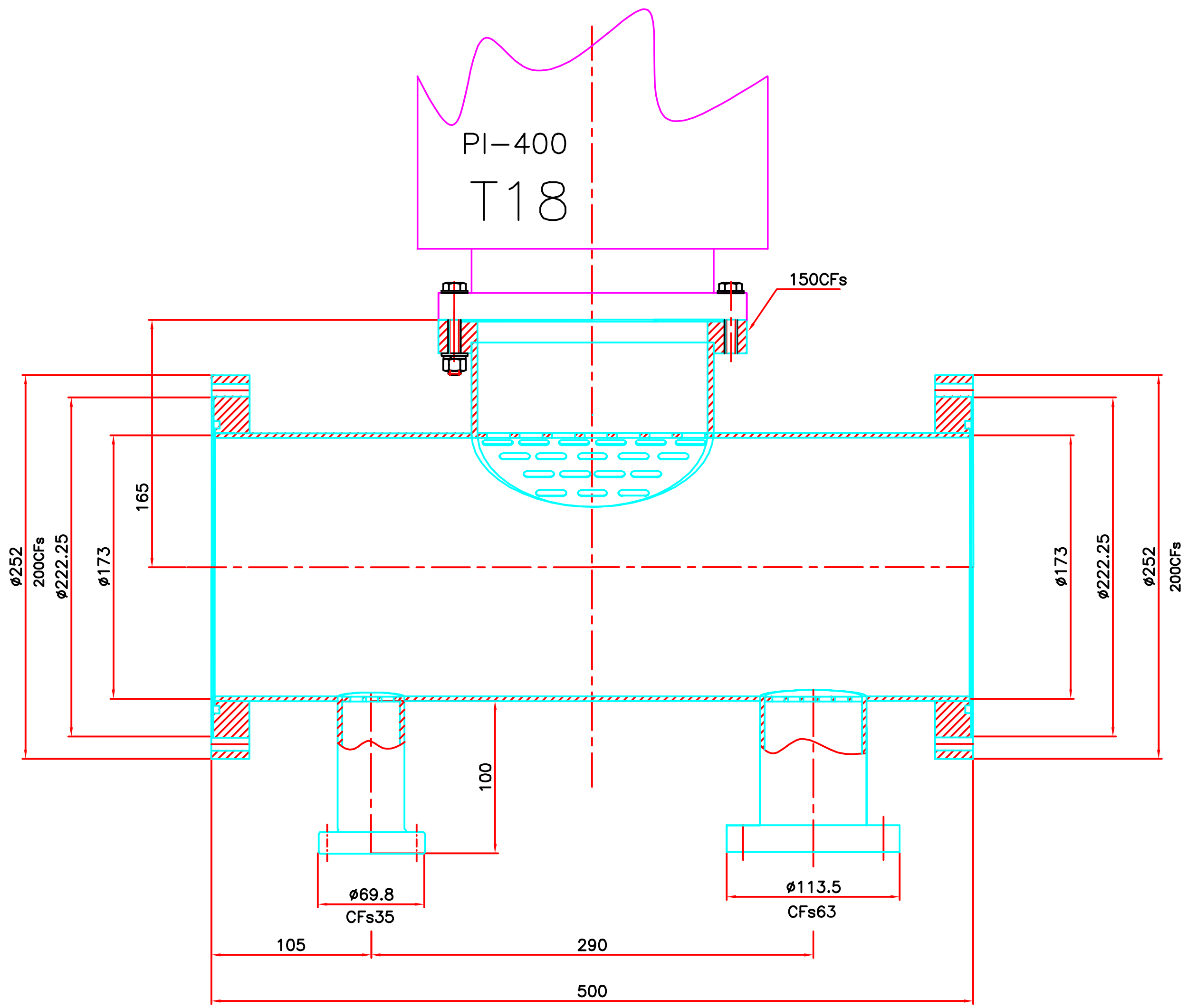
DAMPING RING TESLA

WALL CURRENT MONITOR
– T17 –

Rev. 0 Scala

D02784UX3000L

Segue F. / F. 1



Distribuzione

Data 25/01/01
Redatto
Controllo e Approvazione
Autorizzazione Emissione
Software AUTOCAD 14
File: xxx.dwg D02785

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione
0	FIRST EMISSION	25/01/01			

MATERIALE

FINITURA

ANSALDO
Ansaldo Ricerche s.r.l.

DAMPING RING TESLA

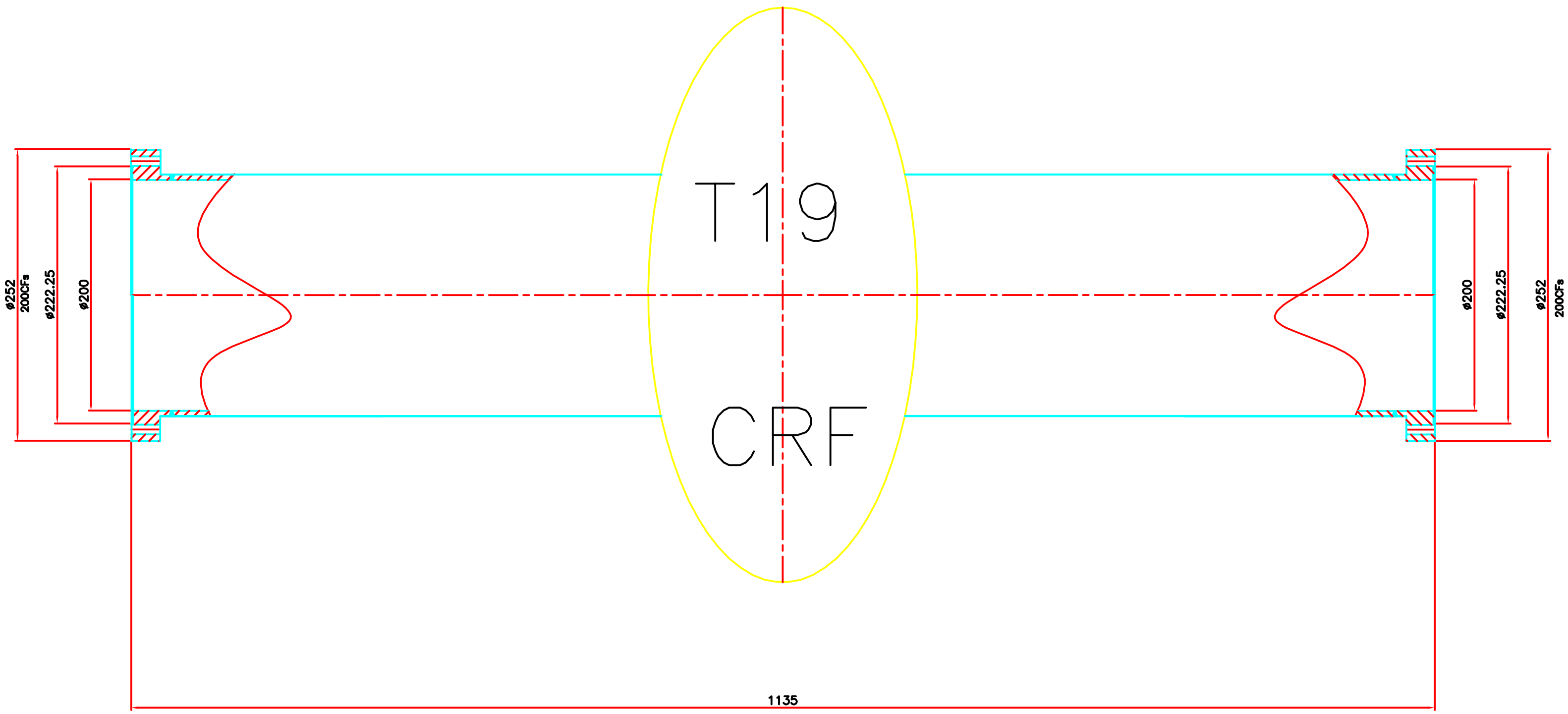
VACUUM PUMP CONNECTION
– RFø200 T18 –

Rev. 0 | Scala

D02785UX3000L

Segue F. 2 | F. 1

Distribuzione



Data
25/01/01
Redatto
Controllo e Approvazione
Autorizzazione Emissione
Software
AUTOCAD 14
File: xxx.dwg
D02786

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione
0	FIRST EMISSION	25/01/01			

MATERIALE

FINITURA

ANSALDO
Ansaldo Ricerche s.r.l.

DAMPING RING TESLA

RADIO FREQUENCY CAVITY
– RFø200 T19 –

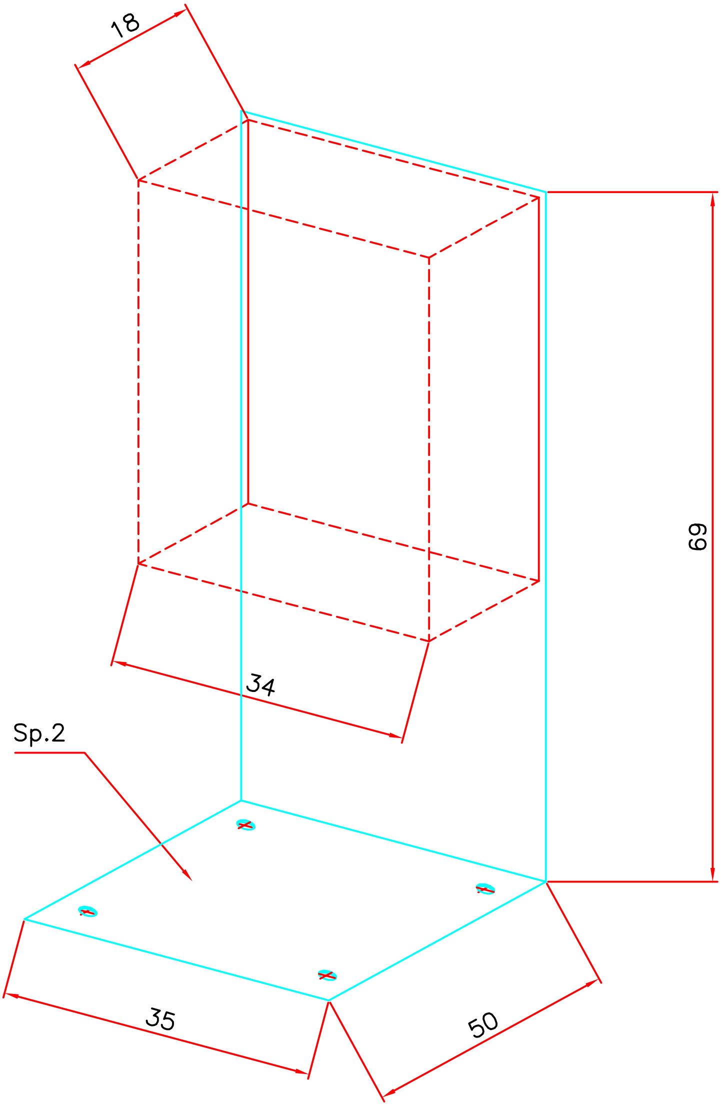
Rev. 0
Scala

D02786UX3000L

Segue F. /
F. 1

Distribuzione

ANSALDO
Ansaldo Ricerche s.r.l.



Data
25/01/01
Redatto

Controllo e Approvazione

Autorizzazione Emissione

Software
AUTOCAD14

File: xxx.dwg
D02787

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo Approvaz.	Autorizz. Emissione
0	FIRST EMISSION	25/01/01			

DAMPING RING TESLA

SUPPORT BEAM LOSS MONITOR
– T20 –

Rev. 0

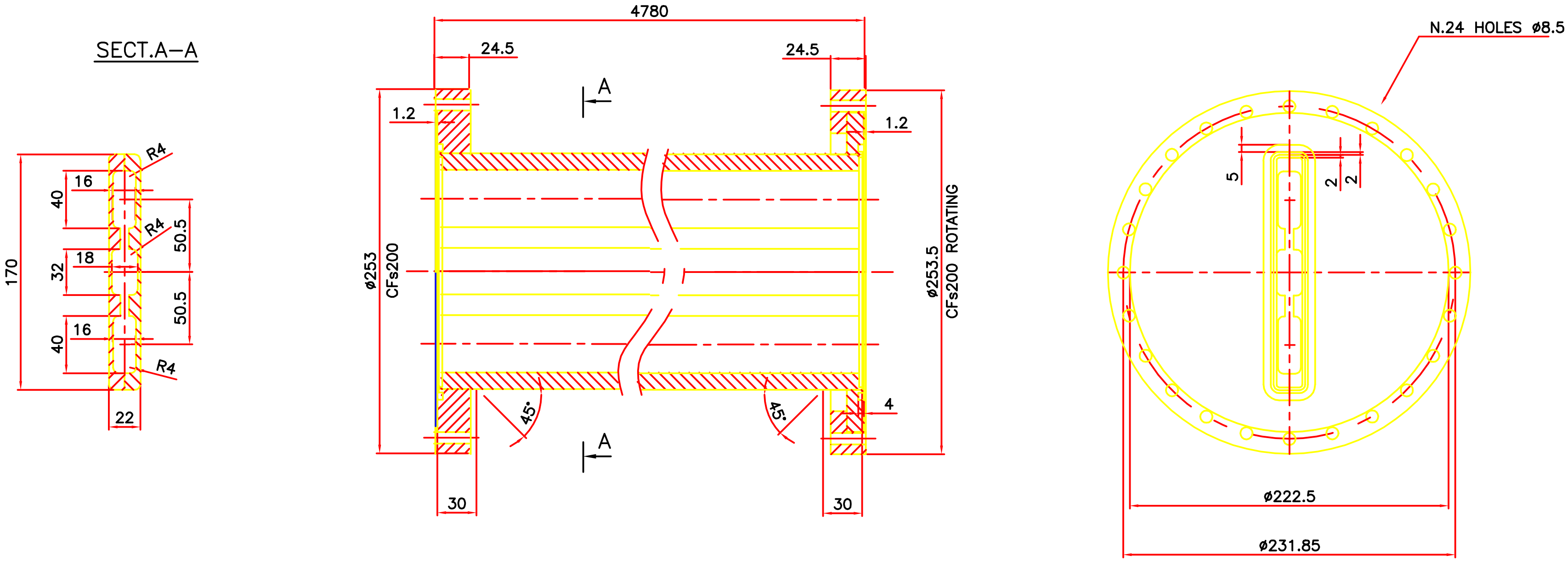
Scala

D02787UX3000L

Segue F. /

F. 1

Distribuzione



Data 25/01/01

Redatto

Controllo e Approvazione

Autorizzazione Emissione

Software AUTOCAD 14

File: xxx.dwg D02788

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768—

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione
0	FIRST EMISSION	25/01/01			

MATERIALE

FINITURA

ANSALDO

Ansaldo Ricerche s.r.l.

DAMPING RING TESLA

WIGGLER VACUUM CHAMBER

\- CVW -

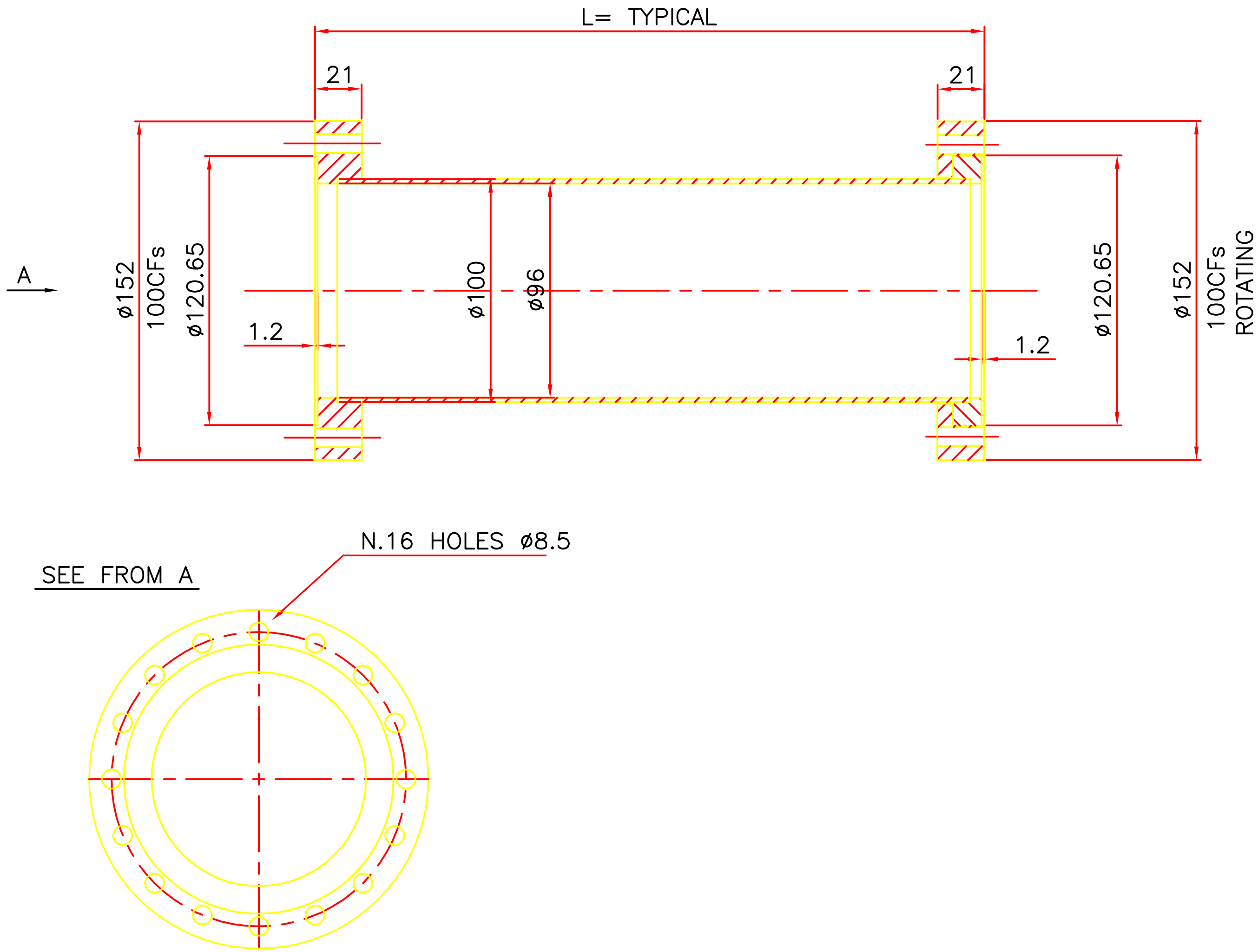
Rev. 0

Scala

D02788UX3000L

Segue F. /

F. 1



Distribuzione

Data 25/01/01
Redatto
Controllo e Approvazione
Autorizzazione Emissione
Software AUTOCAD 14
File: xxx.dwg D02789

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione
0	FIRST EMISSION	25/01/01			

MATERIALE

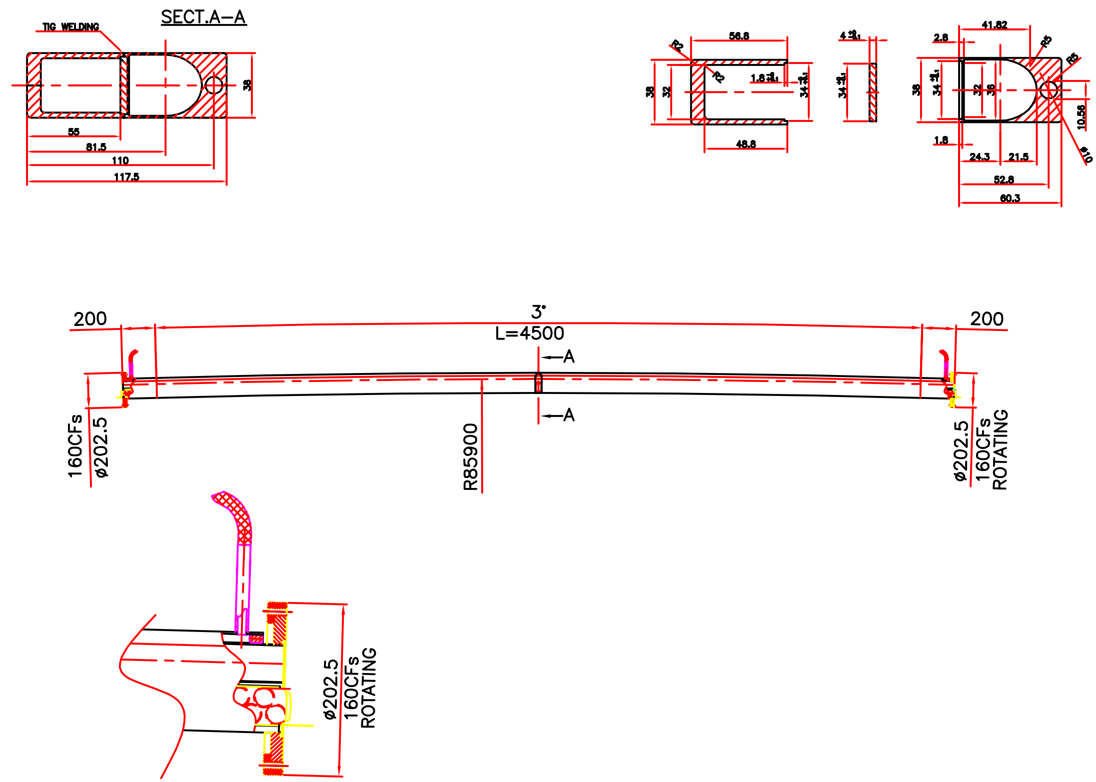
FINITURA

ANSALDO
Ansaldo Ricerche s.r.l.

DAMPING RING TESLA
LONG STRAIGHT SECTION VACUUM CHAMBER
– CV100 –

Rev. 0
Scala
D02789UX3000L
Segue F. /
F. 1

Distribuzione



Data 25/01/01

Redatto

Controllo e Approvazione

Autorizzazione Emissione

Software AUTOCAD 14

File: xxx.dwg D02790

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione
0	FIRST EMISSION	25/01/01			

MATERIALE

FINITURA

ANSALDO

Ansaldo Ricerche s.r.l.

DAMPING RING TESLA

DIPOLE VACUUM CHAMBER

– CVD –

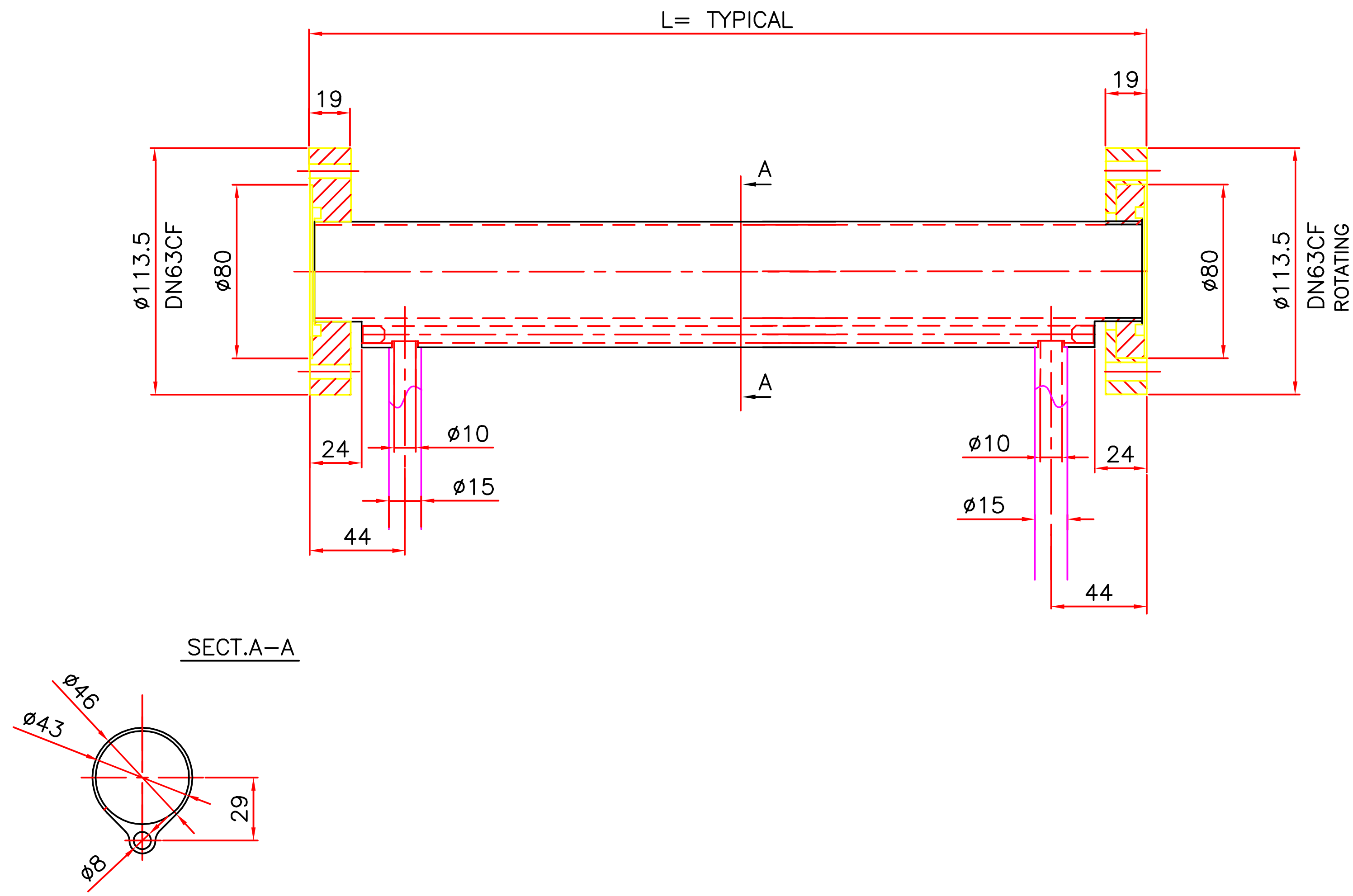
Rev. 0

Scala

D02790UX3000L

Segue F. /

F. 1



Distribuzione

Data 25/01/01

Redatto

Controllo e Approvazione

Autorizzazione Emissione

Software AUTOCAD 14

File: xxx.dwg D02791

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione
0	FIRST EMISSION	25/01/01			

MATERIALE

FINITURA

ANSALDO

Ansaldo Ricerche s.r.l.

DAMPING RING TESLA

QUADRUPOLE VACUUM CHAMBER

– CV43 –

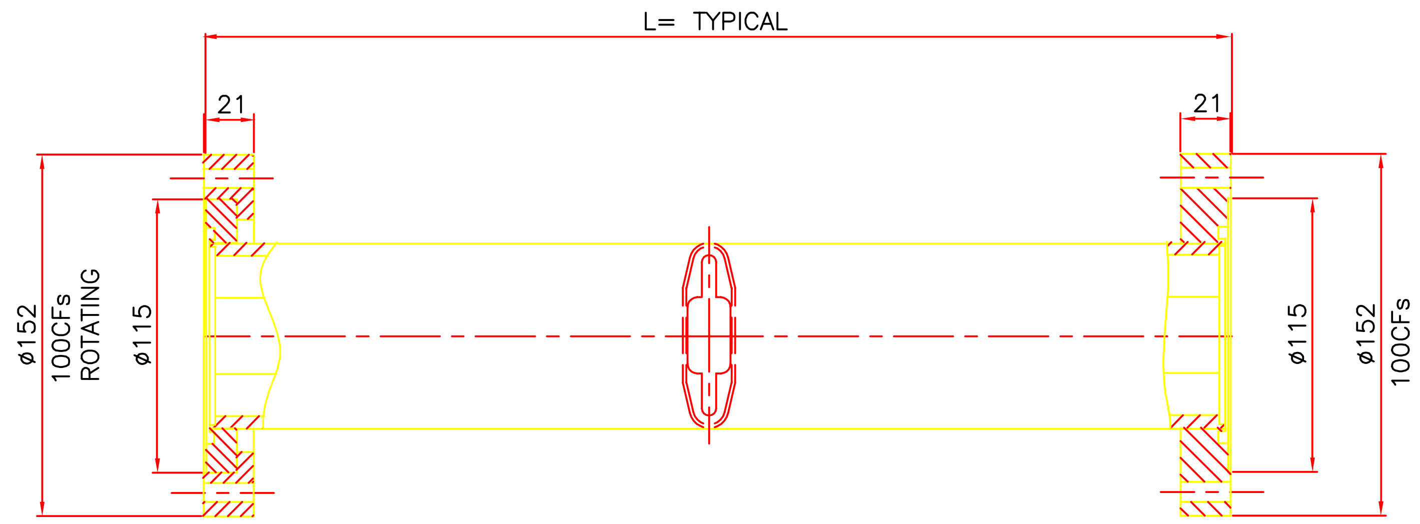
Rev. 0

Scala

D02791UX3000L

Segue F. /

F. 1



Distribuzione

Data 25/01/01
Redatto
Controllo e Approvazione
Autorizzazione Emissione
Software AUTOCAD 14
File: xxx.dwg D02792

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione
0	FIRST EMISSION	25/01/01			

MATERIALE

FINITURA

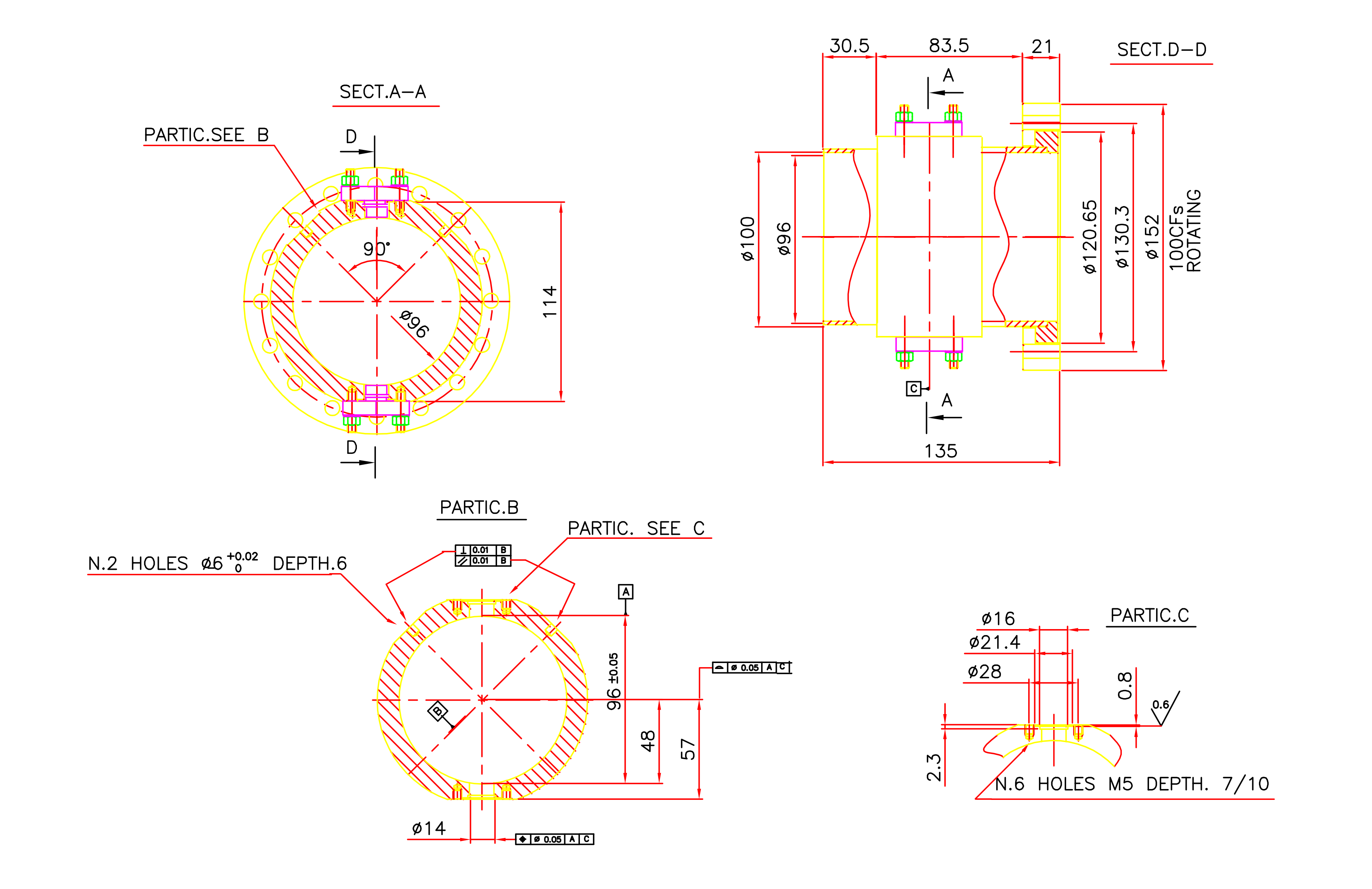
ANSALDO
Ansaldo Ricerche s.r.l.

DAMPING RING TESLA
WIGGLER SECTION
QUADRUPOLE VACUUM CHAMBER
– CW80 –

Rev. 0
Scala

D02792UX3000L

Segue F. /
F. 1



Distribuzione

Data 25/01/01

Redatto

Controllo e Approvazione

Autorizzazione Emissione

Software AUTOCAD 14

File: xxx.dwg D02793

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione	MATERIALE
0	FIRST EMISSION	25/01/01				
						FINITURA

ANSALDO

Ansaldo Ricerche s.r.l.

DAMPING RING TESLA

BEAM POSITION MONITOR

– CV100/6-2 –

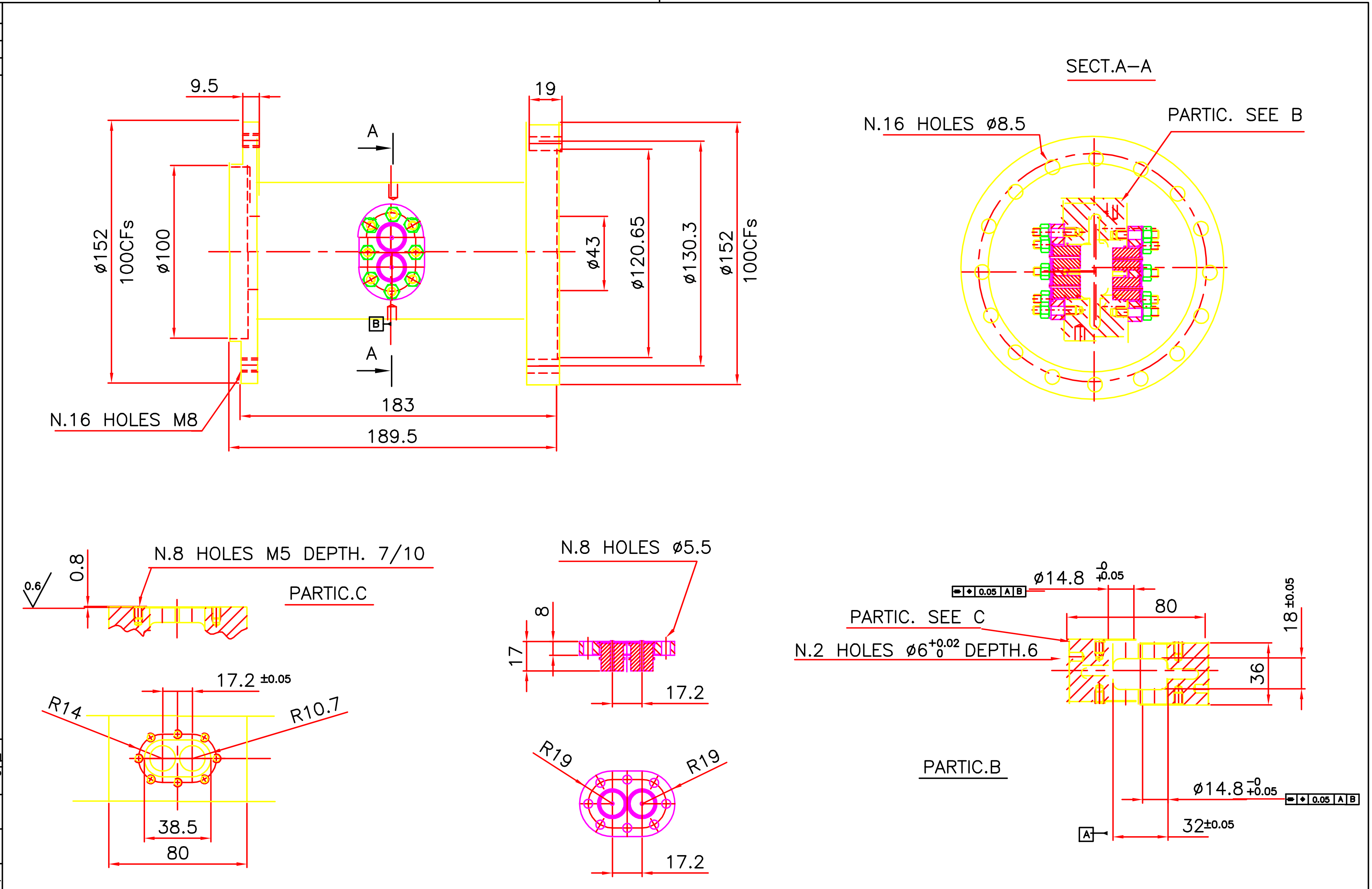
Rev. 0

Scala

D02793UX3000L

Segue F. /

F. 1



Distribuzione

Data 25/01/01

Redatto

Controllo e Approvazione

Autorizzazione Emissione

Software AUTOCAD 14

File: xxx.dwg D02794

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione
0	FIRST EMISSION	25/01/01			

MATERIALE

FINITURA

ANSALDO
Ansaldo Ricerche s.r.l.

DAMPING RING TESLA

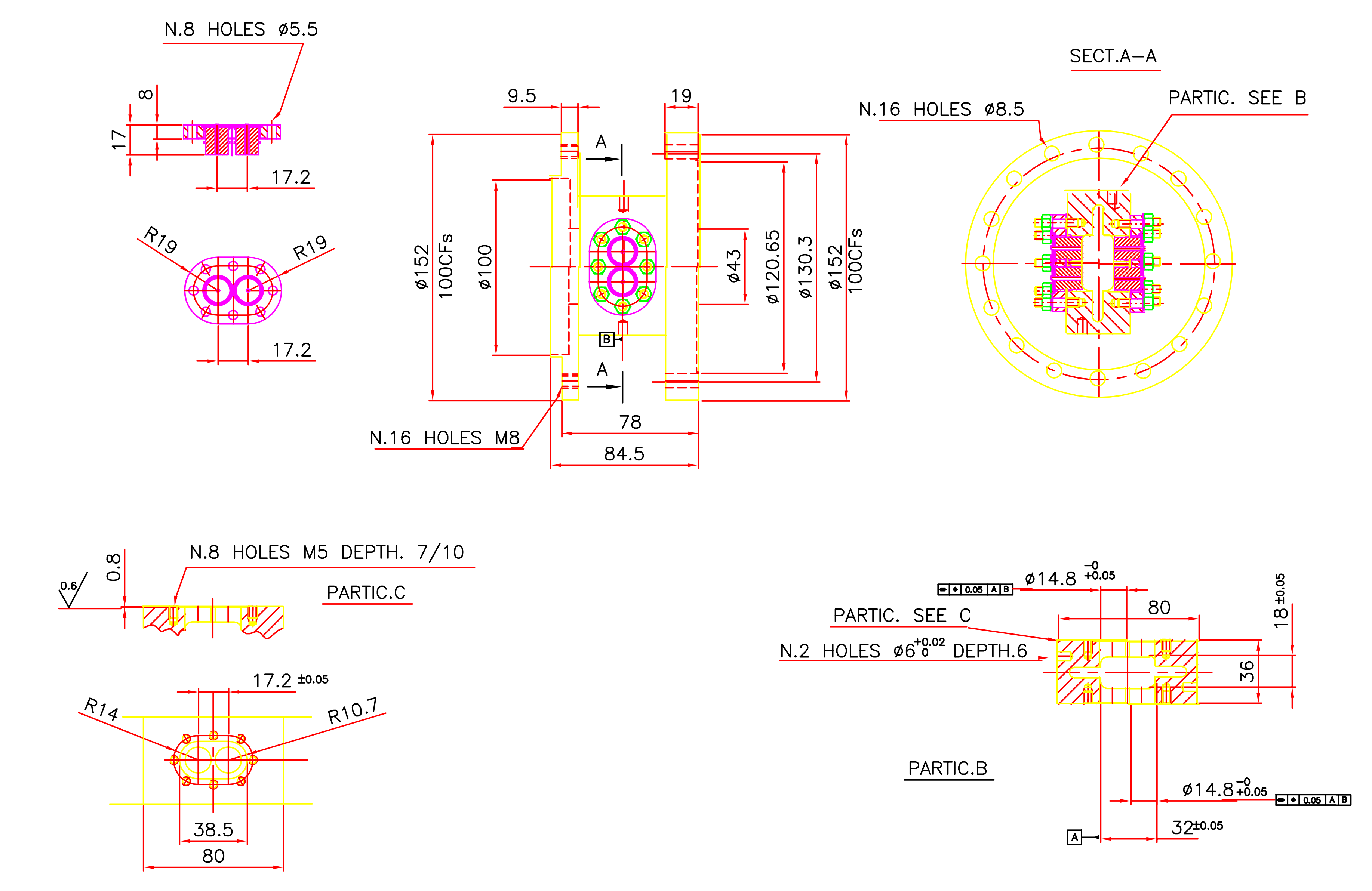
BEAM POSITION MONITOR
– CW80/5 –

Rev. 0

Scala

D02794UX3000L

Segue F. /   F. 1



Distribuzione

L'ANSALDO SI RISERVA A TERMINE DI LEGGE LA PROPRIETA' DI QUESTO DOCUMENTO CON DIVIETO DI RIPRODURLO O DI RENDERLO COMUNQUE NOTO A TERZI O A DITTE CONCORRENTI SENZA LA SUA AUTORIZZAZIONE

Data 25/01/01
Redatto
Controllo e Approvazione
Autorizzazione Emissione
Software AUTOCAD 14
File: xxx.dwg D02795

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione
0	FIRST EMISSION	25/01/01			

MATERIALE

FINITURA

ANSALDO
Ansaldo Ricerche s.r.l.

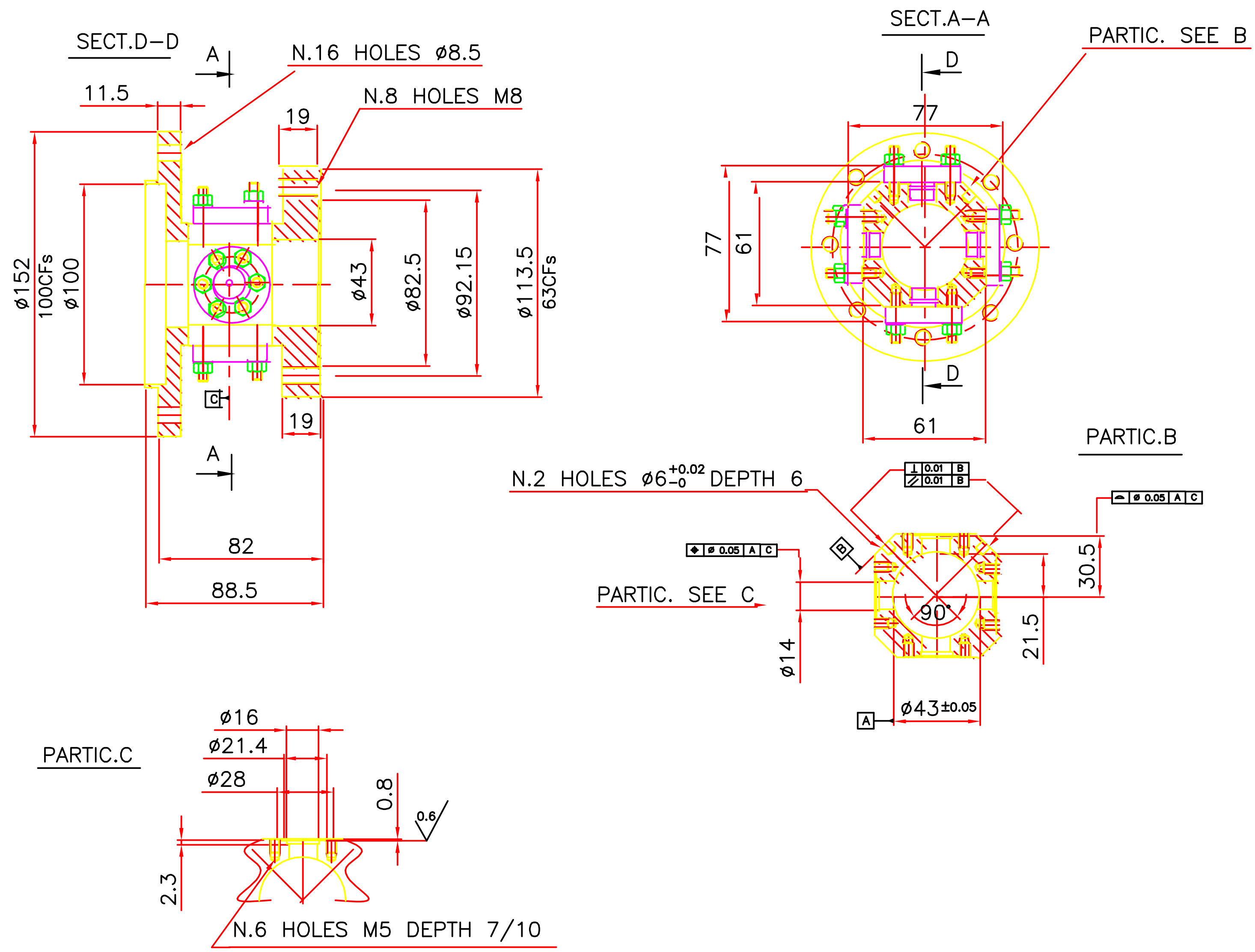
DAMPING RING TESLA

BEAM POSITION MONITOR
– CW80/4 –

Rev. 0 | Scala

D02795UX3000L

Segue F. / F. 1



Distribuzione

Data 25/01/01
Redatto
Controllo e Approvazione
Autorizzazione Emissione
Software AUTOCAD 14
File: xxx.dwg D02796

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione
0	FIRST EMISSION	25/01/01			

MATERIALE

FINITURA

ANSALDO
Ansaldo Ricerche s.r.l.

DAMPING RING TESLA

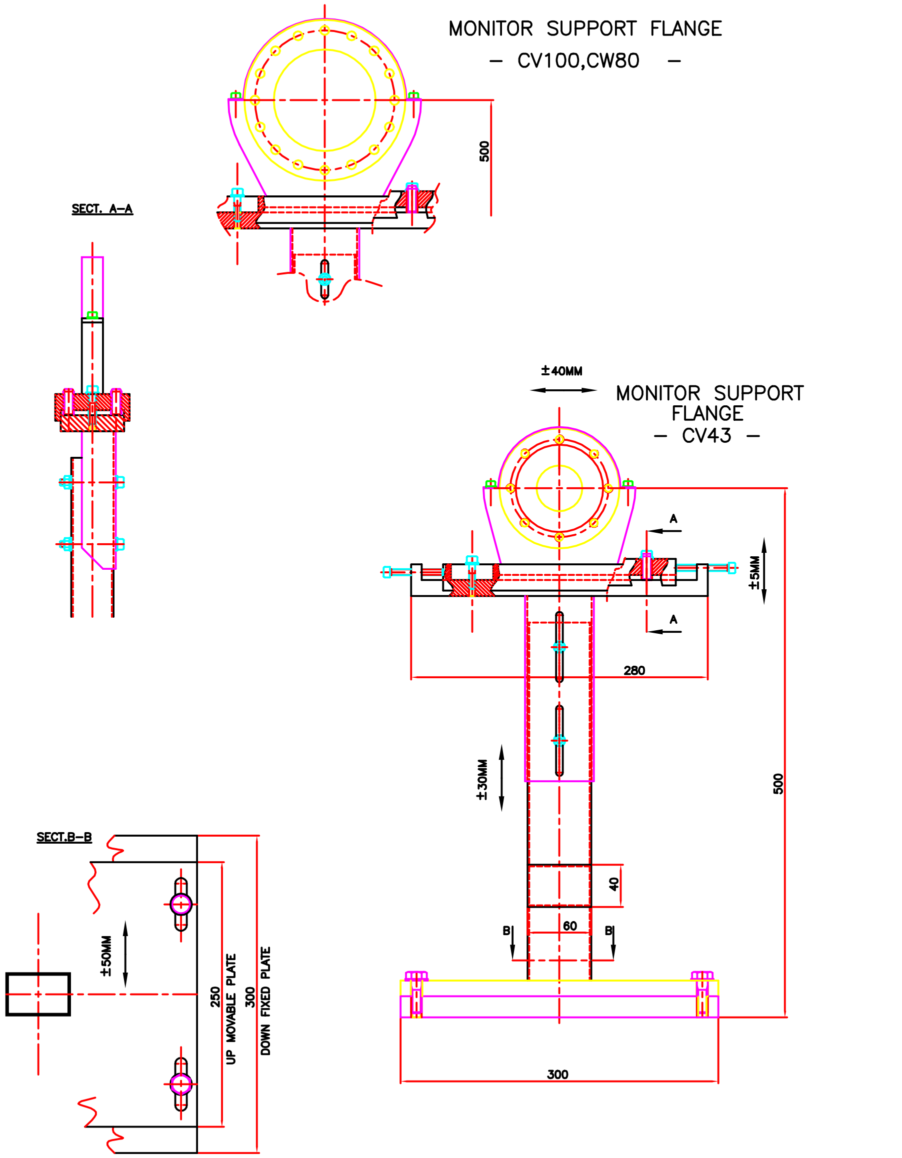
BEAM POSITION MONITOR
- CV43/1-3 -

Rev. 0 | Scala

D02796UX3000L

Segue F. / F. 1

Distribuzione



Data

Redatto

Controllo, e Approvazione

Autorizzazione Emissione

Software
AUTOCAD14

File: xxx.dwg
D02797

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo Approvaz.	Autorizz. Emissione
0	FIRST EMISSION	25/01/01			

DAMPING RING TESLA

B.P.M. SUPPORT
– CV43,CV100,CW80 –

Rev. 0

Scala

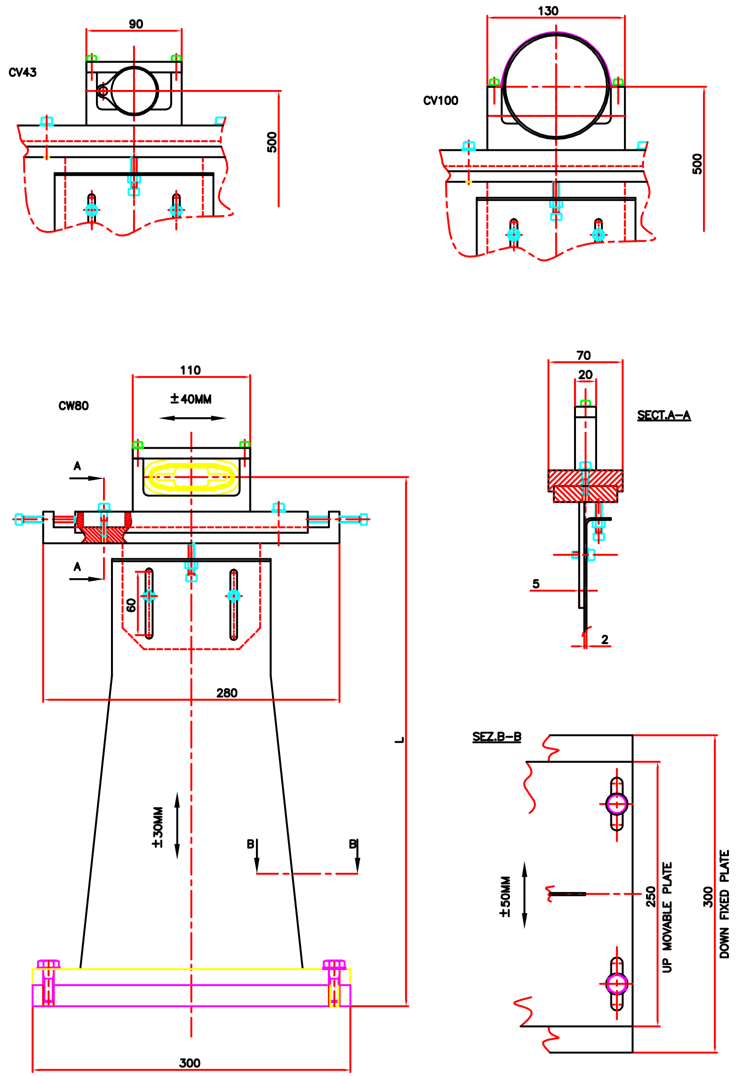
D02797UX3000L

Segue F. /

F. 1

Distribuzione

ANSALDO
Ansaldo Ricerche s.r.l.



Data

Redatto

Controllo e Approvazione

Autorizzazione Emissione

Software
AUTOCAD14

File: xxx.dwg
D02798

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo Approvaz.	Autorizz. Emissione
0	FIRST EMISSION	25/01/01			

DAMPING RING TESLA

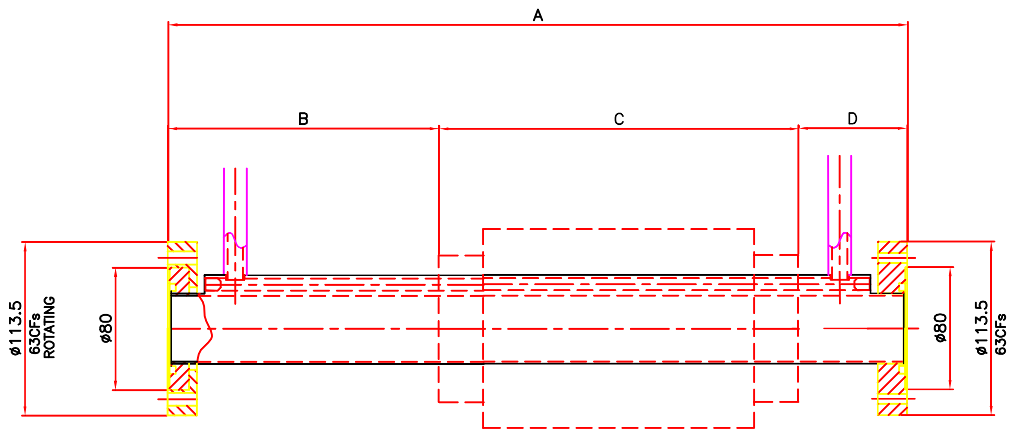
VACUUM CHAMBER SUPPORT
– CV43,CV100,CW80 –

Rev. 0 Scala

D02798UX3000L

Segue F. / F. 1

S2PB	A=402	B= 96	C=235	D=71
S1P	A=455	B= 61	C=335	D=60
S2PA	A=578	B= 83	C=435	D=60
S2PC	A=600	B= 82	C=435	D=83



Distribuzione

Data 25/01/01
Redatto
Controllo e Approvazione
Autorizzazione Emissione
Software AUTOCAD 14
File: xxx.dwg D02799

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione
0	FIRST EMISSION	25/01/01			

MATERIALE

FINITURA

ANSALDO
Ansaldo Ricerche s.r.l.

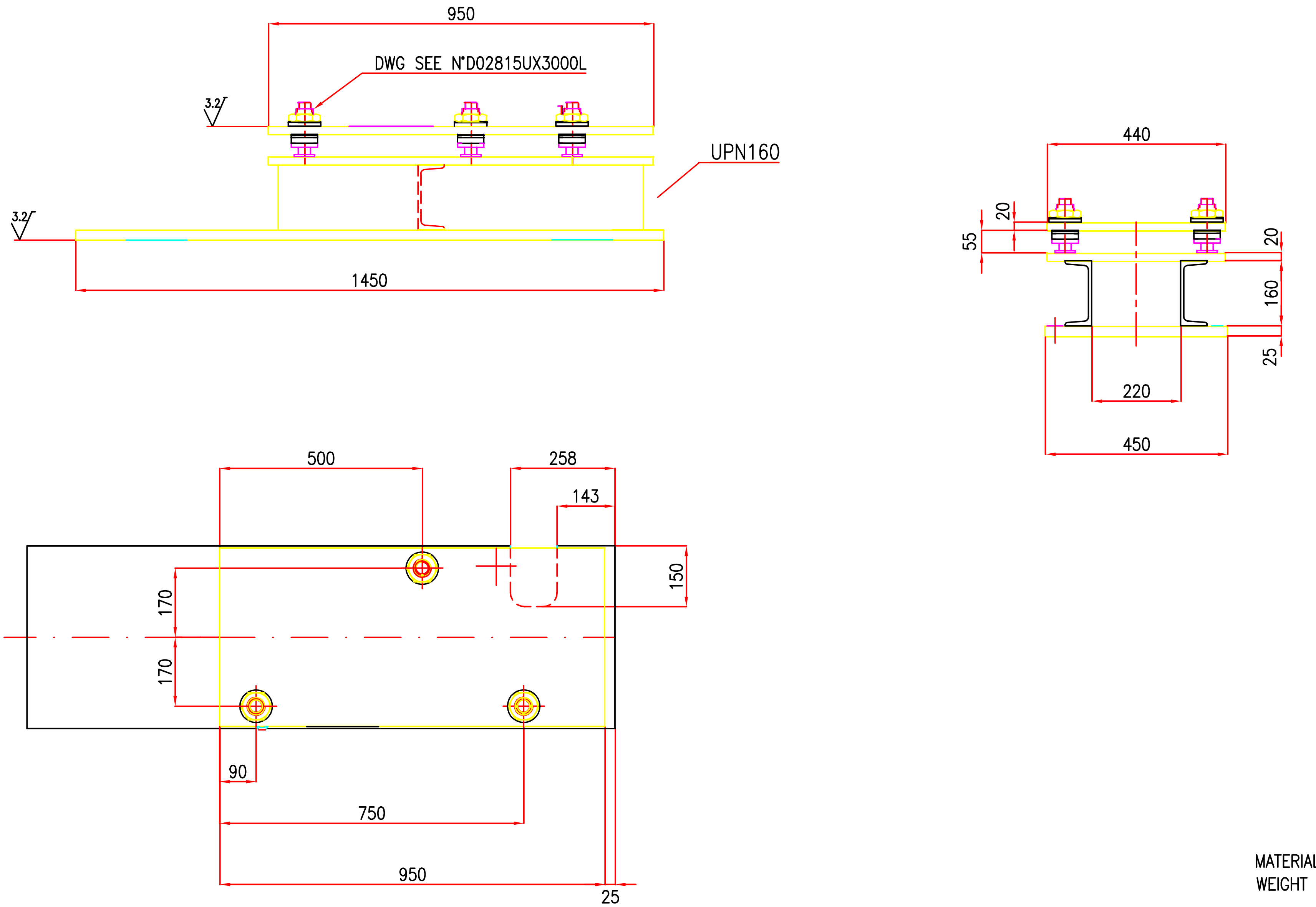
DAMPING RING TESLA
SEXTUPOLE VACUUM CHAMBER
– Sxxx CVW –

Rev. 0 | Scala

D02799UX3000L

Segue F. / F. 1

Distribuzione



MATERIAL FE430
WEIGHT KG.330

Data 25/01/01						
Redatto						
Controllo e Approvazione						
Autorizzazione Emissione						
Software AUTOCAD 14						
File: xxx.dwg D02808/1	Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–					
REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione	MATERIALE
0	FIRST EMISSION	25/01/01				
						FINITURA

ANSALDO
Ansaldo Ricerche s.r.l.

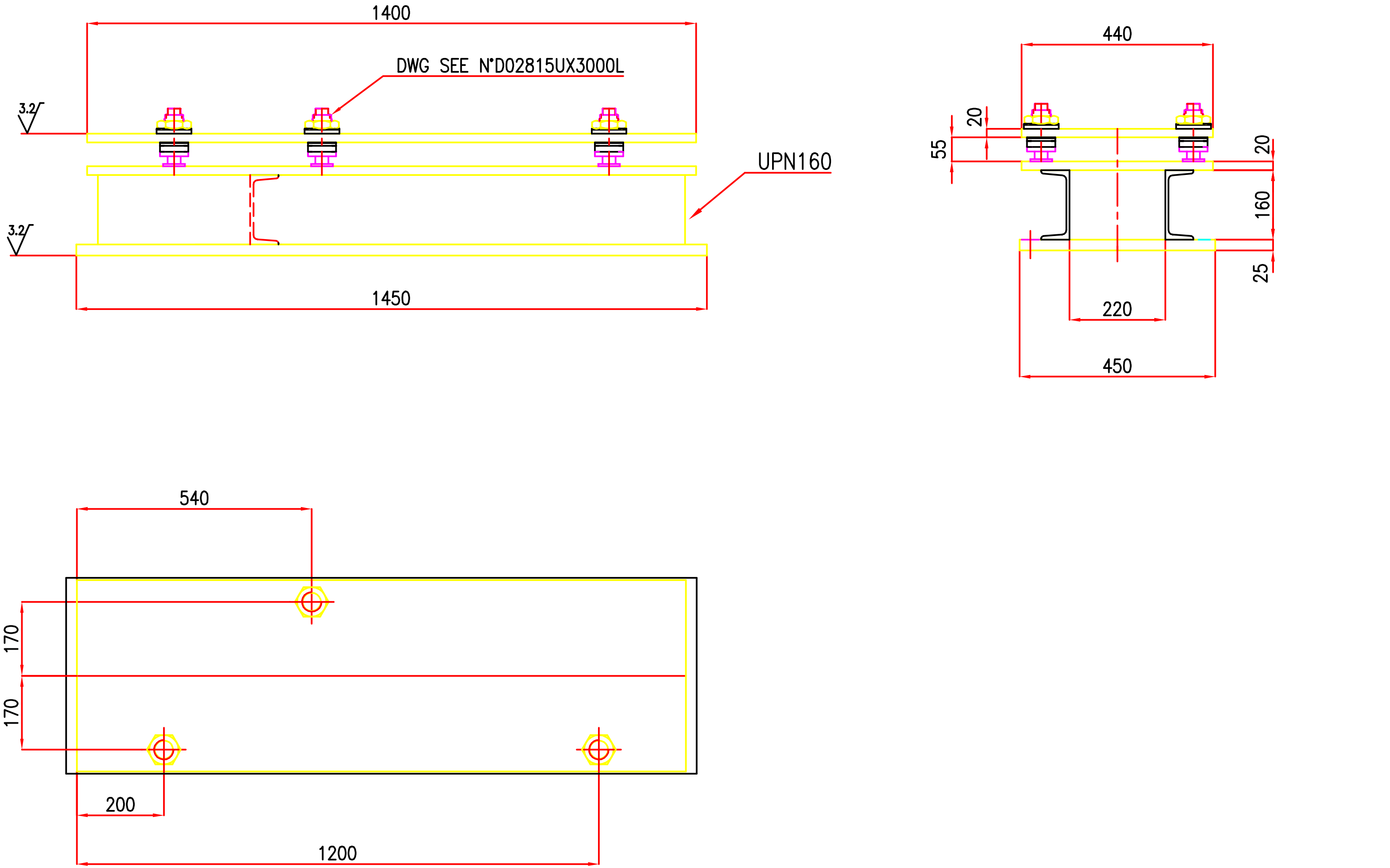
DAMPING RING TESLA

WIGGLER LINE
QUADRUPOLE QDW, QFW SUPPORT

Rev. 0	Scala
D02808UX3000L	
Segue F. 2	F. 1

Distribuzione

L'ANSALDO SI RISERVA A TERMINE DI LEGGE LA PROPRIETA' DI QUESTO DOCUMENTO
CON DIVIETO DI RIPRODURLO O DI RENDERLO COMUNQUE NOTO A TERZI O A DITTE CONCORRENTI SENZA LA SUA AUTORIZZAZIONE



MATERIAL FE430
WEIGHT KG.380

Data	25/01/01
Redatto	
Controllo e Approvazione	
Autorizzazione Emissione	
Software	AUTOCAD 14
File: xxx.dwg	D02808/2

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione
0	FIRST EMISSION	25/01/01			

MATERIALE

FINITURA

ANSALDO
Ansaldo Ricerche s.r.l.

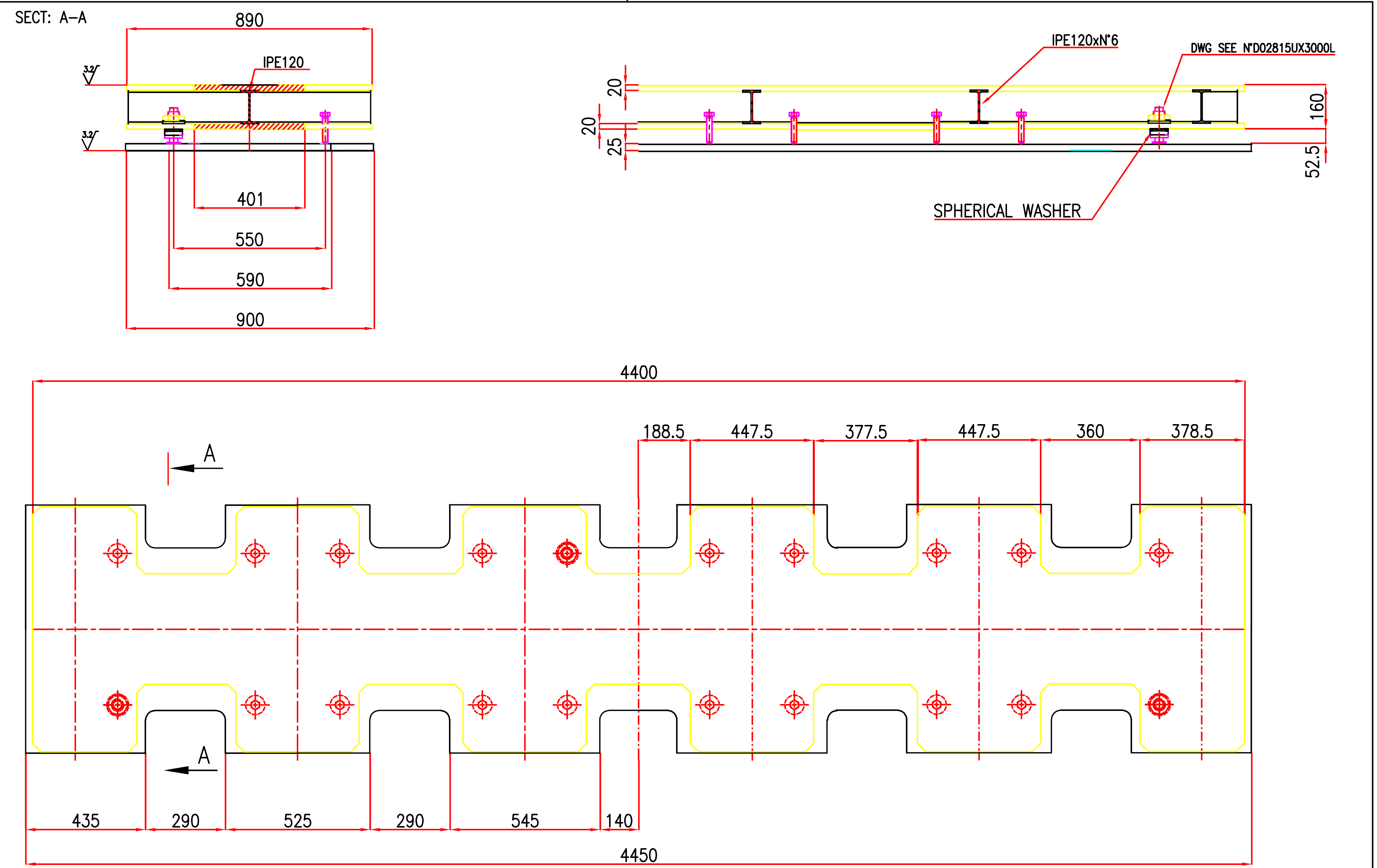
DAMPING RING TESLA

STRAIGHT LINE
QUADRUPOLE QLF, QLD SUPPORT

Rev. 0 | Scala

D02808UX3000L

Segue F. / F. 2



MATERIAL FE430
WEIGHT KG.1670

Distribuzione

Data 25/01/01
Redatto
Controllo e Approvazione
Autorizzazione Emissione
Software AUTOCAD 14
File: xxx.dwg D02809

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione
0	FIRST EMISSION	25/01/01			

MATERIALE

FINITURA

ANSALDO
Ansaldo Ricerche s.r.l.

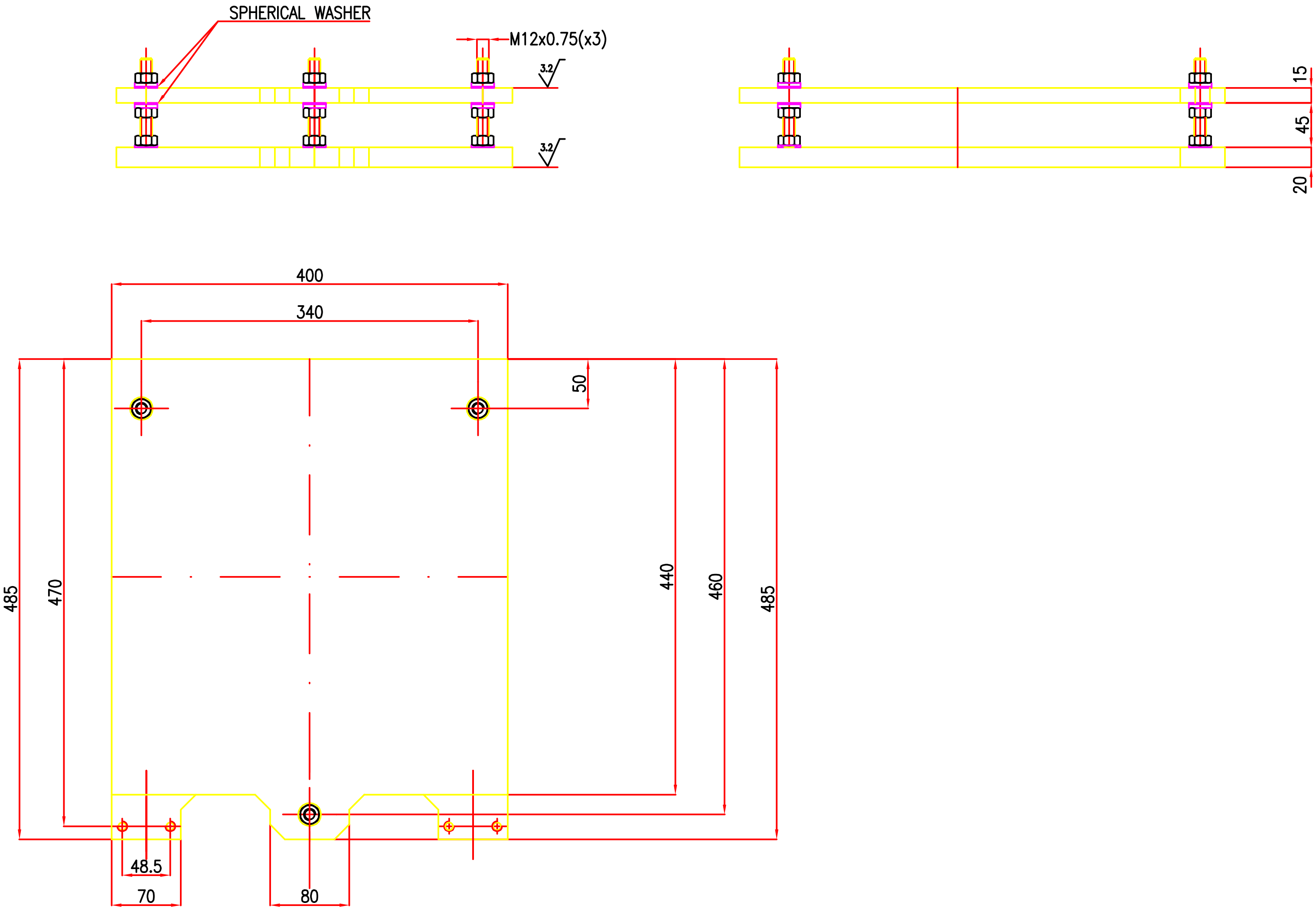
DAMPING RING TESLA

WIGGLER LINE
WIGGLER SUPPORT

Rev. 0 | Scala

D02809UX3000L

Segue F. / F. 1



MATERIAL FE430
WEIGHT KG.50

Distribuzione

Data 25/01/01
Redatto
Controllo e Approvazione
Autorizzazione Emissione
Software AUTOCAD 14
File: xxx.dwg D02810

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione
0	FIRST EMISSION	25/01/01			

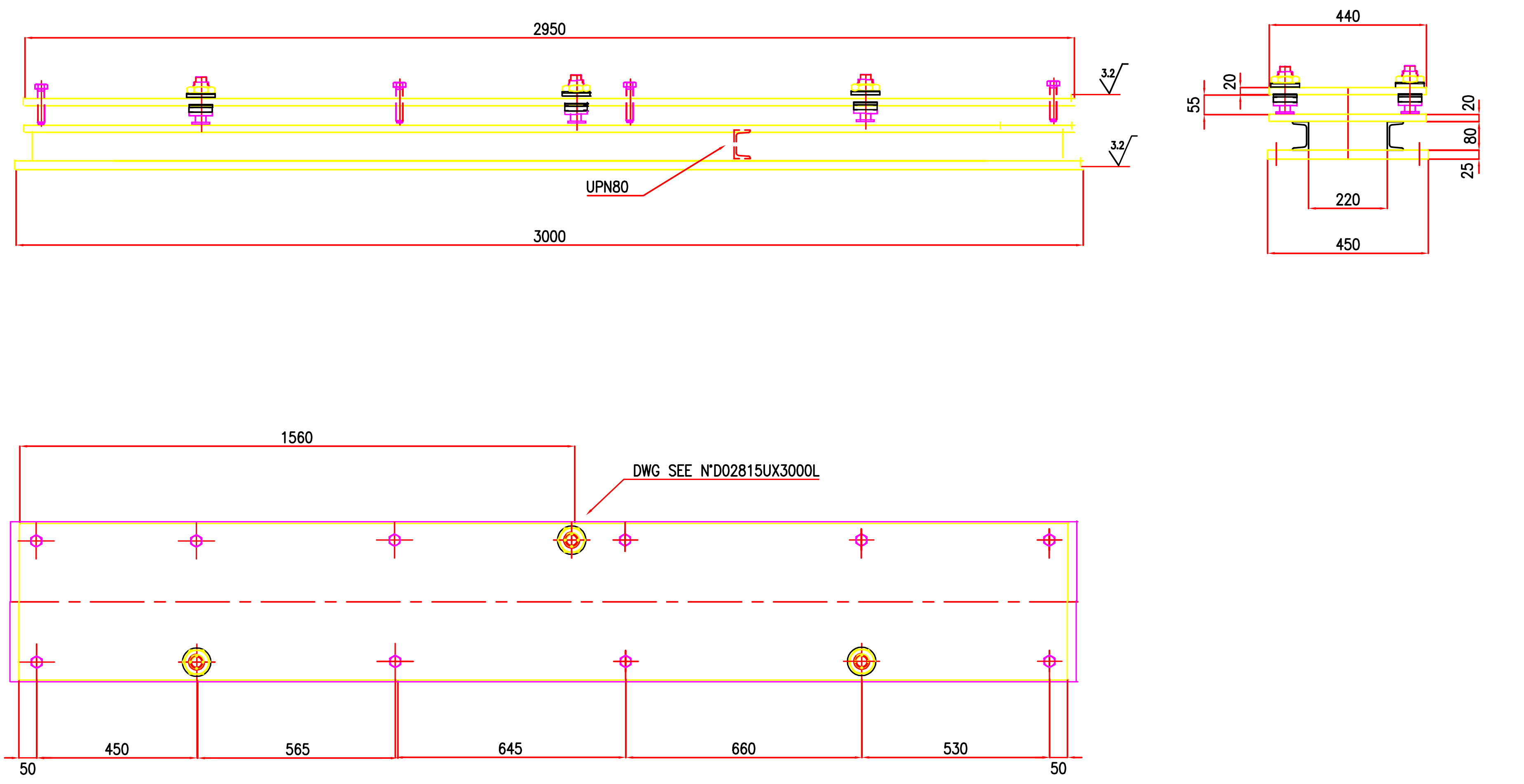
MATERIALE

FINITURA

ANSALDO
Ansaldo Ricerche s.r.l.

DAMPING RING TESLA
ARC PCEL LINE
QUADRUPOLE, SEXTUPOLE
UPPER SUPPORT

Rev. 0
Scala
D02810UX3000L
Segue F. /
F. 1



MATERIAL FE430
WEIGHT KG.710

Distribuzione	
Data	25/01/01
Redatto	
Controllo e Approvazione	
Autorizzazione Emissione	
Software	AUTOCAD 14
File: xxx.dwg	D02811

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione
0	FIRST EMISSION	25/01/01			

MATERIALE

FINITURA

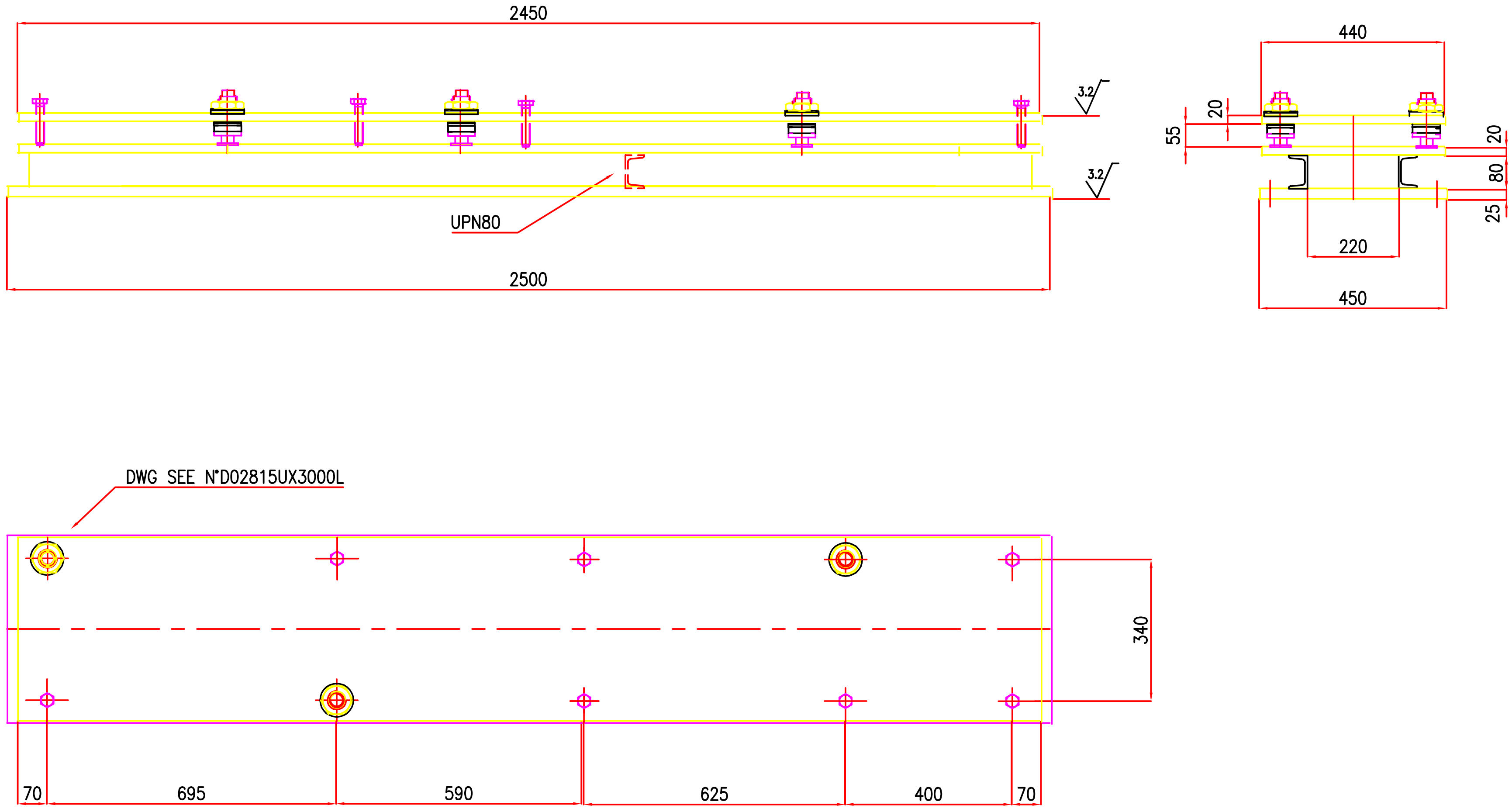
ANSALDO
Ansaldo Ricerche s.r.l.

DAMPING RING TESLA

ARC PCEL LINE
QUADRUPOLE, SEXTUPOLE
LEFT-HAND SIDE LOWER SUPPORT

Rev. 0	Scala
D02811UX3000L	
Segue F. /	F. 1

Distribuzione



MATERIAL FE430
WEIGHT KG.600

Data 25/01/01
Redatto
Controllo e Approvazione
Autorizzazione Emissione
Software AUTOCAD 14
File: xxx.dwg D02812

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione
0	FIRST EMISSION	25/01/01			

MATERIALE

FINITURA

ANSALDO
Ansaldo Ricerche s.r.l.

DAMPING RING TESLA

ARC PCEL LINE
QUADRUPOLE, SEXTUPOLE
RIGHT-HAND SIDE LOWER SUPPORT

Rev. 0

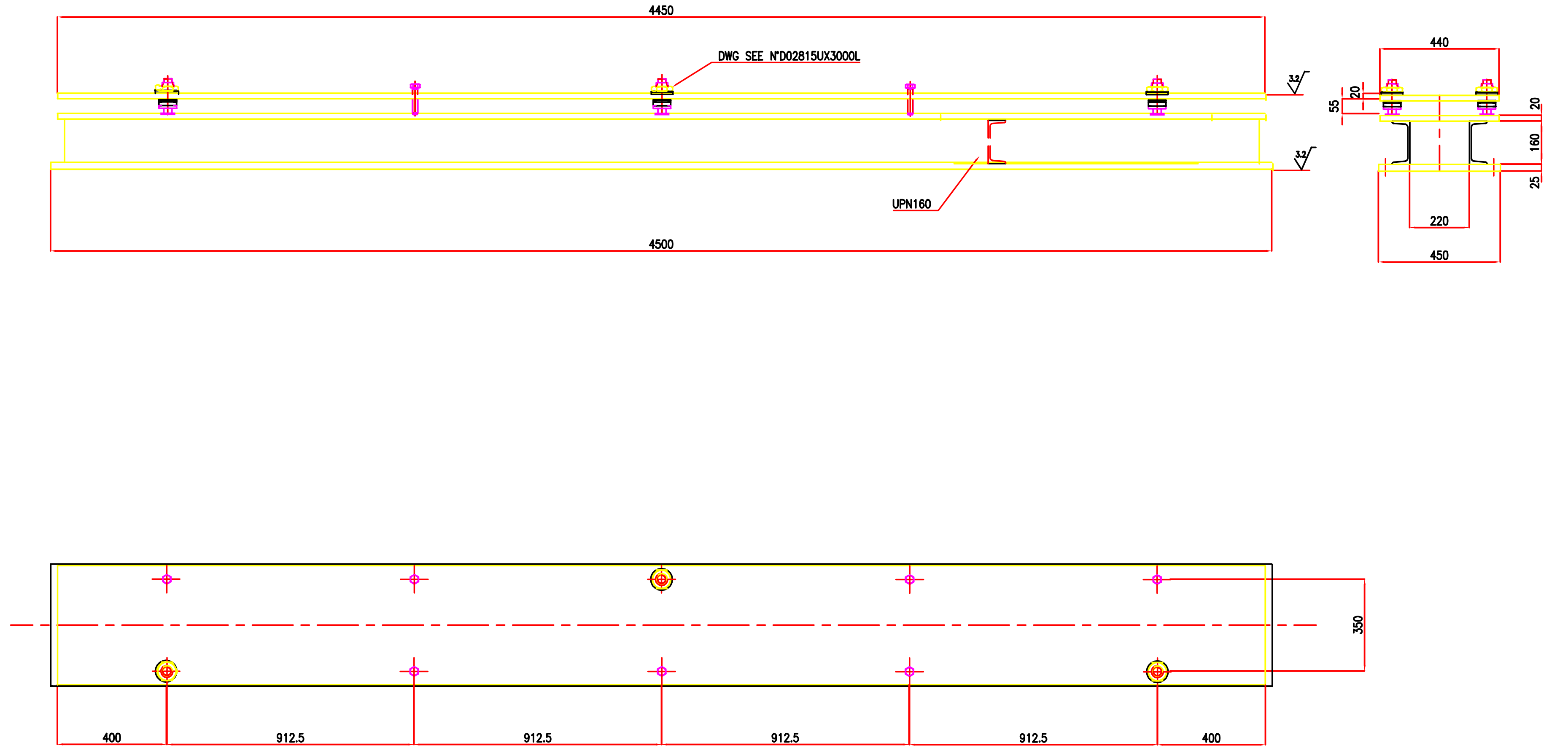
Scala

D02812UX3000L

Segue F. /

F. 1

Distribuzione



MATERIAL FE430
WEIGHT KG.1160

Data	25/01/01
Redatto	
Controllo e Approvazione	
Autorizzazione Emissione	
Software	AUTOCAD 14
File: xxx.dwg	D02813

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione
0	FIRST EMISSION	25/01/01			

MATERIALE

FINITURA

ANSALDO
Ansaldo Ricerche s.r.l.

DAMPING RING TESLA

ARC PCEL LINE

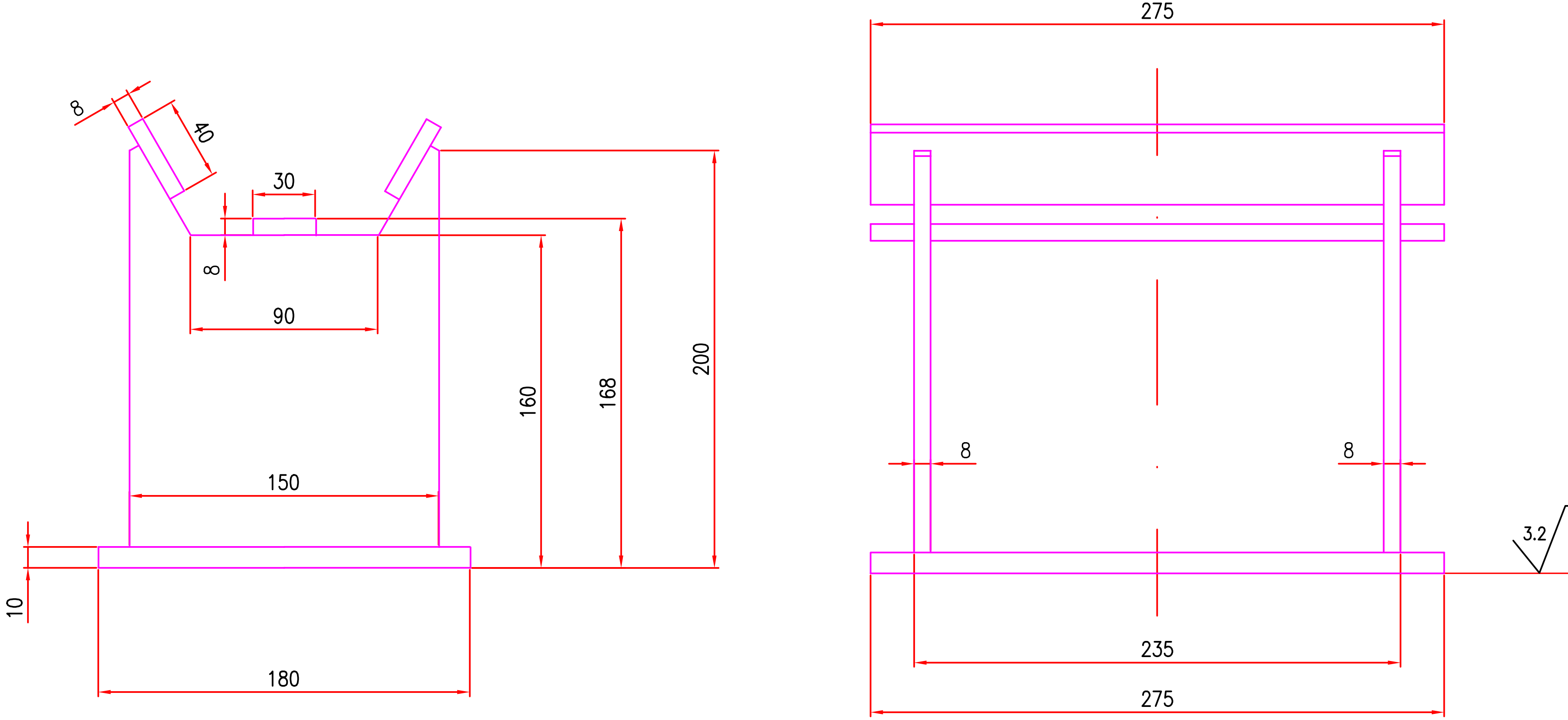
DIPOLE SUPPORT

Rev. 0 | Scala

D02813UX3000L

Segue F. / F. 1

L'ANSALDO SI RISERVA A TERMINE DI LEGGE LA PROPRIETA' DI QUESTO DOCUMENTO CON DIVIETO DI RIPRODURLO O DI RENDERLO COMUNQUE NOTO A TERZI O A DITTE CONCORRENTI SENZA LA SUA AUTORIZZAZIONE

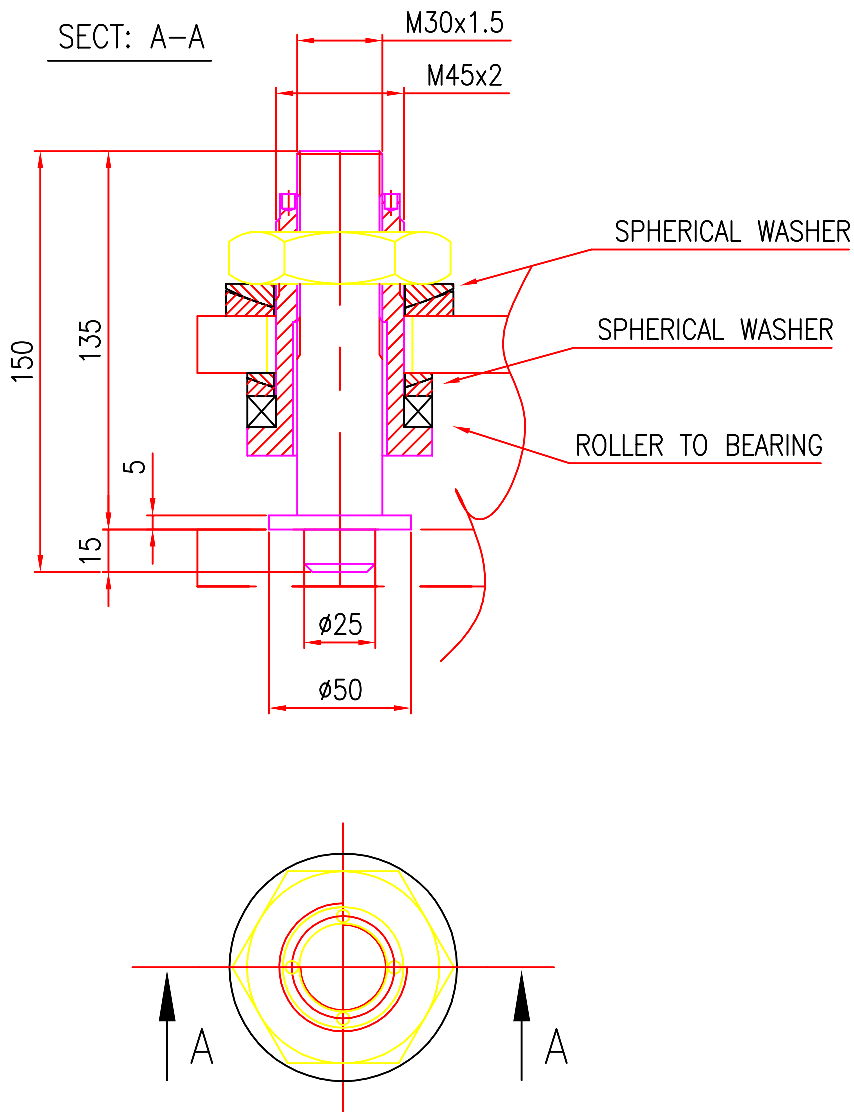


MATERIAL AL
WEIGHT KG.2.5

Distribuzione					
Data 25/01/01					
Redatto					
Controllo e Approvazione					
Autorizzazione Emissione					
Software AUTOCAD 14					
File: xxx.dwg D02814	Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–		ANSALDO Ansaldo Ricerche s.r.l.	DAMPING RING TESLA	Rev. 0 / Scala
REV.	DESCRIZIONE	Data / Redatto / Controllo approv. / Autorizzazione emissione	MATERIALE	ARC PCEL LINE SEXTUPOLE SUPPORT	D02814UX3000L
0	FIRST EMISSION	25/01/01	FINITURA		Segue F. / F. 1

Distribuzione

ANSALDO
Ansaldo Ricerche s.r.l.



Data 25/01/01
Redatto
Controllo e Approvazione
Autorizzazione Emissione
Software AUTOCAD14
File: xxx.dwg D02815

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo Approvaz.	Autorizz. Emissione
0	FIRST EMISSION	25/01/01			

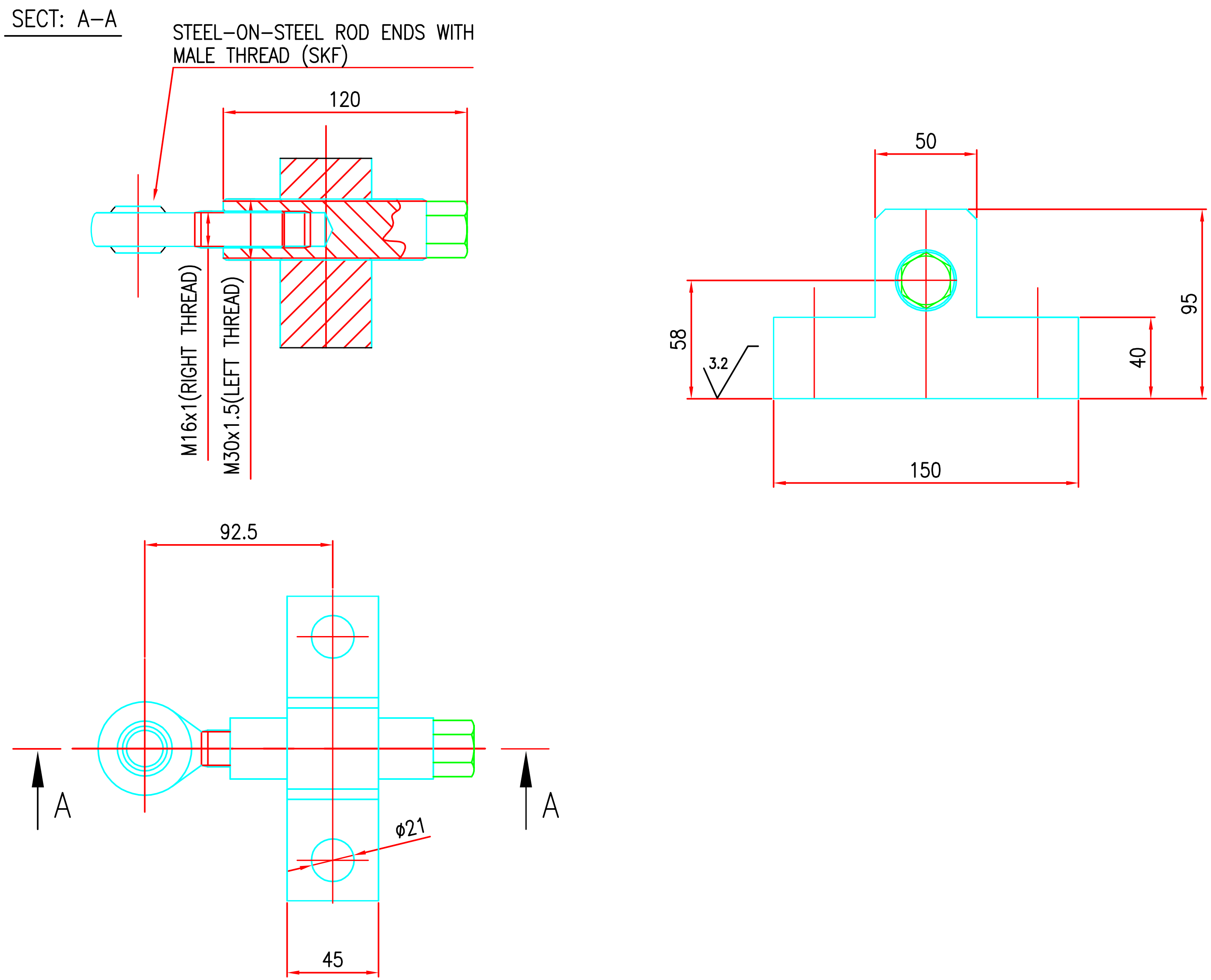
DAMPING RING TESLA

VERTICAL REGISTER SUPPORT

Rev. 0 Scala

D02815UX3000L

Segue F. / F. 1



Distribuzione

Data 25/01/01

Redatto

Controllo e Approvazione

Autorizzazione Emissione

Software AUTOCAD 14

File: xxx.dwg D02816

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione
0	FIRST EMISSION	25/01/01			

MATERIALE

FINITURA

ANSALDO
Ansaldo Ricerche s.r.l.

DAMPING RING TESLA

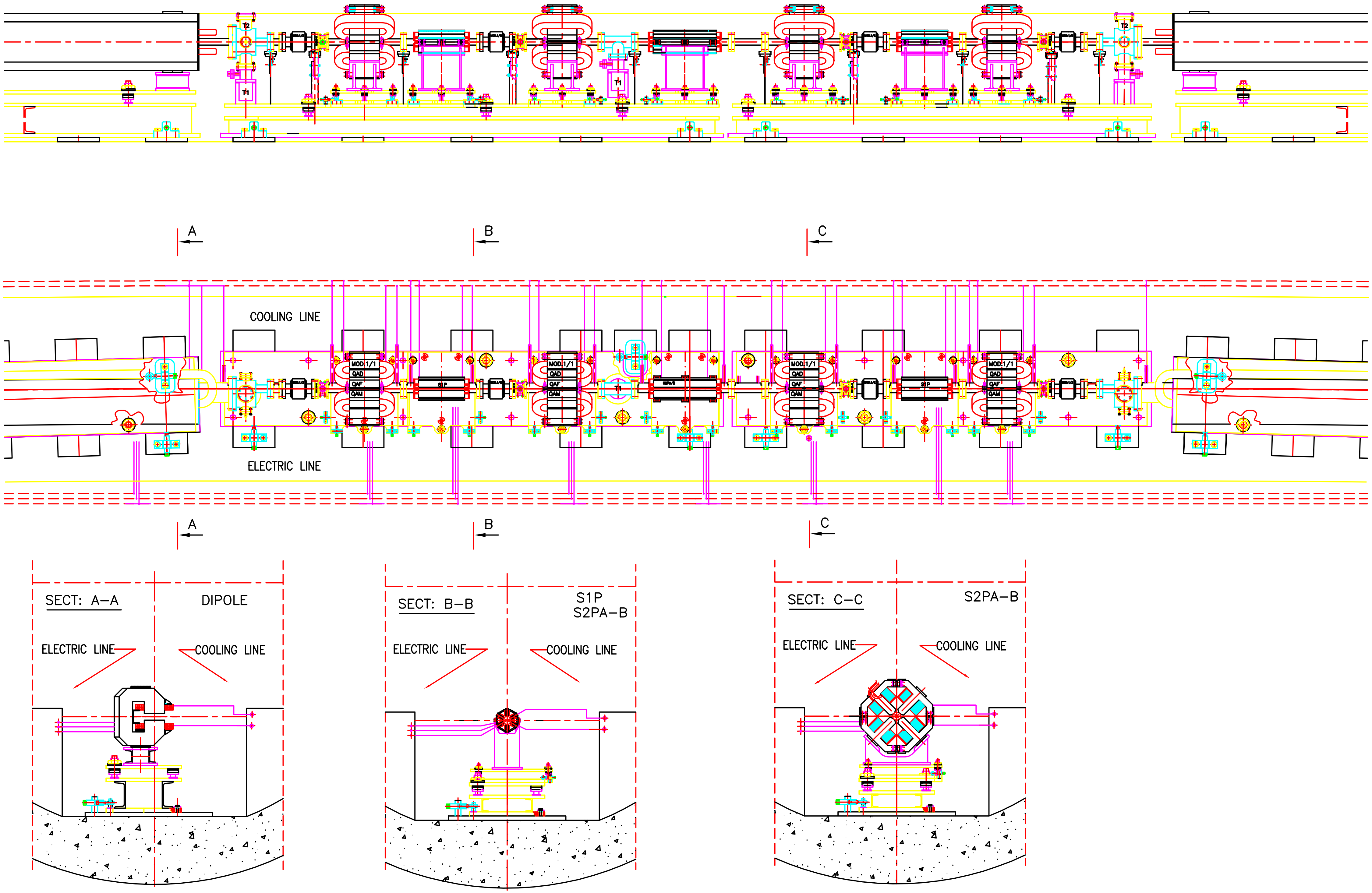
REGISTER SUPPORT

Rev. 0 | Scala

D02816UX3000L

Segue F. / F. 1

Distribuzione



Data
25/01/01
Redatto
Controllo e Approvazione
Autorizzazione Emissione
Software
AUTOCAD 14
File: xxx.dwg
D02893

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione
0	FIRST EMISSION	25/01/01			

MATERIALE

FINITURA

ANSALDO
Ansaldo Ricerche s.r.l.

DAMPING RING TESLA

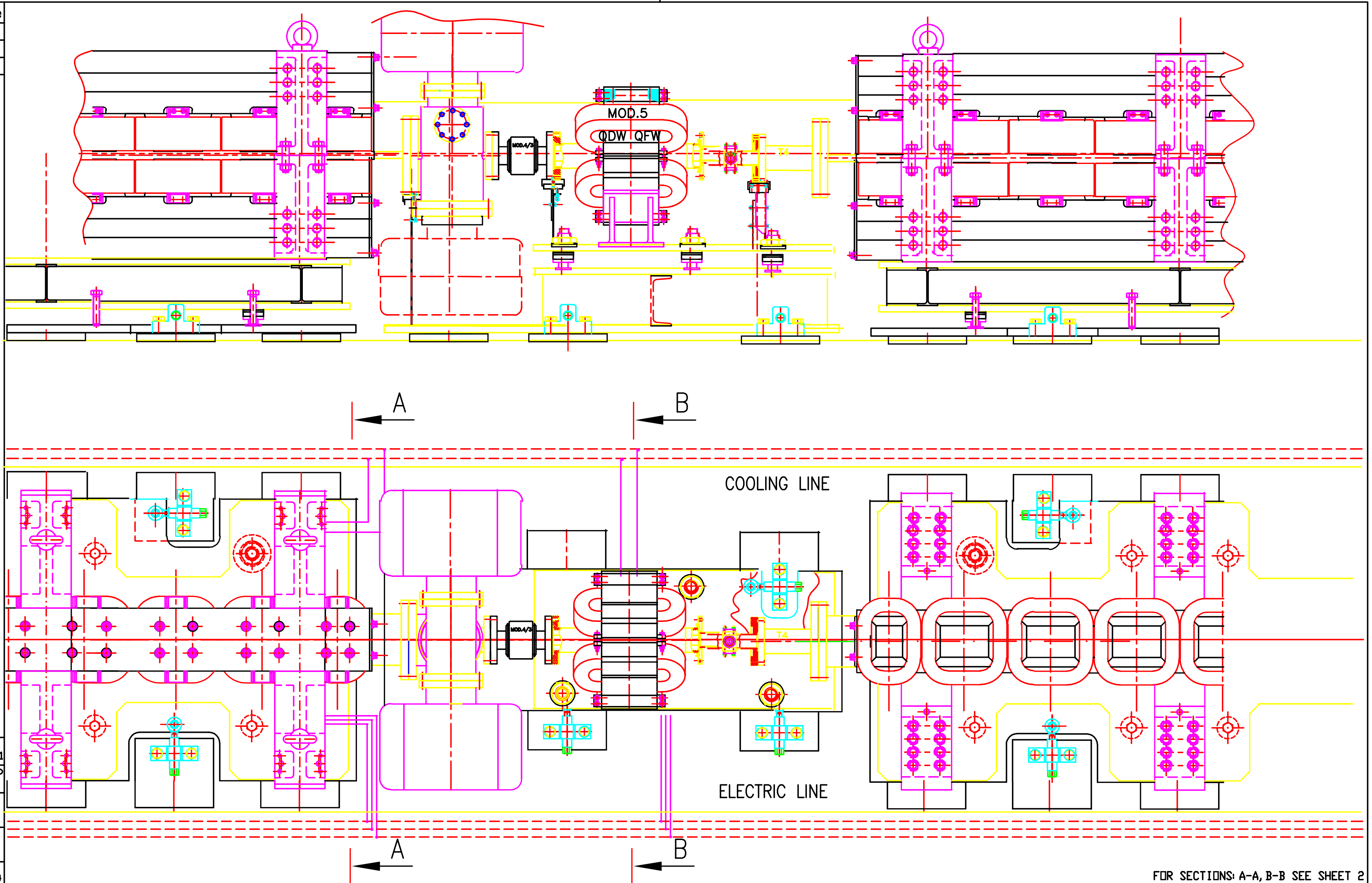
ARC PCEL LINE
DIPOLE, QUADRUPOLE, SEXTUPOLE
PARTICULAR

Rev. 0
Scala

D02893UX3000L

Segue F. /
F. 1

Distribuzione



FOR SECTIONS: A-A, B-B SEE SHEET 2

Data
25/01/01
Redatto
Controllo e Approvazione
Autorizzazione Emissione
Software
AUTOCAD 14
File: xxx.dwg
D02894

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione
0	FIRST EMISSION	25/01/01			

MATERIALE

FINITURA

ANSALDO
Ansaldo Ricerche s.r.l.

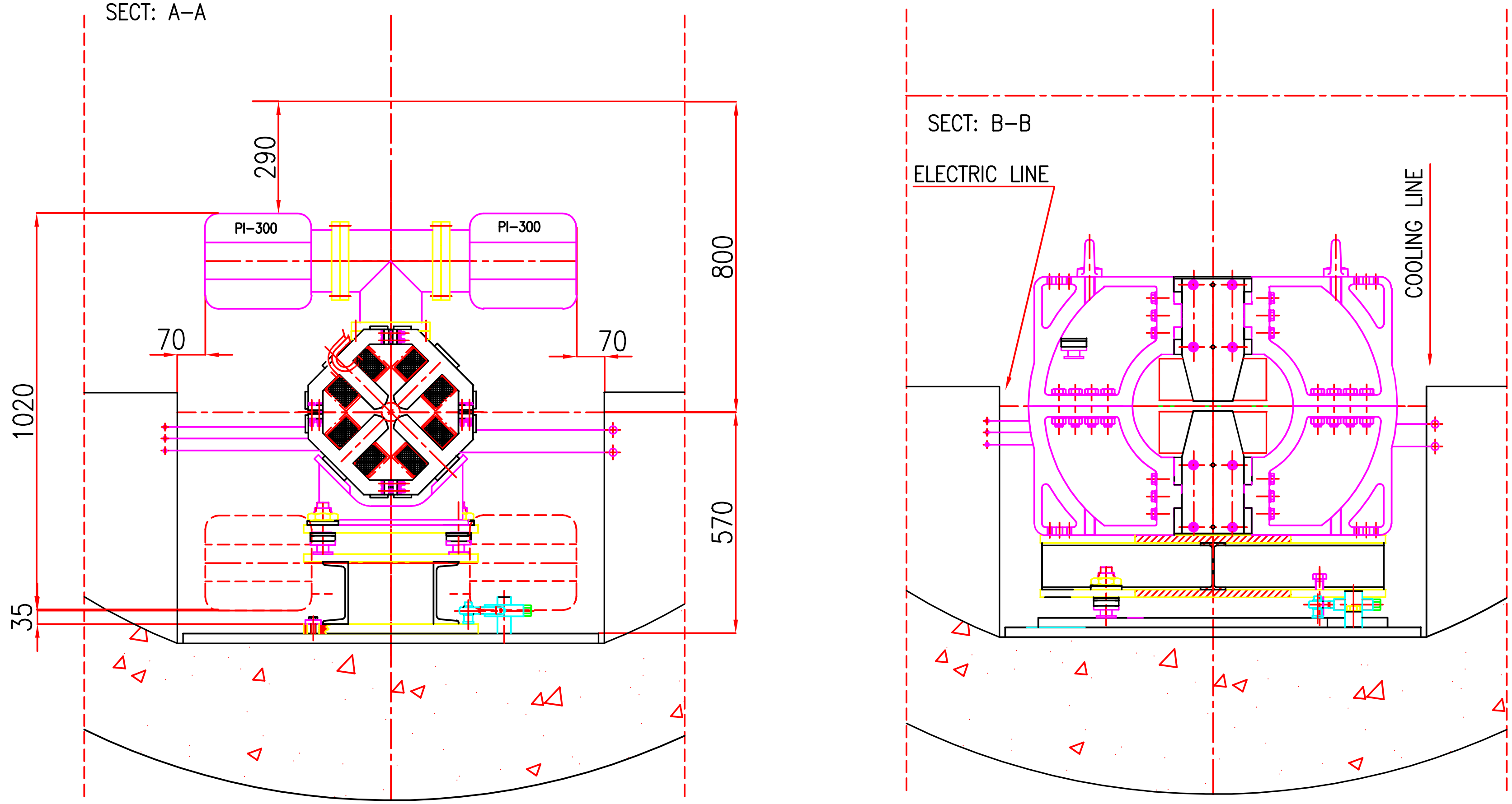
DAMPING RING TESLA

WIGGLER LINE
WIGGLER, QUADRUPOLE, PARTICULAR

Rev. 0 | Scala

D02894UX3000L

Segue F. / F. 1



Distribuzione

Data 25/01/01
Redatto
Controllo e Approvazione
Autorizzazione Emissione
Software AUTOCAD 14
File: xxx.dwg D02895

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione
0	FIRST EMISSION	25/01/01			

MATERIALE

FINITURA

ANSALDO
Ansaldo Ricerche s.r.l.

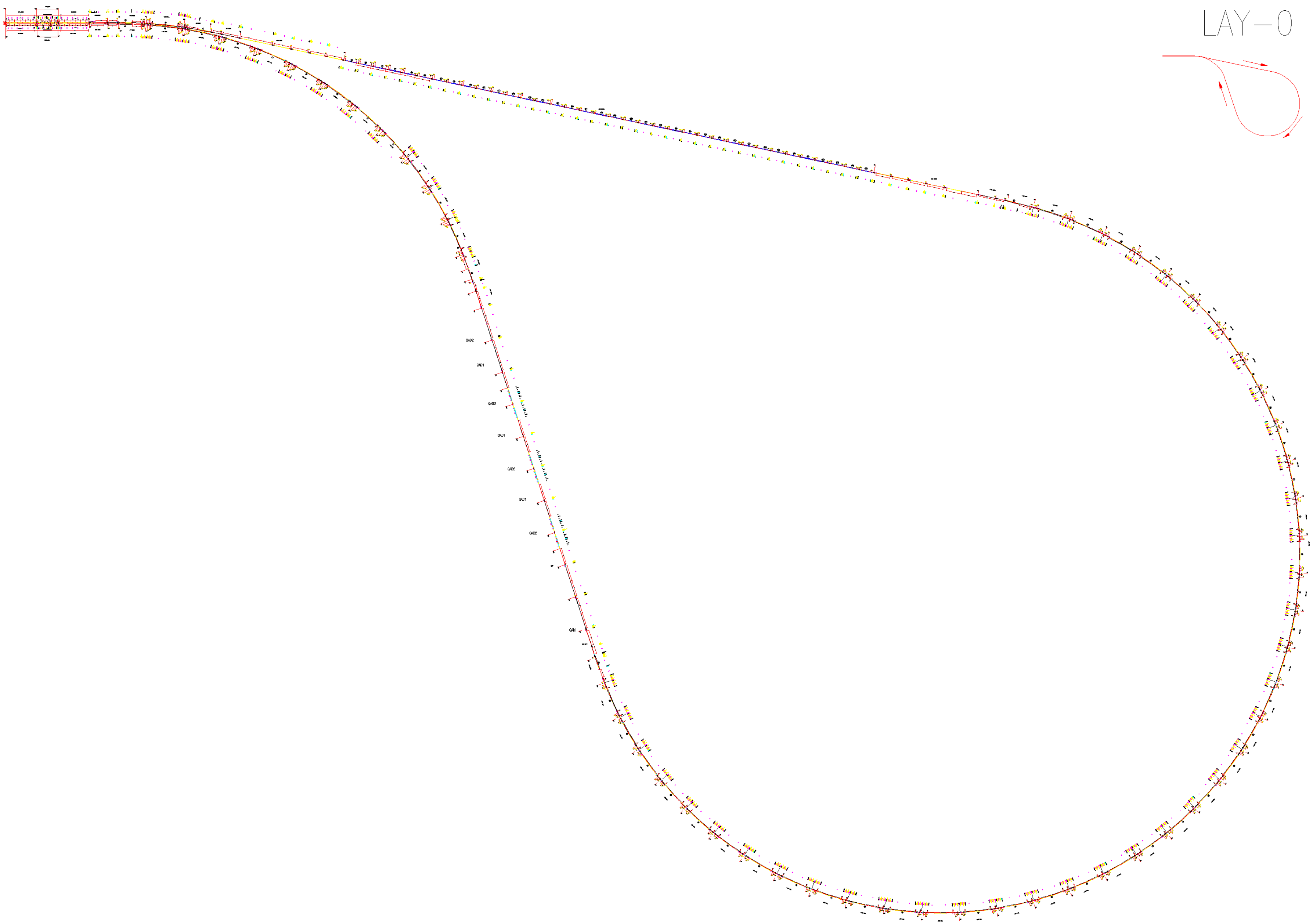
DAMPING RING TESLA

WIGGLER LINE
WIGGLER, QUADRUPOLE
SECTION PARTICULAR

Rev. 0 | Scala

D02895UX3000L

Segue F. / F. 1



Tolleranze secondo uni iso 8015 Tolleranze generali secondo UNI ISO 2768–

MATERIALE

FINITURA

ANSALDO

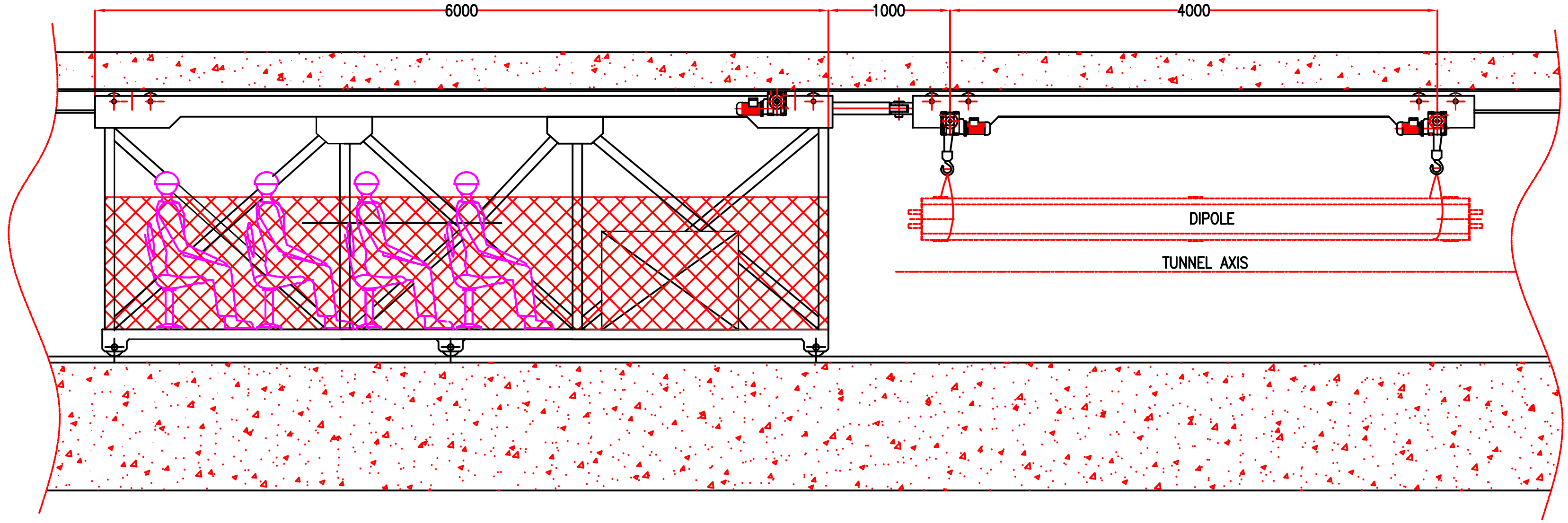
Ansaldo Ricerche s.r.l.

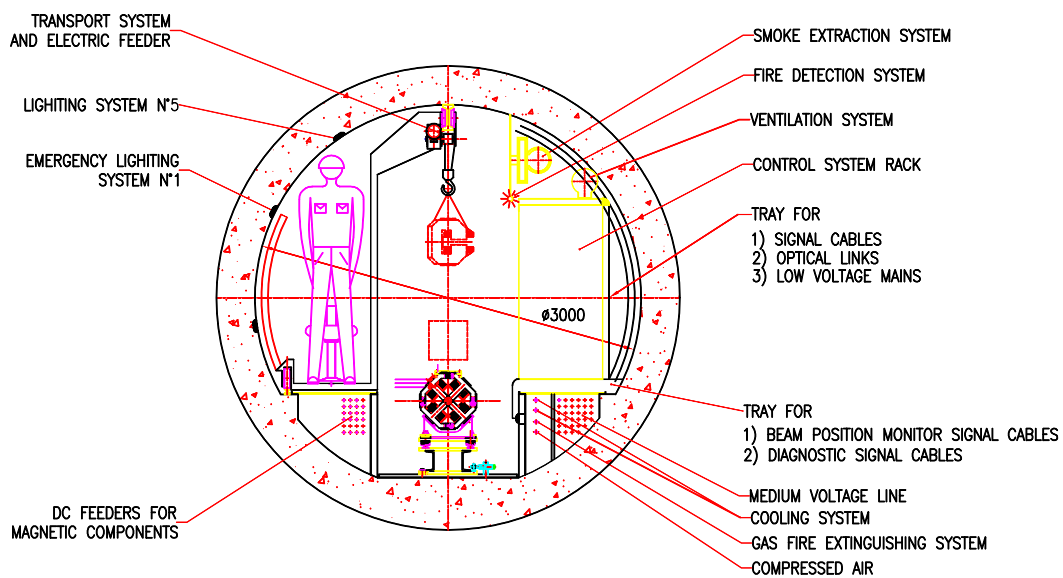
LAY-0

Rev. | Scala

D02954UX3000L

Segue F. F. 1





Distribuzione

Data 25/01/01

Redatto

Controllo e Approvazione

Autorizzazione Emissione

Software AUTOCAD 14

File: xxx.dwg D02955

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione
0	FIRST EMISSION	25/01/01			

MATERIALE

FINITURA

ANSALDO

Ansaldo Ricerche s.r.l.

DAMPING RING TESLA

TUNNEL

TROLLEY PARTICULAR

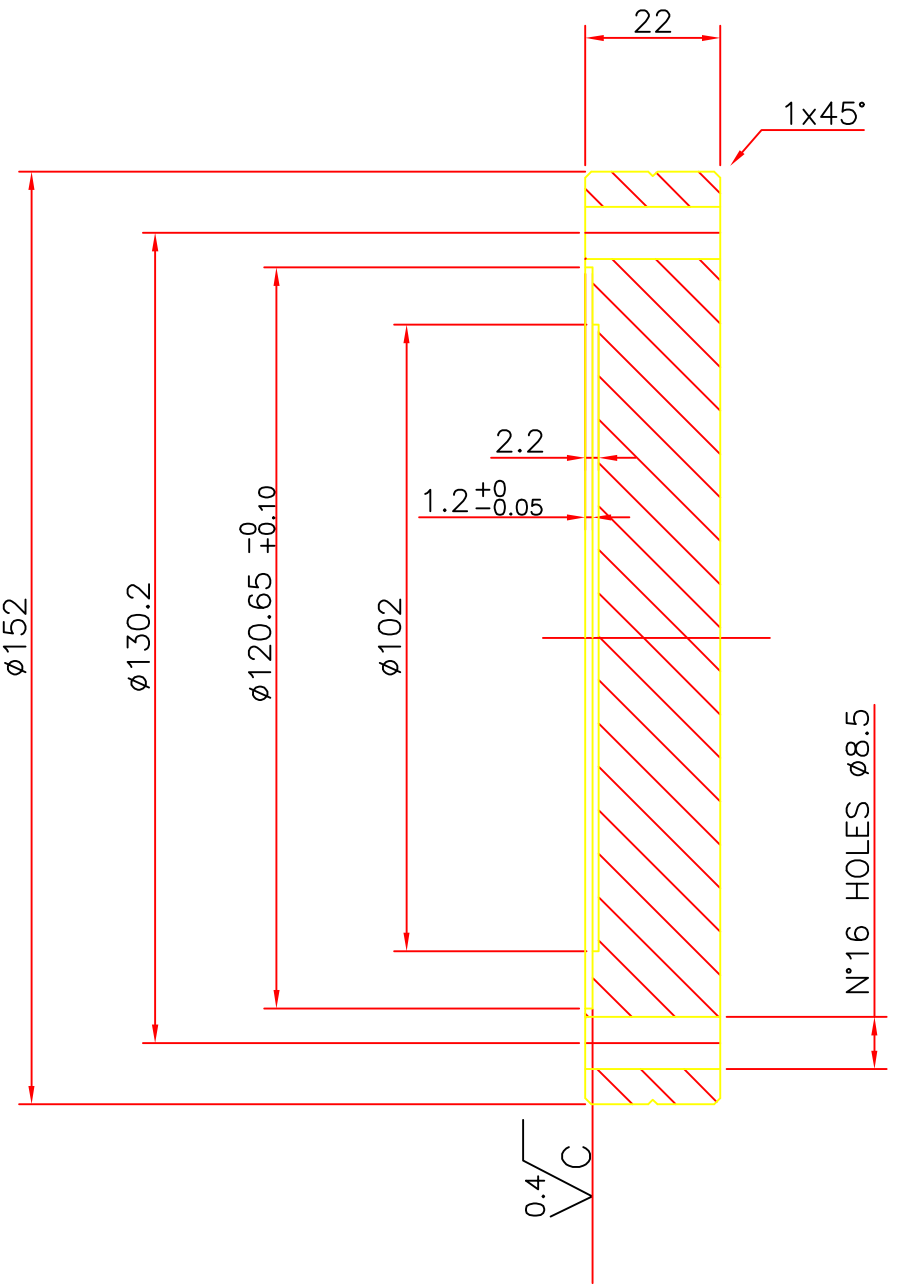
Rev. 0

Scala

D02955UX3000L

Segue F. / F. 1

Distribuzione



Data
Redatto
Controllo e Approvazione
Autorizzazione Emissione
Software
AUTOCAD14
File: xxx.dwg
D03029

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768−

REV.	DESCRIZIONE	Data	Redatto	Controllo Approvaz.	Autorizz. Emissione
0	FIRST EMISSION	25/01/01			

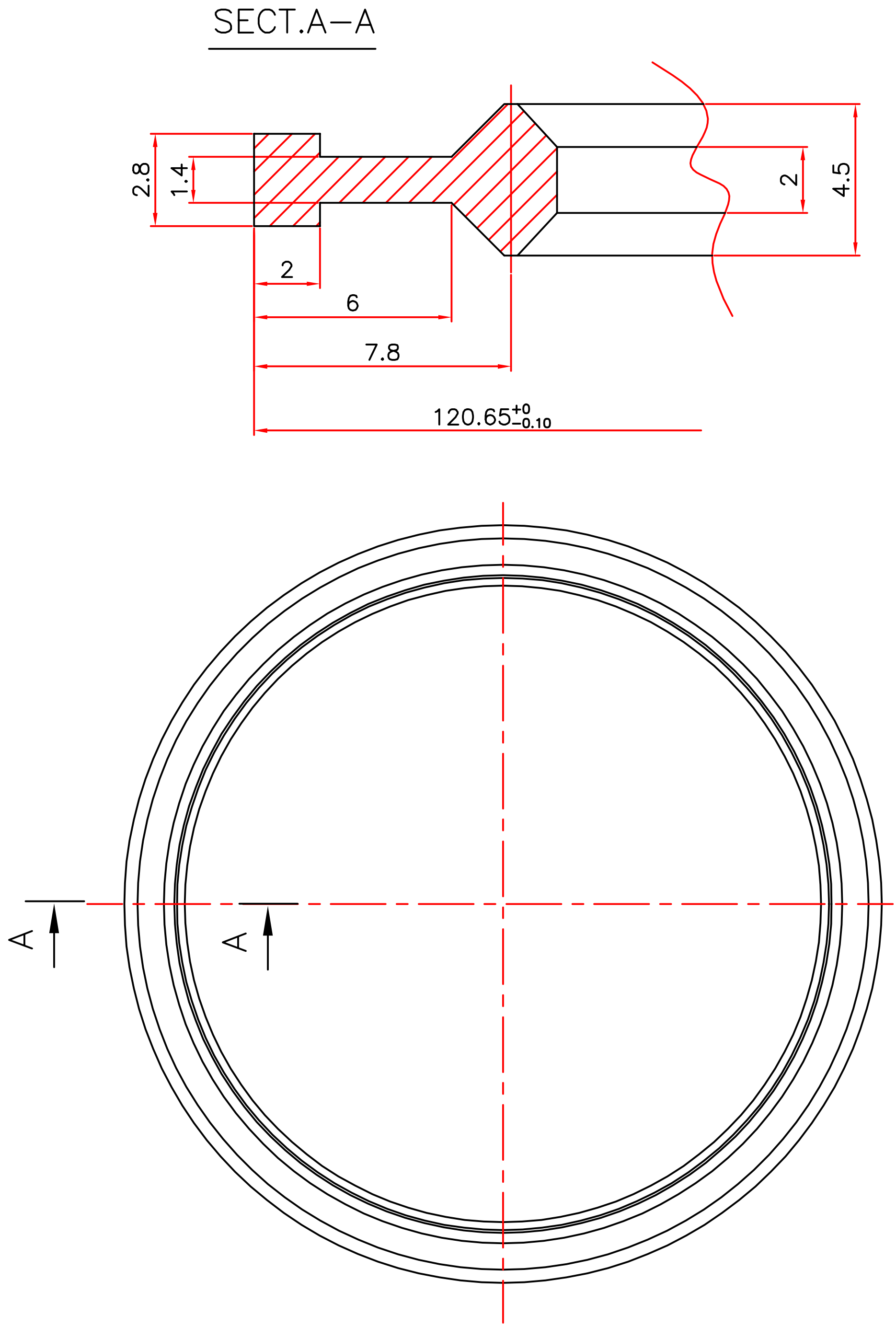
DAMPING RING TESLA

TYPICAL FLANGE CF≤100 SECTION

Rev. 0 Scala

D03029UX3000L

Segue F. / F. 1



Distribuzione

ANSALDO
Ansaldo Ricerche s.r.l.

Data
Redatto
Controllo, e Approvazione
Autorizzazione Emissione
Software
AUTOCAD14
File: xxx.dwg
D03030

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo Approvaz.	Autorizz. Emissione
0	FIRST EMISSION	25/01/01			

DAMPING RING TESLA

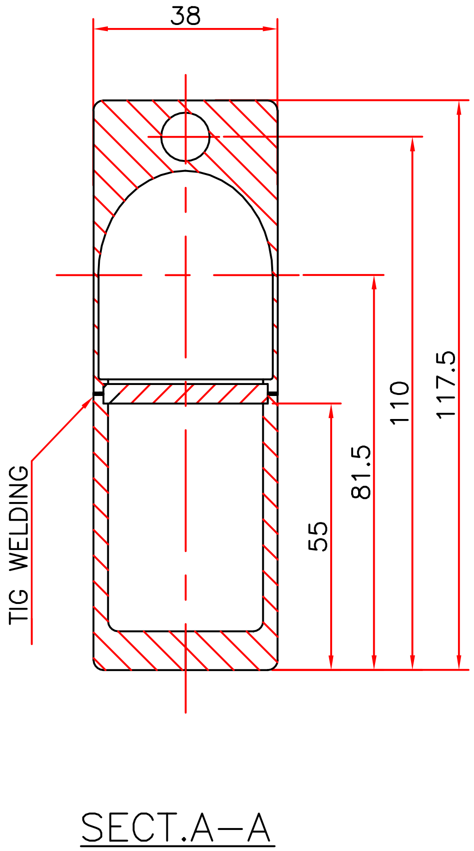
TYPICAL GASKET CFs100 SECTION

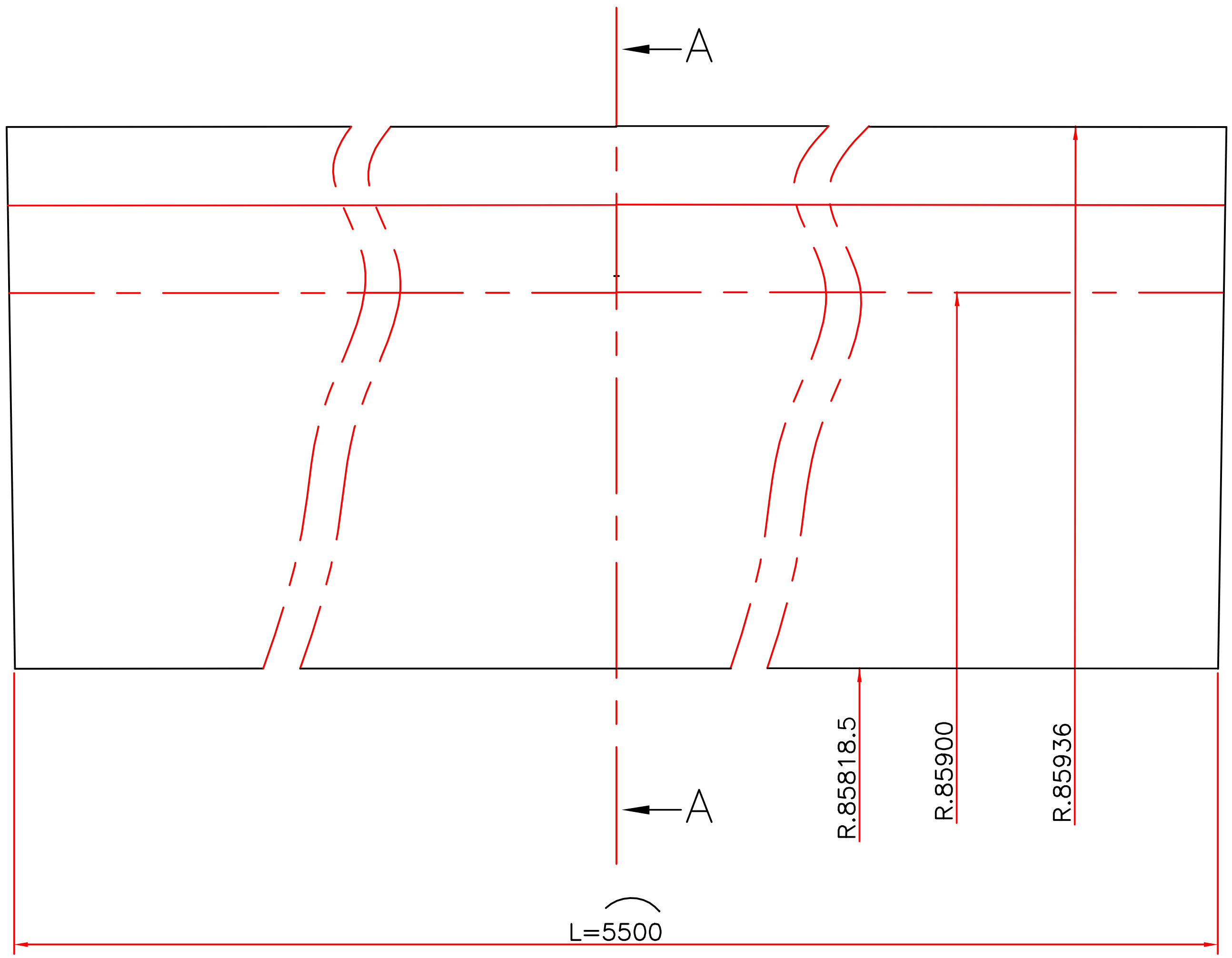
Rev. 0	Scala

D03030UX3000L

Segue F. / F. 1

Distribuzione





WEIGHT: 21.725 KG.

Data

Redatto

Controllo e Approvazione

Autorizzazione Emissione

Software AUTOCAD 14

File: xxx.dwg D03031/1

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione	MATERIALE
0	FIRST EMISSION	25/01/01				FINITURA

ANSALDO
Ansaldo Ricerche s.r.l.

DAMPING RING TESLA

DIPOLE VACUUM CHAMBER

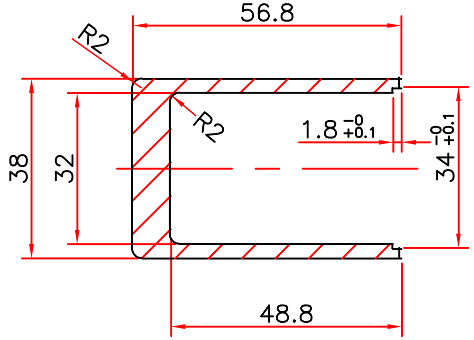
Rev. 0 | Scala

D03031UX3000L

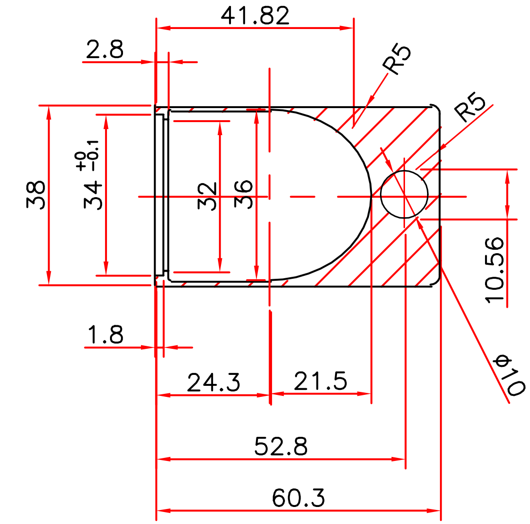
Segue F. 2 F. 1

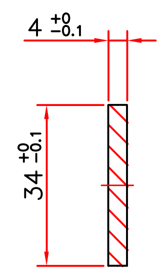
Distribuzione

A1 WEIGHT: 1.60 KG/MT.



A3 WEIGHT: 1.98 KG/MT.





A2 WEIGHT: 0.37 KG/MT.

TOTAL WEIGHT: 3.95 KG/MT.

Data 25/01/01
Redatto
Controllo e Approvazione
Autorizzazione Emissione
Software AUTOCAD 14
File: xxx.dwg D03031/2

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione
0	FIRST EMISSION	25/01/01			

MATERIALE

FINITURA

ANSALDO
Ansaldo Ricerche s.r.l.

DAMPING RING TESLA
DIPOLE VACUUM CHAMBER
– A1,A2,A3 –

Rev. 0 | Scala

D03031UX3000L

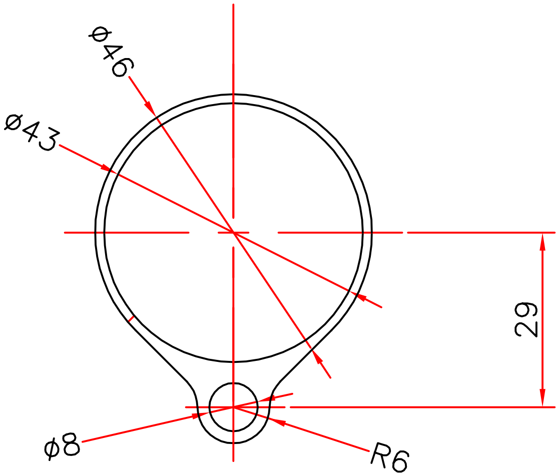
Segue F. / F. 2

Distribuzione

ANSALDO

Ansaldo Ricerche s.r.l.

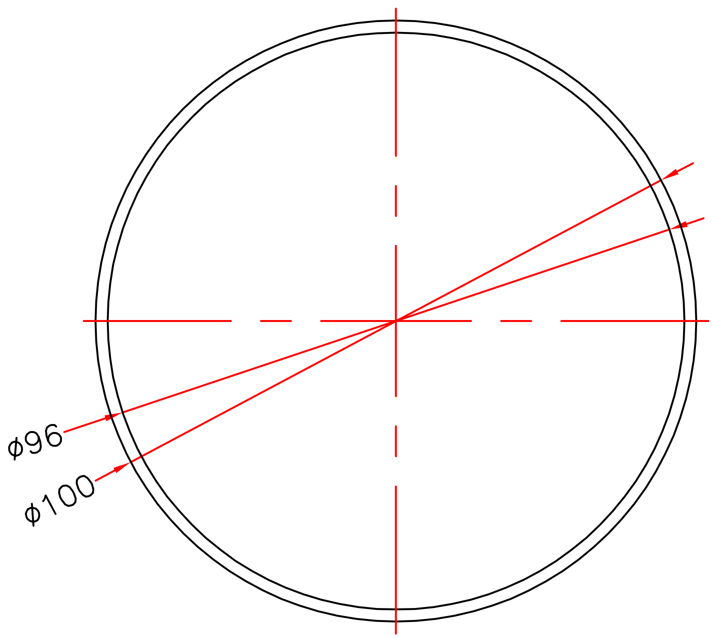
B1/B2



DIPOLE LINE VACUUM CHAMBER

WEIGHT:0,88 KG./MT.

C1



QUADRUPOLE STRAIGHT LINE VACUUM CHAMBER

WEIGHT:1.65 KG./MT.

Data

Redatto

Controllo e Approvazione

Autorizzazione Emissione

Software AUTOCAD14

File: xxx.dwg D03032

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo Approvaz.	Autorizz. Emissione
0	FIRST EMISSION	25/01/01			

DAMPING RING TESLA

VACUUM CHAMBER

– B1/B2–C1 –

Rev. 0

Scala

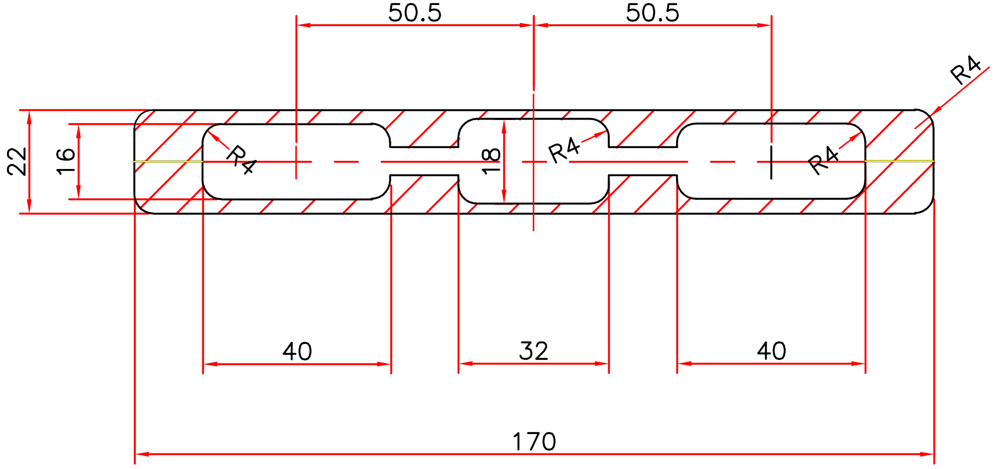
D03032UX3000L

Segue F. /

F. 1

Distribuzione

L'ANSALDO SI RISERVA A TERMINE DI LEGGE LA PROPRIETA' DI QUESTO DOCUMENTO
CON DIVIETO DI RIPRODURLO O DI RENDERLO COMUNQUE NOTO A TERZI O A DITTE CONCORRENTI SENZA LA SUA AUTORIZZAZIONE



WEIGHT: 4,725 KG/MT.

Data 25/01/01
Redatto
Controllo e Approvazione
Autorizzazione Emissione
Software AUTOCAD 14
File: xxx.dwg D03033

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione
0	FIRST EMISSION	25/01/01			

MATERIALE

FINITURA

ANSALDO
Ansaldo Ricerche s.r.l.

DAMPING RING TESLA

WIGGLER VACUUM CHAMBER SECTION

Rev. 0 | Scala

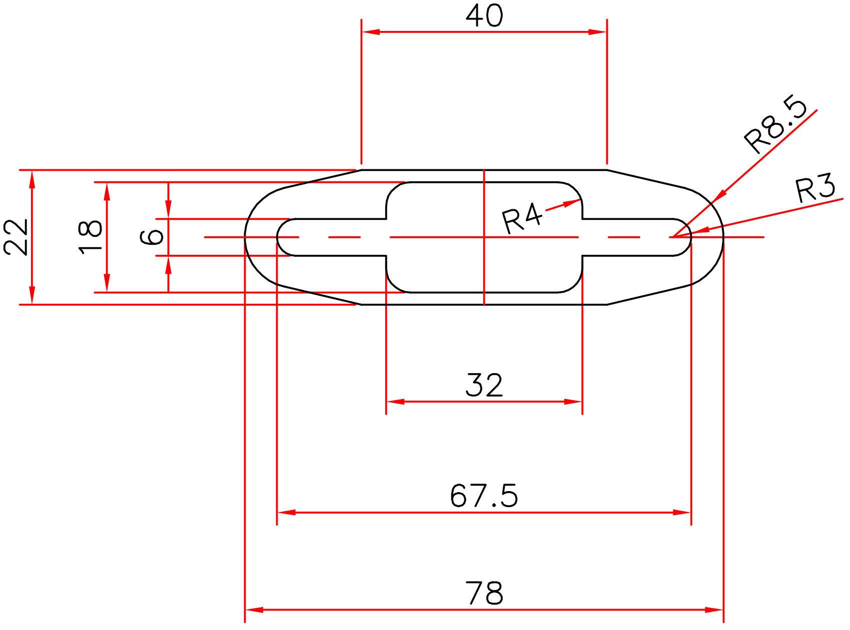
D03033UX3000L

Segue F. / F. 1

Distribuzione

ANSALDO
Ansaldo Ricerche s.r.l.

L'ANSALDO SI RISERVA A TERMINE DI LEGGE LA PROPRIETA' DI QUESTO DOCUMENTO CON DIVIETO DI RIPRODURLO O DI RENDERLO COMUNQUE NOTO A TERZI O A DITTE CONCORRENTI SENZA LA SUA AUTORIZZAZIONE



WEIGHT:2,035KG./MT.

Data

Redatto

Controllo e Approvazione

Autorizzazione Emissione

Software
AUTOCAD14

File: xxx.dwg
D03034

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo Approvaz.	Autorizz. Emissione
0	FIRST EMISSION	25/01/01			

DAMPING RING TESLA

WIGGLER QUADRUPOLE

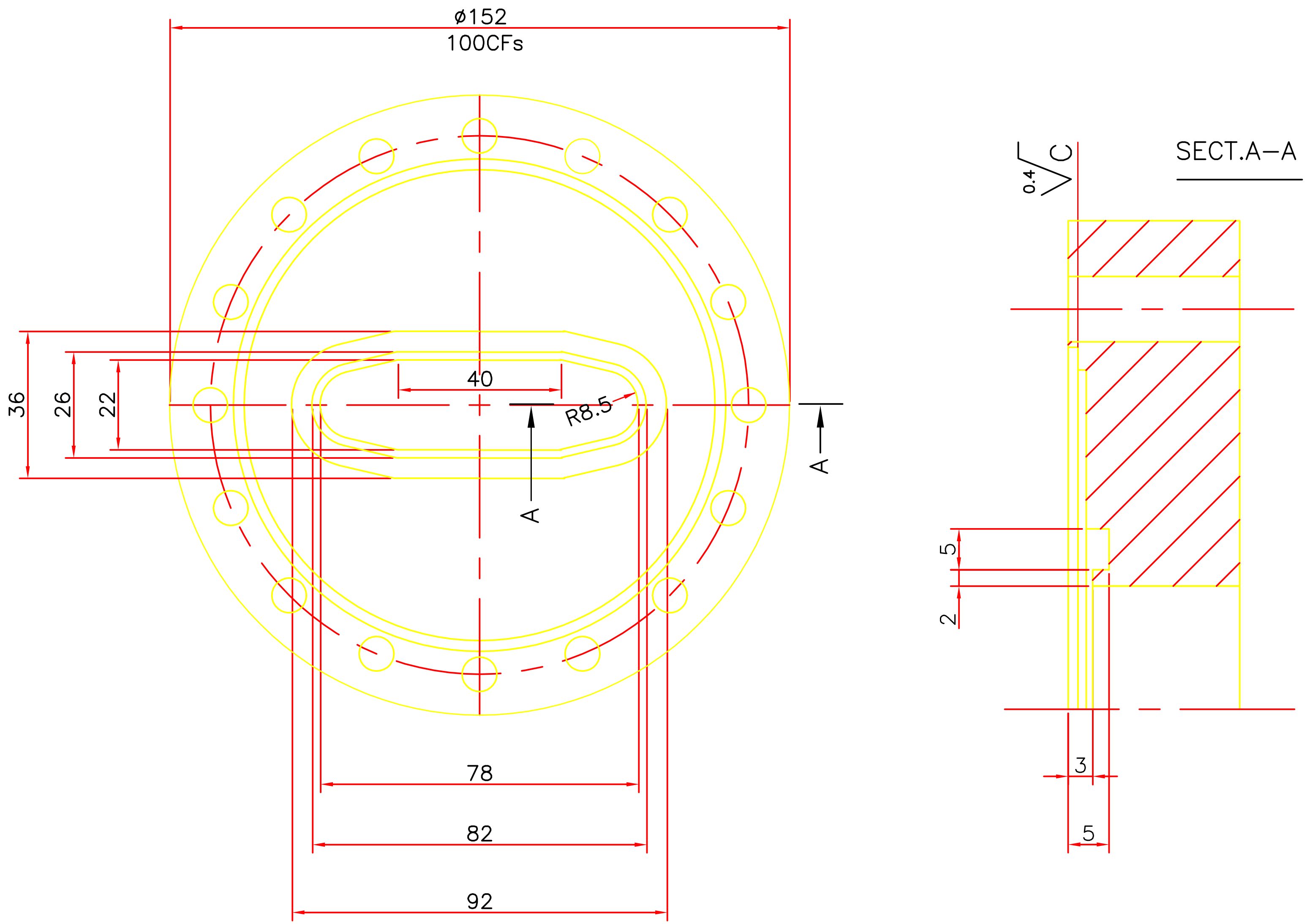
VACUUM CHAMBER

Rev. 0 Scala

D03034UX3000L

Segue F. / F. 1

Distribuzione



Data
Redatto
Controllo e Approvazione
Autorizzazione Emissione
Software AUTOCAD 14
File: xxx.dwg D03035

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione
0	FIRST EMISSION	25/01/01			

MATERIALE

FINITURA

ANSALDO
Ansaldo Ricerche s.r.l.

DAMPING RING TESLA

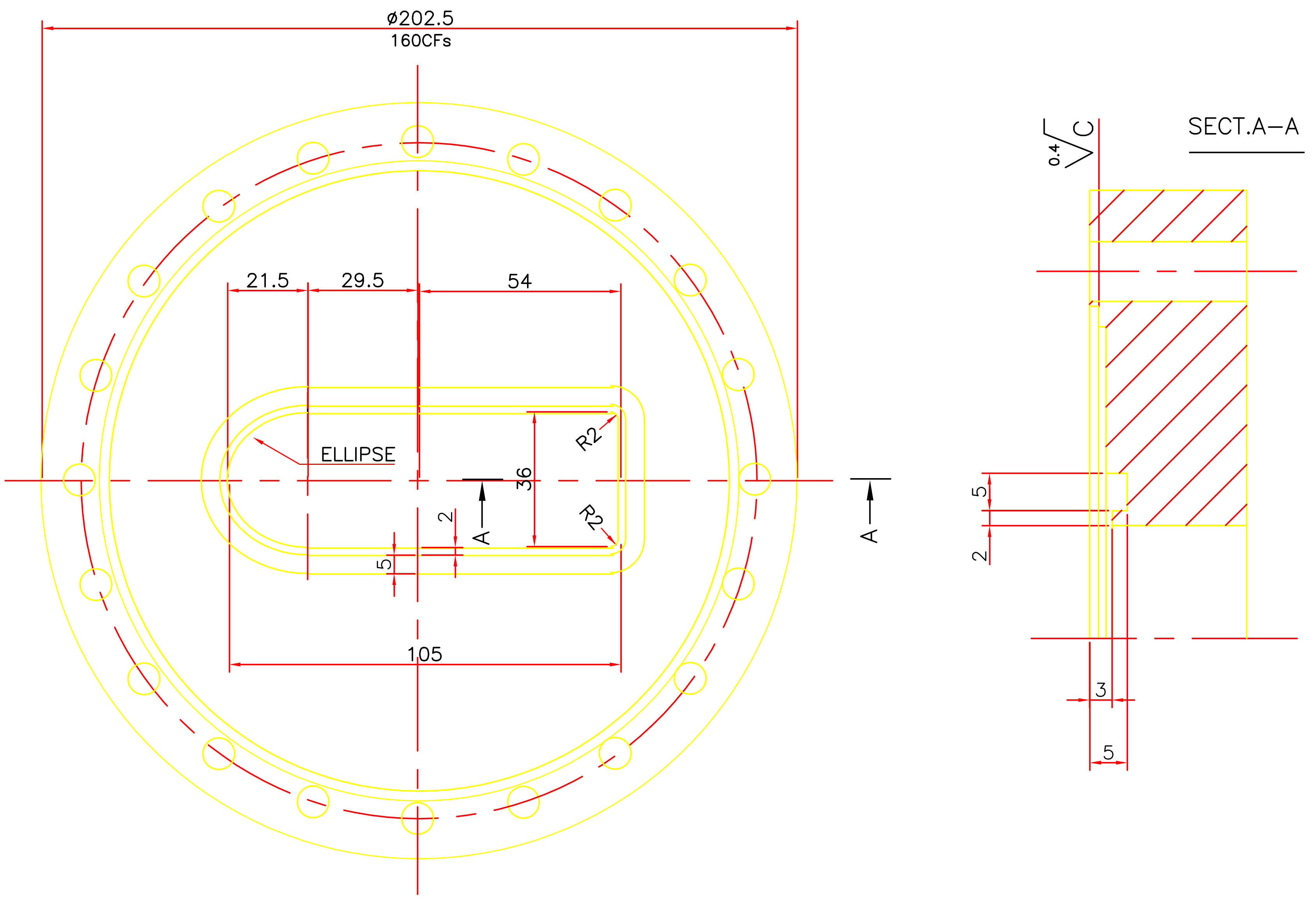
CW80 VACUUM CHAMBER
MACHINING FOR WELDING

Rev. 0
Scala

D03035UX3000L

Segue F. / F. 1

Distribuzione



Data
Redatto
Controllo e Approvazione
Autorizzazione Emissione
Software AUTOCAD 14
File: xxx.dwg D03036

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione
0	FIRST EMISSION	25/01/01			

MATERIALE

FINITURA

ANSALDO
Ansaldo Ricerche s.r.l.

DAMPING RING TESLA

DIPOLE VACUUM CHAMBER
MACHINING FOR WELDING

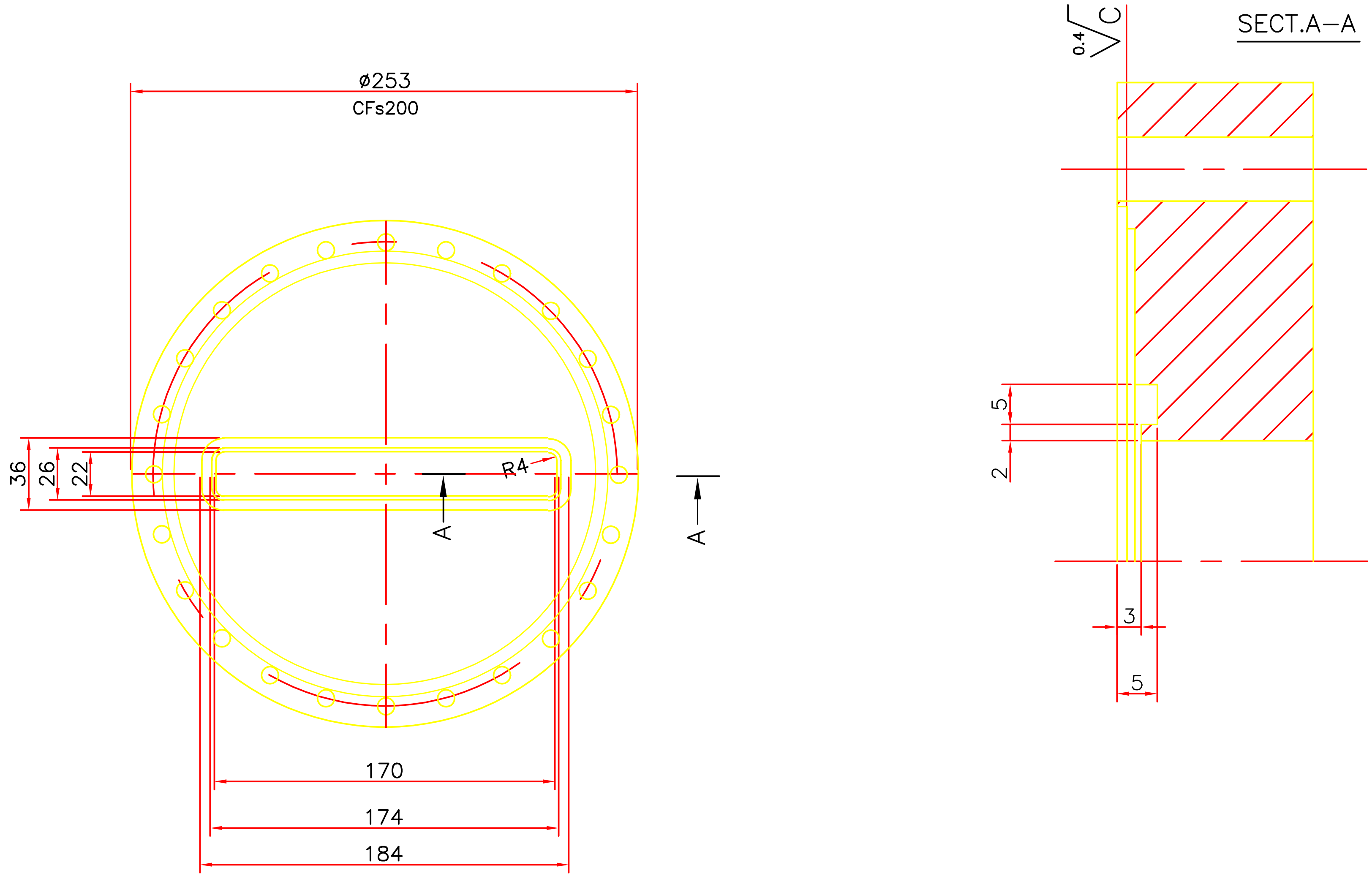
Rev. 0 | Scala

D03036UX3000L

Segue F. / F. 1

Distribuzione

CON DIVIETO DI RIPRODURLO O DI RENDERLO COMUNQUE NOTO A TERZI O A DITTE CONCORRENTI SENZA LA SUA AUTORIZZAZIONE
L'ANSALDO SI RISERVA A TERMINE DI LEGGE LA PROPRIETA' DI QUESTO DOCUMENTO



Data 25/01/01
Redatto
Controllo e Approvazione
Autorizzazione Emissione
Software AUTOCAD 14
File: xxx.dwg D03037

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo approv.	Autorizzazione emissione
0	FIRST EMISSION	25/01/01			

MATERIALE

FINITURA

ANSALDO
Ansaldo Ricerche s.r.l.

DAMPING RING TESLA

WIGGLER VACUUM CHAMBER
MACHINING FOR WELDING

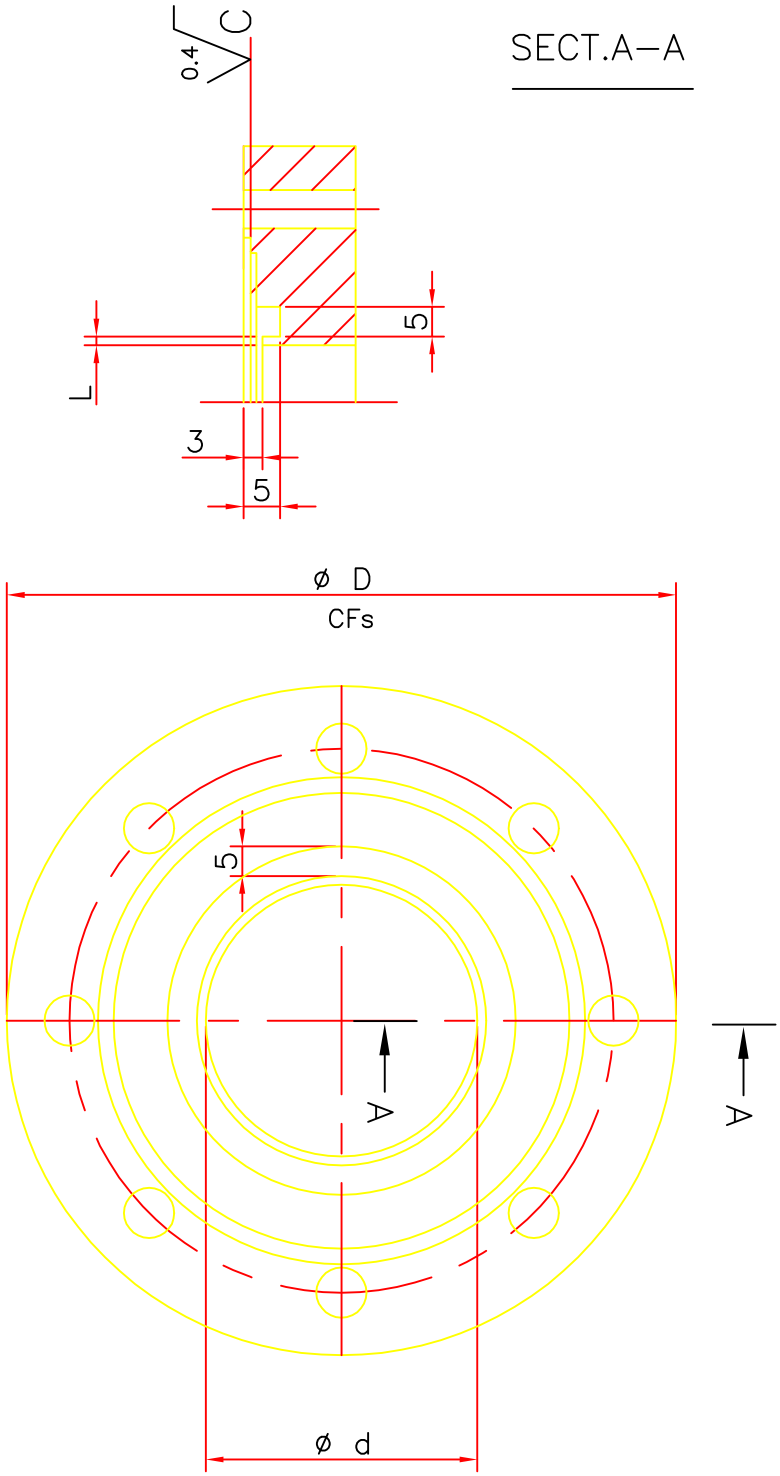
Rev. 0 | Scala

D03037UX3000L

Segue F. / F. 1

Distribuzione

ANSALDO
Ansaldo Ricerche s.r.l.



Data
Redatto
Controllo e Approvazione
Autorizzazione Emissione
Software
AUTOCAD14
File: xxx.dwg
D03038

Tolleranze secondo UNI ISO 8015 Tolleranze generali secondo UNI ISO 2768–

REV.	DESCRIZIONE	Data	Redatto	Controllo Approvaz.	Autorizz. Emissione
0	FIRST EMISSION	25/01/01			

DAMPING RING TESLA
ROUND VACUUM CHAMBER
MACHINING FOR CHAMBER

Rev. 0 Scala

D03038UX3000L

Segue F. / F. 1

3 REFERENCES

(1) TESLA DESIGN REPORT, TDR
http://www.desy.de/~teslatdr/tdr_web/pages/latest_version.html

(2) S. Guiducci, Review of TESLA damping ring parameters, TESLA-LNF Technical Note Tesla-1, Frascati March 9, 2000.

(3) R. Boni, Proposal of the TESLA damping ring RF system, TESLA-LNF Technical Note Tesla-2, Frascati November 23, 2000.