

Titulació

Màster Universitari en Enginyeria Industrial (MUEI)

Alumne

Llorenç Macià Cid

Títol TFM

Estudi i implementació d'un ByPass automàtic per a millorar el sistema hidràulic de refrigeració de l'àrea experimental pels laboratoris del Síncrotró ALBA de Cerdanyola del Vallès

Directors del TFM

Pedro Javier Gamez Montero

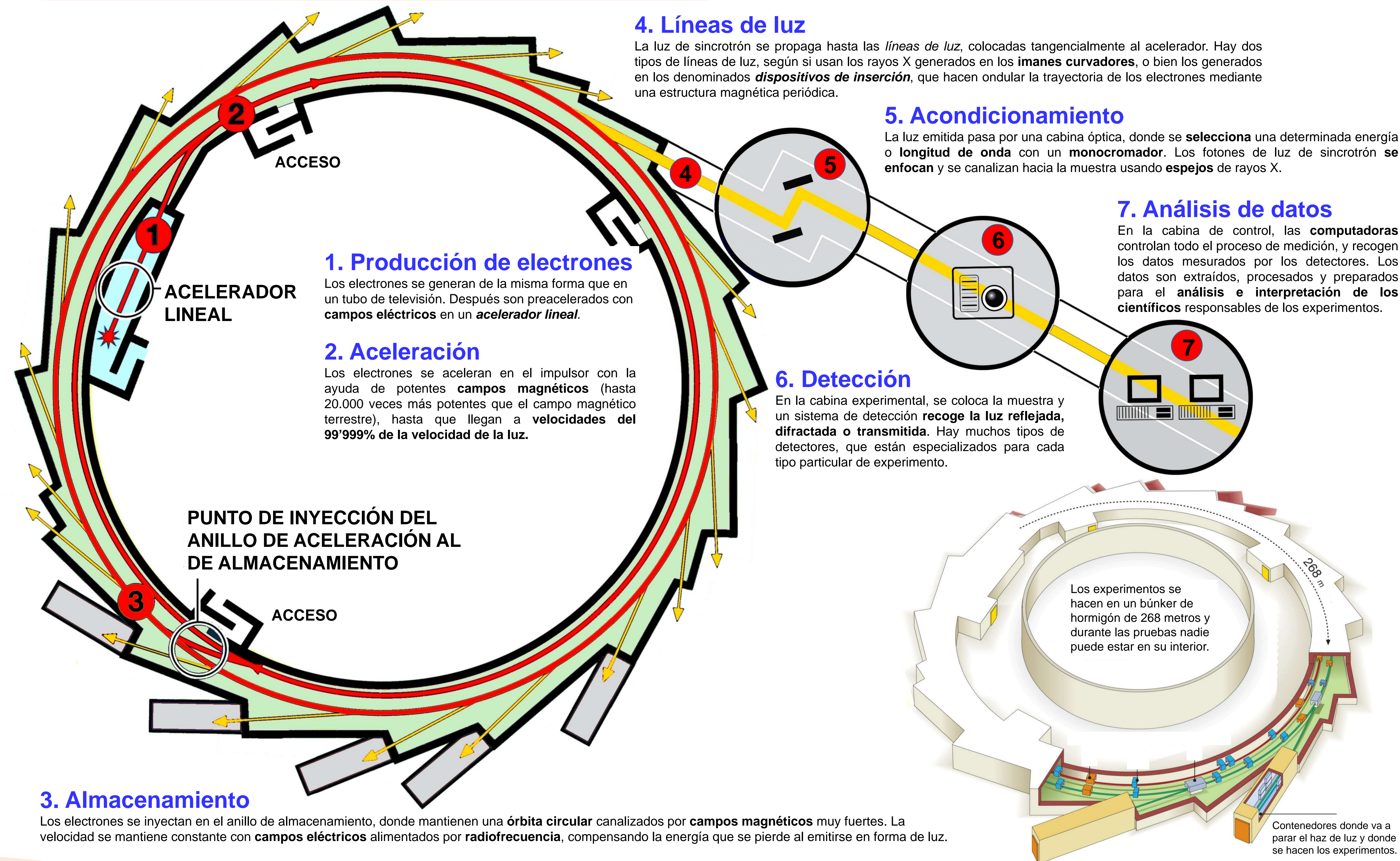
Roberto Castilla Lopez

Convocatòria de lliurament del TFM

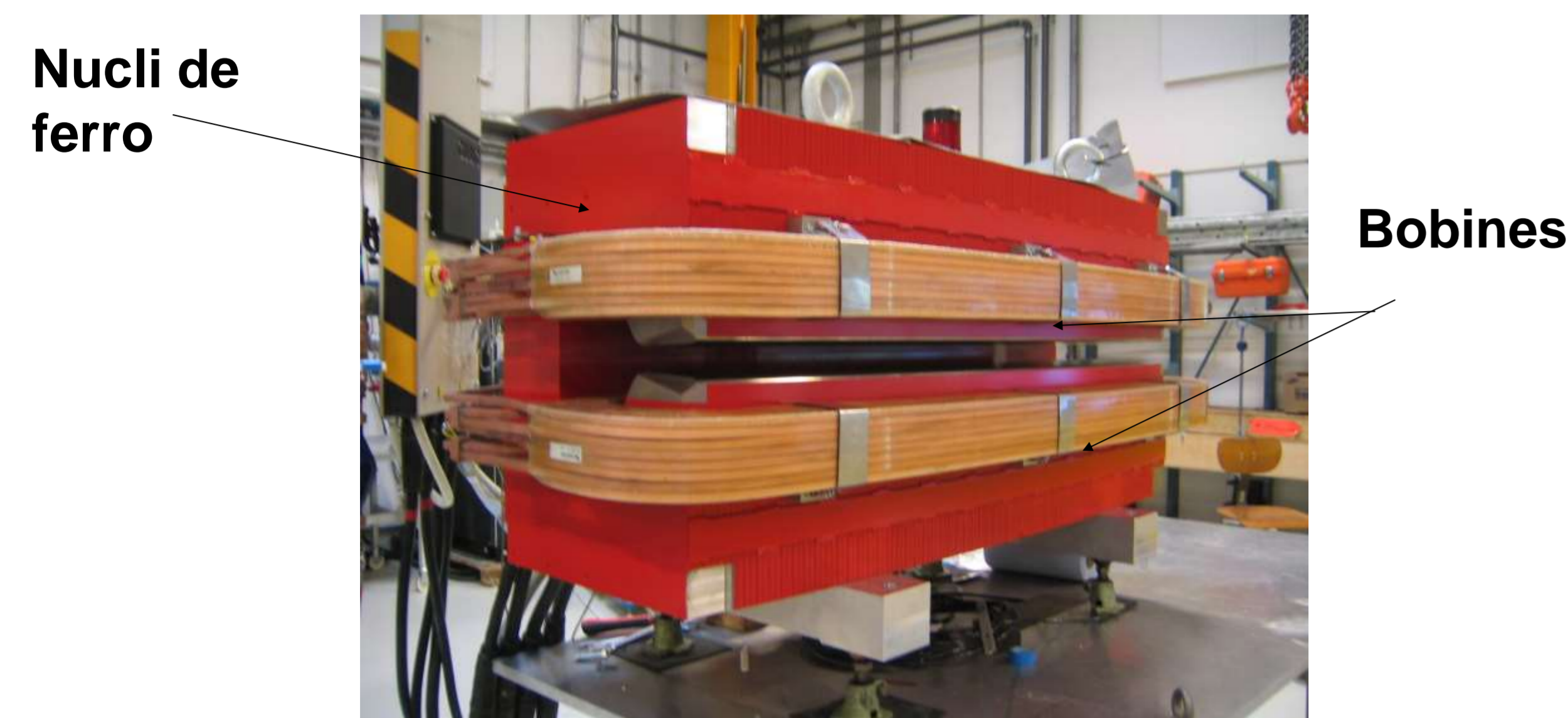
Convocatoria del quadrimestre de primavera del 2016 (Q2)

Entrega la setmana 24 del 2016, del 13 al 17 de juny

Contingut d'aquest volum:



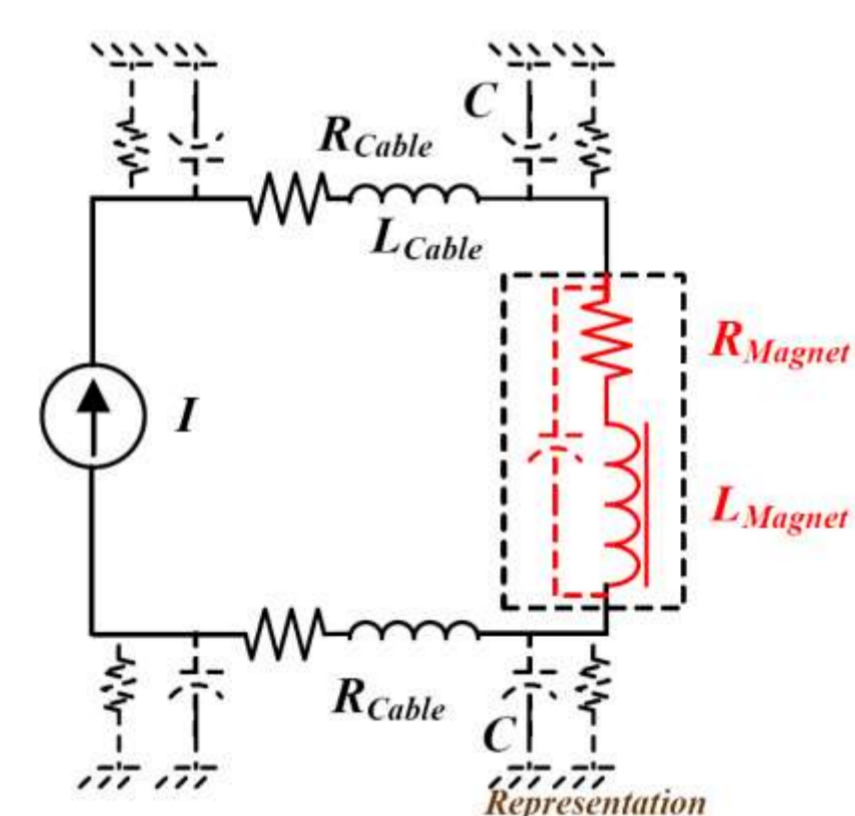
Imants dipolars



Crea un camp magnètic uniforme d'1,4T (tesla) i **corba la trajectòria** dels electrons.

Per crear el camp magnètic cal alimentar les bobines amb un **corrent continu**.

Esquema elèctric equivalent

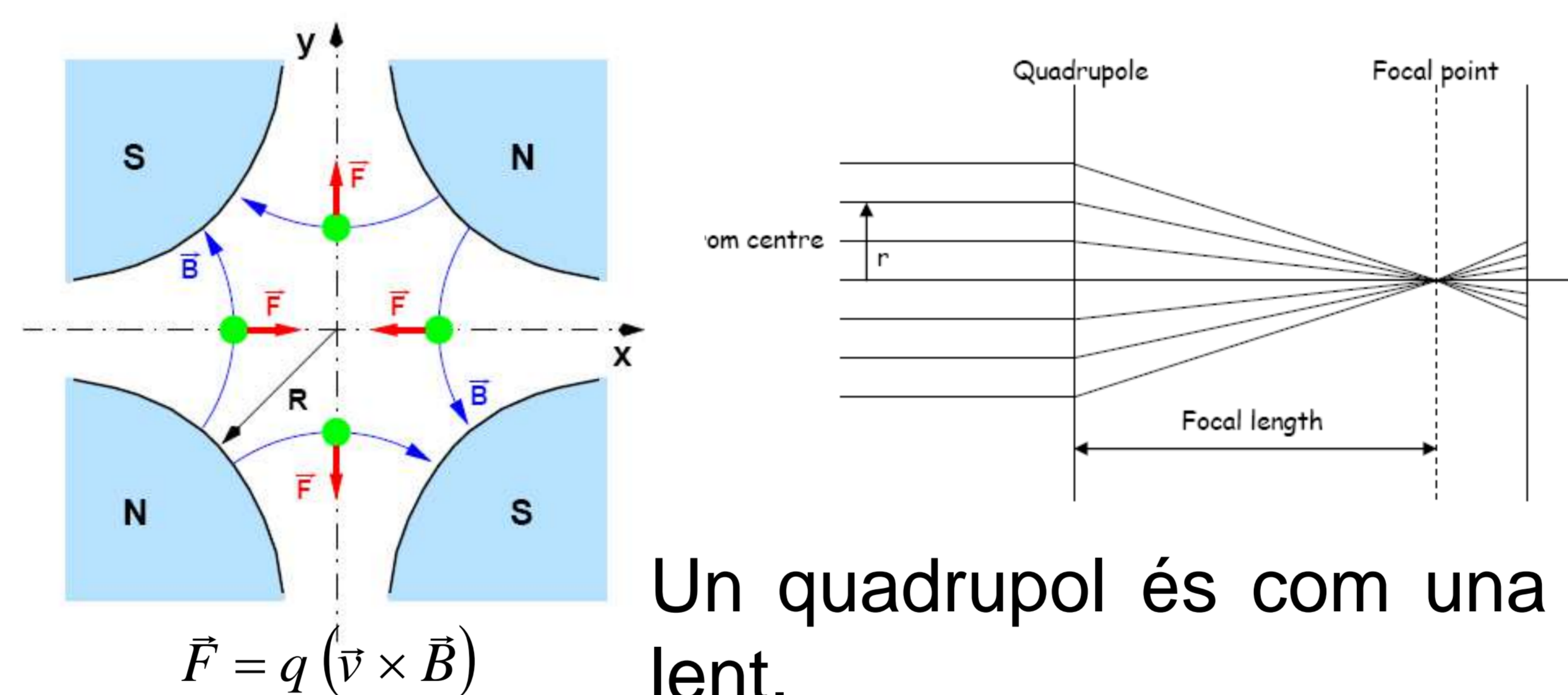


Imants quadrupolars



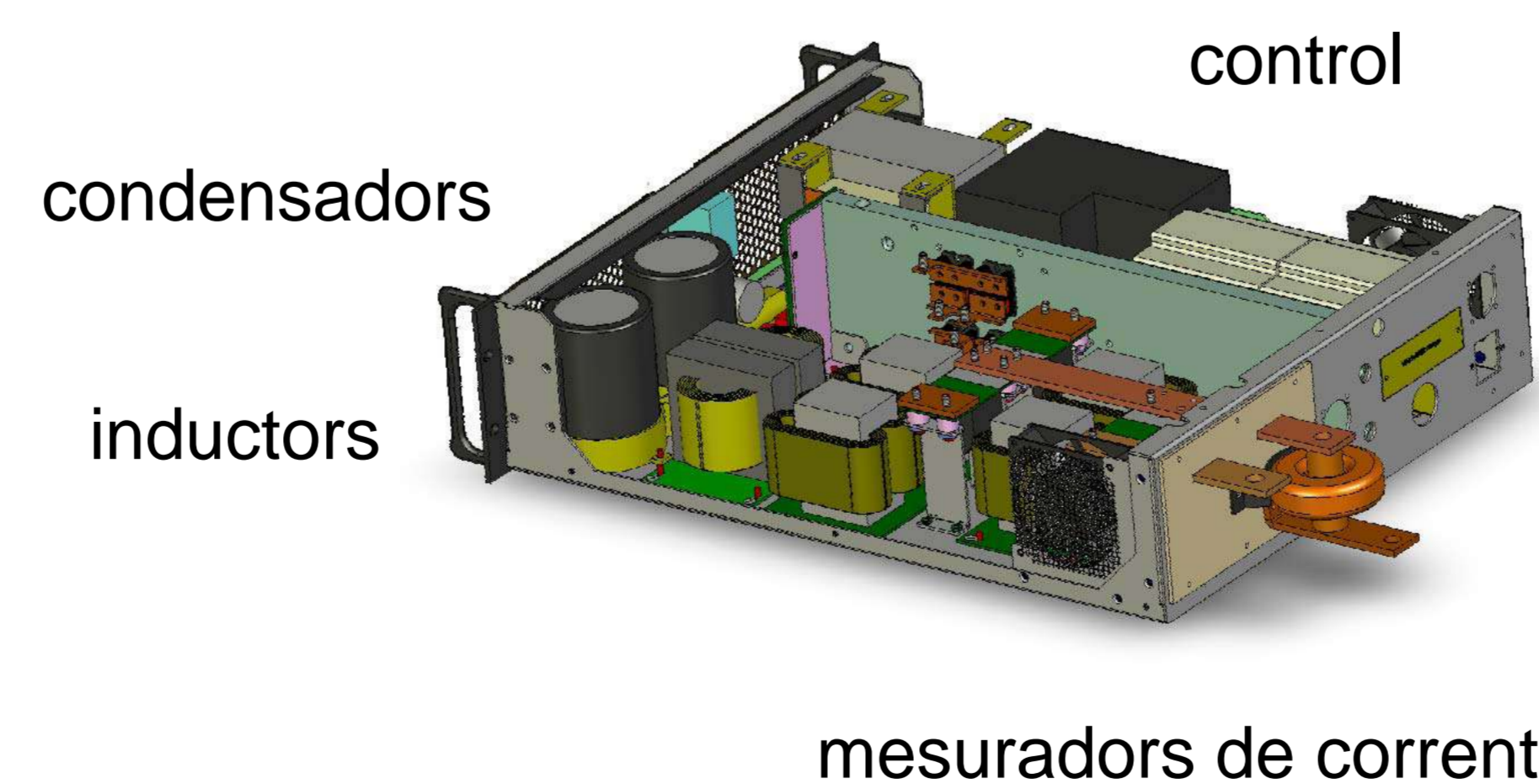
Gradient magnètic: 25 T/m

Té 4 pols magnètics i **focalitza el feix** d'electrons per mantenir-lo petit i ben definit.

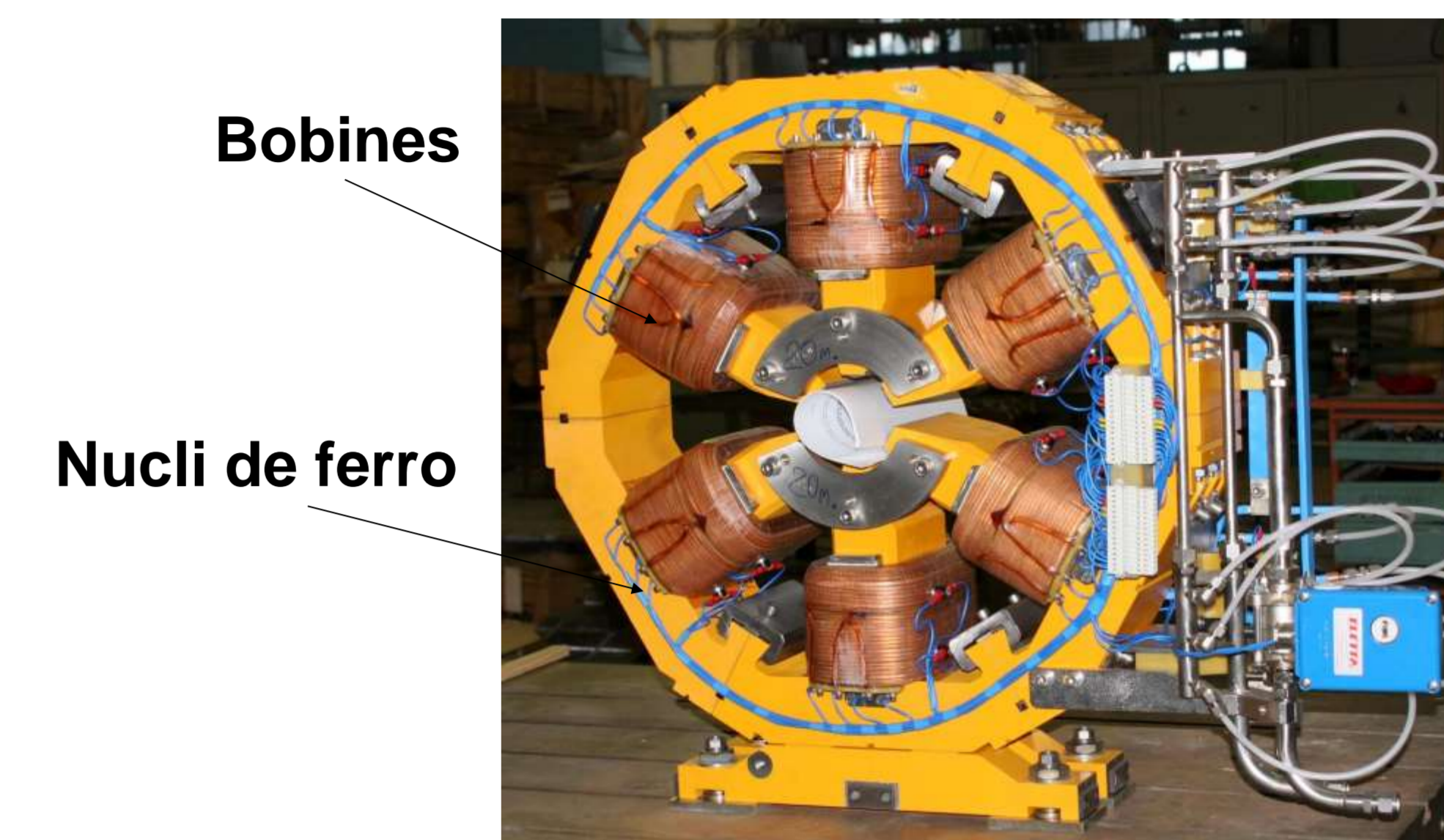


Un quadropol és com una lent.

Hi ha 112 quadropols i cadascun té la seva **font d'alimentació** de 3 kW.



Imants sextupolars



Gradient magnètic: 700 T/m²

Té 6 pols magnètics i serveix per **corregir errors de focalització**.

Hi ha 120 sextupols alimentats en sèrie.

Força dels camps magnètics	
0.00005 T	força del camp magnètic terrestre a l'Equador
0.005 T	força d'un imant de nevera
1.5 T	força d'un sistema mèdic de ressonància magnètica
1.5 T	força magnètica típica en els imants d'un accelerador
10 T	força magnètica en sistemes de recerca

Més de 400 fonts que alimenten a 700 imants 1,5 Megawatt de potència

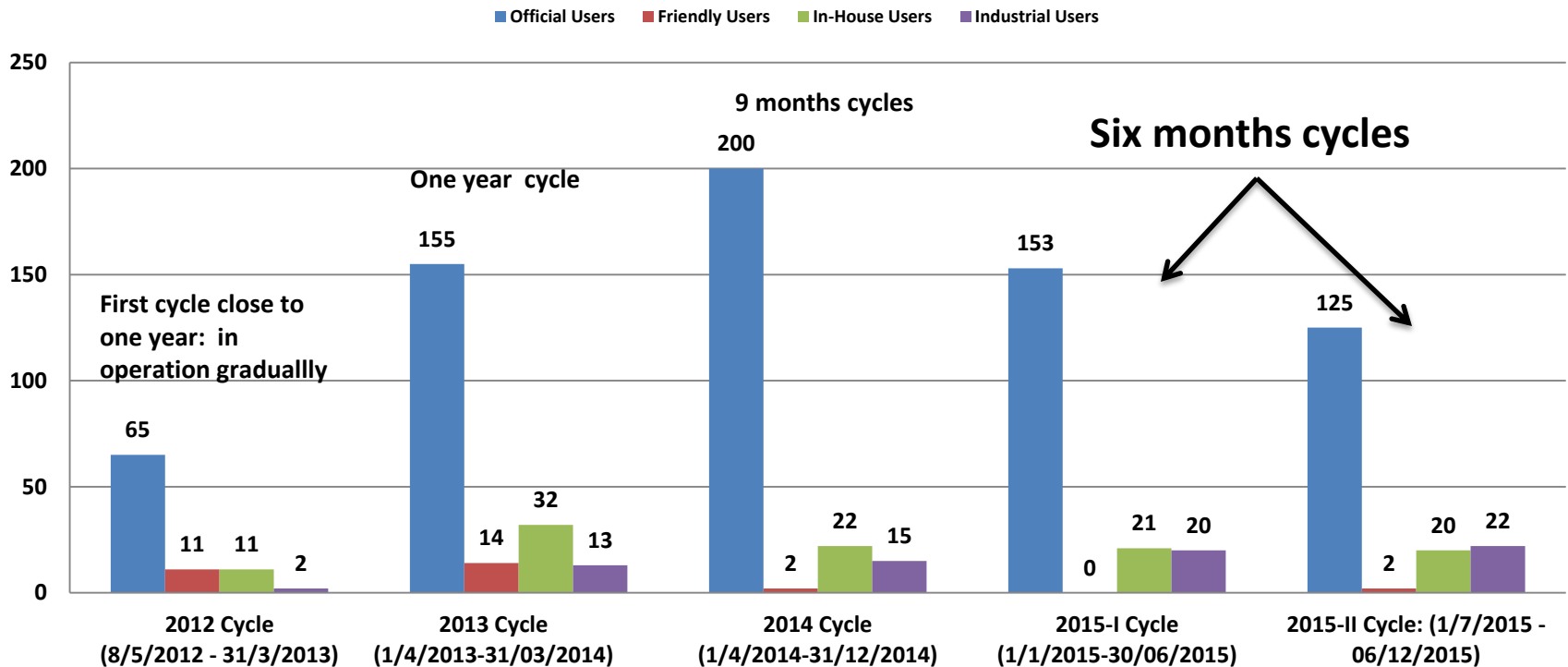
(La majoria de llars tenen entre 3 i 10 kwatt contractats)



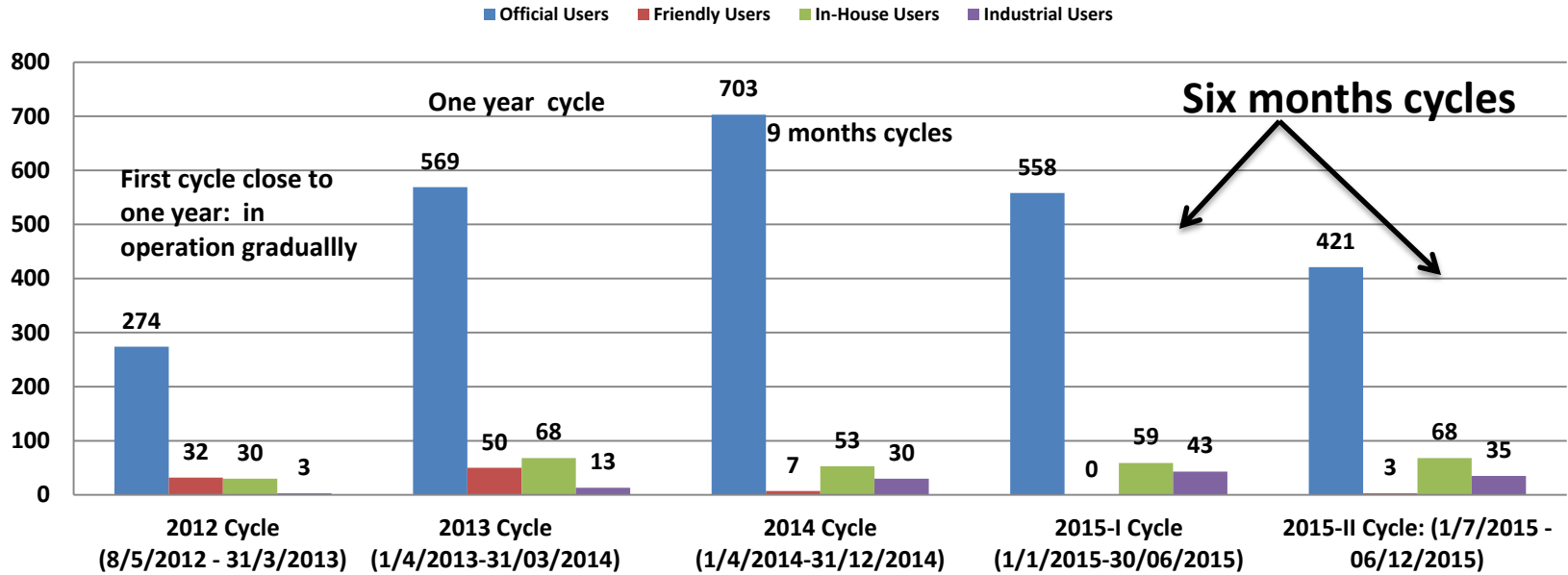
Font d'alimentació per als 32 imants dipolars que estan connectats en sèrie.

Annex 3: Experiments Evolution

Number of visits/experiments per cycle



Number of Users per cycle



Trend for 7 beamlines

- 1000 users per year
- 300 visits experiments per year

In-house collaborators tendency:

- 40 visits per year

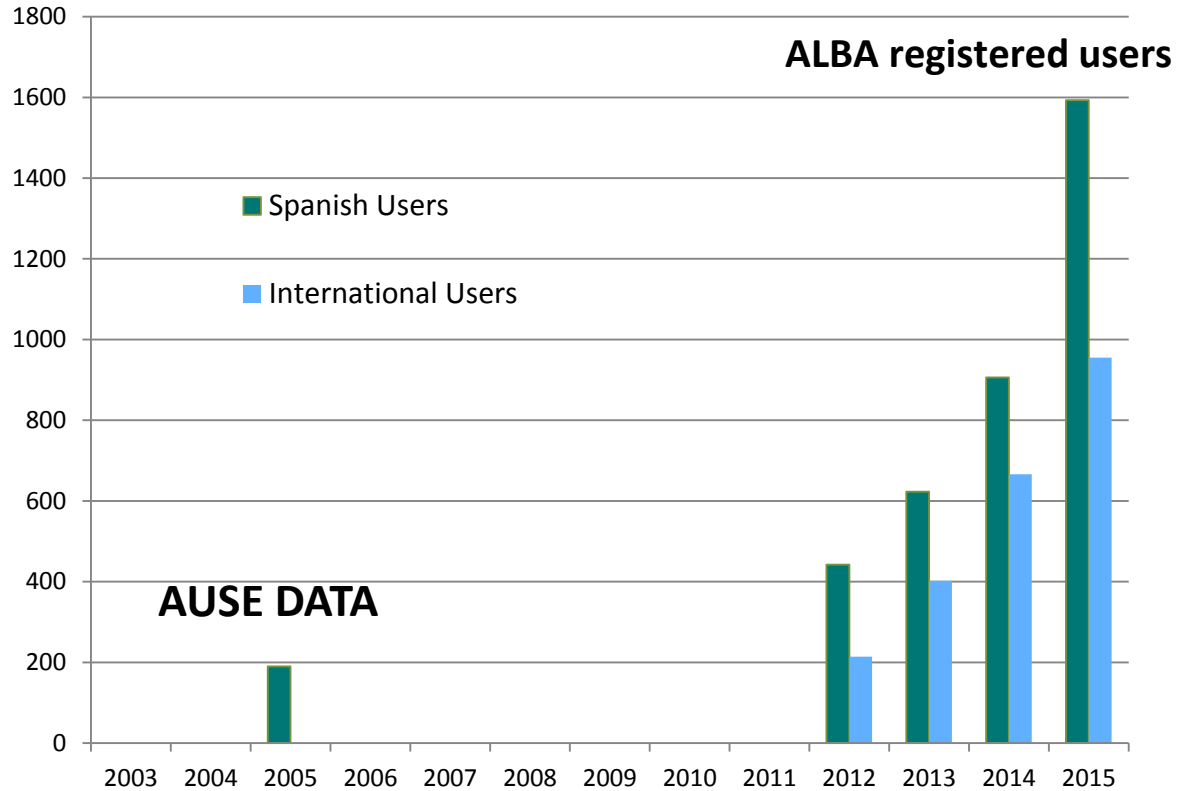
Industrial Office:

- >40 visits/80 users

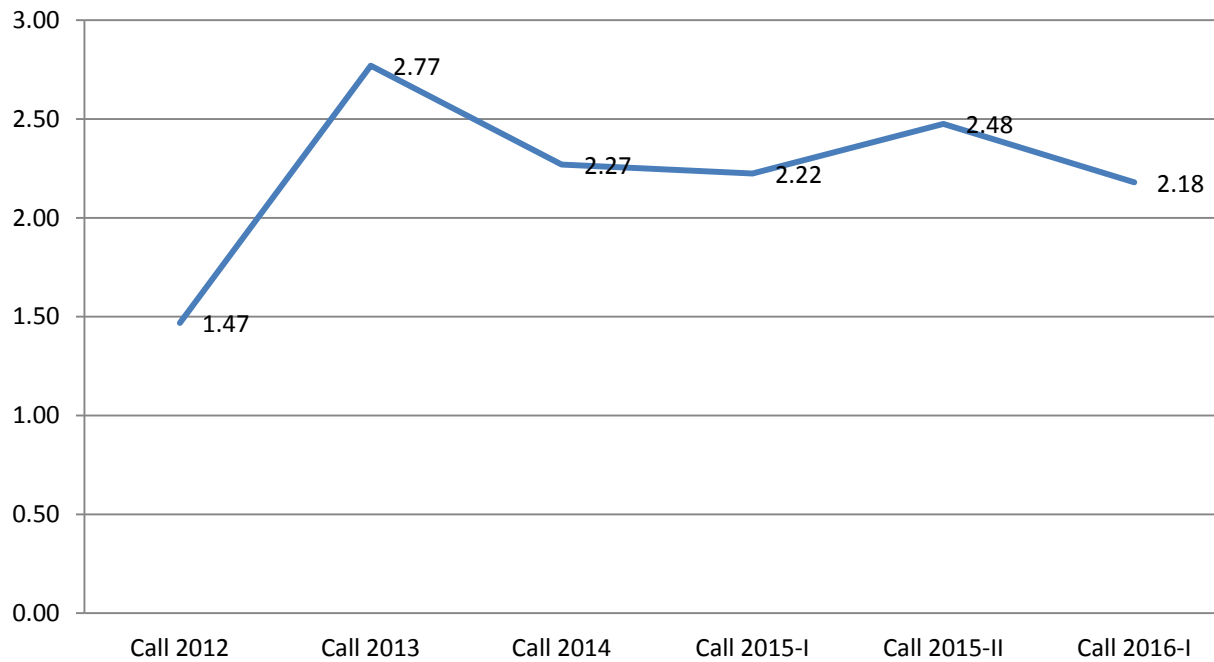
**Total registered Users:
2548 (1593 from Spain)**

**Registered Home
institutions:**

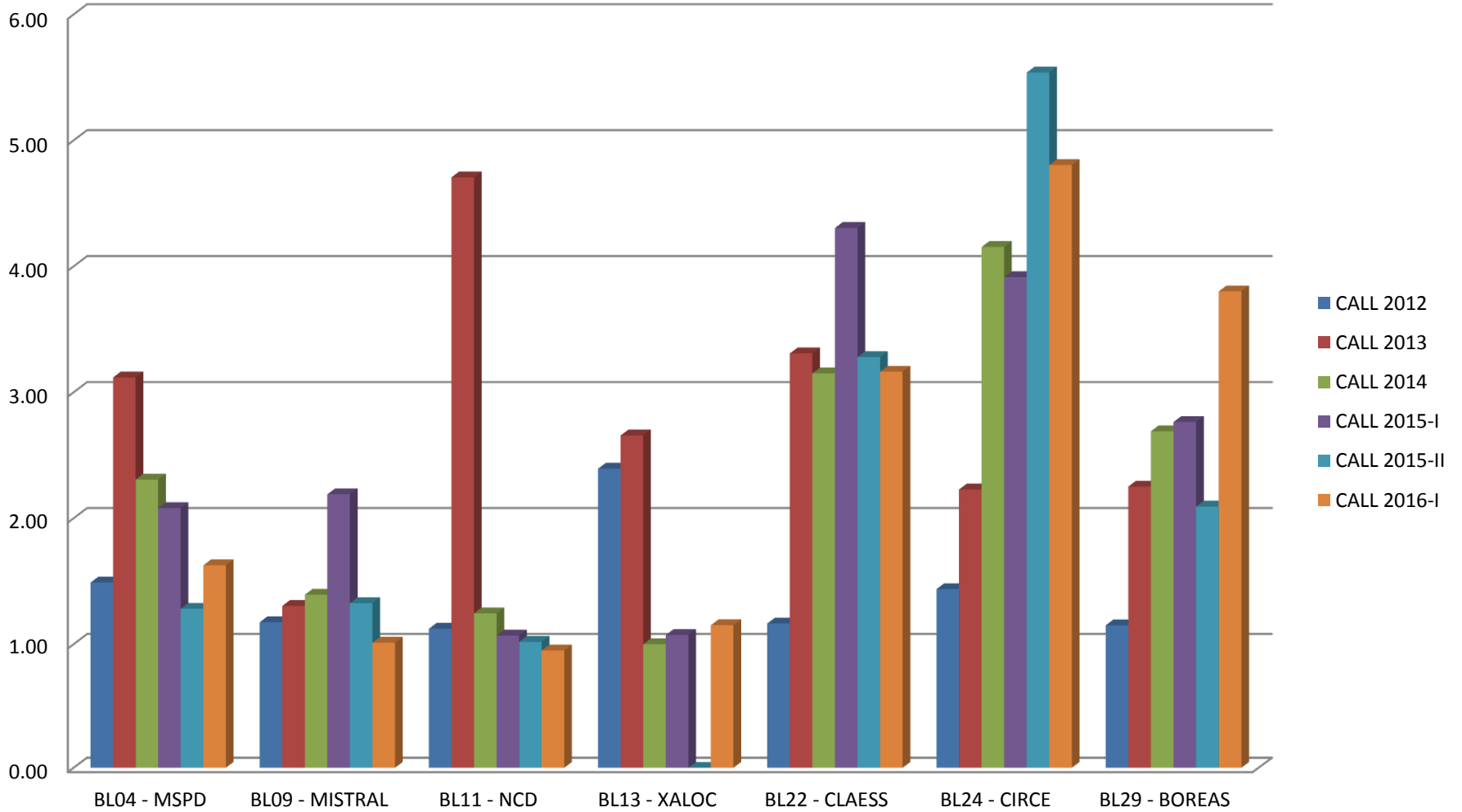
- Spanish Home Institutions: 404
- Foreign Home Institutions: 883



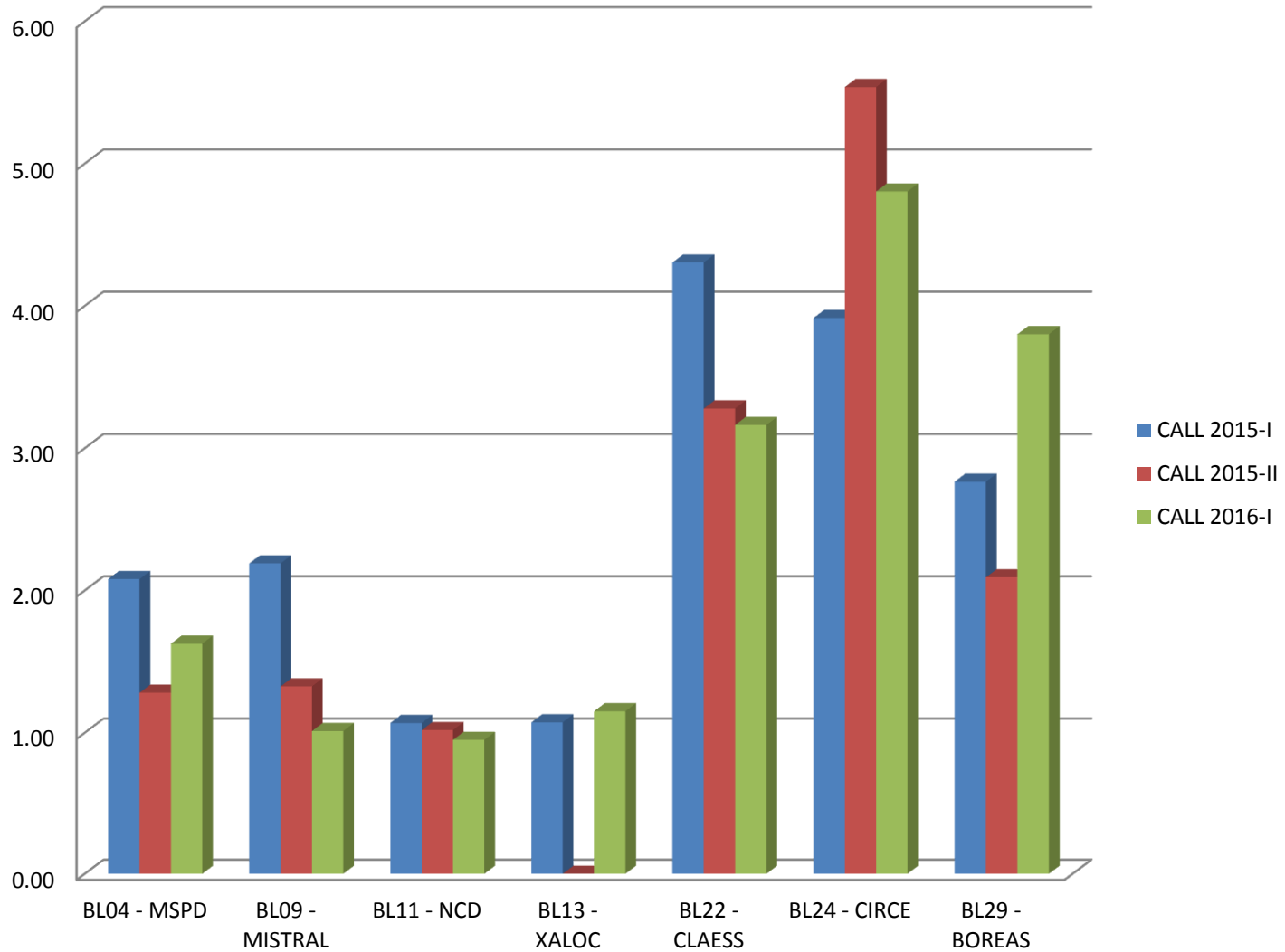
General Oversubscription



Oversubscription by BL



Oversubscription by BL in semesters cycles: 2015 & 2016-I



Annex 4

Facility name	Country	Continent	Energy	Circumfere	Commissioned for
CANDLE	Armenia	Europe	0,00	0	proposed
Australian Synchrotron	Australia	Oceania	3,00	216	2006
LNLS	Brazil	America	1,37	93,2	1997
Sirius	Brazil	America	3,00	518,2	Under Construction
Canadian Light Source	Canada	America	2,90	147	2004
National Synchrotron Radiation Laboratory (NSRL)	China	Asia	3,70	240	2008
Beijing Synchrotron Radiation Facility (BSRF)	China	Asia	2,50	0	1991
Shanghai Synchrotron Radiation Facility (SSRF)	China	Asia	3,50	432	2007
Beijing Electron-Positron Collider II (BEPC II)	China	Asia	0,00	0	1991
ASTRID	Denmark	Europe	0,58	40	1991
ASTRID 2	Denmark	Europe	0,00	0	planning
ACO (Anneau de Collisions d'Orsay)	France	Europe	6,00	844	1992
Electromagnétique)	France	Europe	0,54	0	1973
(LURE)	France	Europe	0,00	0	-
European Synchrotron Radiation Facility (ESRF)	France	Europe	1,00	0	1981
SOLEIL	France	Europe	0,80	0	1987
Centre Laser Infrarouge d'Orsay (CLIO)	France	Europe	3,00	354	2006
DESY (Deutsches Elektronen Synchrotron)	Germany	Europe	0,60	48	2008
DORIS (Doppel-Ring-Speicher)	Germany	Europe	7,40	0	1967
DORIS III	Germany	Europe	5,00	289	1974
PETRA II	Germany	Europe	5,00	289	1993
PETRA III	Germany	Europe	12,00	2304	1995
BESSY II	Germany	Europe	6,50	2304	2009
ANKA	Germany	Europe	1,50	115,2	-
MLS	Germany	Europe	1,70	240	1998
DELTA	Germany	Europe	2,50	110,4	2000
Indus 1	India	Asia	0,45	18,96	1999
Indus 2	India	Asia	2,50	173	2005
ILSF	Iran	Europe	3,00	300	Under Design
Superiore di Sanità ISS (Rome)	Italy	Europe	1,00	12	1963
Rome, ISS, INFN, Univ. of L'Aquila & Univ. of Camerino	Italy	Europe	0,51	32	1999
Ricerche (CNR) & INFN	Italy	Europe	1,00	12	1972
ELETTRA	Italy	Europe	1,50	33,5	1980
DAFNE light	Italy	Europe	2,30	260	1993
INS-SOR (Institute for Nuclear Studies-Synchrotron Orbital Radiation)	Japan	Asia	0,70	22	1997
Radiation)	Japan	Asia	0,00	0	-
Photon Factory (PF) at KEK	Japan	Asia	0,00	0	-
SPring-8	Japan	Asia	0,00	0	-
Hiroshima Synchrotron Radiation Center (HSRC)	Japan	Asia	0,00	0	-
Institute of Free Electron Laser (iFEL)	Japan	Asia	8,00	1436	1997
IR FEL Research Center (FEL-SUT)	Japan	Asia	0,75	0	1965
Medical Synchrotron Radiation Facility	Japan	Asia	0,30	0	1974
Nagoya University Small Synchrotron Radiation Facility (NSSR)	Japan	Asia	0,00	0	-
Photonics Research Institute	Japan	Asia	0,00	0	-
Saga Light Source (SAGA-LS)	Japan	Asia	2,50	187	1982
Ultraviolet Synchrotron Orbital Radiation Facility(UVSOR)	Japan	Asia	0,00	0	-
VSX Light Source	Japan	Asia	0,00	0	-
(SESAME)	Jordan	Asia	2,50	133	Under Construction
Physics	Netherlands	Europe	0,00	0	-
Synchrotron	Russia	Europe	0,00	0	-
Synchrotron U-70	Russia	Europe	70,00	0	1967
Kurchatov Synchrotron Radiation Source (SIBIR-1, SIBIR-2)	Russia	Europe	0,00	0	-
Dubna Electron Synchrotron (DELSY)	Russia	Europe	10,00	180	1957
Siberian Synchrotron Radiation Centre (SSRC)	Russia	Europe	2,50	124	1999
TNK F,V Lukin Institute	Russia	Europe	0,00	0	-
Singapore Synchrotron Light Source (SSLS)	Singapore	Asia	0,70	10,8	2000
Pohang Accelerator Laboratory	South Korea	Asia	0,00	0	-
ALBA	Spain	Europe	3,00	270	2010
MAX-I	Sweden	Europe	1,50	96	expected June 2016
MAX-II	Sweden	Europe	3,00	528	expected June 2016
MAX-III	Sweden	Europe	0,55	30	1986
MAX IV 1,5 GeV Storage Ring	Sweden	Europe	1,50	90	1997
MAX IV 3 GeV Storage Ring	Sweden	Europe	0,70	36	2008
Proton Synchrotron	Switzerland	Europe	209,00	26659	1989
Large Electron-Positron Collider (LEP)	Switzerland	Europe	7000,00	26659	2008
Swiss Light Source	Switzerland	Europe	28,00	628,3	1959
Large Hadron Collider (LHC)	Switzerland	Europe	2,80	288	2001
Taiwan Light Source	Taiwan	Asia	1,50	120	1993
Taiwan Photon Source	Taiwan	Asia	3,00	518,4	2015
Synchrotron Light Research Institute (SLRI)	Thailand	Asia	1,20	81,4	2004
Birmingham synchrotron	UK	Europe	2,00	96	1981
Nimrod	UK	Europe	3,00	561,6	2006
Synchrotron Radiation Source	UK	Europe	0,80	163	1985
ISIS	UK	Europe	7,00	0	1957
Diamond Light Source	UK	Europe	1,00	0	1953
National Synchrotron Light Source (NSLS-II)	US	America	7,00	1104	1995
Cosmotron	US	America	33,00	800	1960
Bevatron	US	America	3,00	72	1953
Alternating Gradient Synchrotron (AGS)	US	America	2,80	170	1982
SURF (SYNCHROTRON ULTRAVIOLET RADIATION FACILITY) Synchrotron	US	America	3,00	792	2015
SURFII storage ring, Synchrotron Ultraviolet Radiation Facility	US	America	5,50	768	1979
Tantalus at the Synchrotron Radiation Center	US	America	1000,00	6300	1983
Synchrotron Radiation Center (SRC)	US	America	1,90	196,8	1993
Stanford Synchrotron Radiation Lightsource (SSRL)	US	America	6,00	114	1954
Cornell High Energy Synchrotron Source (CHESS)	US	America	1,50	0	-
National Synchrotron Light Source (NSLS)	US	America	0,18	0	1961
Tevatron	US	America	0,25	0	1974
Advanced Light Source (ALS)	US	America	3,00	234	1973
Advanced Photon Source (APS)	US	America	1,00	121	1987
Center for Advanced Microstructures and Devices (CAMD)	US	America	0,24	9,38	1968
	Mitjana		95	878	1987
	Mediana		2	92	1991
	Moda		3	96	



Annex 5: Gama ASTM

Tubos soldados y sin soldadura

Dimensiones según ASME / ANSI B 36.19 y B 36.10
Pesos lineales en lbs/pie y Kg/metro.

Pulgadas nominales	Diámetro D	Schedule 5 S		Schedule 10 S		Schedule 40 S/STD		Schedule 80 S/XS		Schedule 160		Schedule XXS	
	Exterior	Espesor T	Peso	Espesor T	Peso	Espesor T	Peso	Espesor T	Peso	Espesor T	Peso	Espesor T	Peso
	Pulgadas	Pulgadas	lbs/p	Pulgadas	lbs/p	Pulgadas	lbs/p	Pulgadas	lbs/p	Pulgadas	lbs/p	Pulgadas	lbs/p
	mm	mm	Kg/m	mm	Kg/m	mm	Kg/m	mm	Kg/m	mm	Kg/m	mm	Kg/m
1/4"	0.540			0.065	0.33	0.088	0.43	0.119	0.54				
	13,72			1,65	0,49	2,24	0,64	3,02	0,80				
3/8"	0.675			0.065	0.42	0.091	0.57	0.126	0.74				
	17,15			1,65	0,63	2,31	0,85	3,20	1,11				
1/2"	0.840	0.065	0.54	0.083	0.68	0.109	0.86	0.147	1.10	0.188	1.32		
	21,34	1,65	0,81	2,11	1,01	2,77	1,28	0,73	1,64	4,78	1,97		
3/4"	1.050	0.065	0.69	0.083	0.87	0.113	1.14	0.154	1.49	0.219	1.97	0.308	2.48
	26,67	1,65	1,03	2,11	1,30	2,87	1,71	3,91	2,23	5,56	2,94	7,82	3,70
1"	1.315	0.065	0.88	0.109	1.42	0.133	1.70	0.179	2.20	0.250	2.88	0.358	3.71
	33,40	1,65	1,31	2,77	2,12	3,38	2,54	4,55	3,28	6,35	4,29	9,09	5,53
1 1/4"	1.660	0.065	1.12	0.109	1.83	0.140	2.31	0.191	3.04	0.250	3.82	0.382	5.29
	42,16	1,65	1,67	2,77	2,73	3,56	3,44	4,85	4,53	6,35	5,70	9,70	7,89
1 1/2"	1.900	0.065	1.29	0.109	2.11	0.145	2.76	0.200	3.67	0.281	4.93	0.400	6.51
	48,26	1,65	1,92	2,77	3,16	3,68	4,11	5,08	5,49	7,14	7,36	10,16	9,70
2"	2.375	0.065	1.62	0.109	2.68	0.154	3.70	0.218	5.09	0.343	7.57	0.436	9.16
	60,33	1,65	2,42	2,77	3,99	3,91	5,52	5,54	7,59	8,71	11,26	11,07	13,64
2 1/2"	2.875	0.083	2.51	0.120	3.58	0.203	5.88	0.276	7.77	0.375	10.16	0.552	13.90
	73,03	2,11	3,74	3,05	5,34	5,16	8,76	7,01	11,58	9,52	15,14	14,02	20,70
3"	3.500	0.083	3.07	0.120	4.40	0.216	7.69	0.300	10.41	0.438	14.55	0.600	18.86
	88,90	2,11	4,58	3,05	6,55	5,49	11,46	7,62	15,50	11,13	21,66	15,24	28,10
3 1/2"	4.000	0.083	3.52	0.120	5.05	0.226	9.25	0.318	12.70				
	101,60	2,11	5,25	3,05	7,52	5,74	13,7	8,08	18,81				

Tolerancias

Espesor nominal	Diámetro nominal	Diámetro exterior		Longitud
		+	-	
Todas dimensiones - según ASTM A-530 - 12,5%	1/8" a 1 1/2"	0,4 mm	0,8 mm	Ø de 1/8" a 8" Largos 4,6 a 7,3 m Tolerancia: por acuerdo Largos fijos Tolerancia: + 6 mm - 0 mm
	2" a 4"	0,8 mm	0,8 mm	
	5" a 8"	1,6 mm	0,8 mm	
	10" a 18"	2,4 mm	0,8 mm	
	20" a 26"	3,2 mm	0,8 mm	
	28" a 34"	4 mm	0,8 mm	
	36" a 48"	4,8 mm	0,8 mm	



Tubos soldados y sin soldadura

Dimensiones según ASME / ANSI B 36.19 y B 36.10
Pesos lineales en lbs/pie y Kg/metro.

Pulgadas nominales	Diámetro D	Schedule 5 S		Schedule 10 S		Schedule 40 S/STD		Schedule 80 S/XS		Schedule 160		Schedule XXS	
	Exterior	Espesor T	Peso	Espesor T	Peso	Espesor T	Peso	Espesor T	Peso	Espesor T	Peso	Espesor T	Peso
	Pulgadas	Pulgadas	lbs/p	Pulgadas	lbs/p	Pulgadas	lbs/p	Pulgadas	lbs/p	Pulgadas	lbs/p	Pulgadas	lbs/p
	mm	mm	Kg/m	mm	Kg/m	mm	Kg/m	mm	Kg/m	mm	Kg/m	mm	Kg/m
4"	4.500	0.083	3.98	0.120	5.70	0.237	10.95	0.337	15.21	0.531	22.85	0.674	27.54
	114,30	2,11	5,93	3,05	8,49	6,02	16,32	8,56	22,66	13,49	34,04	17,12	41,64
5"	5.563	0.109	6.45	0.134	7.88	0.258	14.83	0.375	21.08	0.625	33.47	0.750	32.53
	141,30	2,77	9,61	3,40	11,74	6,55	22,09	9,52	31,40	15,87	49,82	19,05	58,29
6"	6.625	0.109	7.72	0.134	9.42	0.280	19.26	0.432	29.00	0.718	46.04	0.864	53.16
	168,28	2,77	11,50	3,40	14,03	7,11	28,69	10,97	43,20	18,24	60,58	21,95	80,31
8"	8.625	0.109	10.1	0.148	13.40	0.322	29.00	0.500	44.05	0.906	75.82	0.875	72.42
	219,08	2,77	15,0	3,76	19,94	8,18	43,18	12,70	65,61	23,01	112,9	22,23	109,50
10"	10.750	0.134	15.4	0.165	18.70	0.365	41.13	0.500	55.57	1.125	117.4	1.000	104.13
	273,05	3,40	22,9	4,19	27,83	9,27	61,22	12,70	82,78	28,57	174,9	25,40	154,97
12"	12.750	0.156	21.3	0.180	24.20	0.375	49.56	0.500	66.41	1.312	162.8	1.000	125.49
	323,85	3,96	31,7	4,57	36,00	9,52	73,82	12,70	98,89	33,34	242,5	25,40	186,77
14"	14.000	0.156	23.4	0.188	27.73	0.375	54.57	0.500	72.09	1.406	192.0		
	355,60	3,96	34,9	4,78	41,30	9,52	81,28	12,70	109,00	37,71	285,9		
16"	16.000	0.165	28.2	0.188	31.75	0.375	62.58	0.500	82.77	1.549	244.9		
	406,40	4,19	42,0	4,78	47,29	9,52	93,21	12,70	123,29	40,49	364,85		
18"	18.000	0.165	31.9	0.188	35.77	0.375	70.59	0.500	93.45	1.781	308.55		
	457,20	4,19	47,5	4,78	53,26	9,52	105,14	12,70	139,19	45,24	459,15		
20"	20.000	0.188	40.4	0.218	46.06	0.375	78.60	0.500	104.13	1.969	379.14		
	508,00	4,78	60,2	5,54	68,50	9,52	117,07	12,70	155,10	50,01	564,14		
24"	24.000	0.218	55.37	0.250	63.41	0.375	94.62	0.500	125.49	2.344	542.13		
	609,60	5,54	84,16	6,35	96,33	9,52	141,12	12,70	187,07	59,54	823,66		

Aplicación: Para trabajos a alta temperatura y ambiente corrosivo.

Fabricación: La tubería será soldada, sin aportación de material o sin soldadura.

Análisis químico: Ver tabla página 6.

Los valores indicados para pesos lineales corresponden a aceros austeníticos y han sido calculados según la fórmula:

$$P = \frac{T(D-T)}{K} \text{ (Para una densidad de 7,97, } K = 40)$$

Para calcular los pesos lineales de aceros ferríticos, multiplicar los valores de la tabla por el factor 0,97 (correspondiente a una densidad de 7.73)

$$\text{Peso lineal en lbs./p} = \frac{\text{Peso lineal en Kg./m.}}{1.4895}$$



Tubos para intercambiador de calor. Soldados y sin soldadura de acero inoxidable

Diámetro		Galga, B.W.G						
		22	20	18	16	14	12	11
Pulgadas	mm	Espesor / mm						
		0,71	0,89	1,24	1,65	2,11	2,77	3,05
		Peso: Kg/m						
5/8"	15,88	0,288	0,334	0,455	0,588	0,728	-	-
3/4"	19,05	0,348	0,405	0,553	0,719	0,895	-	-
1"	25,40	0,469	0,546	0,750	0,981	1,231	1,570	1,707
1 1/4"	31,80	-	-	0,949	1,246	1,569	2,014	2,196
1 1/2"	38,10	-	-	1,144	1,506	1,902	2,451	2,677
1 3/4"	44,45	-	-	1,342	1,768	2,237	2,891	3,162
2"	50,80	-	-	1,539	2,031	2,573	3,331	3,647
2 1/4"	57,15	-	-	1,736	2,293	2,908	3,772	4,132
2 3/8"	60,30	-	-	1,834	2,423	3,074	3,990	4,372
2 1/2"	63,50	-	-	1,933	2,555	3,244	4,212	4,617
2 3/4"	69,90	-	-	2,132	2,820	3,582	4,656	5,105
3"	76,20	-	-	2,327	3,080	3,915	5,093	5,587
3 1/2"	88,90	-	-	-	3,605	4,585	5,974	6,557
4"	101,60	-	-	-	4,130	5,256	6,855	7,526
4 1/2"	114,30	-	-	-	4,654	5,927	7,736	8,496

Normas: ASTM A-213, A-249, A-269

Tolerancias: según ASTM A-450

Calidad del material: AISI 304 / 304 L, 316 / 316 L.

Otras calidades especiales bajo consulta.

Equivalencia Galgas B.W.G

BWG (Birmingham Wire Gauge)		
BWG	Pulgadas	milímetros
22	0,028	0,711
20	0,035	0,889
19	0,042	1,066
18	0,049	1,244
17	0,058	1,473
16	0,065	1,651
15	0,072	1,828
14	0,083	2,108
13	0,095	2,413
12	0,109	2,768
11	0,120	3,048
10	0,134	3,403
9	0,148	3,759
8	0,165	4,191
7	0,180	4,572
6	0,203	5,156
5	0,220	5,588
4	0,238	6,045
3	0,259	6,578
2	0,284	7,213
1	0,300	7,620
0	0,340	8,636



Grupo motobomba, completo, con cuerpo de bomba y motor de accionamiento acoplado, de las características siguientes:

- REFERENCIA DEL PROYECTO: P07

Cuerpo de bomba:

- Marca: Bombas Itur
- Modelo: NM-65/250B
- Tipo: DIN-22858
- Material de cuerpo, tapa, impulsor, eje, anillo de desgaste y camisa: AISI 316
- Fluido a bombear: Agua Desionizada
- Temp. del fluido a bombear: 22 °C
- Caudal del fluido a bombear: 84,7 m³/h
- Altura manométrica: 101 m
- Potencia absorbida: 36,73 kW
- Diámetro del rodete: 250 mm

Motor de accionamiento:

- Marca: Siemens
- Tipo: Jaula de Ardilla
- Arranque: Estrella triángulo
- Velocidad: 3000 rpm
- Protección: IP-55
- Aislamiento: Clase F
- Potencia: 45 kW
- Tensión eléctrica: 400V/50 Hz

El grupo incluirá los elementos siguientes:

- Bancada metálica común para cuerpo de bomba y motor, con chapa de protección del acoplamiento.
- Acoplamiento elástico del motor al cuerpo de bomba.
- Bridas normalizadas: Aspiración e impulsión PN-16.
- Chapa troquelada en el cuerpo de la bomba, con sus características y con nuestra referencia.



Datos Técnicos

Oferta N° **N140004-G014-05**

Proyecto **SINCROTRON NM-NL-IN-ETALINE Z**

Fecha **29/05/2007**

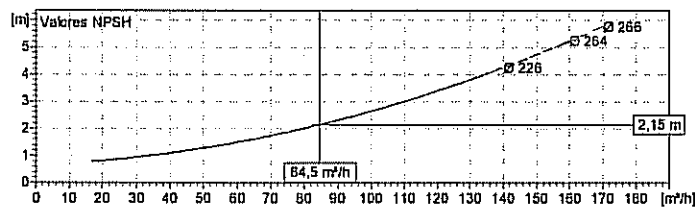
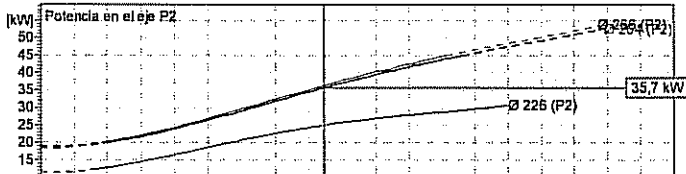
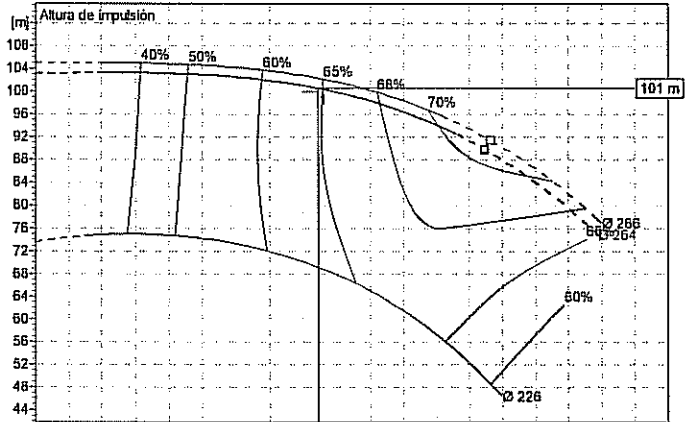
Página 4 / 25

140004

Cliente **AXIMA SISTEMAS E INSTALACIONES,S.A.**

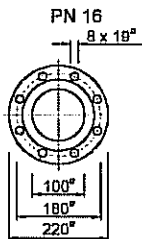
Posición **P07**

Plazo de entrega: **General**

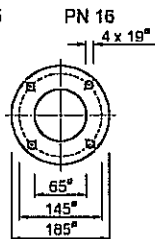


DNs Lado aspiración
EN1092/DIN
DN 100

DNd Lado impulsión
EN1092/DIN
DN 65



Bocas



Características de funcionamiento requeridas

Fluido **Agua, limpia** 100 %
Temp: **20 °C** Dens: **0,9983 kg/dm³** Visc: **1,005 cSt**
Caudal **84,3** m³/h
Altura **100** m

Datos de la bomba

Tipo **NM-65/250B**
Tipo de construcción **Grupo con Motor (distanciador)**
Tipo de rodete **Cerrado**
Ancho de salida **15** mm
Bocas asp-imp **DIN_PN-16**

Datos hidráulicos (según ISO 9906-2A)

Caudal **84,5** m³/h
Altura manométrica **101** m
Velocidad **2960** rpm
Rendimiento **64,7** %
Potencia absorbida **35,7** kW

Materiales

Cuerpo de bomba **Acero Inoxidable (CF8M)**
Tapa de bomba **Acero Inoxidable (CF8M)**
Impulsor **Acero Inoxidable (CF8M)**
Eje de bomba **Acero Inoxidable (AISI-316L)**
Anillo desgaste cuerpo **Acero Inoxidable (AISI-316L)**
Camisa recambiable **Acero Inoxidable**

Ejecución: 4205

Sellado del eje

Cierre mecánico **DIN-K**
Tipo **ITUR DIN K**
Materiales / Junta **CS/GR-NI**

Acoplamiento

Tipo de acoplamiento **ITUR con espaciador**
FH-125-140
Protección del acoplamiento **Estándar**

Datos del motor

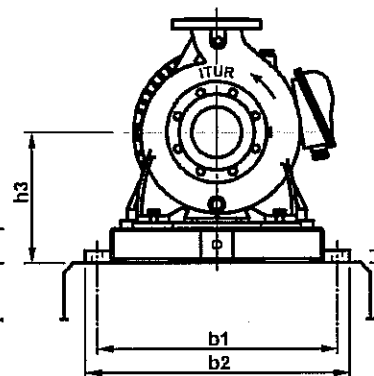
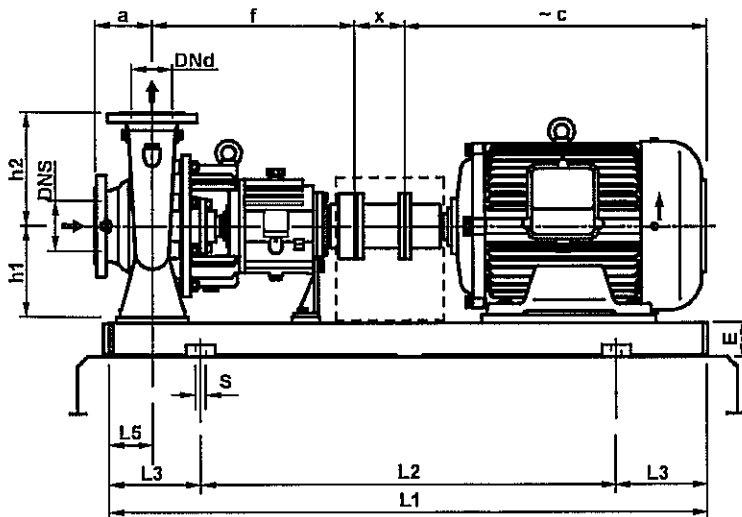
Trifásico Terrestre **IP-55**
Potencia nominal P2 **45 kW**
Velocidad **2960 rpm** 50 Hz
Tensión nominal **400V**
Intensidad nominal **79 A**
Tipo de protección **IP 55**
Clase de aislamiento **F**
Clase de temperatura **B**

ITUR

Tamaño **225 M**

Bancada **3661-7**

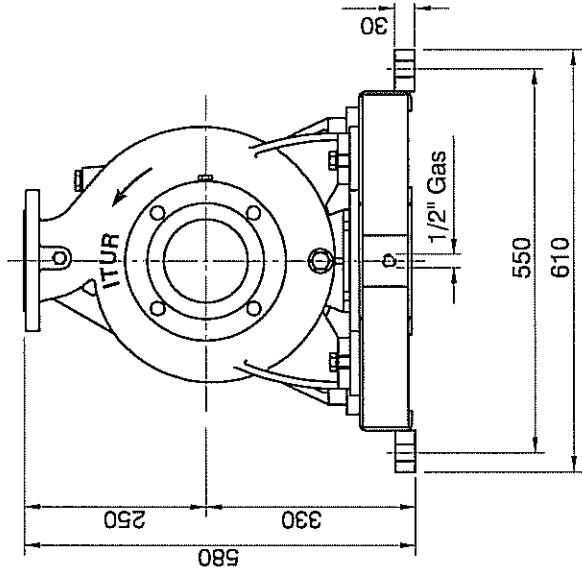
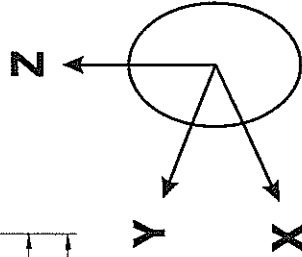
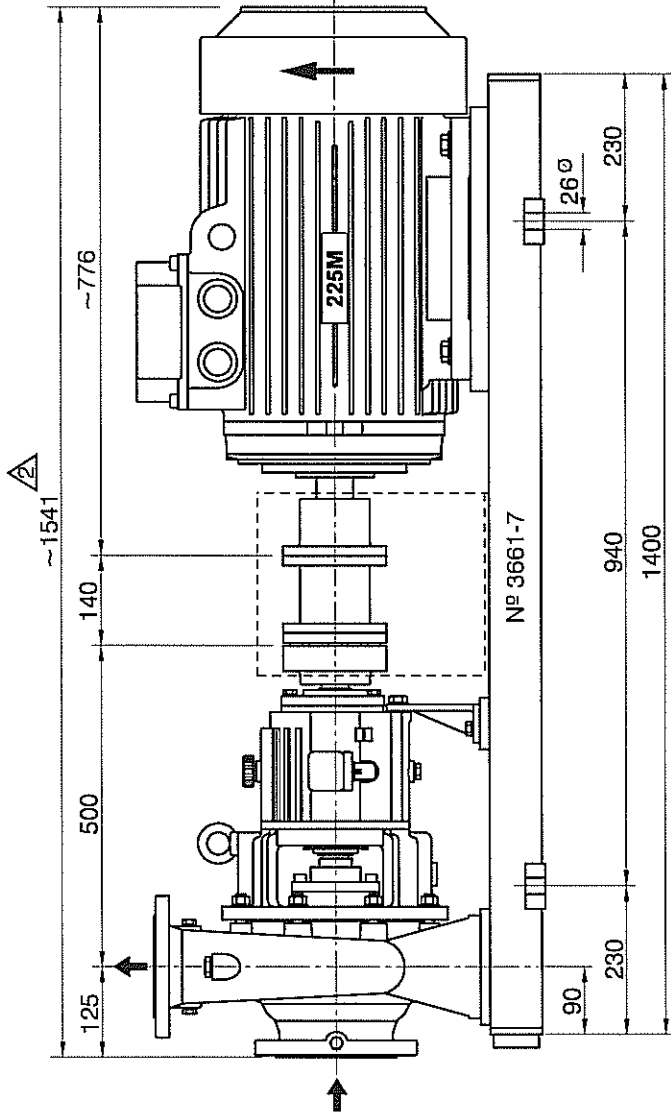
Dimensiones en mm



a	125
b1	550
b2	610
c	778
DNd	65
DNs	100
E	85
f	500
h1	200
h2	250
h3	330
L1	1400
L2	940
L3	230
L5	90
S	26
T	30
x	140

Peso **447 kg**

GRUPO ELECTROBOMBA CENTRIFUGA ITUR TIPO : NM-65/250 B
ELECTRIC DRIVEN CENTRIFUGAL PUMP ITUR TYPE :
GROUPE ELECTROPOMPE CENTRIFUGE ITUR TYPE :

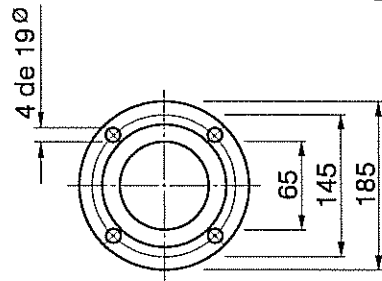


CARGAS EN FUNDACIONES - FUNDATION LOADS CHARGES SUR FONDATIONS		X		Y		Z		PERNOS FUNDACION-ANCHOR BOLTS BOULONS DE FONDATIONS		CANTIDAD-CANTITY DE-OF DIL		
FUERZA-FORCE-SENS	N	3.640	3.290	10.895	TRACCIÓN-TRACTION /PERNO - BOLT /BOULON		CORTADURA-SHEARING /PERNO - BOLT /BOULON		DIMENSIONES EN mm. - DIMENSIONS IN mm.		DIRECCIONES DE TENDIDO-PEINTED DEVIATIONS -3 mm.	
MOMENTOS-MOMENT COUPLE-Nm		3.803	7.968	6.447	CARGAS EN TOBERAS-HOZZLE LOADS CHARGES SUR TOUVERIA		PESO WEIGHT FLANGE		BRIDA FLANGE		VELOCIDAD-SPEED-VELOCITE	
ESTRUEBOS VIBRACIONES	Fx	Fy	Fz	Mx	My	Mz	447 Kg.		45 KW		3.000 R.P.M.	
LABRIFICAC. SUC.FLANG.	2.345	2.100	1.890	1.225	875	1.015	447 Kg.		45 KW		3.000 R.P.M.	
ELABORACION DEL FLANG. ELABO.DREF.	1.295	1.190	1.470	1.050	770	840	447 Kg.		45 KW		3.000 R.P.M.	

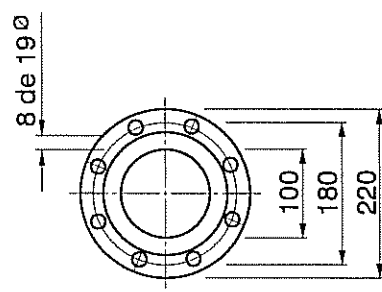
ITEM: P07

Dibujado Drawn Design	Fecha Date	Firma Name Signature	16-02-07	E.E.	Comprobado Checked Verifié	Fecha Date	Firma Name Signature	28-11-07	27-11-07	28-11-07	27-11-07
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CLIENTE : AXIMA SISTEMAS E INSTAL.		CONTRATO - COMMANDE ORDER	
CUSTOMER :		Nº 155526-01/001 Rev.2	
PLANO DIMENSIONAL DIMENSIONAL DRAWING		Nº	
PLAN D'ENCOMBREMENT		KSB	
BOMBAS ITUR		ITUR	

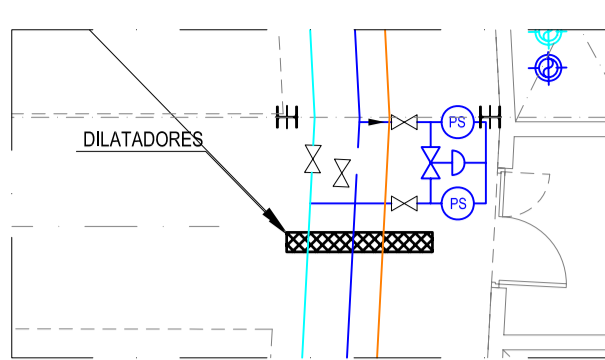
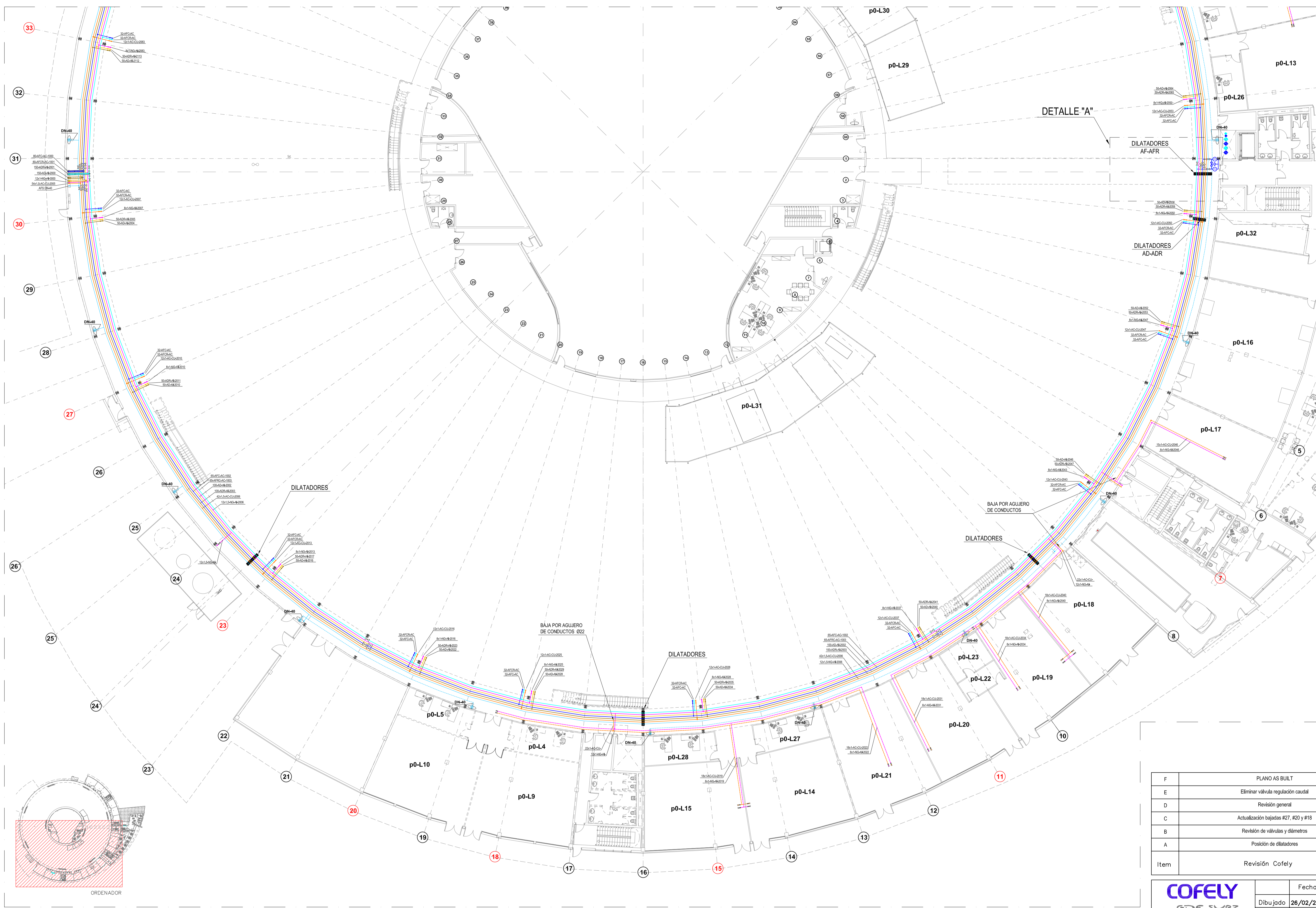


Brida de impulsión
Delivery flange
Bride de refoulement



Brida de aspiración
Suction flange
Bride d'aspiration

2	Cambiar cota	28-11-07	28-11-07	28-11-07	28-11-07	28-11-07	28-11-07
1	Cargas en toberas y fund.	27-11-07	27-11-07	27-11-07	27-11-07	27-11-07	27-11-07
Rev.	Modificación						



COORDINACION LINEAS

DIAMETRO NOMINAL (mm)	150-175-200-225-250-300-350-400-450-500
MATERIAL	ACERO INOXIDABLE ABSTINER
ESPEC. TUBO	ACERO AL CARBONO SEGUN EN 10217-2
NUMERO DE LINEA	1-10

SIMBOLOGIA

AD	IMPULSION AGUA DEBENDADA
ADR	RETORNO AGUA DEBENDADA
AC	AIRE COMPRIMIDO
AFC	IMPULSION AGUA FRIA CLIMATIZACION
AFCR	RETORNO AGUA FRIA CLIMATIZACION
NG	NITROGENO GAS
SIMBOLO	DESIGNACION

SIMBOLOGIA

∅	PLACA DE ORIFICIO
∅2	VÁLVULA REGULACION
∅	REDUCCION CONCENTRICA
∅∅	AMORTIGUADOR VIBRACIONES
∅∅	VÁLVULA DE CORTE
∅∅	VÁLVULA DE CONTROL DE 3 VÍAS
∅∅	VÁLVULA TODODONDA
∅∅	VÁLVULA TODODONDA DE 3 VÍAS
SIMBOLO	DESIGNACION

F	PLANO AS BUILT	05-08-09	R.R.G.	D.X.
E	Eliminar válvula regulación caudal	09-10-08	R.R.G.	D.X.
D	Revisión general	01-08-08	R.R.G.	D.X.
C	Actualización bajadas #27, #20 y #18	22-04-08	R.R.G.	D.X.
B	Revisión de válvulas y diámetros	13-03-08	R.R.G.	D.X.
A	Posición de dilataores	16-11-07	R.R.G.	D.X.
Item	Revisión Cofely	Fecha	Dibujado	Visado

COFELY GDF SVEZ	Fecha	Nombre	Aprobacion por MASTER:	V.B. CELLS
	Dibujado 26/02/2007	R.R.G.		
	Revisado 26/02/2007	D.X.	FECHA:	

CELLS BLOC CL. EDIFICI GENERS CAMPUS UAB SERIS BELLATERRA (BARC)	ALBA	Life cycle	Size A1	Doc No. Annex 7	1.25201.00568.037-A
Título IMPLANTACION. AREA EXPERIMENTAL PB. AGUA REFRIGERACION. AIRE COMPRIMIDO.		Nombre del proyecto PROYECTO DEL CELLS			
		Referencia 2 07 1 05 2			
		Referencia 91A/04 AS			

2	Revisión general	Abril-06	F. RANGEL	J.M. RIMBAU
1	Revisión general	Marzo-06	F. RANGEL	J.M. RIMBAU
Item	Revisión	Fecha	Dibujado	Visado

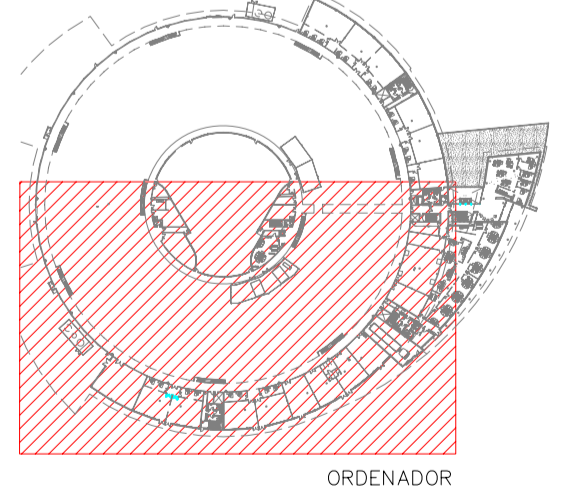
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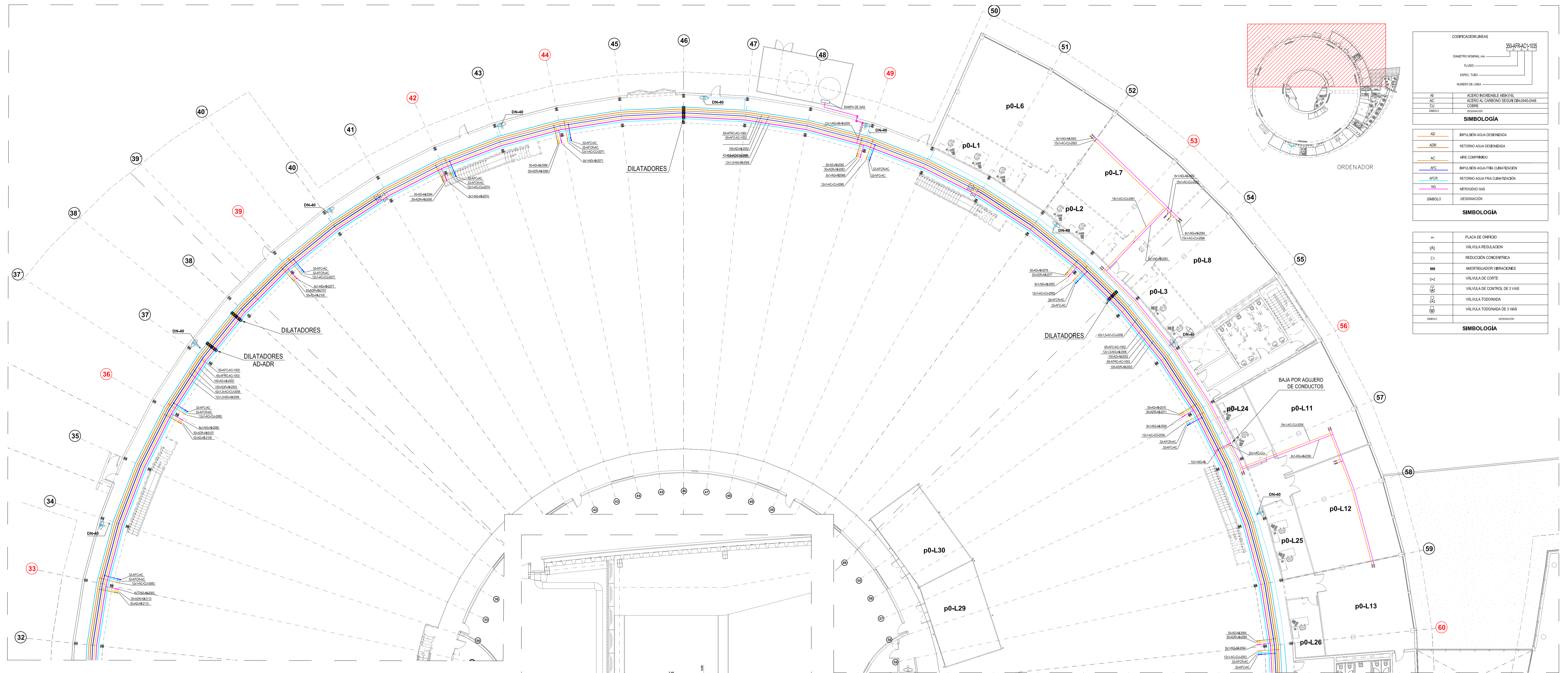
Reg.Merc.Barcelona,Hoja 21147,Tomo 2112. Folio 34,Libro 1512,Seccion 2°.

Copia emitida en fecha	Objeto
Autorizada por	

	Fecha	Nombre	Firma	Escala
Dibujado	ABRIL 2006	F. RANGEL		1/200
Proyectado	ABRIL 2006	J.M. RIMBAU		
Revisado	ABRIL 2006	J.M. RIMBAU		
Aprobado	ABRIL 2006	F. VELARDE		
Coordinador del Proyecto	General	ALFONS PERDRIX		Sustituye a
				Sustituido por
				Archivo N.

DIRECCION





COORDINACION LINEAS

50-AFR-AC-1003

DIAMETRO NOMINAL mm

FLUIDO

ESPEC. TUBO

NUMERO DE LINEA

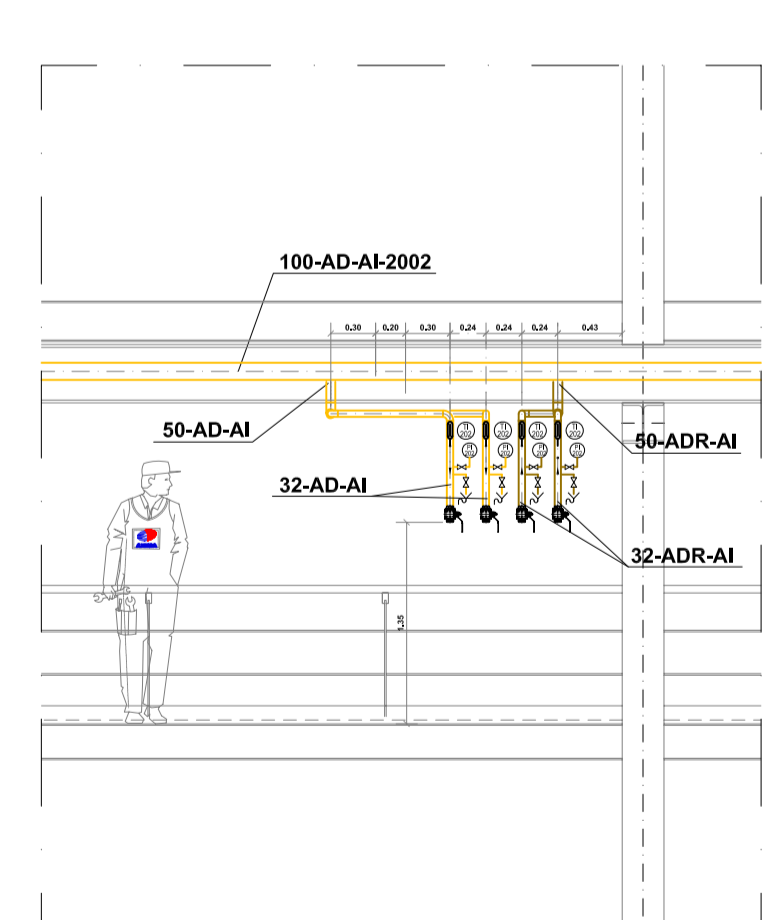
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AC	ACERO AL CARBONO SEGUN EN 10204
CU	COPPER
NG	NITROGENO

SIMBOLOGIA

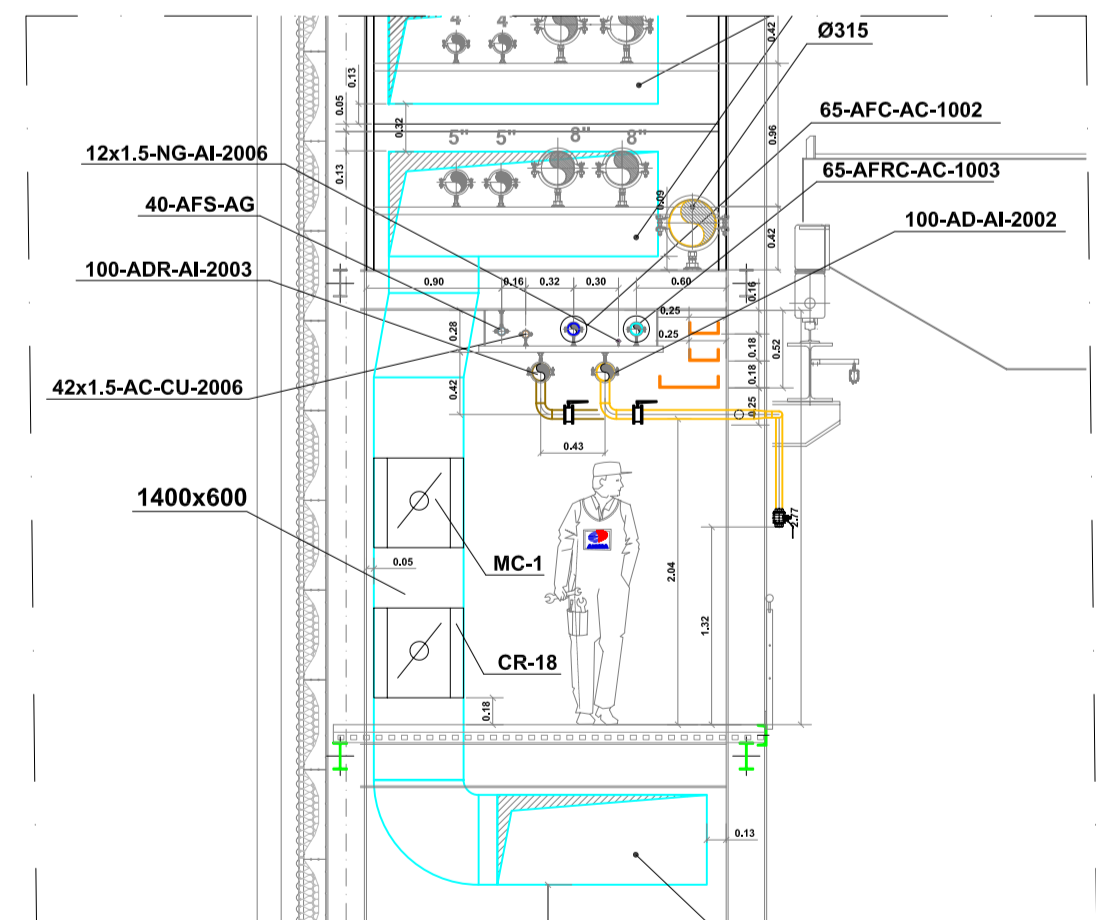
AD	IMPULSION AGUA DESMINERALIZADA
ADR	RETORNO AGUA DESMINERALIZADA
AC	AGUA COMPRIMIDA
AFS	IMPULSION AGUA FREIA CLIMATIZACION
AFR	RETORNO AGUA FREIA CLIMATIZACION
NG	RETORNO GAS
NG	IMPULSION GAS
SIMBOLO	DESIGNACION

SIMBOLOGIA

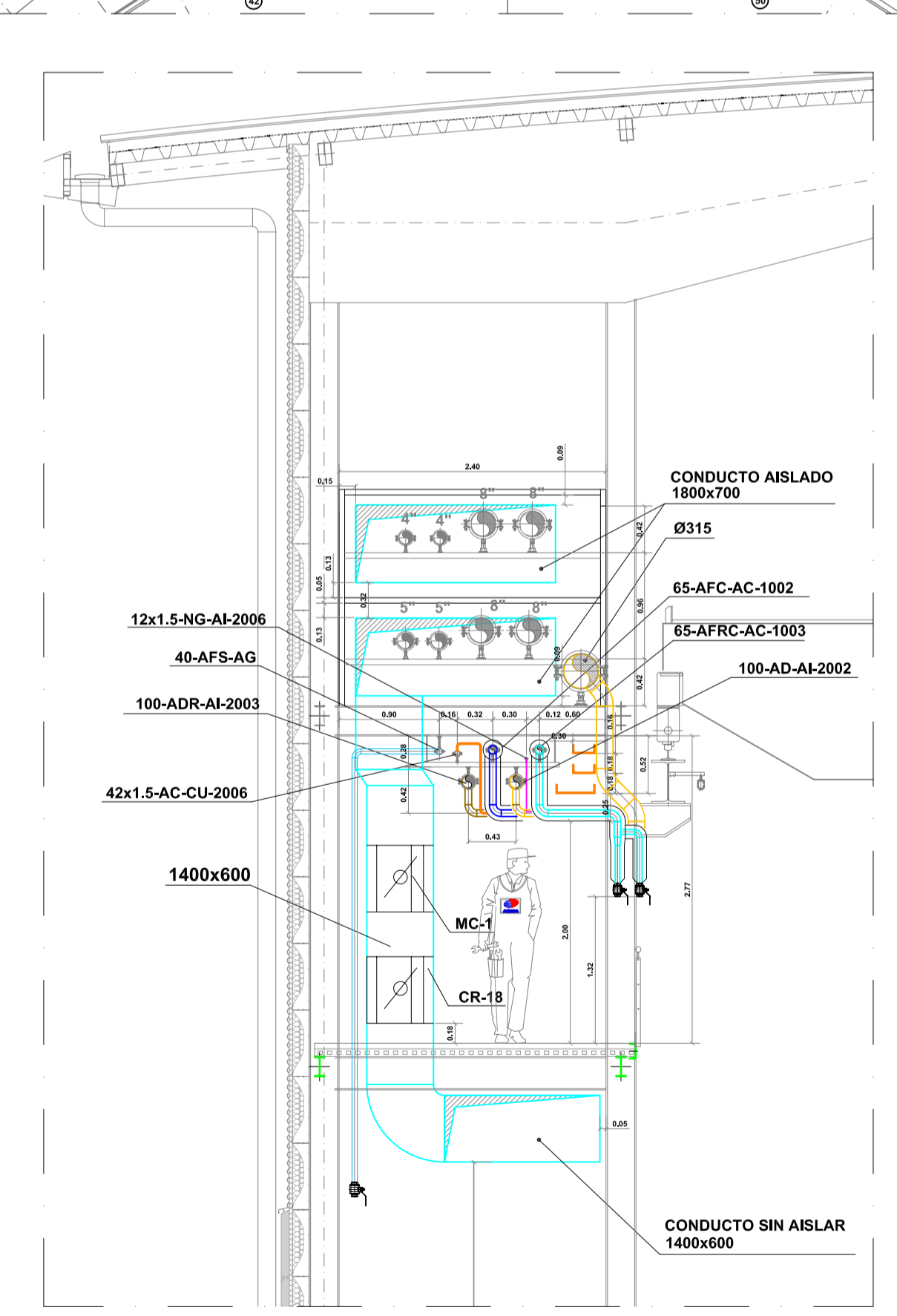
PL	PLACA DE ORIFICIO
VR	VALVULA REGULACION
RC	REDUCCION CONCENTRICA
AM	AMORTIGUADOR VIBRACIONES
VC	VALVULA DE CORTE
CV	VALVULA DE CONTROL DE 3 VIAS
TV	VALVULA TODODIADA
TV3	VALVULA TODODIADA DE 3 VIAS
SE	SEÑALIZACION



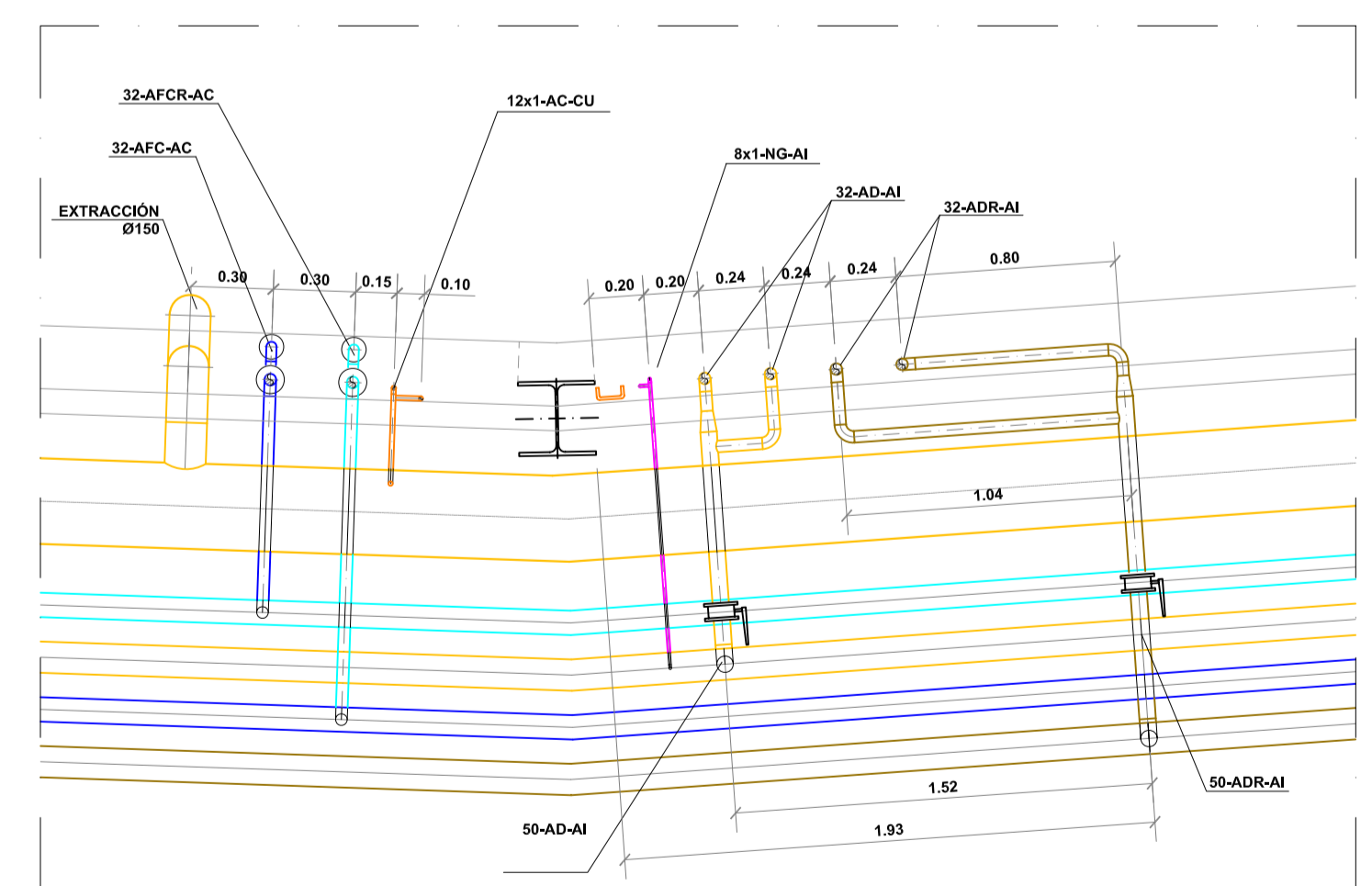
DETALLE BAJADAS INOX
ESC. 1:50



DETALLE BAJADAS INOX
ESC. 1:50



SECCION-DETALLE BAJADA TIPO
ESC. 1:50



DETALLE BAJADAS
ESC. 1:25

F	PLANO AS BUILT	05-08-09	R.R.G.	D.X.
E	Eliminar válvula regulación caudal	09-10-08	R.R.G.	D.X.
D	Revisión general	01-08-08	R.R.G.	D.X.
C	Actualización bajadas #27, #20 y #18	22-04-08	R.R.G.	D.X.
B	Revisión de válvulas y diámetros	13-03-08	R.R.G.	D.X.
A	Posición de dilataores	16-11-07	R.R.G.	D.X.
Item	Revisión Cofely	Fecha	Dibujado	Visado

COFELY		Fecha	Nombre	Aprobación por MASTER:	V.B. CELLS
Dibujado	26/02/2007	R.R.G.			
Revisado	26/02/2007	D.X.		FECHA:	

CELLS
BLOC CL. EDIFICIO GENDES
CAMPUS UAB (893)
BELLATERRA (0893)

ALBA

Life cycle

Size A1 Doc No. **Annex 8** 1.25201.00568.037-B

Título
IMPLANTACION. AREA EXPERIMENTAL PB. AGUA REFRIGERACION. AIRE COMPRIMIDO.

Nombre del proyecto
PROYECTO DEL CELLS

2 07 1 05 2

Referencia 91A/04 AS

master
INGENIERIA ARQUITECTURA

2	Revisión general	Abril-06	F. RANGEL	J.M. RIMBAU
1	Revisión general	Marzo-06	F. RANGEL	J.M. RIMBAU
Item	Revisión	Fecha	Dibujado	Visado

VALIDO PARA

Reg.Merc.Barcelona,Hoja 21147,Tomo 2112.
Folio 34,Libro 1512,Seccion 2°.

Copia emitida en fecha Autorizada por

Objeto

Fecha	Nombre	Firma	Escala
ABRIL 2006	F. RANGEL		1/200
ABRIL 2006	J.M. RIMBAU		
ABRIL 2006	J.M. RIMBAU		
ABRIL 2006	F. VELARDE		
General del Proyecto	ALFONS PERDRIX		Sustituye a Sustituido por Archivo N.

6. Criteria for air bubble/pocket movement

As described by Little (2002), there is no well accepted analytical solution for the transport of long air pockets, or indeed for the transport of dispersed bubble flow. At present, information must be drawn from existing experimental results.

Dimensional analysis (Bendiksen 1984; Falvey 1980; Wisner et al 1975) shows that the critical velocity to move an air bubble is a function of surface tension, Froude number, Reynolds number and pipe slope. Where the effects of surface tension are negligible, the critical velocity for a given pipe slope is proportional to $(gD)^{1/2}$, where g is acceleration due to gravity and D is the pipe diameter.

The papers reviewed in this section all provide experimental results relating to the critical velocity for air bubble movement in an air-water pipe system. The results of each of the authors are compared and an overview of the present state of knowledge is provided.

Kalinske, A.A. and Bliss, P.H. 1943. Removal of air from pipe lines by flowing water. ASCE, Civil Engineering, Vol. 13, No. 10 pp480-482

Based on their experimental data, Kalinske and Bliss provide a curve of Q_c^2/gD^5 versus slope, where Q_c is critical flow, g is the acceleration due to gravity and D is pipe diameter. The curve showed the point at which air starts to move in a pipe. For downward slopes, θ , higher than approximately 5% (2.9°) the following equation can be fitted:

$$\frac{V_c}{\sqrt{gD}} = 1.509\sqrt{\tan \theta} \quad (14)$$

For slopes less than 5% (2.9° or 1:20) the experimental data deviates from this prediction equation, and in the region 0-2% (0° – 1.1°) the critical velocity decreases as the slope increases.

Kent, J.C. 1952. The entrainment of air by water flowing in circular conduits with downgrade slopes. Doctoral thesis, University of California, Berkley, California

Kent's experimental results have been used by many authors to describe the movement of air bubbles in pipe systems. He presented the critical velocity in terms of flow Froude number as a function of the pipe slope, and this has been adopted throughout this paper as a simple means of comparing the various experimental results. Kent's tests were carried out using a pipe of approximately 100mm diameter.

The critical velocity required to keep stationary the air pockets that are formed in a pipe was given as:

$$\frac{V_c}{\sqrt{gD}} = C_o^{1/2}\sqrt{\sin \theta} \quad (15)$$

where his experimental results gave a value of $C_o = 1.53$ (using consistent units). Kent carried out tests for 15, 30, 45 and 60 degree downward sloping pipes of approximately

100mm diameter for a range of bubble volumes. The minimum velocity required to move the air pockets was found not to be dependent upon the bubble volume, as shown in Figure 11. The size of the air pockets is denoted by n where

$$n = \frac{4\nabla_b}{\pi D^3} \quad (16)$$

∇_b is the bubble volume, and D is the pipe diameter.

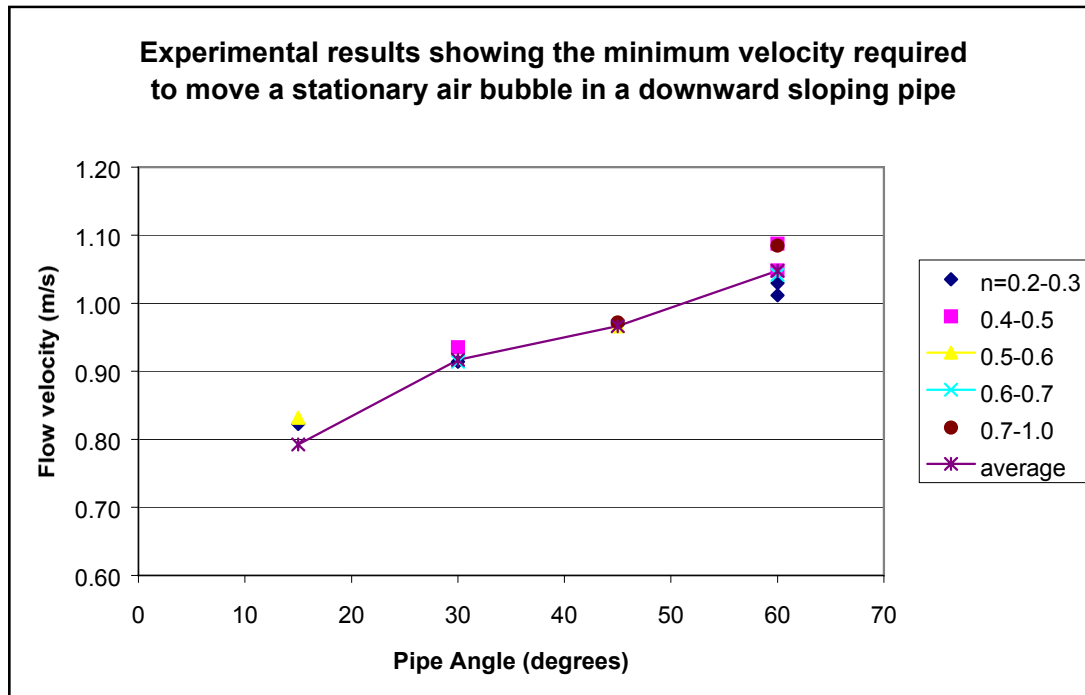


Figure 11 Experimental data of Kent (1952) showing minimum flow velocities for the transport of bubbles in a downwardly sloping pipe

Gandenberger, W. 1957. Design of overland water supply pipelines for economy and operational reliability(rough summary of work by W.A. Mechler, discussion of "Factors influencing flow in large conduits", Report of the Task Force on Flow in Large Conduits of the Committee on Hydraulic Structures, ASCE, vol. 92, HY4, 1966)*
*Gandenberger, W., 1957. *Über die Wirtschaftliche und betriebssichere Gestaltung von Fernwasserleitung*, R. Oldenbourg Verlag, Munich, Germany

Gandenberger's work (as summarised by Mechler 1966) resulted in the development of a graph which showed, for a pipe diameter of 1.0m, the water velocities corresponding to incipient movement of bubbles of different relative sizes from a high point into a downward inclined section of varying slope. The graph gives the minimum average water velocity required to clear a given volume of air from a peak in the profile for a certain inclination of the leg through which the water is flowing downward. The data from this graph are reproduced in Figure 13 for comparison with results from other authors.

Mechler states that the values in the graph are comparable to the equation of Kent when $C_o = 1.4$. There is however an incongruity in this statement as the equation of Kent gives increasing values of V_c for 15 to 60 degrees whereas the data given by Gandenberger

increase to a peak at around 50 degrees and then decrease again as the pipe gradient increases.

Wisner, P.E., Mohsen, F.N. and Kouwen, N. 1975. Removal of air from water lines by hydraulic means. ASCE, Journal of the Hydraulics Division, Vol. 101, HY2, p243-257

Wisner et al undertook a series of experiments to investigate the relationship between V_r/\sqrt{gD} and Re , where V_r is the rise velocity of the air pocket, D is the pipe diameter, and Re is the flow Reynolds number ($=V_r D \rho / \mu$ where μ is the dynamic viscosity of the water and ρ is the density of the fluid). The tests were performed with air pockets of different sizes in a 244mm diameter downward sloping pipe. The pipe slope tested was 18.5°.

Experimental results in still water showed that for values of Reynolds number above 10^5 , V_r/\sqrt{gD} becomes independent of Reynolds number. Also, for the same slope the experiments suggest that V_r/\sqrt{gD} becomes independent of the pocket volume for $n \geq 0.8$, where n is the pocket volume parameter ($\nabla_b = n\pi D^3/4$ where ∇_b is the pocket volume).

The variation of the rise velocity with slope was found to be complicated by the change of shape of the bubble with slope. The authors plotted the variation of rise velocity versus slope for their experiments along with those of Gandenberger, covering a range of angles from 10° to 60°. No experimental results are available outside this range.

Results of tests in moving water on the limit length and velocity showed that within the range of the available experimental results, an equilibrium may be achieved for a particular size of pocket and flow velocity. They showed that for a particular diameter and slope there is one stable length and corresponding velocity. The authors concluded that through comparison with previous experimental work:

1. The limit velocity may not become a constant quantity with increasing diameter, but may decrease with diameter (within the range of available tests, i.e. pipe diameters between 100mm and 244mm); and
2. The pocket limit length does not become constant beyond 100mm diameter but decreases at a decreasing rate.

A comparison of previous and present experimental results showed that the critical velocity for removal of air is given as the envelope equation:

$$\frac{V_c}{\sqrt{gD}} = 0.25\sqrt{\sin \theta} + 0.825 \quad (17)$$

This equation does not appear to take into account the secondary effect of pipe diameter, as mentioned in (1) above or air volume.

Wisner et al suggest that design values of the velocity parameter should not be much higher than this limit as this will introduce problems of blow back. They suggest, from experience, that the most satisfactory performance would be achieved if the velocity parameter were kept within +5% of the limit.

An important conclusion of this work was that clearing of isolated air pockets entrapped during filling may require very high velocities for fast clearing.

Wisner et al. also quote the work of Veronese (1937), who observed that for pipes larger than 0.1m in diameter air bubbles would be swept out at a certain “limit velocity”. Veronese found that the “limit velocity” for a 0.1m diameter pipe was 0.59 m/s. No mention is made as to the inclination of the pipe to the horizontal.

Mosvell, G. 1976. Pra 8 Air in outfall pipes, Project committee for the treatment of wastewater, (in Norwegian)

Moswell refers to the work of Kent to describe the minimum critical velocity required to move air pockets in a pipe. He provided a best-fit curve to the data of Kent as given by:

$$\frac{V_c}{\sqrt{gD}} = (0.55 + 0.5\sqrt{\sin \theta}) \quad (18)$$

for pipe slopes from 15 to 60 degrees.

Falvey, H.T. 1980. Air-water flow in hydraulic structures. Engineering Monograph No. 41, United States Department of the Interior Water and Power Resources Service, Denver, Colorado, pp143

Falvey summarises results for bubble motion in closed conduits flowing full using Figure 12, reproduced here. This shows limits for movement for both air pockets and air bubbles. The limits given for bubble movement and air pocket movement have been used for comparison with the other prediction equations described herein.

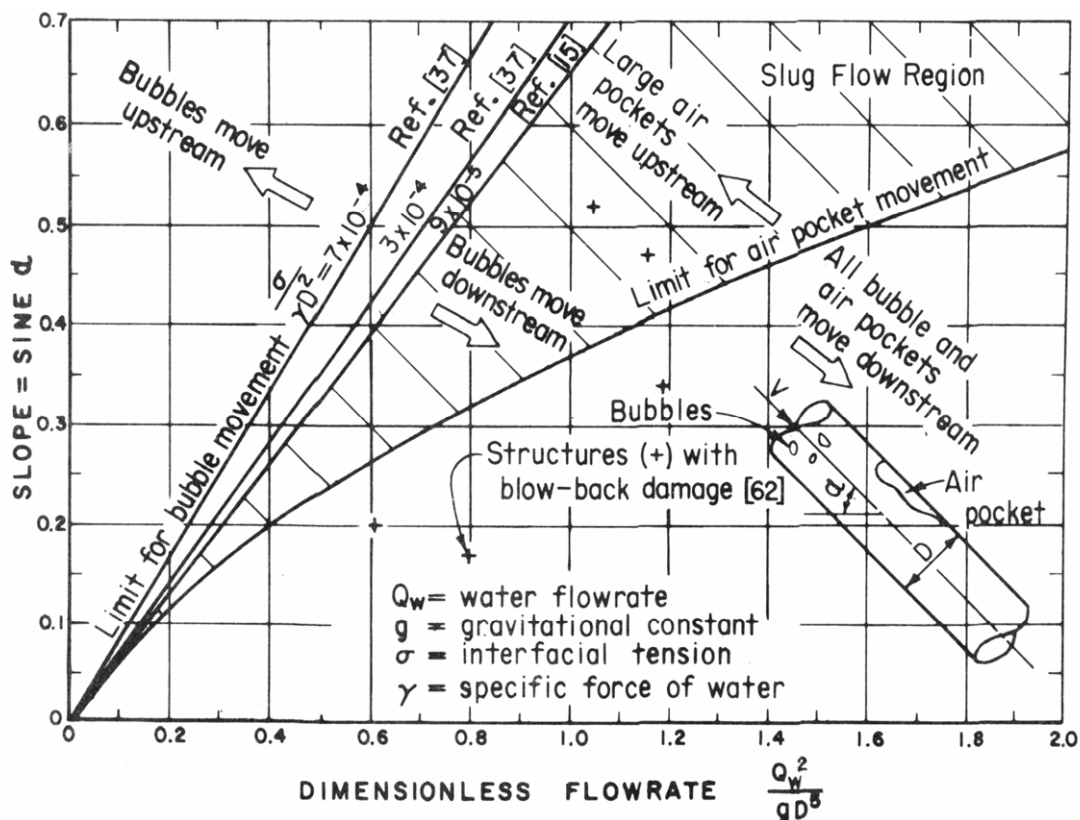


Figure 12 Graph showing flow rates required to transport air bubbles and pockets in pipes of varying slope (taken from Falvey, 1980)

A.R.I. www.arivalves.com

A.R.I is a valve manufacturer that has produced a program for the user to size and place air valves within a pipe system. The program was developed in conjunction with Prof. van Vuuren from the University of Pretoria, in South Africa. As part of the program the following relationship is used to establish the ability to transport air hydraulically.

$$\frac{V_c}{\sqrt{gD}} = 0.25\sqrt{\sin \theta} + 0.4 \quad (19)$$

No information is provided as to the basis of this equation.

Alves, I.N., Shoham, O., and Taitel, Y. 1993. Drift velocity of elongated bubbles in inclined pipes, Chemical Engineering Science, Vol. 48, No. 17, pp3063-3070

Alves et al provides a short review of existing estimates of drift velocity of elongated bubbles in pipes. Drift velocity is defined as the buoyancy-induced velocity that results in propagation of bubbles in a pipe with stationary liquid. For the present review the drift velocity is considered to be the critical velocity for bubble movement in a stationary liquid.

In terms of vertical flow they note that the potential flow analysis presented by Davies and Taylor (1950) gives

$$\frac{V_c}{\sqrt{gD}} = 0.33 \quad (20)$$

while more accurate calculations by Dumitrescu (1943) show a constant of 0.35 instead of 0.33.

The horizontal flow situation is less clear. Some authors claim that the drift velocity is zero for the horizontal case since the buoyant force does not act in the flow direction. Others, such as Bendiksen (1984), who tested small diameter pipes in the range of 0.02 to 0.05m, have shown that the drift velocity does exist for the horizontal flow case, and may in fact exceed the value for the vertical flow case. It is thought that the drift velocity in horizontal pipes results from the elevation difference along the bubble nose region.

Benjamin (1968) provides a theoretical analysis of this situation, which results in the equation:

$$\frac{V_c}{\sqrt{gD}} = 0.542 \quad (21)$$

For the inclined pipe situation no models have been proposed and the results of experimental investigations are the primary source of data. Many of the studies examined by the authors report “peculiar” behaviour, whereby the drift velocity increases as the angle of inclination decreases from the vertical. The drift velocity then decreases towards the horizontal position with the maximum drift velocity occurring at an intermediate angle of inclination between 30° and 50° from the horizontal.

According to Bonnecaze et al (1971) the gravity potential of the flow that drives the liquid velocity along the curved surface at the bubble nose first increases and then decreases as the angle of inclination changes from the vertical position to the horizontal position.

The authors present a theoretical approach for estimating the drift velocity of inclined pipes along with experimental data. The experimental data showed that the velocity tends to increase as the inclination angle increases, reaching a maximum at about 40°. Further increase in the inclination angle resulted in a decrease in the drift velocity. The model was able to predict these values of drift velocity for the range of pipe inclinations.

Walski, T.M. et al. 1994. Hydraulics of corrosive gas pockets in force mains. Water Environment Research, Vol. 66, No. 6, Sept/Oct, pp772-778

This paper details a model study of a pumping main (force main), undertaken at Wilkes University. The study was for the Wyoming Valley Sanitary Authority (WVSA) West Side Force Main, which was 4.5km long and had a diameter of 0.5 to 0.92m. The pipe was modelled using a 50mm diameter clear PVC pipe.

It was found that the following relationship could be used to describe the air flow conditions in the pipe.

$$\frac{0.88V_{nom}^2}{gDS^{0.32}} = P' \quad \text{or} \quad \frac{V_{nom}^2}{gD} = \frac{P'S^{0.32}}{0.88} \quad (22)$$

where $P' = 1$ for equilibrium and $P' > 1$ for gas to move downstream. V_{nom} is the nominal velocity with no air in the pipeline, S is the pipe slope, and D is the pipe diameter.

Dewhirst, R.A. 1991. Optimising the use of air valves in piped water systems, Master of Engineering Thesis, Department of Civil Engineering, The University of Auckland, Auckland, New Zealand

The author presents a theoretical calculation for the estimation of the critical velocity required to move air pockets in sloping pipes. The following equation was developed:

$$V_c^2 = 2g \left[\frac{V_p \sin \theta}{A} + \left(\frac{D}{2} - y_3 + \frac{\bar{D}_3 A_3}{A} \right) \cos \theta \right] \left(\frac{A_3}{A_3 - A} \right)^2 \quad (23)$$

where A is the pipe cross-sectional area, A_3 is the area of water at the downstream end of the bubble (before the hydraulic jump section forms), D is the pipe diameter, \bar{D}_3 is the distance perpendicular to the pipe, from the water surface to the centroid of A_3 , V_c is the critical velocity in the pipe upstream of the pocket, V_p is the volume of the pocket, and θ is the angle of inclination of the pipe.

The analysis showed that the head loss in the system occurs at the downstream end of the pocket where a hydraulic jump forms. Upstream of the jump the water surface resembles a free surface and the flow is analogous to open channel flow. These findings were supported by the experimental results (detailed in Section 5.2.2). The

main difference between the theoretical considerations and the experimental results was that the experimental results found the critical velocity to be independent of pocket volume; however this could not be resolved in the theoretical analysis.

It is not possible to plot Equation 23 on Figure 13, however the experimental results showing the critical velocity for different pipe slopes are included.

Corcos, G. 2003. Air in water pipes, Agua Para La Vida, 2nd Edition, www.aplv.org

The paper is a manual for designers of gravity water supply systems in rural areas. It provides a method for assessing if and where air problems are likely to occur in gravity water supply systems and gives a methodology for designing such systems. A computer program can be downloaded to automate the design.

The following equations are provided for estimating the critical flow rate required to move air pockets in pipelines.

$$\frac{V_c}{\sqrt{gD}} = 0.484 \quad (24)$$

V_c is the critical velocity for moving air out of a horizontal pipe section and preventing any further accumulation of air. It states that the critical flow rate depends only on the diameter of the pipe in the region of the air pocket.

$$\frac{V_s}{\sqrt{gD}} = 0.638 \quad (25)$$

V_s is the velocity required to move stationary air pockets downstream past a sloping part of the pipe. D is the internal diameter of the pipe.

Summary

The prediction equations outlined in this section are presented in Figure 10, along with some of the air bubble movement criteria for still water. The equations and data presented in this graph have been taken from the reports and papers described in this review. They have been plotted as the dimensionless flow velocity (Froude number) versus the square root of the pipe slope angle (downward sloping). It can be seen that there is a wide variation between the different prediction equations.

The authors Bendiksen and Gandenberger both present results whereby the critical flow velocity to move the air bubble increases with slope angle from the horizontal to reach a peak at downward angle of inclination of 30° to 50°. For any further increases in slope angle the critical velocity decreases, reaching a minimum at 90° (vertical pipe flow). In contrast to these results, Kalinske and Bliss found the critical velocity to reach a minimum for a downward pipe angle of 1.2° and then increase for either flatter or steeper slopes. These results and observations are supported by the work of various authors such as Zukoski (1966) and Alves et al (1993), who measured the drift velocity of bubbles in pipes with stationary flow for a range of pipe inclination angles.

The remaining prediction equations show increasing critical velocity with increasing downward pipe slope, up to a maximum for vertically downward pipe flow.

Gandenberger's results also show the critical velocity to be dependent on the volume of the bubble for $n = 0.02$ to 1.0 . Wisner et al found that for $n > 0.8$ the velocity was independent of bubble volume, and Kent's results do not show any strong dependence between the two parameters. Only Kent gives any details of the bubble volumes used in his tests.

For the horizontal pipe there appears to be the greatest confusion. Falvey suggests that the critical velocity is zero for movement of both bubbles and air pockets in horizontal pipes. In the discussion by Mechler of Gandenberger's work he continues the curves, given in Figure 13, to zero for horizontal slopes. As shown in the Figure, other authors suggest however, that there is some minimum velocity greater than zero for movement of air bubble and pockets in horizontal pipes. The values range from $V_c/\sqrt{(gD)} = 0.35$ to around 0.8 . For a 200mm diameter horizontal pipe this gives a critical velocity range of 0.49 to 1.12m/s .

Notes for Figure 13: n is the bubble size, defined as $\frac{4V_b}{\pi D^3}$ (Equation 16)

E is the surface tension parameter $\frac{g\rho_l D^2}{\sigma}$ (Equation 2)

*no information available as to basis of the equations

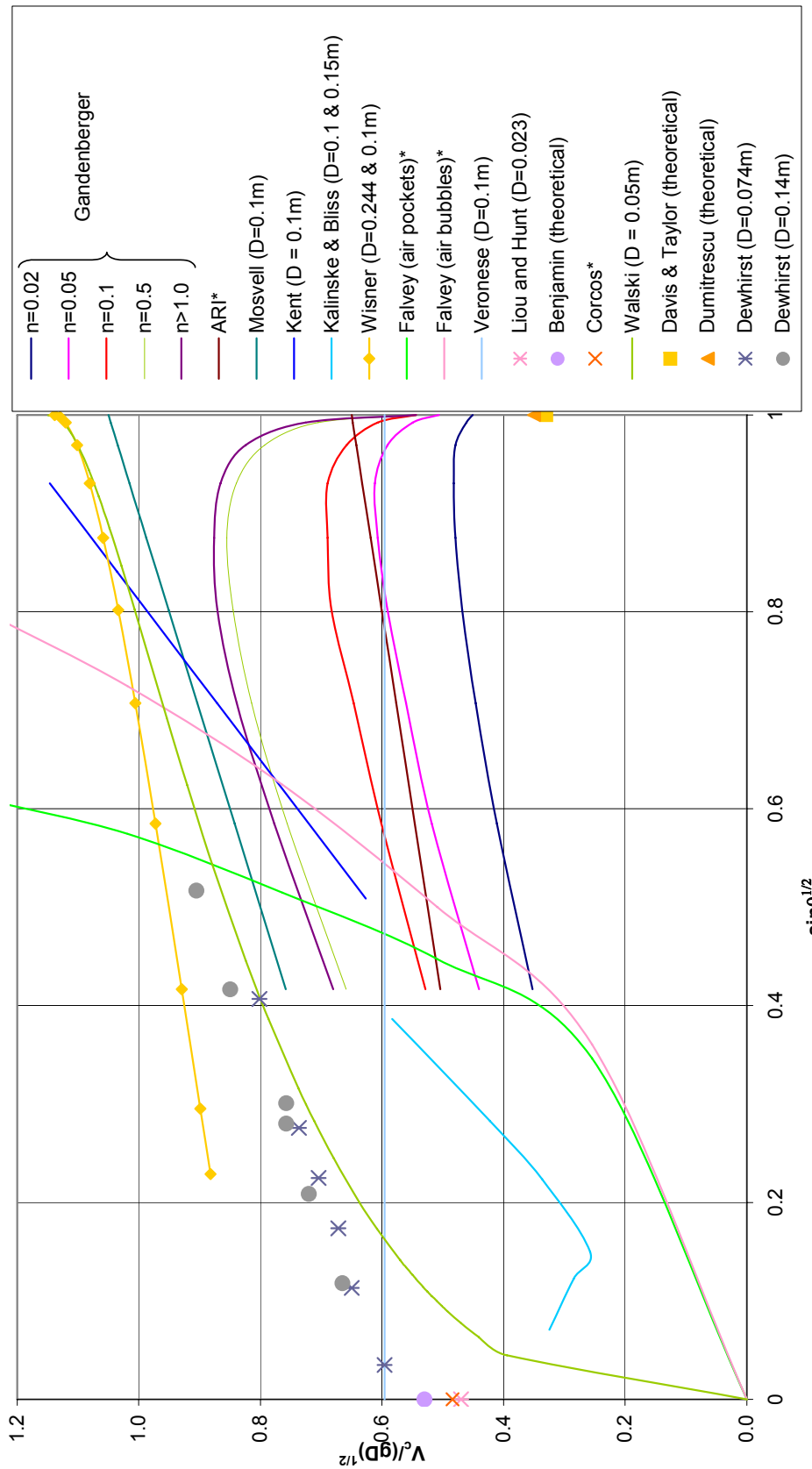
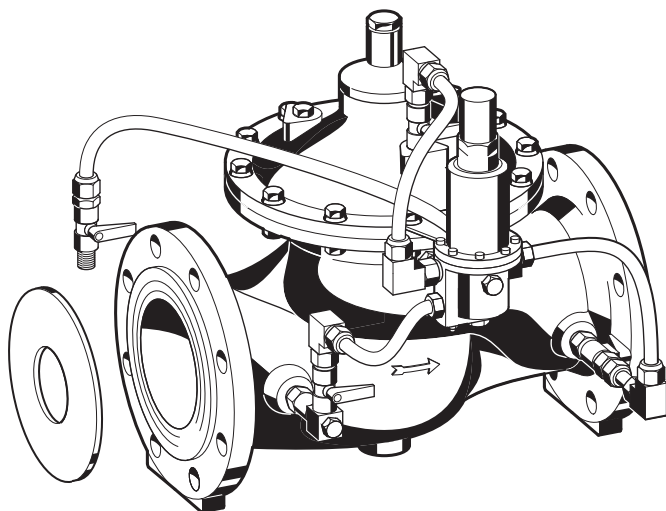


Figure 13 Comparison of various prediction equations and experimental results for the critical velocity of air bubble transport through water in downward inclined pipes

Válvula reguladora de caudal

Especificaciones Técnicas



Construcción

La válvula reguladora de caudal se compone de:

- Cuerpo con bridas PN16 según ISO7005-2, EN1092-2
- Válvula piloto CX-FR
- Circuito de control con válvulas de bola en entradas y salidas
- Circuito de control con filtro integral lavable
- Orificio de medida integrado en la entrada

Materiales

- Cuerpo y tapa superior de fundición dúctil, (ISO 1083), con protección superficial
- Cono de regulación de bronce rojo/acero inoxidable
- Muelle y eje de acero inoxidable
- Diafragma de NBR reforzado
- Asientos de NBR y EPDM
- Asiento de válvula de acero inoxidable
- Circuitos de control de material sintético de alta calidad
- Accesorios de compresión de latón
- Cuerpo de válvula piloto de latón
- Cartucho del filtro de acero inoxidable

Aplicación

Las válvulas reguladoras de caudal, también llamadas válvulas limitadoras de caudal, regulan a un caudal fijo, independientemente de la fluctuación de las presiones de trabajo y caudales de inicio. Previene, por ejemplo, el funcionamiento de bombas a un rendimiento demasiado elevado o regula el rendimiento de todos los sistemas e instalaciones.

Características

- Elevados caudales
- Ligera
- Alta precisión de control
- Con protección superficial interna y externa - El recubrimiento empleado no presenta toxicidad.
- Circuito de control integrado con válvulas de bola
- No requiere de alimentación de energía externa para su funcionamiento

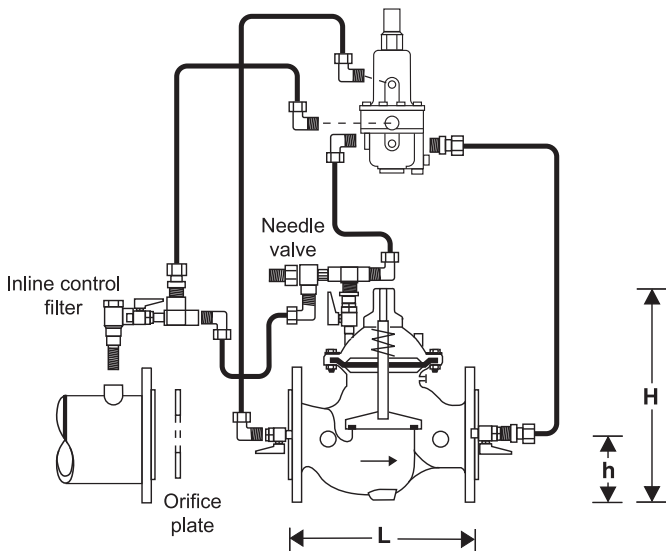
Rango de Aplicación

Medio	Agua
Presión de trabajo	Máx. 16 bar

Datos técnicos

Temperatura de trabajo	Máx. 70 °C
Presión Nominal	PN 16 PN 25 bajo demanda
Mín presión	0.7 bar
Tamaños	DN 40- 450

VR300 Válvula Reguladora de Caudal



Modo de Funcionamiento

La válvula reguladora de caudal ajusta automáticamente un caudal constante, independientemente de las fluctuaciones de presión en el sistema, utilizando un orificio calibrado funcionando conjuntamente con una válvula piloto.

La válvula abre totalmente si el consumo es inferior al caudal máximo calculado o el sistema no es capaz de suministrar el caudal requerido. La válvula piloto de tres vías mide la diferencia de presión entre los dos lados del orificio calibrado y la emplea para regular el diafragma de la válvula.

Opciones

VR300- ... A Cuerpo con bridas, PN 16,
= ISO 7005, EN 1092-2

VR300- ... Z = PN 25, bajo demanda

┌ Connection size

Tamaño	DN	40	50	80	100	150	200	250	300	350	400	450
Peso	aprox. kg	16	17	26	41	84	161	249	409	514	826	949
Dimensiones	(mm)											
	L	230	292	310	350	480	600	730	850	980	1100	1200
	H	235	294	400	433	558	650	823	944	990	1250	1250
	h	83	93	100	110	143	173	205	230	260	290	310
Caudal (Q_{max}) en m ³ /h - V=5.5 m/s		40	40	90	160	350	480	970	1400	1900	2500	3150
Valor k_{vs}	m ³ /h	43	43	103	167	407	676	1160	1600	1600	3300	3300

Accesorios

FY69P Filtro

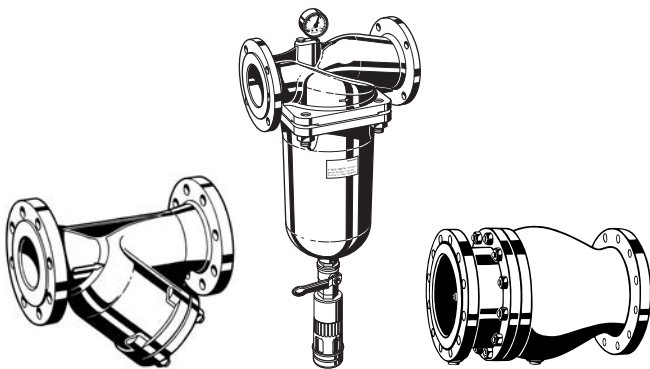
Con doble malla, cuerpo de fundición gris, protección superficial interna y externa.
A = Tamaño aproximado de malla 0.5 mm

F76S-F Filtro con lavado a contracorriente

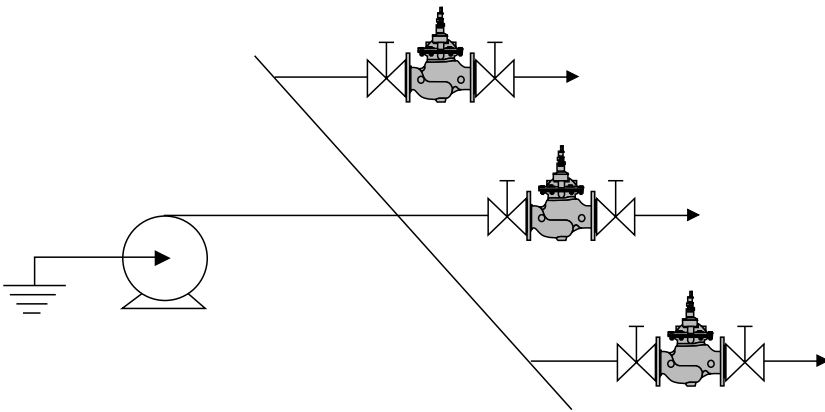
Cuerpo y vaso del filtro de broce rojo.
Disponibles en tamaños DN 40 a DN 100, con tamaños de malla de 100 μ m o 200 μ m

RV283P Válvula de retención

Cuerpo de fundición gris, protección superficial interna y externa. Certificado DIN/DVGW para los tamaños DN 40, DN 80 and DN 100



Ejemplo de Instalación



Normas de Instalación

- Instalar válvulas de corte a ambos lados de la válvula reguladora
- Instalar un filtro aguas arriba o proteger contra daños por suciedad
- Observar la dirección del caudal (indicado mediante una flecha)
- Permitir buen acceso a la válvula para mantenimiento e inspección
- Los orificios calibrados están diseñados para conseguir una pérdida de presión de 0.20 - 0.25 bar
- Se debe dejar un punto de medida de presión de 1/2" a la entrada
- Se puede ajustar en la válvula piloto el funcionamiento para un caudal precalculado entre -10 % y +40 % del valor predeterminado. Variaciones superiores requieren otro diseño del orificio de medida.
- Instalar bobinas para desmontaje y mantenimiento.

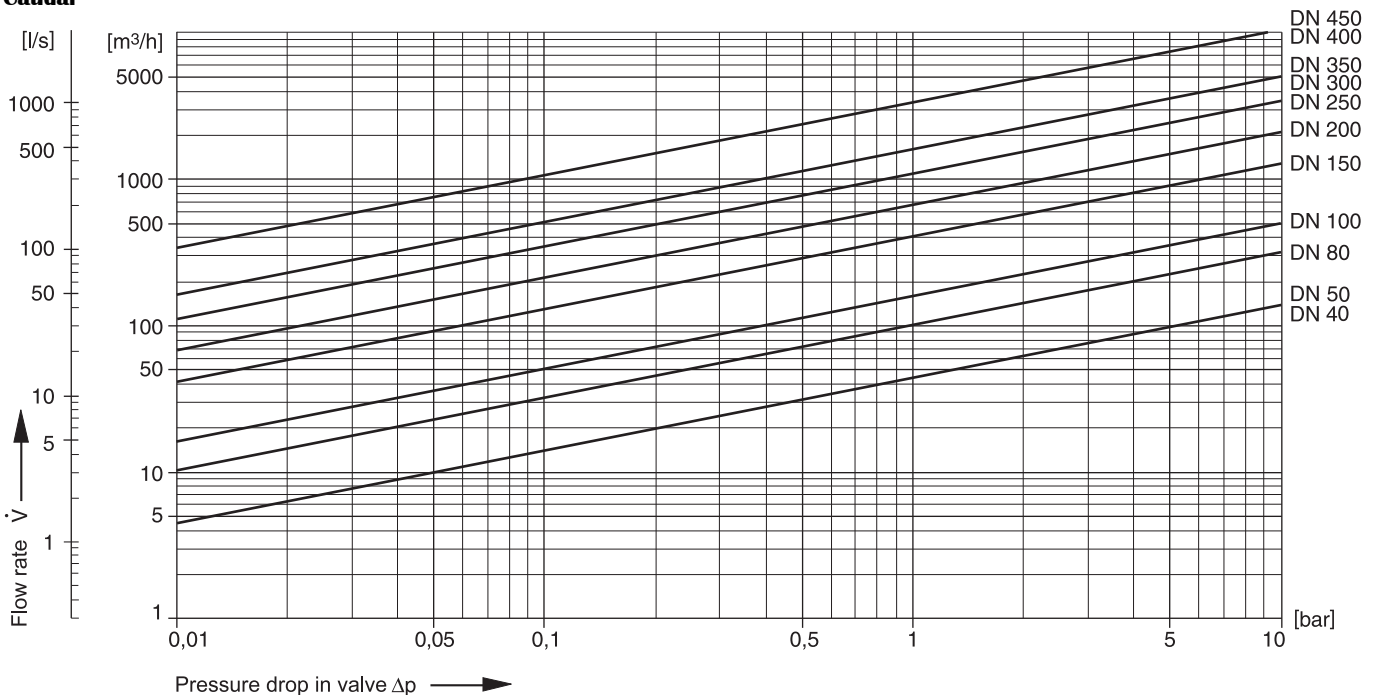
Usos Típicos

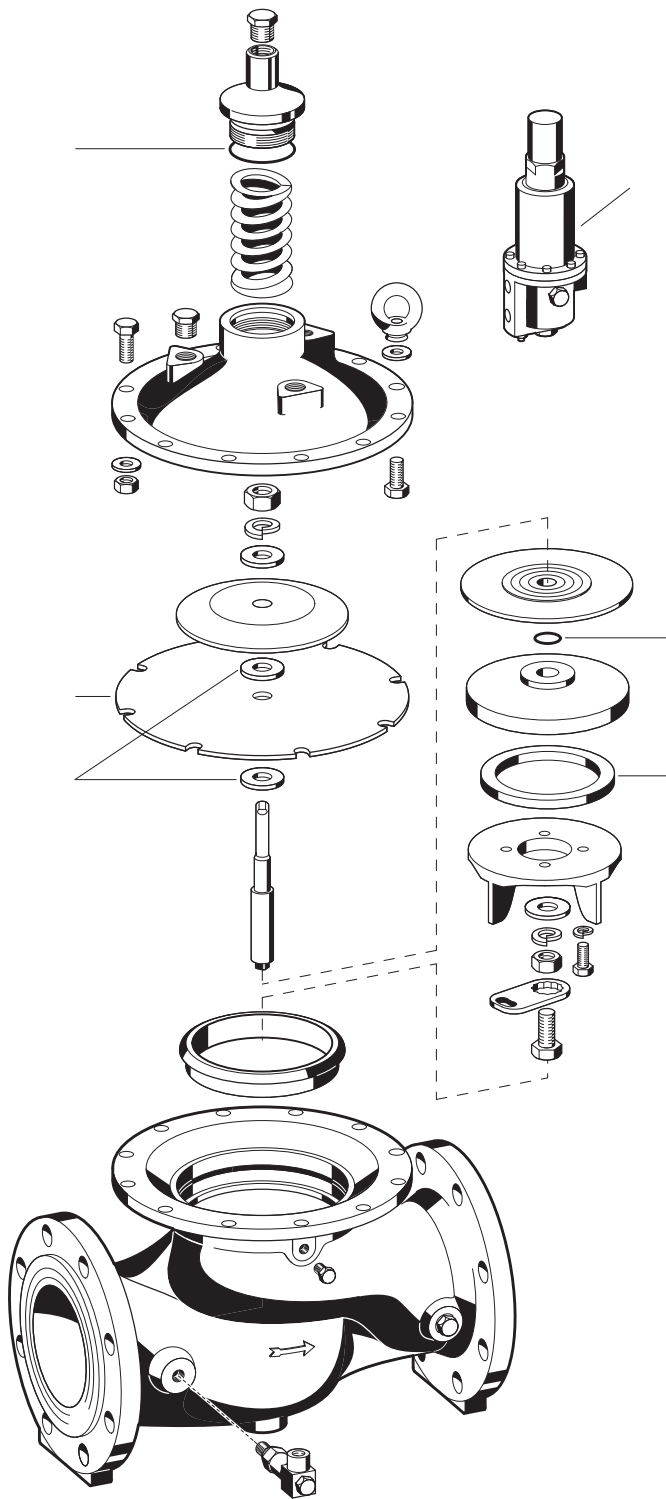
Este tipo de válvulas reguladoras de caudal, dentro de los límites de su especificación, son válidas para instalaciones de suministro de agua en instalaciones industriales y comerciales.

Los siguientes son algunos ejemplos de aplicaciones típicas:

- Limitación del rendimiento de bombas
- Red de suministro de agua optimizando los sistemas de control

Diagrama de Caudal





Recambios

Válvula reguladora de caudal VR300, desde 2002

No.	Descripción	Tamaño	Referencia
1	Recambio piloto	DN 40 - DN 450	CX-FR
2	Juego de juntas	DN 40	0903750
		DN 50	0903751
		DN 80	0903752
		DN 100	0903753
		DN 150	0903754
		DN 200	0903755
		DN 250	0903756
		DN 300	0903757
		DN 350	0903758
		DN 400	0903759
		DN 450	0903760



Válvula reductora/estabilizadora de presión aguas-abajo - Mod. VRCD FF

La válvula Mod. VRCD FF reduce y mantiene la presión aguas abajo independientemente de las variaciones del caudal y presión de entrada. Puede ser utilizada para agua, aire y fluidos en general hasta una presión máxima de 64 bar.



Características técnicas y ventajas

- Enteramente realizado a partir de barras macizas de acero inoxidable.
- Estabiliza la presión aguas-abajo sobre un valor fijado en base a las exigencias del proyecto, independientemente de las variaciones de la presión aguas-arriba y del caudal.
- Pistón autolimpiante (patente CSA), con tecnología innovadora que mejora las prestaciones en funcionamiento y reduce la necesidad de mantenimiento.
- Bloque móvil en acero inoxidable mecanizado por control numérico para evitar, gracias a la precisión de la elaboración, la fricción en el deslizamiento y pérdidas.
- Gracias a la conformación y a juntas especiales se reduce el riesgo de cavitación, aún en presencia de diferencias elevadas de presión.

Aplicaciones principales

- Redes de distribución del agua caracterizadas por altas presiones.
- Edificios y plantas civiles donde se requiere o recomienda el acero inoxidable.
- Agua desmineralizada y plantas de embotellamiento.
- Plantas industriales y sistemas de enfriamiento.
- Carburantes y otros líquidos con la utilización de juntas especiales (se ruega contactar la CSA).

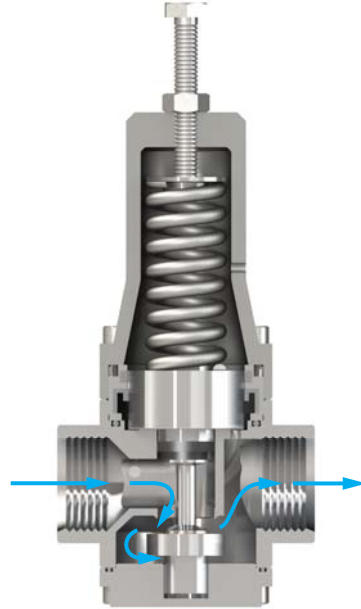
Principio de funcionamiento

El principio de operación de la VRCD FF esta basado en el deslizamiento lineal del pistón de cierre a través de dos casquillos de diferentes diámetros. Estos casquillos, gracias a juntas labiadas, forman una cámara de estanqueidad, llamada cámara de compensación de la presión aguas-abajo y aguas-arriba.



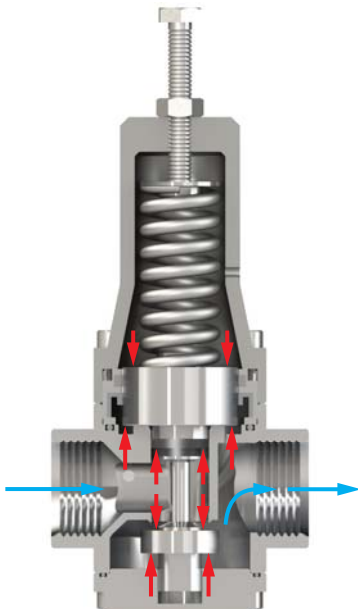
Válvula normalmente abierta

Sin presión aguas abajo la VRCD FF es una válvula normalmente abierta, el pistón es empujado hacia abajo por la fuerza del resorte superior.



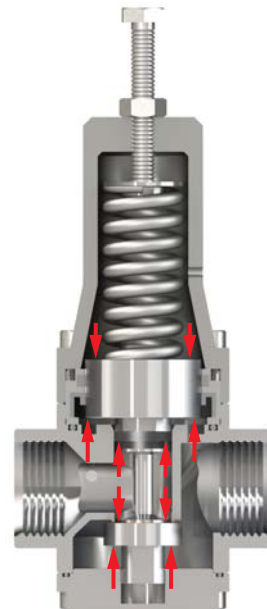
Válvula completamente abierta

Si la presión aguas abajo es inferior a la presión de consigna ajustada en el muelle, la VRCD FF se mantiene abierta completamente.



Válvula modulando

Si la presión aguas abajo aumenta por encima de la presión de ajuste, la resultante de la fuerza de esta presión actuando sobre el obturador contra la fuerza del resorte en sentido descendente, provocarán la reducción del paso y estabilizarán la presión al valor consignado.

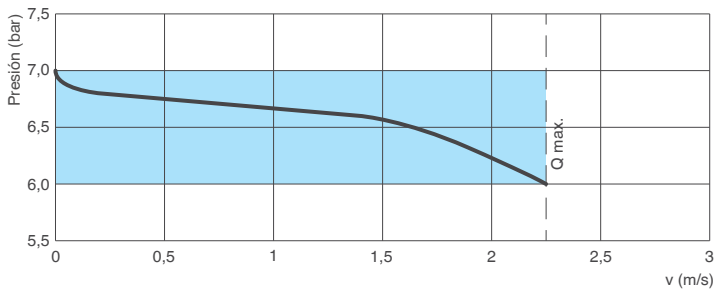
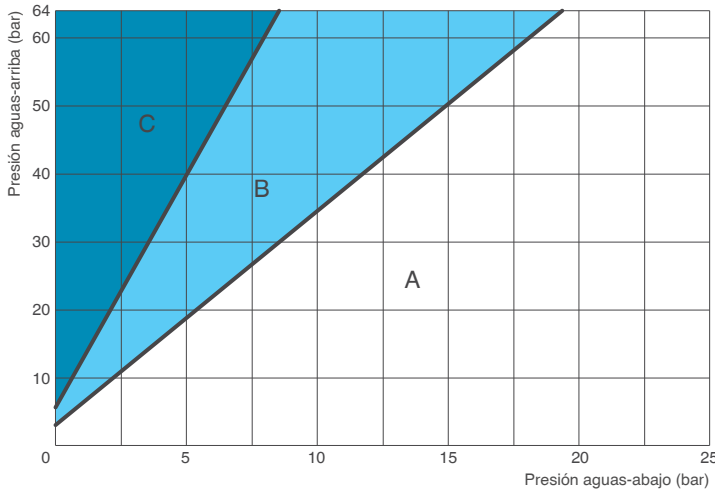


Válvula cerrada (condición estática)

En caso de que la presión aguas abajo continúe aumentando por encima del valor de consigna, la válvula irá cerrando el paso hasta llegar a cerrar completamente si es necesario, manteniendo así la presión reducida aguas abajo incluso en condiciones estáticas (sin flujo).

Datos técnicos

DN in	1/2	1	1 1/2	2
Kv (m³/h)/bar	2,9	7,2	10,8	21



Condiciones de trabajo

Agua limpia hasta 70°C (120°C bajo demanda).
 Presión máxima aguas-arriba 40/64 bar.
 Presión aguas-abajo: rangos de calibración en la tabla siguiente; valores superiores bajo demanda.

DN (pulgadas)	1/2	1	1 1/2	2
Rangos de calibración del muelle disponibles bar	1,5-10	1,5-10	1,5-7	1,5-6
	2-20	2-20	2-15	5-12

DN pulgadas	A mm	B mm	C mm	D mm	Peso Kg
1/2	53	--	108	25	1,0
1	90	CH 41	170	45	2,1
1 1/2	110	CH 55	205	50	2,8
2	152	CH 70	290	60	5,9

Coeficiente de caudal

El coeficiente Kv, representa el caudal que debe circular a través de la válvula completamente abierta para generar una pérdida de carga de 1 bar.

Gráfica de cavitación

Para un correcto dimensionamiento de la válvula es importante considerar el riesgo de cavitación, que puede provocar grandes daños, además de vibraciones y ruido. En el gráfico, el punto correspondiente a la condición de trabajo de la válvula, determinado por la presión aguas-abajo (en abscisas) y la presión aguas-arriba (en ordenadas) se sitúa en una de las 3 zonas identificadas de la siguiente manera:

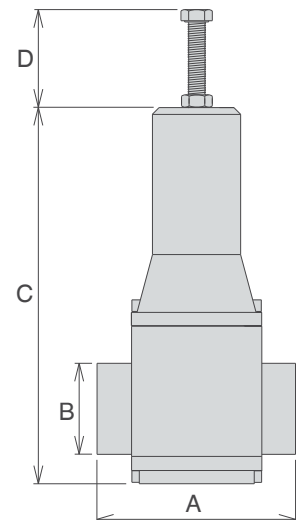
- A: zona de trabajo recomendada;
- B: cavitación incipiente;
- C: daños por cavitación.

Sensibilidad del reductor

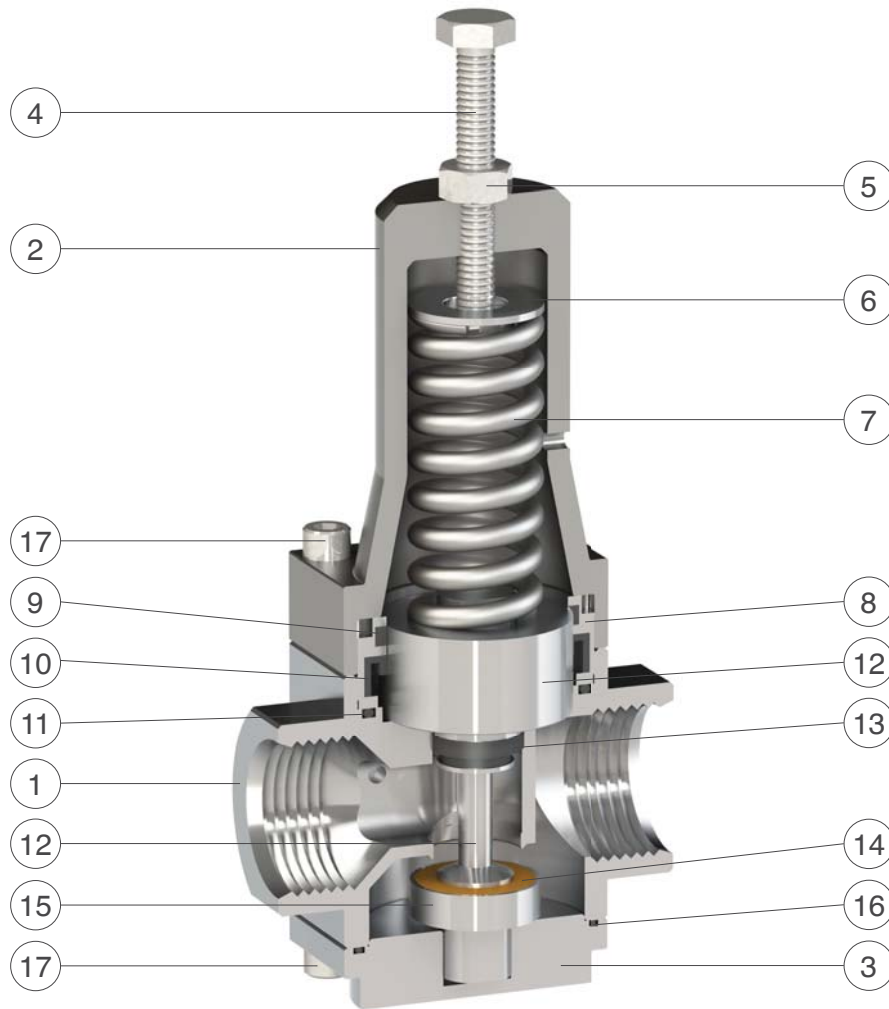
La curva mostrada a la izquierda, muestra la variación de la presión de salida respecto a la de consigna en función de las variaciones de caudal. Se indica la velocidad máxima y las condiciones de trabajo asumibles en el área azul.

Estándar

Diseño según EN 1074/4.
 Conexiones roscadas de acuerdo a normas ISO;
 otras roscas bajo demanda.



Especificaciones técnicas

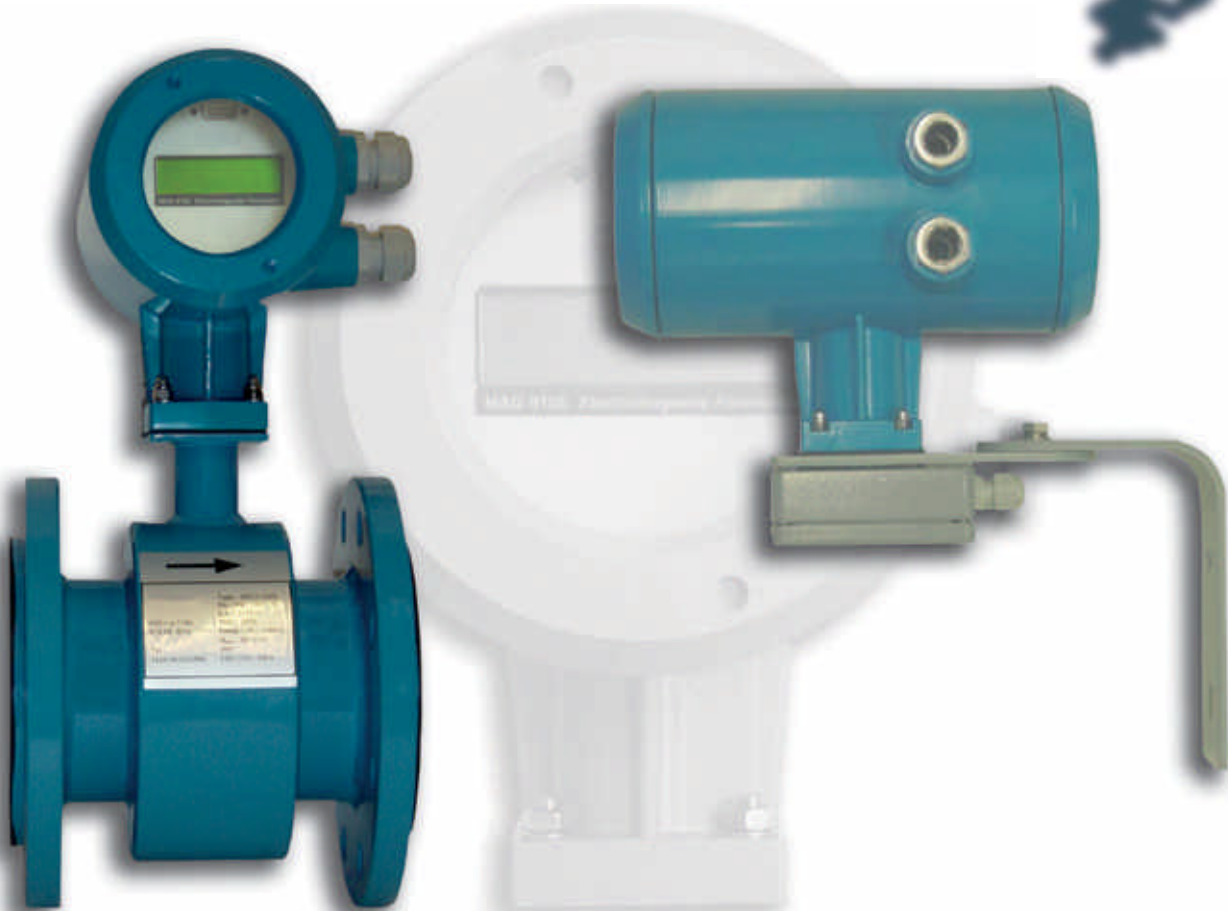


N.	Componente	Material estándar	Materiales opcionales
1	Cuerpo	a.i. AISI 303 (DN 1"-1 1/2"), AISI 304 (DN 1/2"-2")	
2	Tapa	aluminio niquelado S11	
3	Tapón guía	a.i. AISI 303 (DN 1"-1 1/2"), AISI 304 (DN 1/2"-2")	
4	Tornillo guía	acero inoxidable AISI 304	acero inoxidable AISI 316
5	Tuerca de ajuste	acero inoxidable AISI 304	acero inoxidable AISI 316
6	Disco del muelle	acero inoxidable AISI 304	acero inoxidable AISI 316
7	Muelle	a.i. AISI 302 (acero barnizado 52SiCrNi5 para DN 2")	
8	Casquillo superior	acero inoxidable AISI 304	acero inoxidable AISI 316
9	Anillo de deslizamiento	PTFE	
10	Junta labiada superior	NBR	EPDM/Viton
11	Junta tórica	NBR	EPDM/Viton
12	Pistón	acero inoxidable AISI 303	acero inoxidable AISI 316
13	Junta labiada superior	NBR	EPDM/Viton
14	Junta plana	poliuretano	
15	Obturador	acero inoxidable AISI 303	acero inoxidable AISI 316
16	Junta tórica	NBR	EPDM/Viton
17	Tornillos	acero inoxidable AISI 304	acero inoxidable AISI 316

...flow measurement
& control...



BELL
Flow Systems
www.bellflowsystems.co.uk



MAG 910

ELECTROMAGNETIC FLOWMETER

Main Features:

- ↳ Range of diameter 10 to 800 mm
- ↳ Compact and remote version with protection IP67, optionally IP68
- ↳ Mounting of electronic unit in two directions
- ↳ Power supply voltage 95 to 250 VAC or 24VACDC, 50/60 Hz
- ↳ Non-touch basic manual control with magnetic pointer
- ↳ Programmable datalogger as standard
- ↳ Remote control RS-485
- ↳ Dosing feature with several type of digital/analogue outputs
- ↳ Pipe and electronic self diagnostics

Application:

- ↳ Water and Wastewater Measurement
- ↳ Chemical industry (acids, alkaline solutions)

Pipe dimensions	
Inner size DN [mm]	Length L [mm]
10 - 100	200
125 - 150	300
200 - 250	400
300 - 500	500
600	600
700	700
800	800

Technical data

Nominal size	DN10 to DN800
Nominal pressure	PN10 to PN25 (depending on diameter)
Flow range	0.1 to 10 m/s (0.02 to 5000 l/s)
Accuracy	0.5% (0.5 to 10 m/s) of reading value 1% (0.1 to 0.5 m/s) of reading value
Maximal medium temperature	70°C (154°F) for rubber liner 130°C (200°F) for PTFE liner in remote version
Ambient temperature	-20 to 70°C (-4 to 154°F)
Power supply	• 115/230V (+10%, -20%), 50/60Hz, auto selectable • 24V DC/50/60Hz as option
Power consumption	10 VA
Liner	• hard rubber • PTFE
Electrodes	• CrNi (stainless) steel 1.4571 • Hastelloy C276
Measuring tube	Stainless steel 1.4201, dimensions according to DIN 17457
Flange	Steel 1.0402 or higher Dimensions according to DIN 2501 (BS 4504), ANSI B16.5
Protection category	IP67, optionally IP68
Outputs	• Frequency 0 to 12 kHz with programmable flowrate and function • Pulse 0 to 50 Hz with programmable volume, function and pulse width • Relay contacts 100V/0.5A with programmable function • Current loop 4 to 20 mA with programmable flowrate and function
Input	Digital input with programmable function
Communication	RS485, RS232
Displayed values	• Flowrate (m ³ /h, l/s, US.Gal/min, user) • Volume (m ³ , l, US.Gal, user) • Positive, total, negative and auxiliary (clearable, daily) volume
Control	• Keyboard • Magnetic pointer • RS232 and RS485
Low-flow cutoff	Programmable value
Time constant	Settable in range 1 to 20 s
Other features	• Test of excitation coils, status of pipe line and electronic unit • Diagnostic of internal temperature and power supply voltages • Real time circuit for datalogging • Datalogger memory up to 1000 values (programmable sample rate) • Registration of min. and max. flowrate including date and time
Conformity requirements	• LVD (safety) according to EN 61010-1, EN61010-1/A2 • PED according to directive 97/23/EC • EMC according to EN 61000 part 3-2, 3-3, EN 61000 4-3, 4-4, 4-5, 4-6, 4-8, 4-11, EN 61000 part 6-2, EN 50081-1

Inductive flowmeter MAG 910 is an instrument designed for measuring and indicating flow and total volume of conductive liquids. The flowmeter MAG 910 records both positive and negative flows. As there are no moving parts in the flow profile the device can be used to measure extremely dirty liquids containing solids. The flowmeter is for use with conductive liquids only.

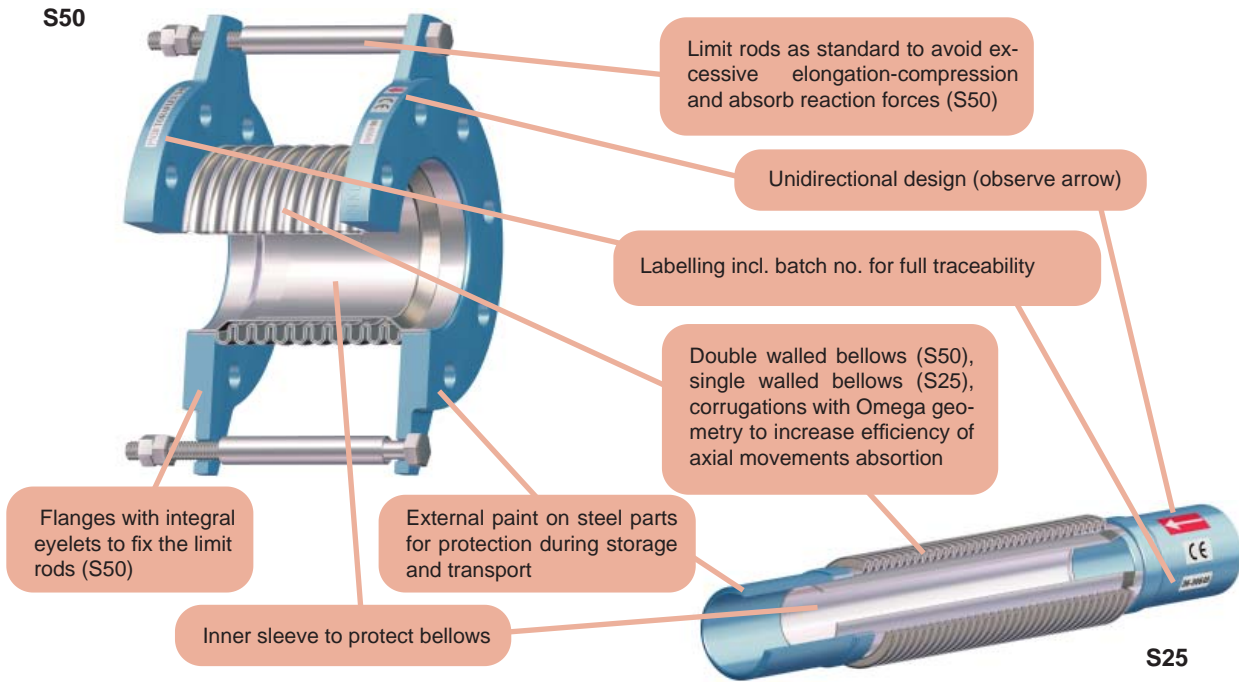
Range of applications. The inductive flowmeter MAG 910 has been designed for use in all process industries including chemical, water and wastewater.

Features. The inductive flowmeter MAG 910 is a highly accurate and stable device. The construction of the MAG 910 indicator uses components with a long-term time and temperature stability. Configuration data is backed up and can be recovered after a power failure. The back-up structure enables data recovery in case of a partial loss of data (as a result of e.g. high level electrostatic discharge or noisy power supplies). Internal CPU provides all functions usually built in electronic flowmeters, incl. low flow rate correction, frequency response setting, bandwidth of sensitivity setting at low flow rates, etc.

Inputs / Outputs. Flowmeter MAG 910 is equipped with six isolated outputs and one isolated input as standard. Digital outputs (frequency, pulse and relays) and input are user configurable. Current output 4-20 mA can be used as passive or active type. RS232 and RS485 outputs are available for communication.



S25-50 Metal Compensators are flexible unions used on rigid pipe work systems to absorb axial thermal movements. They consist of a corrugated Omega shaped bellow, with welded ends (S25) or flanged ends (S50), and an internal sleeve, which protects the bellow from wear and turbulences. Additionally S50 type incorporates limit rods as standard. A correct pipe system arrangement and installation according to our Installation Operating and Maintenance Manual is essential to ensure a safe and efficient performance.



Main Features

Design: EJMA 9th Edition
 Nominal Pressure: S50 PN16 / S25 PN10
 Valve end connections: S50 - Drilled to EN1092-1 PN16 (valves DN65 with 4 holes as accepted variant in standard)
 S25 - Butt weld ends
 Marking: EN 19
 Pressure Tests: EN 12266-1
 Steel parts painted in metal blue color for protection during storage and transport
 Product compliant with Pressure Equipment Directive PED, max. category I

Main Duties / Limits of use

Liquids compatible with materials of construction, acc. to PED Annex II tables 8 (group 1) & 9 (group 2) up to category I;
 Stable gases compatible with materials of construction, acc. to PED Annex II tables 6 (group 1) & 7 (group 2) up to category I

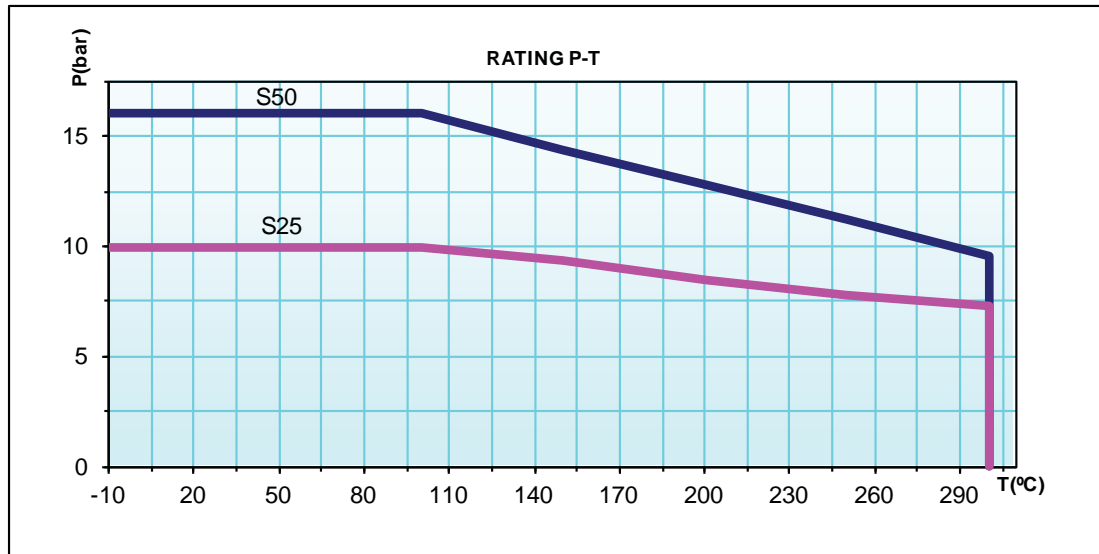
S50	S25
PS: 16 bar; TS: -10/300°C	PS: 10 bar; TS: -10/300°C
Table 6: PS 16 bar DN32-DN50	Table 6: PS 10 bar DN20-DN100 (Art. 3.3 DN20-DN25)
PS 13 bar DN65	Table 7: PS 10 bar DN20-DN300 (Art. 3.3 DN20-DN100)
PS 10 bar DN80-100	Table 8: PS 10 bar DN20-DN300 (Art. 3.3 DN20-DN200)
Table 7: PS 16 bar DN32-DN200 (Art. 3.3 DN32-DN50)	Table 9: PS 10 bar DN20-DN300 (Art. 3.3)
PS 13 bar DN250	
PS 10 bar DN300-350	
PS 6 bar DN400-500	
PS 3 bar DN600	
Table 8: PS 16 bar DN32-DN125 (Art. 3.3)	
PS 13 bar DN150 (Art. 3.3)	
PS 10 bar DN200-600 (Art. 3.3 DN32-DN200)	
Table 9: PS 16 bar DN32-DN600 (Art. 3.3 DN32-DN300)	

Questions referring to chemical resistance, please consult us
 Observe also pressure/temperature limits on diagram on next page

Options

Higher service temperatures, other designs and approvals; please consult us

Pressure/Temperature limits diagram



S50

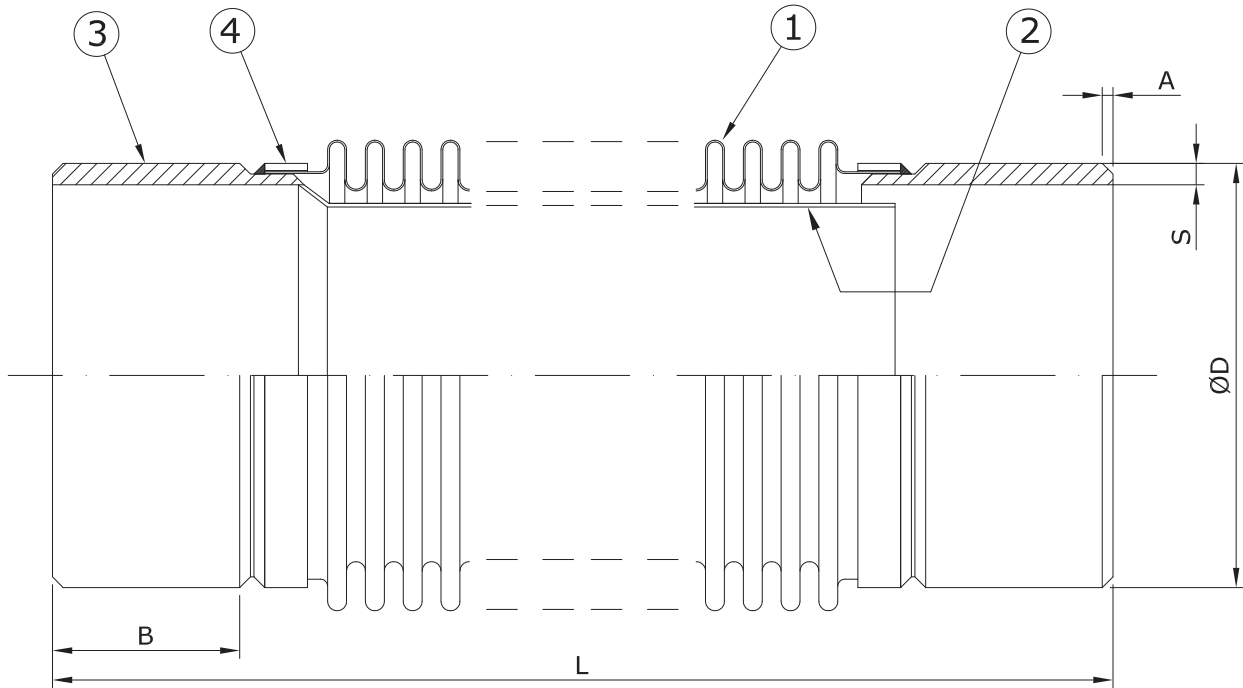
P (bar)	16	16	14,4	12,8	11,2	9,6
T (°C)	-10	100	150	200	250	300

S25

P (bar)	10	10	9,4	8,5	7,8	7,3
T (°C)	-10	100	150	200	250	300

Main Parts and Materials

TYPE S25



Nº	PART	MATERIAL
1	BELLOWS	St. Steel SS304
2	INTERNAL SLEEVE	St. Steel SS304
3	TUBE ENDS	S250_ Steel DIN St 44-2
		S25L_ St. Steel SS304
4	SEAL RING	St. Steel SS304

Main Valve Parameters

DN	20	25	32	40	50	65
L	250	250	350	350	350	350
Axial Movement	+5, -25	+5, -25	+10, -40	+10, -40	+10, -40	+10, -40
No. of Corrugations	30	28	36	32	24	20
A	1,17	1,70	1,79	1,80	1,90	1,75
B	47,30	45,20	66,60	66,90	59,00	60,00
S	2,8	3,4	3,6	3,7	3,9	4,2
ØD	27,2	34	42,3	48,3	60,3	76,3
S	3	3	3	3	3,5	4
ØD	27,2	34	42,3	48,3	60,3	76,3
Effective Area	6	9	13	21	32	50
Approx. Weight	1	1	1	1,5	2	2,5

DN	80	100	125	150	200	250	300
L	350	350	350	350	350	350	350
Axial Movement	+10, -40	+10, -40	+10, -40	+10, -40	+10, -40	+10, -40	+10, -40
No. of Corrugations	20	16	15	14	13	12	12
A	2,20	2,30	2,50	3,75	3,75	3,75	3,75
B	58,70	65,50	62,10	60,9	58,8	60,10	59,50
S	4,2	4,5	5	5,5	6,5	6,3	7,9
ØD	89,1	114,3	139,8	168,3	219,1	273,1	323,9
S	4	4	5	5	6,5	6,5	6,5
ØD	89,1	114,3	139,8	168,3	219,1	273,1	323,9
Effective Area	67	110	182	259	417	661	907
Approx. Weight	2,5	4	5,5	6,5	8	11	17

Dimensions in mm subject to manufacturing tolerance / Effective Area in cm² / Weights in kg

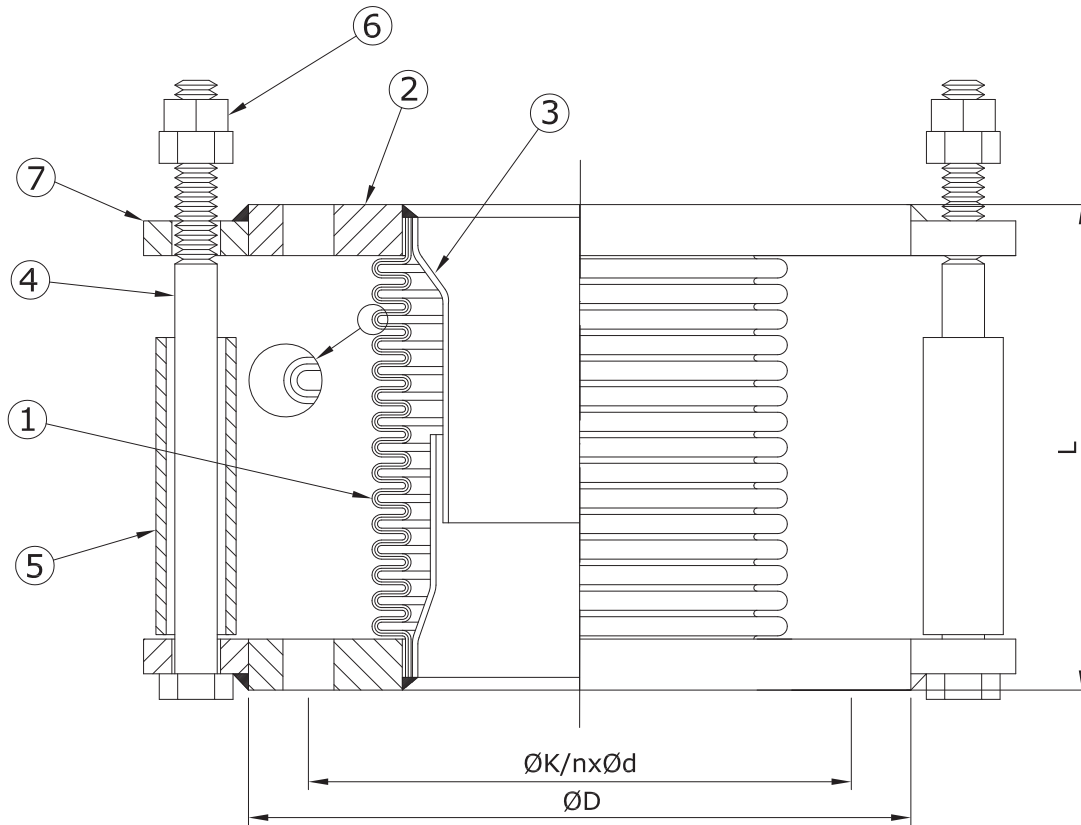
Information / restriction of technical rules need to be observed!

Installation, Operating and Maintenance Manual can be downloaded at www.comeval.es

The engineer, designing a system or a plant, is responsible for the selection of the correct valve Product suitability must be verified, contact manufacturer for information

Main Parts and Materials

TYPE S50



Nº	PART	MATERIAL
1	BELLOWS	St. Steel SS304
2	FLANGE	Steel DIN ST-37.2
3	INTERNAL SLEEVE	St. Steel SS304
4	LIMIT ROD	Steel DIN ST-44.2
5	LIMIT PIPE	St. Steel SS304
6	NUT	Steel DIN ST-44.2
7	LUG	Steel DIN ST-44.2

Main Valve Parameters

DN	32	40	50	65	80	100	125	150
L	150	150	150	150	150	150	150	150
Axial Movement	+10, -25	+10, -25	+10, -25	+10, -25	+10, -25	+10, -25	+10, -25	+10, -25
ØD	140	150	165	185	200	220	250	285
ØK	100	110	125	145	160	180	210	240
n	4	4	4	4	8	8	8	8
Ød	18	18	18	18	18	18	18	22
Effective Area	13	20	32	49	67	109	167	229
Weight	5	6	6,5	8	9	10	14	17,5

DN	200	250	300	350	400	450	500	600
L	200	200	200	200	200	200	200	250
Axial Movement	+10, -35	+10, -35	+10, -35	+10, -35	+10, -35	+10, -25	+10, -25	+10, -40
ØD	340	405	460	520	580	640	715	840
ØK	295	355	410	470	525	585	650	770
n	12	12	12	16	16	20	20	20
Ød	22	26	26	26	30	30	33	36
Effective Area	384	579	820	1171	1515	1886	2324	3274
Weight	23	33	37	77	92	107	129	185

Dimensions in mm subject to manufacturing tolerance / Effective Area in cm² / Weights in kg

Information / restriction of technical rules need to be observed!
Installation, Operating and Maintenance Manual can be downloaded at www.comeval.es

The engineer, designing a system or a plant, is responsible for the selection of the correct valve
Product suitability must be verified, contact manufacturer for information

Annex 11

1a iteració exemple

Columna	Lab	Con ducte	Número	Escenari final desfavorable									
				Cabal tram (m3/h)	Cabal tram (l/min)	Consum l/min	Consum m3/h	Outer D (mm)	Thickness(mm)	Inner D maximum (mm)	Velocity minimum [m/s]	Inner D (mm) minimum	Velocity [m/s] maximum
30	BL 31	10	20	197,4	3290	110	6,6	114,3	3,05	301,1	0,770	152,6	3,000
	BL 30	10	19	197,40	3290,00	110,00	6,60	114,30	3,05	301,11	0,77	152,55	3,00
27	BL 29 BOREAS	9	18	184,20	3070,00	40,00	2,40	114,30	3,05	290,87	0,77	147,36	3,00
	BL 28	9	17	184,20	3070,00	110,00	6,60	114,30	3,05	290,87	0,77	147,36	3,00
23	BL 27	8	16	175,20	2920,00	110,00	6,60	114,30	3,05	283,68	0,77	143,72	3,00
	BL26	8	15	175,20	2920,00	110,00	6,60	114,30	3,05	283,68	0,77	143,72	3,00
20	BL 25 LOREA?	7	14	162,00	2700,00	110,00	6,60	114,30	3,05	272,78	0,77	138,20	3,00
		7	13	162,00	2700,00	0,00	0,00	114,30	3,05	272,78	0,77	138,20	3,00
18	BL 24 CIRCE	6	12	155,40	2590,00	32,00	1,92	114,30	3,05	267,17	0,77	135,35	3,00
	BL 23	6	11	155,40	2590,00	110,00	6,60	114,30	3,05	267,17	0,77	135,35	3,00
15	BL 22	5	10	146,88	2448,00	110,00	6,60	114,30	3,05	259,74	0,77	131,59	3,00
	BL 21 CLAESS	5	9	146,88	2448,00	26,00	1,56	114,30	3,05	259,74	0,77	131,59	3,00
11	BL 20	4	8	138,72	2312,00	110,00	6,60	114,30	3,05	252,42	0,77	127,88	3,00
	BL 19	4	7	138,72	2312,00	110,00	6,60	114,30	3,05	252,42	0,77	127,88	3,00
7	BL 18	3	6	125,52	2092,00	110,00	6,60	114,30	3,05	240,11	0,77	121,65	3,00
	BL 17	3	5	125,52	2092,00	110,00	6,60	114,30	3,05	240,11	0,77	121,65	3,00
4	BL 16	2	4	112,32	1872,00	110,00	6,60	114,30	3,05	227,14	0,77	115,07	3,00
	BL 15	2	3	112,32	1872,00	110,00	6,60	114,30	3,05	227,14	0,77	115,07	3,00
2	BL 14	1	2	99,12	1652,00	110,00	6,60	114,30	3,05	213,37	0,77	108,10	3,00
		1	1	99,12	1652,00	0,00	0,00	114,30	3,05	213,37	0,77	108,10	3,00
60	BL 13 XALOC	19	38	92,52	1542,00	60,00	3,60	114,30	3,05	206,15	0,77	104,44	3,00
	BL 12	19	37	92,52	1542,00	110,00	6,60	114,30	3,05	206,15	0,77	104,44	3,00
56	BL 11 NCD	18	36	82,32	1372,00	12,00	0,72	114,30	3,05	194,45	0,77	98,51	3,00
	BL 10	18	35	82,32	1372,00	110,00	6,60	114,30	3,05	194,45	0,77	98,51	3,00
53	BL 09 MISTRAL	17	34	75,00	1250,00	45,00	2,70	114,30	3,05	185,60	0,77	94,03	3,00
	BL 08	17	33	75,00	1250,00	110,00	6,60	114,30	3,05	185,60	0,77	94,03	3,00
49	BL 07	16	32	65,70	1095,00	110,00	6,60	114,30	3,05	173,72	0,77	88,01	3,00
	BL 06	16	31	65,70	1095,00	110,00	6,60	114,30	3,05	173,72	0,77	88,01	3,00
44	BL 05	15	30	52,50	875,00	110,00	6,60	114,30	3,05	155,29	0,77	78,67	3,00
	BL 04 MSPD	15	29	52,50	875,00	105,00	6,30	114,30	3,05	155,29	0,77	78,67	3,00
42	BL03	14	28	39,60	660,00	110,00	6,60	114,30	3,05	134,87	0,77	68,33	3,00
	BL 02	14	27	39,60	660,00	110,00	6,60	114,30	3,05	134,87	0,77	68,33	3,00
39	BL 01	13	26	26,40	440,00	110,00	6,60	114,30	3,05	110,12	0,77	55,79	3,00
	MIRAS?	13	25	26,40	440,00	110,00	6,60	114,30	3,05	110,12	0,77	55,79	3,00
36	BL 34 XANADÚ - ByPass	12	24	13,20	220,00	0,00	6,60	114,30	3,05	77,87	0,77	39,45	3,00
		12	23	13,20	220,00	0,00	0,00	114,30	3,05	77,87	0,77	39,45	3,00
33	BL 33 Bypass	11	22	13,20	220,00	110,00	6,60	114,30	3,05	77,87	0,77	39,45	3,00
	BL 32	11	21	13,20	220,00	110,00	6,60	114,30	3,05	77,87	0,77	39,45	3,00

2a iteracio + resultats

Columna	Laboratori	Número	Conducte	Final desfavorable		Final Mitjana		Final realista	
				Inner D maximum (mm)	Velocity minimum [m/s]	Inner D maximum (mm)	Velocity minimum [m/s]	Inner D maximum (mm)	Velocity minimum [m/s]
30 BL 31		10	20	161,48	2,68	108,20	3,20	108,2	2,85
BL 30		10	19	161,48	2,68	108,20	3,20	108,2	2,85
27 BL 29 BOREAS		9	18	161,48	2,50	108,20	3,03	108,2	2,70
BL 28		9	17	161,48	2,50	108,20	3,03	108,2	2,70
23 BL 27		8	16	161,48	2,38	108,20	2,88	108,2	2,56
BL26		8	15	161,48	2,38	108,20	2,88	108,2	2,56
20 BL 25 - LOREA?		7	14	161,48	2,20	108,20	2,71	108,2	2,41
		7	13	161,48	2,20	108,20	2,71	108,2	2,41
18 BL 24 CIRCE		6	12	161,48	2,11	108,20	2,54	108,2	2,27
BL 23		6	11	161,48	2,11	108,20	2,54	108,2	2,27
15 BL 22		5	10	161,48	1,99	108,20	2,40	108,2	2,14
BL 21 CLAESS		5	9	161,48	1,99	108,20	2,40	108,2	2,14
11 BL 20		4	8	161,48	1,88	108,20	2,26	108,2	2,02
BL 19		4	7	161,48	1,88	108,20	2,26	108,2	2,02
7 BL 18		3	6	161,48	1,70	108,20	2,10	108,2	1,87
BL 17		3	5	161,48	1,70	108,20	2,10	108,2	1,87
4 BL 16		2	4	161,48	1,52	108,20	1,93	108,2	1,73
BL 15		2	3	161,48	1,52	108,20	1,93	108,2	1,73
2 BL 14		1	2	108,20	2,99	108,20	1,76	108,2	1,58
		1	1	108,20	2,99	108,20	1,76	108,2	1,58
60 BL 13 XALOC		19	38	108,20	2,80	108,20	1,59	108,2	1,44
BL 12		19	37	108,20	2,80	108,20	1,59	108,2	1,44
56 BL 11 NCD		18	36	108,20	2,49	108,20	1,39	108,2	1,25
BL 10		18	35	108,20	2,49	108,20	1,39	108,2	1,25
53 BL 09 MISTRAL		17	34	108,20	2,27	108,20	1,29	108,2	1,16
BL 08		17	33	108,20	2,27	108,20	1,29	108,2	1,16
49 BL 07		16	32	108,20	1,98	108,20	1,12	108,2	1,01
BL 06		16	31	108,20	1,98	108,20	1,12	108,2	1,01
44 BL 05		15	30	108,20	1,59	108,20	0,95	108,2	0,86
BL 04 MSPD		15	29	108,20	1,59	108,20	0,95	108,2	0,86
42 BL03		14	28	108,20	1,20	108,20	0,68	42,7	3,84
BL 02		14	27	108,20	1,20	108,20	0,68	42,7	3,84
39 BL 01		13	26	108,20	0,80	42,72	3,26	42,7	2,91
MIRAS?		13	25	108,20	0,80	42,72	3,26	42,7	2,91
36 BL 34 XANADÚ - ByPass		12	24	66,93	1,04	42,72	2,17	42,7	1,98
		12	23	66,93	1,04	42,72	2,17	42,7	1,98
33 BL 33 Bypass		11	22	66,93	1,04	42,72	1,09	42,7	1,05
BL 32		11	21	66,93	1,04	42,72	1,09	42,7	1,05

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Columna	Laboratori	Número	Conducte	Final desfavorable		Final Mitjana		Final realista	
				Inner D maximum (mm)	Velocity minimum [m/s]	Inner D maximum (mm)	Velocity minimum [m/s]	Inner D maximum (mm)	Velocity minimum [m/s]
30	BL 31	10	20	161,48	2,68	108,20	3,20	108,2	2,85
	BL 30	10	19	161,48	2,68	108,20	3,20	108,2	2,85
27	BL 29 BOREAS	9	18	161,48	2,50	108,20	3,03	108,2	2,70
	BL 28	9	17	161,48	2,50	108,20	3,03	108,2	2,70
23	BL 27	8	16	161,48	2,38	108,20	2,88	108,2	2,56
	BL26	8	15	161,48	2,38	108,20	2,88	108,2	2,56
20	BL 25 - LOREA?	7	14	161,48	2,20	108,20	2,71	108,2	2,41
		7	13	161,48	2,20	108,20	2,71	108,2	2,41
18	BL 24 CIRCE	6	12	161,48	2,11	108,20	2,54	108,2	2,27
	BL 23	6	11	161,48	2,11	108,20	2,54	108,2	2,27
15	BL 22	5	10	161,48	1,99	108,20	2,40	108,2	2,14
	BL 21 CLAEISS	5	9	161,48	1,99	108,20	2,40	108,2	2,14
11	BL 20	4	8	161,48	1,88	108,20	2,26	108,2	2,02
	BL 19	4	7	161,48	1,88	108,20	2,26	108,2	2,02
7	BL 18	3	6	161,48	1,70	108,20	2,10	108,2	1,87
	BL 17	3	5	161,48	1,70	108,20	2,10	108,2	1,87
4	BL 16	2	4	161,48	1,52	108,20	1,93	108,2	1,73
	BL 15	2	3	161,48	1,52	108,20	1,93	108,2	1,73
2	BL 14	1	2	108,20	2,99	108,20	1,76	108,2	1,58
		1	1	108,20	2,99	108,20	1,76	108,2	1,58
60	BL 13 XALOC	19	38	108,20	2,80	108,20	1,59	108,2	1,44
	BL 12	19	37	108,20	2,80	108,20	1,59	108,2	1,44
56	BL 11 NCD	18	36	108,20	2,49	108,20	1,39	108,2	1,25
	BL 10	18	35	108,20	2,49	108,20	1,39	108,2	1,25
53	BL 09 MISTRAL	17	34	108,20	2,27	108,20	1,29	108,2	1,16
	BL 08	17	33	108,20	2,27	108,20	1,29	108,2	1,16
49	BL 07	16	32	108,20	1,98	108,20	1,12	108,2	1,01
	BL 06	16	31	108,20	1,98	108,20	1,12	108,2	1,01
44	BL 05	15	30	108,20	1,59	108,20	0,95	108,2	0,86
	BL 04 MSPD	15	29	108,20	1,59	108,20	0,95	108,2	0,86
42	BL03	14	28	108,20	1,20	108,20	0,68	108,2	0,60
	BL 02	14	27	108,20	1,20	108,20	0,68	108,2	0,60
39	BL 01	13	26	108,20	0,80	42,72	3,26	42,7	2,91
	MIRAS?	13	25	108,20	0,80	42,72	3,26	42,7	2,91
36	BL 34 XANADÚ - ByPass	12	24	66,93	1,04	42,72	2,17	42,7	1,98
		12	23	66,93	1,04	42,72	2,17	42,7	1,98
33	BL 33 Bypass	11	22	66,93	1,04	42,72	1,09	42,7	1,05
	BL 32	11	21	66,93	1,04	42,72	1,09	42,7	1,05

Columna	Lab	Número	Cond. ucte	Escenari actual				Escenari final desfavorable				Escenari final mitjana				Escenari final realista			
				Cabal tram (l/min)	Consum l/min	Inner D (mm)	Velocity (m/s)	Cabal tram (l/min)	Consum l/min	Inner D maximum (mm)	Velocity minimum (m/s)	Cabal tram (l/min)	Consum l/min	Inner D maximum (mm)	Velocity minimum (m/s)	Cabal tram (l/min)	Consum l/min	Inner D maximum (mm)	Velocity minimum (m/s)
30	BL 31	10	20	486,00		108,20	0,88	3290,00	110,00	161,48	1,47	1767,70	46,70	108,20	3,20	1480,00	40,00	108,20	2,83
	BL 30	10	19	486,00		108,20	0,88	3290,00	110,00	161,48	1,47	1767,70	46,70	108,20	3,20	1480,00	40,00	108,20	2,83
27	BL 29 BOREAS	9	18	486,00	40,00	108,20	0,88	3070,00	40,00	161,48	1,47	1674,30	40,00	108,20	3,03	1400,00	40,00	108,20	2,68
	BL 28	9	17	486,00		108,20	0,88	3070,00	110,00	161,48	1,47	1674,30	46,70	108,20	3,03	1400,00	40,00	108,20	2,68
23	BL 27	8	16	486,00		108,20	0,88	2920,00	110,00	161,48	1,47	1587,60	46,70	108,20	2,88	1320,00	40,00	108,20	2,54
	BL26	8	15	486,00		108,20	0,88	2920,00	110,00	161,48	1,47	1587,60	46,70	108,20	2,88	1320,00	40,00	108,20	2,54
20	BL 25 LOREA?	7	14	486,00		108,20	0,88	2700,00	110,00	161,48	1,47	1494,20	46,70	108,20	2,71	1240,00	40,00	108,20	2,39
		7	13	486,00		108,20	0,88	2700,00	0,00	161,48	1,47	1494,20	46,70	108,20	2,71	1240,00	40,00	108,20	2,39
18	BL 24 CIRCE	6	12	446,00	32,00	108,20	0,81	2590,00	32,00	161,48	1,47	1400,80	32,00	108,20	2,54	1160,00	32,00	108,20	2,25
	BL 23	6	11	446,00		108,20	0,81	2590,00	110,00	161,48	1,47	1400,80	46,70	108,20	2,54	1160,00	40,00	108,20	2,25
15	BL 22	5	10	414,00		108,20	0,75	2448,00	110,00	161,48	1,47	1322,10	46,70	108,20	2,40	1088,00	40,00	108,20	2,12
	BL 21 CLAEISS	5	9	150,00	26,00	108,20	0,75	2448,00	26,00	161,48	1,47	1322,10	26,00	108,20	2,40	1088,00	26,00	108,20	2,12
11	BL 20	4	8	133,33		108,20	0,75	2312,00	110,00	161,48	1,47	1249,40	46,70	108,20	2,26	1022,00	40,00	108,20	2,00
	BL 19	4	7	116,67		108,20	0,75	2312,00	110,00	161,48	1,47	1249,40	46,70	108,20	2,26	1022,00	40,00	108,20	2,00
7	BL 18	3	6	100,00		108,20	0,75	2092,00	110,00	161,48	1,47	1156,00	46,70	108,20	2,10	942,00	40,00	108,20	1,85
	BL 17	3	5	83,33		108,20	0,75	2092,00	110,00	161,48	1,47	1156,00	46,70	108,20	2,10	942,00	40,00	108,20	1,85
4	BL 16	2	4	66,67		108,20	0,75	1872,00	110,00	161,48	1,47	1062,60	46,70	108,20	1,93	862,00	40,00	108,20	1,71
	BL 15	2	3	50,00		108,20	0,75	1872,00	110,00	161,48	1,47	1062,60	46,70	108,20	1,93	862,00	40,00	108,20	1,71
2	BL 14	1	2	33,33		108,20	0,75	1652,00	110,00	108,20	3,27	969,20	46,70	108,20	1,76	782,00	40,00	108,20	1,56
		1	1	16,67		108,20	0,75	1652,00	0,00	108,20	3,27	969,20	46,70	108,20	1,76	782,00	40,00	108,20	1,56
60	BL 13 XALOC	19	38	388,00	60,00	108,20	0,70	1542,00	60,00	108,20	3,27	875,80	60,00	108,20	1,59	702,00	60,00	108,20	1,42
	BL 12	19	37	388,00		108,20	0,70	1542,00	110,00	108,20	3,27	875,80	46,70	108,20	1,59	702,00	40,00	108,20	1,42
56	BL 11 NCD	18	36	328,00	12,00	108,20	0,59	1372,00	12,00	108,20	3,27	769,10	12,00	108,20	1,39	602,00	12,00	108,20	1,24
	BL 10	18	35	583,33		108,20	0,59	1372,00	110,00	108,20	3,27	769,10	46,70	108,20	1,39	602,00	40,00	108,20	1,24
53	BL 09 MISTRAL	17	34	316,00	45,00	108,20	0,57	1250,00	45,00	108,20	3,27	710,40	45,00	108,20	1,29	550,00	45,00	108,20	1,14
	BL 08	17	33	316,00		108,20	0,57	1250,00	110,00	108,20	3,27	710,40	46,70	108,20	1,29	550,00	40,00	108,20	1,14
49	BL 07	16	32	316,00		108,20	0,57	1095,00	110,00	108,20	3,27	618,70	46,70	108,20	1,12	465,00	40,00	108,20	0,99
	BL 06	16	31	316,00		108,20	0,57	1095,00	110,00	108,20	3,27	618,70	46,70	108,20	1,12	465,00	40,00	108,20	0,99
44	BL 05	15	30	271,00		108,20	0,49	875,00	110,00	108,20	3,27	525,30	46,70	108,20	0,95	385,00	40,00	108,20	0,84
	BL 04 MSPD	15	29	271,00	105,00	108,20	0,49	875,00	105,00	108,20	3,27	525,30	105,00	108,20	0,95	385,00	105,00	108,20	0,84
42	BL03	14	28	271,00		108,20	0,49	660,00	110,00	108,20	3,27	373,60	46,70	108,20	0,68	240,00	40,00	42,72	3,72
	BL 02	14	27	271,00		108,20	0,49	660,00	110,00	108,20	3,27	373,60	46,70	108,20	0,68	240,00	40,00	42,72	3,72
39	BL 01	13	26	271,00		108,20	0,49	440,00	110,00	108,20	3,27	280,20	46,70	42,72	3,26	160,00	40,00	42,72	2,79
	MIRAS?	13	25	271,00		108,20	0,49	440,00	110,00	108,20	3,27	280,20	46,70	42,72	3,26	160,00	40,00	42,72	2,79
36	BL 34 XANADÚ - ByPass	12	24	400,00		108,20	0,30	220,00	0,00	66,93	8,54	186,80	46,70	42,72	2,17	80,00	40,00	42,72	1,86
		12	23	166,00	71,00	108,20	0,30	220,00	0,00	66,93	8,54	186,80	46,70	42,72	2,17	80,00	40,00	42,72	1,86
33	BL 33 Bypass	11	22	95,00	95,00	108,20	0,17	220,00	110,00	66,93	8,54	93,40	46,70	42,72	1,09	80,00	40,00	42,72	0,93
	BL 32	11	21	350,00		108,20	0,17	220,00	110,00	66,93	8,54	93,40	46,70	42,72	1,09	80,00	40,00	42,72	0,93

The inverse rotation: Protocol

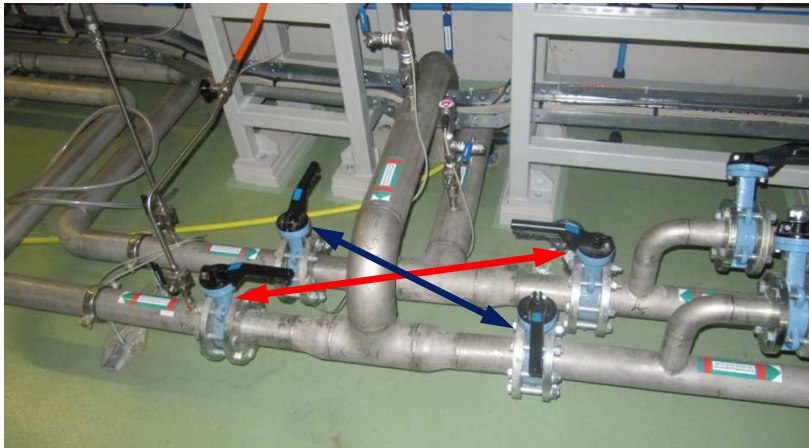


Fig 3.3.3 Booster example case: the four main valves inlet/outlet of the ring. Open and close these valves in opposite way we are forcing the flow inverse rotation

Protocol description

Cooling intervention: inverse rotation of the flow in the four rings; at least one per year.

Goal: remove the air accumulated in the rings parts where the velocities are less than 0.5 m/s

Action: Preventive

Divisions involved: Experiment, Accelerator, Computing and Engineering

Time: 8 hours

Steps:

- 1) Switch off the flowrate of IOTs (Service Area)
- 2) Switch off the pumps groups (EA, SR, BO and SA)
- 3) Close the inlet/outlet valves of the Experimental Area in the main branch
- 4) Open the bypasses of the Experimental Area
- 5) Open and close the main valves in the four rings, in order to force the inverse rotation
- 6) Switch on the pumps groups (EA, SR, BO and SA). Keep this operation point for 2 hours
- 7) Switch off the pumps groups (EA, SR, BO and SA)
- 8) Recover the original position open/close of the main valves of the four rings
- 9) Switch on the pumps groups (EA, SR, BO and SA).
- 10) Switch on the flowrate of IOTs (Service Area)
- 11) Open the inlet/outlet valves of the Experimental Area in the main branch
- 12) Close the bypasses of the Experimental Area

Inverse rotation executed:

8 August 2014

8 January 2015



Annex 13

Fitxer txt generat per l'ultrasònic. Exemple de les primeres 100 mesures.

Indica el canal, que és l'A. La data de la mesura. És data absoluta, no relativa a l'inici de presa de dades i la lectura en l/min. L'última dada és el cabal absolut en litres que ha mesurat des de l'últim reset de l'aparell.

Al principi afegeix un petit informe de la màquina i de les condicions i paràmetres especificades per fer aquesta lectura.

```
.....  
\SOURCE=received data[01] (V5.88)  
DEVICE      : F 601 -06010493  
MODE        : STORED  
NAME        : SCANDATA  
CHAN        : 1 (A:)  
START       : 23/03/2016 16:56:47  
\COMMENTS  
\PARAMS  
Par.Record  : Par.Record  14  
Meas. Point No.: : A:4  
Pipe        :  
Outer Diameter : 114,3 mm  
Wall Thickness : 3,1 mm  
Roughness     : 0,0 mm  
Pipe Material  : Stainless Steel  
c-Material    : 3100,0 m/s  
Lining        : WITHOUT LINING  
Medium        : Water  
c-Medium     MIN: 1482,0 m/s  
c-Medium     MAX: 1482,0 m/s  
Kinem.Viscosity : 0,99 mm2/s  
Density       : 1,00 g/cm3  
Medium Temperat.: 23 C  
Fluid pressure : 1,00 bar  
Tranducer Type : CDS1NZ70768  
Sound Path    : 6 NUM  
Transd. Distance : 237,8 mm  
Damping       : 10 s  
Storage Rate  : 00:01:00 SAMPLES  
Profile corr. : ON  
Physic. Quant. : Volume Flow  
Unit Of Measure : [l/min]/[l]  
Numb.Of Meas.Val : 8179
```




\DATA

*	DATE_TIME	MEASURE	Q_POS	Q_NEG
\#		[l/min] [l]	[l]	
A	23/03/2016 16:56:47	97,47	+12686380,30	
A	23/03/2016 16:57:47	95,82	+12686476,70	
A	23/03/2016 16:58:47	96,37	+12686572,00	
A	23/03/2016 16:59:47	95,82	+12686669,70	
A	23/03/2016 17:00:47	95,82	+12686765,30	
A	23/03/2016 17:01:47	96,92	+12686862,40	
A	23/03/2016 17:02:47	95,82	+12686958,80	
A	23/03/2016 17:03:47	95,27	+12687054,80	
A	23/03/2016 17:04:47	96,37	+12687150,40	
A	23/03/2016 17:05:47	96,92	+12687247,90	
A	23/03/2016 17:06:47	95,82	+12687344,40	
A	23/03/2016 17:07:47	96,92	+12687440,30	
A	23/03/2016 17:08:47	96,37	+12687536,30	
A	23/03/2016 17:09:47	98,57	+12687632,00	
A	23/03/2016 17:10:47	96,92	+12687730,30	
A	23/03/2016 17:11:47	97,47	+12687826,40	
A	23/03/2016 17:12:47	96,92	+12687923,10	
A	23/03/2016 17:13:47	95,82	+12688018,90	
A	23/03/2016 17:14:47	96,37	+12688116,10	
A	23/03/2016 17:15:47	95,82	+12688212,20	
A	23/03/2016 17:16:47	95,27	+12688307,10	
A	23/03/2016 17:17:47	96,92	+12688403,90	
A	23/03/2016 17:18:47	96,92	+12688500,10	
A	23/03/2016 17:19:47	95,27	+12688595,00	
A	23/03/2016 17:20:47	96,37	+12688691,60	
A	23/03/2016 17:21:47	96,37	+12688789,20	
A	23/03/2016 17:22:47	96,37	+12688885,10	
A	23/03/2016 17:23:47	97,47	+12688981,60	



A	23/03/2016	17:24:47	97,47	+12689078,90
A	23/03/2016	17:25:47	98,02	+12689176,10
A	23/03/2016	17:26:47	96,37	+12689272,60
A	23/03/2016	17:27:47	95,82	+12689368,60
A	23/03/2016	17:28:47	96,92	+12689464,00
A	23/03/2016	17:29:47	96,92	+12689561,40
A	23/03/2016	17:30:47	96,37	+12689656,90
A	23/03/2016	17:31:47	95,82	+12689753,60
A	23/03/2016	17:32:47	96,37	+12689849,90
A	23/03/2016	17:33:47	97,47	+12689946,20
A	23/03/2016	17:34:47	96,37	+12690042,00
A	23/03/2016	17:35:47	95,27	+12690136,40
A	23/03/2016	17:36:47	96,92	+12690233,60
A	23/03/2016	17:37:47	96,37	+12690329,80
A	23/03/2016	17:38:47	97,47	+12690426,30
A	23/03/2016	17:39:47	97,47	+12690522,10
A	23/03/2016	17:40:47	97,47	+12690618,90
A	23/03/2016	17:41:47	95,82	+12690715,00
A	23/03/2016	17:42:47	96,92	+12690810,50
A	23/03/2016	17:43:47	95,27	+12690905,70
A	23/03/2016	17:44:47	95,82	+12691002,70
A	23/03/2016	17:45:47	95,82	+12691098,60
A	23/03/2016	17:46:47	95,82	+12691194,40
A	23/03/2016	17:47:47	95,82	+12691290,20
A	23/03/2016	17:48:47	95,82	+12691386,10
A	23/03/2016	17:49:47	97,47	+12691482,50
A	23/03/2016	17:50:47	95,82	+12691577,70
A	23/03/2016	17:51:47	95,82	+12691672,60
A	23/03/2016	17:52:47	97,47	+12691768,70
A	23/03/2016	17:53:47	95,82	+12691864,80

.....