Abstract

This project consists of the development and validation of a numerical model to simulate transient responses of the ALBA’s synchrotron cooling system. In particular, the work aims at studying the pumping system start-up and stop in order to detect possible problems that can lead to piping failures.

The project focus on the hydrodynamic response of the cooling system, which is part of the activities integrated in a stability and reliability plan promoted by CELLS (Consortium for the Exploitation of the Synchrotron Light Laboratory).

Flowmaster® is the 1D thermo-fluid simulation software that has been used to model the cooling system to detect dangerous pressure peaks and flow oscillations when operation conditions of the pumping stations are suddenly changed.

The first part of this project has been involved in learning and familiarizing with Flowmaster® program in order to perform correctly the simulations. Simple models have been designed to understand and learn the properties and the response influence of the components and model set-up.

The second part has involved the simulations of the actual cooling system. A model available from preliminary studies has been modified to take into account compressibility effects by replacing and adding the adequate components. In addition, it has also been necessary to create scripts and to introduce and make changes in the PID controllers in order to simulate the real ALBA synchrotron pumping system startup/stop procedures.

The normal start-up maneuver of the pumping system has been simulated and the fluid dynamic response has been analyzed. The results indicate the generation of significant pressure rises. To mitigate them, changes to the PID controller parameters have been proposed that improve the transient behavior reducing such peaks.

The simulation and analysis of pumps’ shutdowns due to unexpected failures has served to identify the consequences on the system behavior and to prevent possible life-reduction conditions. The calculations have been carried out without and with simultaneous thermal regulation. For example, the results indicate that when the thermal regulation is on the consequences of the simultaneous shut-down of all pumps are mitigated.

Finally, the effect of air in the pipes has been analyzed during a pump shut-down and it has been confirmed that the transient pressure fluctuations predicted in the system are modified.

Summary

A. Glossari

BL: Beam Lines o línies experimentals.

BO: Booster Ring o accelerador circular.

CELLS: Consortium for the Exploitation of the Synchrotron Light Laboratory.

CFD: Computational Fluid Dynamics

D02: Accumulator.

D03: Pneumatex

EA: Experimental Area

EX07: Heat exchanger

PID: Proportional-integrative-derivative controller

P07: Experimental Area pumping system

P08: Storage Ring pumping system

P09: Booster Ring pumping system.

P10: Service Area pumping system.

P11: Pumping system that bring the heated water to the heat exchangers.

PEM: It is the Budget of Material Execution. In Catalan, stand for "*Pressupost d'Execució Material*".

PEC: It is the Contracted Operation Budget. In Catalan, stands for "*Pressupost d'Execució per contracte*".

SA: Service Area

SR: Storage Ring.

$V3V_{D02}$: Three-way valve connected to the accumulator.

$V3V_{P07}$: Three way valves of the pumping ring P07

$V3V_{P08}$: Three way valves of the pumping ring P08

$V3V_{P09}$: Three way valves of the pumping ring P09

$V3V_{P10}$: Three way valves of the pumping ring P10

B. ALBA beam lines

The beam lines are made of steel and once the light arrives in the line, the wavelength must be selected in order to proceed with the testing and experimentation. The beam lines that are operating in ALBA synchrotron are explained below.

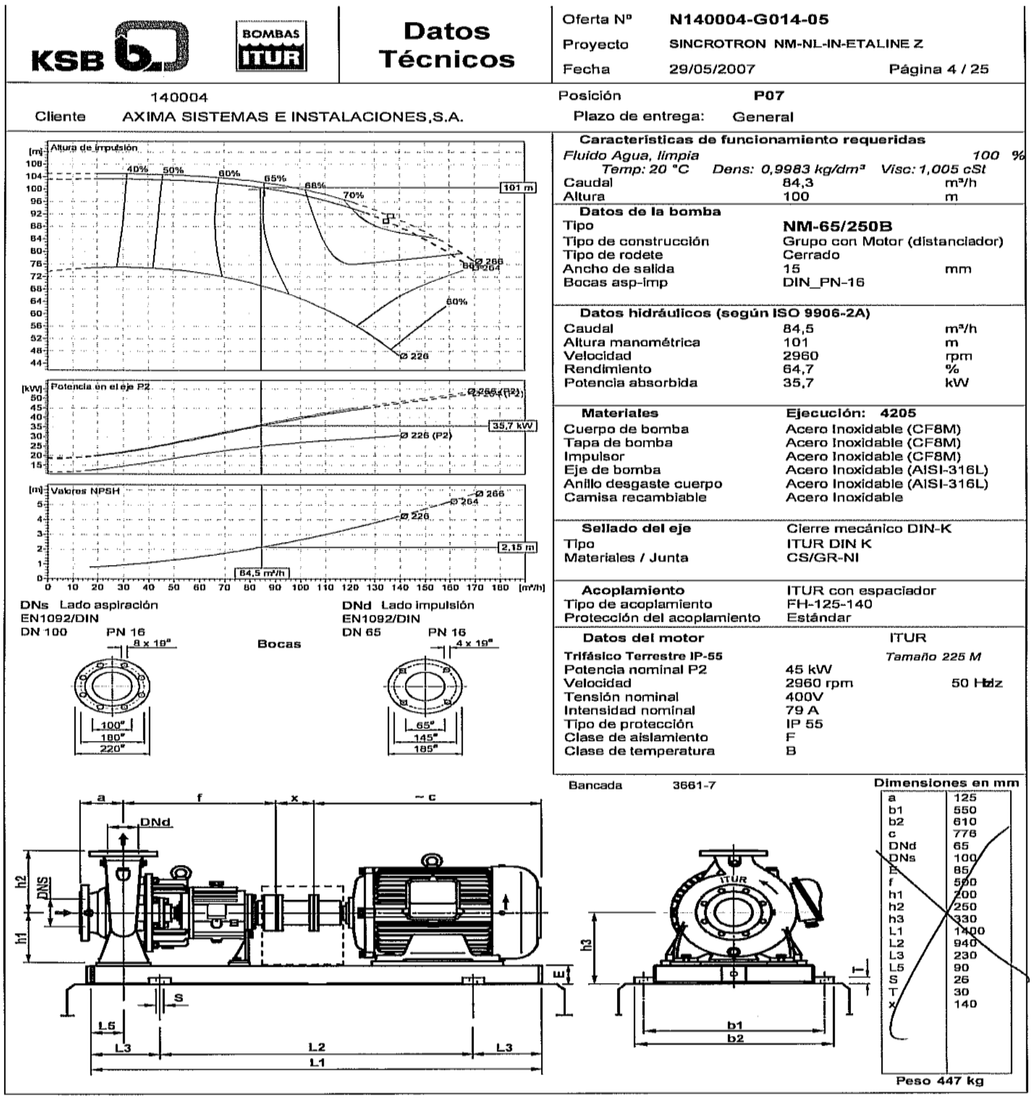
- BL04 – MSPD: The Materials Science and Powder Diffraction Beamline is devoted to high-resolution powder diffraction and high pressure powder diffraction using diamond anvil cells.
- BL09 - Mistral soft x-ray microscopy: The full-field Transmission X-ray Microscopy beamline MISTRAL is devoted to cryo Nano-tomography in the water window and for biological applications.
- BL11 – NCD non-crystalline diffraction: The experiments provide structural and dynamic information of large molecular assemblies like polymers, colloids, proteins and fibers.
- BL13 – XALOC macromolecular crystallography: It aims to provide the present and future structural biology groups with a flexible and reliable tool to help in finding solutions for structures of macromolecules and complexes.
- BL22 – CLÆSS core level absorption & emission spectroscopies: The beamline will provide a simultaneous and unified access to two complementary techniques; absorption and emission spectroscopes.
- BL24-CIRCE photoemission spectroscopy and microscopy: The beamline is dedicated to advanced photoemission experiments.
- BL29 – BOREAS resonant absorption and scattering: It is a soft X-ray beamline dedicated to polarization spectroscopic investigations of advanced materials, as well as, applied interest.

CELLS is broaden the number of beam lines with two more, which are in construction.

C. Technical data sheet

C.1. Pumps data sheet

C.1.1. P07 (EA)



KSB BOMBAS ITUR

Datos Técnicos

Oferta Nº **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

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	**Ejecución: 4205**
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

Sellado del eje	Cierre mecánico DIN-K
Tipo	ITUR DIN K
Materiales / Junta	CS/GR-NI

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

Datos del motor ITUR

Trifásico Terrestre IP-55		*Tamaño 225 M*
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	

Bancada 3661-7

Dimensiones en mm

a	125
b1	550
b2	610
c	776
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

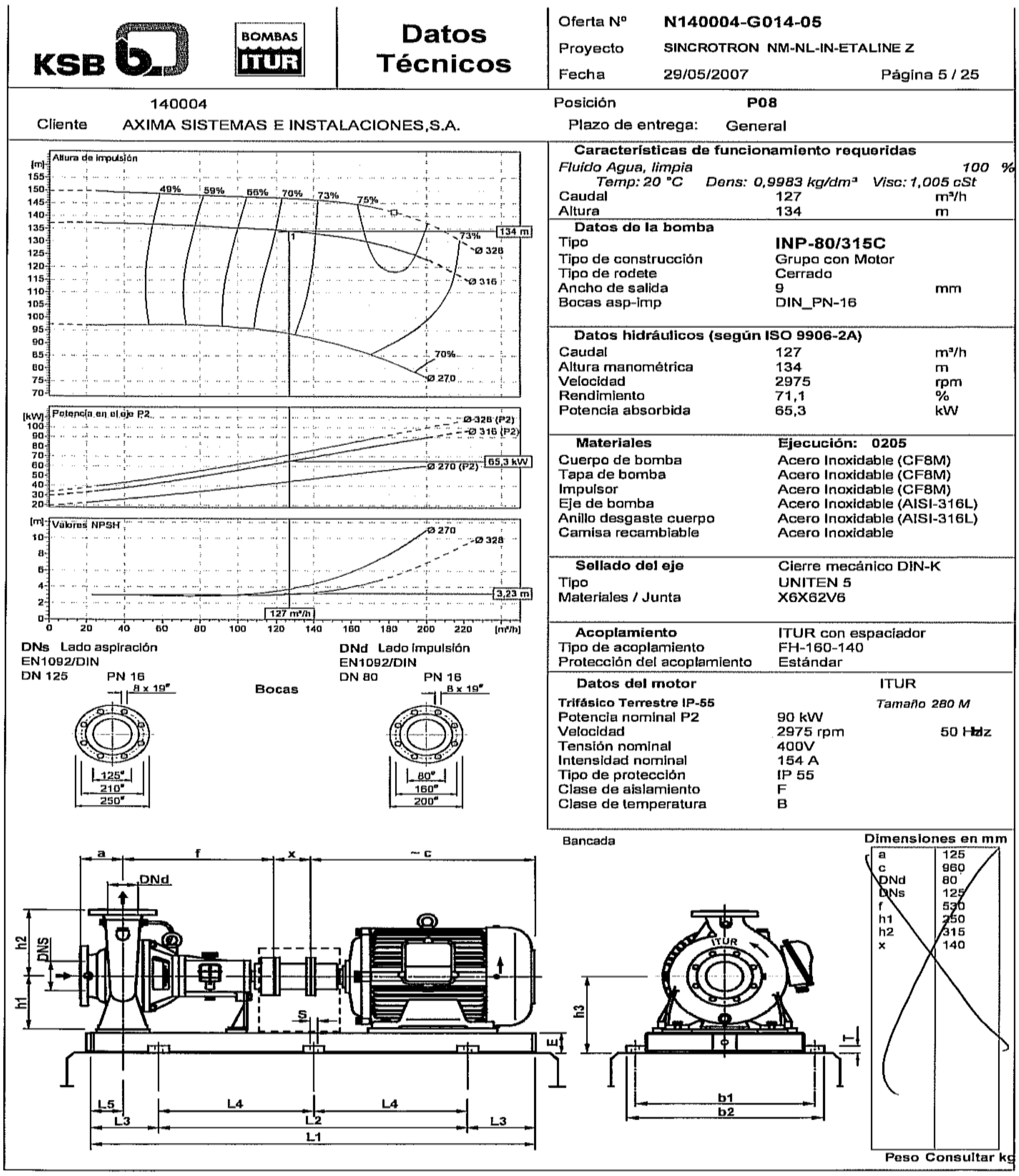
Peso 447 kg

DNs Lado aspiración
EN1092/DIN
DN 100 PN 16

DNd Lado impulsión
EN1092/DIN
DN 65 PN 16

Figure C.1 P07 pump technical description

C.1.2. P08 (SR)



KSB BOMBAS ITUR

Datos Técnicos

Oferta Nº	**N140004-G014-05**
Proyecto	SINCROTRON NM-NL-IN-ETALINE Z
Fecha	29/05/2007 Página 5 / 25

140004

Cliente AXIMA SISTEMAS E INSTALACIONES,S.A.

Posición **P08**

Plazo de entrega: General

Características de funcionamiento requeridas

Fluido Agua, limpia *100 %*

Temp: 20 °C *Dens: 0,9983 kg/dm³* *Visc: 1,005 cSt*

Caudal	127	m³/h
Altura	134	m

Datos de la bomba

Tipo	**INP-80/315C**	
Tipo de construcción	Grupo con Motor	
Tipo de rodete	Cerrado	
Ancho de salida	9	mm
Bocas asp-imp	DIN_PN-16	

Datos hidráulicos (según ISO 9906-2A)

Caudal	127	m³/h
Altura manométrica	134	m
Velocidad	2975	rpm
Rendimiento	71,1	%
Potencia absorbida	65,3	kW

Materiales	**Ejecución: 0205**
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

Sellado del eje	Cierre mecánico DIN-K
Tipo	UNITEN 5
Materiales / Junta	X6X62V6

Acoplamiento	ITUR con espaciador
Tipo de acoplamiento	FH-160-140
Protección del acoplamiento	Estándar

Datos del motor		ITUR
Trifásico Terrestre IP-55		*Tamaño 280 M*
Potencia nominal P2	90 kW	
Velocidad	2975 rpm	50 Hz
Tensión nominal	400V	
Intensidad nominal	154 A	
Tipo de protección	IP 55	
Clase de aislamiento	F	
Clase de temperatura	B	

DNs Lado aspiración
EN1092/DIN
DN 125 PN 16

DNd Lado impulsión
EN1092/DIN
DN 80 PN 16

Bancada

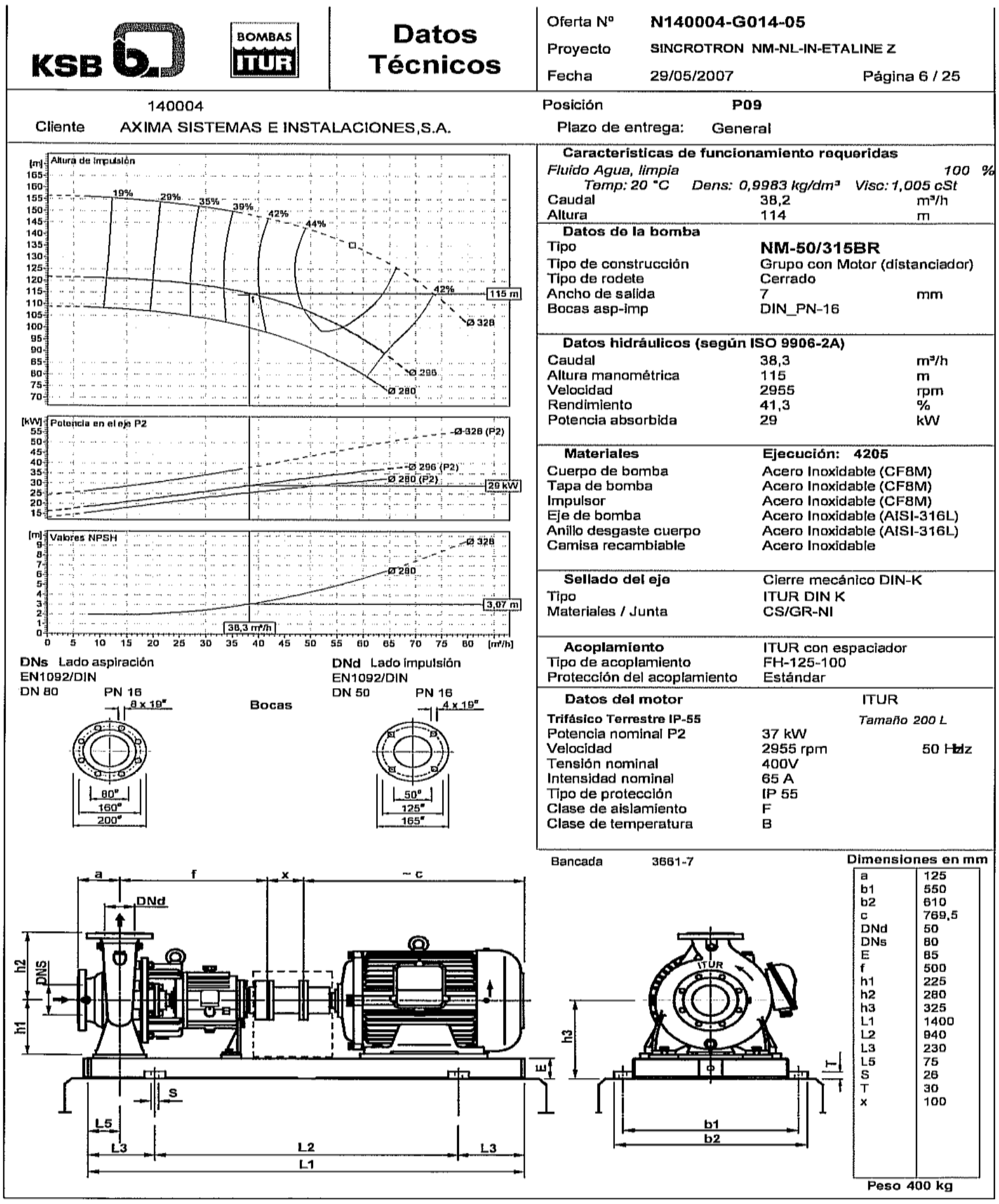
Dimensiones en mm

a	125
c	960
DNd	80
DNs	125
f	530
h1	250
h2	315
x	140

Peso Consultar kg

Figure C.2 P08 pump technical description

C.1.3. P09 (BO)



Datos Técnicos

Oferta Nº	**N140004-G014-05**
Proyecto	SINCROTRON NM-NL-IN-ETALINE Z
Fecha	29/05/2007

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140004

Cliente AXIMA SISTEMAS E INSTALACIONES,S.A.

Posición **P09**

Plazo de entrega: General

Caracteristicas de funcionamiento requeridas

Fluido Agua, limpia *100 %*

Temp: 20 °C *Dens: 0,9983 kg/dm³* *Visc: 1,005 cSt*

Caudal	38,2	m³/h
Altura	114	m

Datos de la bomba

Tipo	**NM-50/315BR**	
Tipo de construcción	Grupo con Motor (distanciador)	
Tipo de rodete	Cerrado	
Ancho de salida	7	mm
Bocas asp-imp	DIN_PN-16	

Datos hidráulicos (según ISO 9906-2A)

Caudal	38,3	m³/h
Altura manométrica	115	m
Velocidad	2955	rpm
Rendimiento	41,3	%
Potencia absorbida	29	kW

Materiales	**Ejecución: 4205**
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

Sellado del eje	Cierre mecánico DIN-K
Tipo	ITUR DIN K
Materiales / Junta	CS/GR-NI

Acoplamiento	ITUR con espaciador
Tipo de acoplamiento	FH-125-100
Protección del acoplamiento	Estándar

Datos del motor		ITUR
Trifásico Terrestre IP-55		*Tamaño 200 L*
Potencia nominal P2	37 kW	
Velocidad	2955 rpm	50 Hz
Tensión nominal	400V	
Intensidad nominal	65 A	
Tipo de protección	IP 55	
Clase de aislamiento	F	
Clase de temperatura	B	

DNs Lado aspiración
EN1092/DIN
DN 80 PN 16

Bocas

DNd Lado impulsión
EN1092/DIN
DN 50 PN 16

Bancada 3661-7

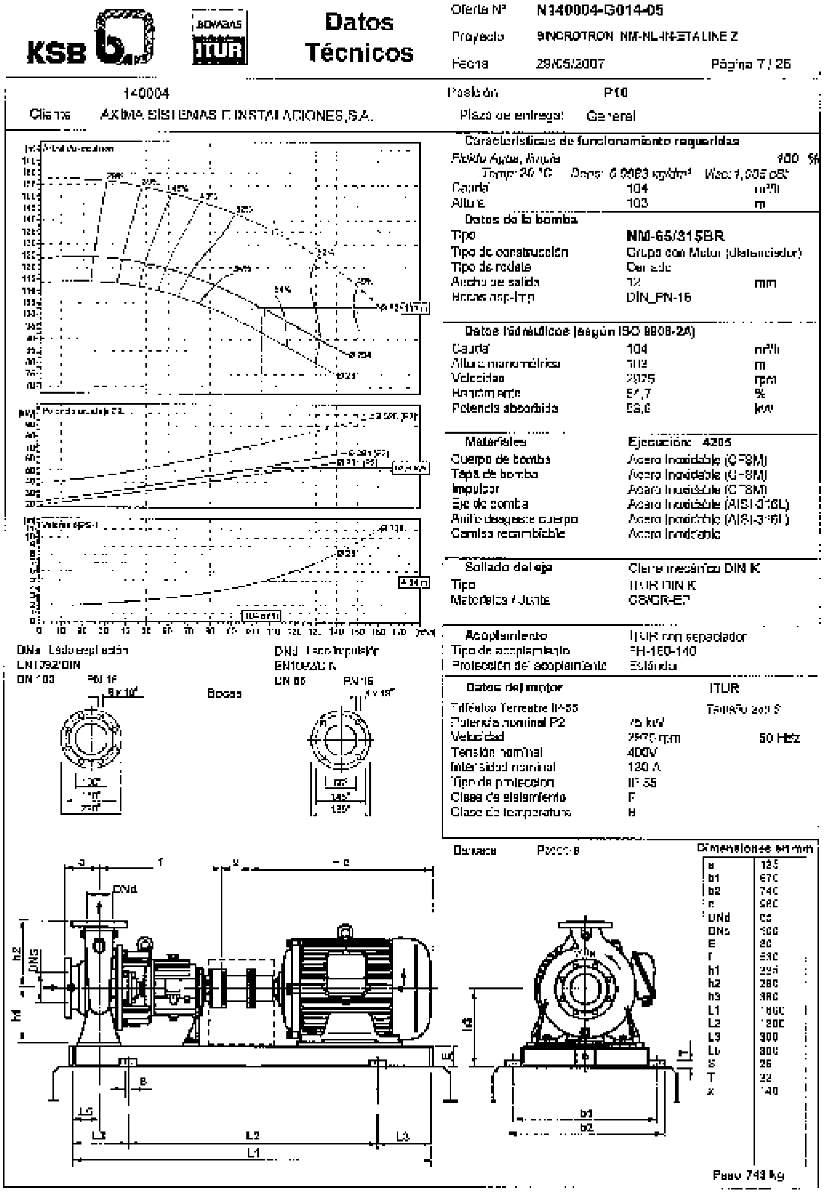
Dimensiones en mm

a	125
b1	550
b2	610
c	769,5
DNd	50
DNs	80
E	85
f	500
h1	225
h2	280
h3	325
L1	1400
L2	940
L3	230
L5	75
S	26
T	30
x	100

Peso 400 kg

Figure C.3 P09 pump technical description

C.1.4. P10 (SA)



KSB BOMBAS ITUR

Datos Técnicos

Oferta Nº N140004-G014-05
Proyecto SINCROTRON NM-NL-INSTALINE Z
Fecha 29/05/2007 Página 7 / 26

140004 Posición P10
Cliente AXIMA SISTEMAS E INSTALACIONES,S.A. Plazo de entrega: General

Características de funcionamiento requeridas

Fluido Agua, limpia 100 %
Temp: 20 °C Dens: 0,9983 kg/dm³ Visc: 1,003 cSt

Caudal	104	m³/h
Altura	103	m

Datos de la bomba

Tipo	**NM-65/315BR**	
Tipo de construcción	Grupo con Motor (distanciador)	
Tipo de rodete	Cerrado	
Ancho de salida	12	mm
Bridas asp-imp	DIN_PN-16	

Datos hidráulicos (según ISO 9906-2A)

Caudal	104	m³/h
Altura manométrica	103	m
Velocidad	2975	rpm
Rendimiento	54,7	%
Potencia absorbida	53,3	kW

Materiales	**Ejecución: 4205**
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

Sellado del eje	Cierre mecánico DIN K
Tipo	ITUR DIN K
Materiales / Junta	Q8/QR-EP

Acoplamiento	ITUR con separador
Tipo de acoplamiento	FH-160-140
Protección del acoplamiento	Estándar

Datos del motor ITUR

Trifásico Terrestre IP-55		Tamaño 280 S
Potencia nominal P2	75 kW	
Velocidad	2975 rpm	50 Hz
Tensión nominal	400V	
Intensidad nominal	130 A	
Tipo de protección	IP 55	
Clase de aislamiento	F	
Clase de temperatura	B	

DNs Lado aspiración
EN1092/DIN
DN 100 PN 16

DNd Lado impulsión
EN1092/DIN
DN 65 PN 16

Bridas

Dibujo Posición

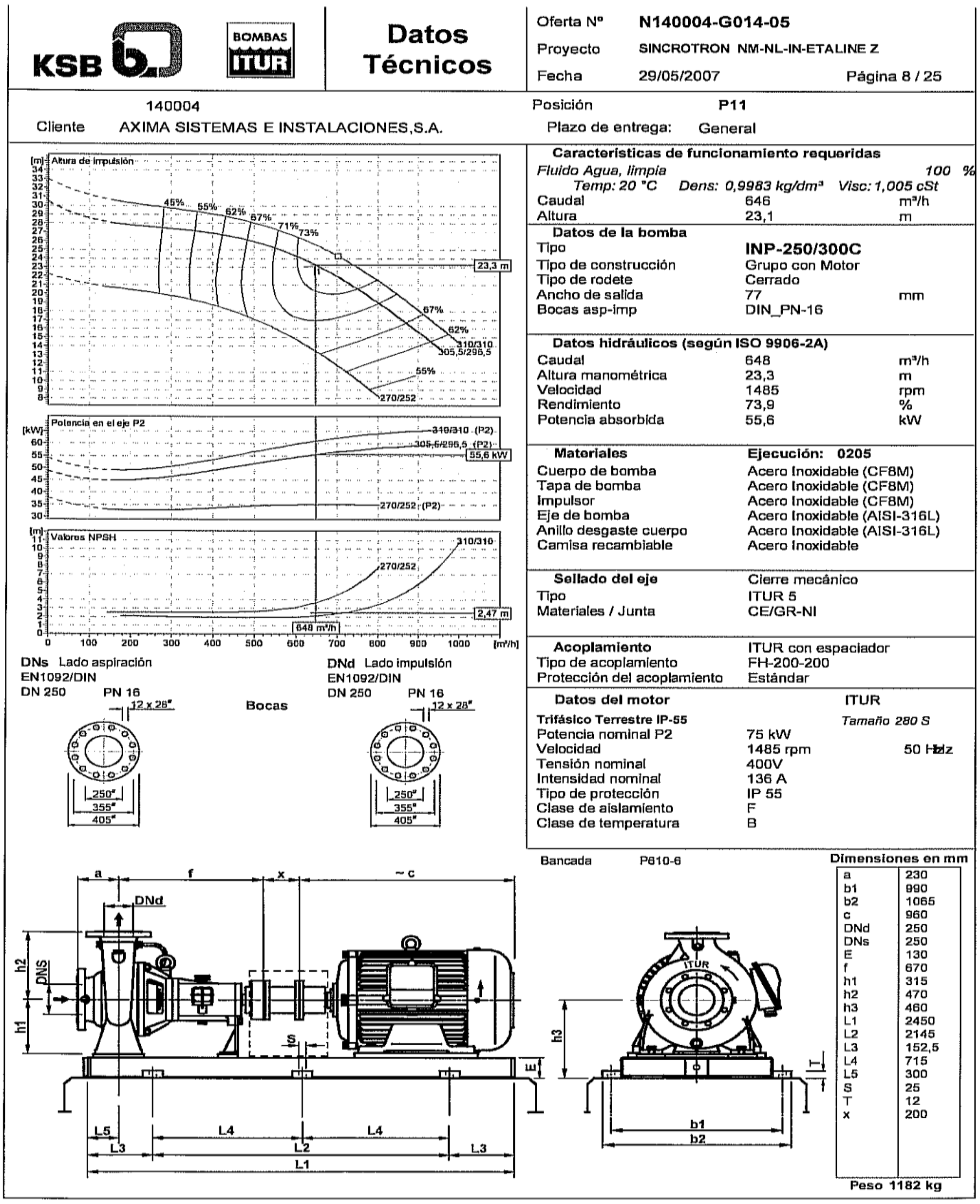
Dimensiones en mm

a	125
b1	670
b2	740
c	580
DNd	65
DNs	100
E	20
f	530
h1	225
h2	280
h3	380
L1	1800
L2	1200
L3	300
Lb	300
s	26
T	22
x	140

Peso 749 kg

Figure C.4 P10 pump technical description

C.1.5. P11 (common line)



KSB BOMBAS ITUR

Datos Técnicos

Oferta Nº	**N140004-G014-05**	
Proyecto	SINCROTRON NM-NL-IN-ETALINE Z	
Fecha	29/05/2007	Página 8 / 25

140004
Cliente AXIMA SISTEMAS E INSTALACIONES,S.A.

Posición **P11**
Plazo de entrega: General

Características de funcionamiento requeridas

Fluido Agua, limpia *100 %*
Temp: 20 °C Dens: 0,9983 kg/dm³ Visc: 1,005 cSt

Caudal	646	m³/h
Altura	23,1	m

Datos de la bomba

Tipo	**INP-250/300C**	
Tipo de construcción	Grupo con Motor	
Tipo de rodete	Cerrado	
Ancho de salida	77	mm
Bocas asp-imp	DIN_PN-16	

Datos hidráulicos (según ISO 9906-2A)

Caudal	648	m³/h
Altura manométrica	23,3	m
Velocidad	1485	rpm
Rendimiento	73,9	%
Potencia absorbida	55,6	kW

Materiales	**Ejecución: 0205**
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

Sellado del eje	Cierre mecánico
Tipo	ITUR 5
Materiales / Junta	CE/GR-NI

Acoplamiento	ITUR con espaciador
Tipo de acoplamiento	FH-200-200
Protección del acoplamiento	Estándar

Datos del motor		ITUR
Trifásico Terrestre IP-55		*Tamaño 280 S*
Potencia nominal P2	75 kW	
Velocidad	1485 rpm	50 Hz
Tensión nominal	400V	
Intensidad nominal	136 A	
Tipo de protección	IP 55	
Clase de aislamiento	F	
Clase de temperatura	B	

DNs Lado aspiración
EN1092/DIN
DN 250 PN 16

Bocas

DNd Lado impulsión
EN1092/DIN
DN 250 PN 16

Bancada P610-6

Dimensiones en mm

a	230
b1	990
b2	1065
c	960
DNd	250
DNs	250
E	130
f	670
h1	315
h2	470
h3	460
L1	2450
L2	2145
L3	152,5
L4	715
L5	300
S	25
T	12
x	200

Peso 1182 kg

Figure C.5 P11 pump technical description

C.1.6. Maximum torque calculations

	P07	**P08**	**P09**	**P10**	**P11**
Max Power (W)	56550	97450	41800	66150	59050
Max Rotational Speed (rad/s)	314.16	314.16	314.16	314.16	157.08
Max Torque (N·m)	180.0038	310.1923	133.0532	210.5615	375.9231

The formula to calculate the maximum torque is the following:

$$\Gamma \max = \frac{Pmax}{\omega max} \qquad \text{(Eq C.1)}$$

D. Pipe data

Last column, water speed (a) has been calculated according the formula presented in the chapter 6.2 of this project, which is the following:

$$a = \sqrt{\frac{1}{\rho(\frac{1}{k} + \frac{d}{tE})}}$$

(Eq. D.1)

Table D.1 Geometrical information of the pipes

nominal size/DN	OUTSIDE DIAMETRE (mm)	WALL THICKNESS (mm)	Inner diametre (m)	Inner diametre (mm)	speed of sound in water (a)
0.125/6	10,287	1,2446	0,008	7,7978	1434
0.25/8	13,716	1,651	0,010	10,414	1434
0.375/10	17,145	1,651	0,014	13,843	1418
0.5/15	21,336	2,1082	0,017	17,1196	1420
0.75/20	26,67	2,1082	0,022	22,4536	1402
1/25	33,401	2,7686	0,028	27,8638	1406
1.25/32	42,164	2,7686	0,037	36,6268	1384
1.5/40	48,26	2,7686	0,043	42,7228	1369
2/50	60,325	2,7686	0,055	54,7878	1341
2.5/65	73,025	3,048	0,067	66,929	1328
3/80	88,9	3,048	0,083	82,804	1297
3.5/90	101,5999	3,048	0,096	95,5039	1274
4/100	114,2999	3,048	0,108	108,2039	1253
5/125	141,3001	3,4036	0,134	134,4929	1233
6/150	168,2749	3,4036	0,161	161,4677	1196
8/200	219,0749	3,7592	0,212	211,5565	1159
10/250	273,0498	4,191	0,265	264,6678	1132
12/300	323,8498	4,572	0,315	314,7058	1111
14/350	355,5998	6,35	0,343	342,8998	1168
16/400	406,3998	6,35	0,394	393,6998	1136
18/450	457,1998	6,35	0,444	444,4998	1107
20/500	507,9997	6,35	0,495	495,2997	1080
22/550	558,7997	6,35	0,546	546,0997	1055
24/600	609,5997	6,35	0,597	596,8997	1032
26/650	660,3996	7,9248	0,645	644,55	1070
28/700	711,1996	7,9248	0,695	695,35	1050
30/750	761,9996	7,9248	0,746	746,15	1031
32/800	812,7996	7,9248	0,797	796,95	1013
34/850	863,5995	7,9248	0,848	847,7499	997

E. Verification of Flowmaster software

The system that will be studied is composed by two reservoirs, an elastic pipe, a valve controller and a valve that closes very fast. The simulation will consist of a valve closing its gates very fast, within 0,01 second.

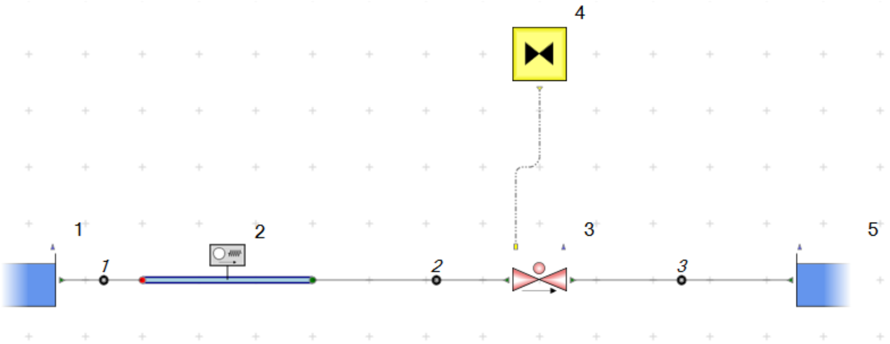


Figure E.1 Model used to verify Flowmaster software

In order to check if the closure of valve generates water hammer, it is check the pressure variation in 2nd node. It is the following:

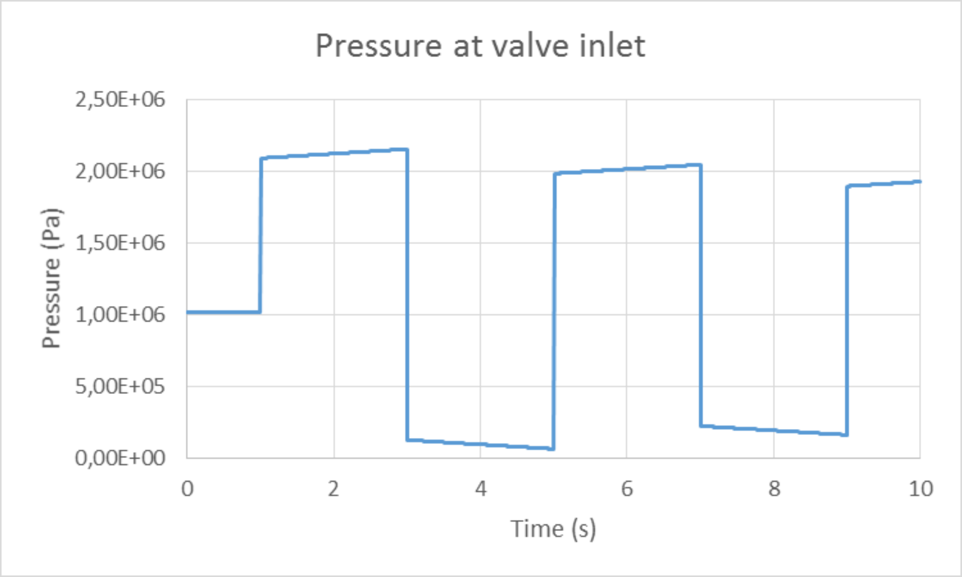


Figure E.2 Water hammer phenomenon

Water hammer can be seen. A peak pressure of $1{,}073 \cdot 10^6$ Pa is generated and the pressure reaches $2{,}15 \cdot 10^6$ Pa before the wave pressure goes back and counteract the pressure generated by itself.

The calculation used by Joukowsky equation is the following:

ρ = 1000 kg/m^3 a = 1000 m/s Δv = 1,075 m/s

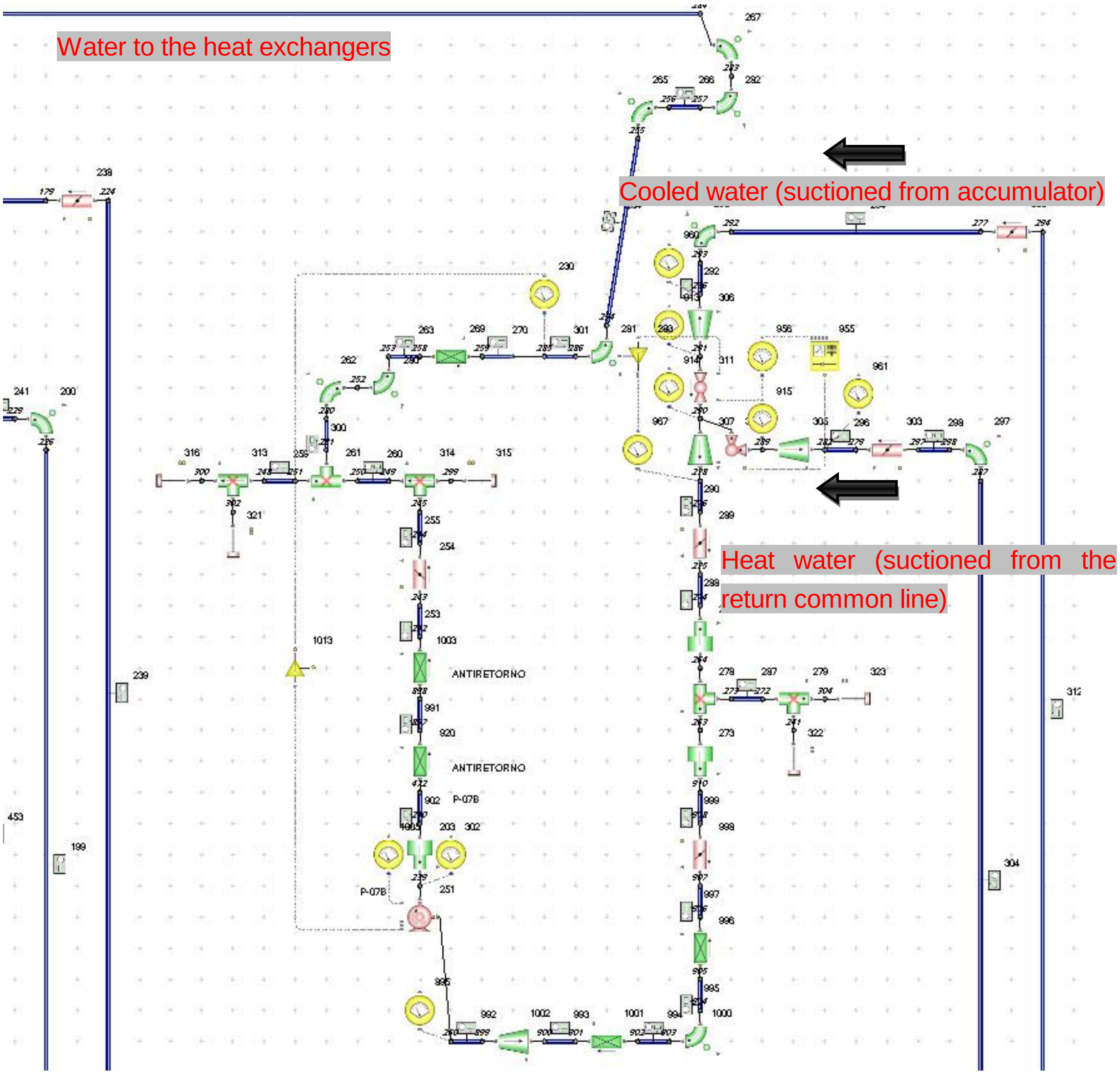
Δp = 1000 x 1000 x 1,075 = 1,075·10^6 Pa

The theorical result and by simulation are almost the same. It is this way because the valve is closed in 0,01 seconds. As the closure is slower, the calculated values would be more different as in Joukowsky calculation, the closing is instantaneously.

Flomaster software is verified to provide plausible results.

F. Initial simulation model

F.1. P07


Water to the heat exchangers

Cooled water (suctioned from accumulator)

Heat water (suctioned from the return common line)

Figure F.1 Pumping P07 ring

F.2. P08

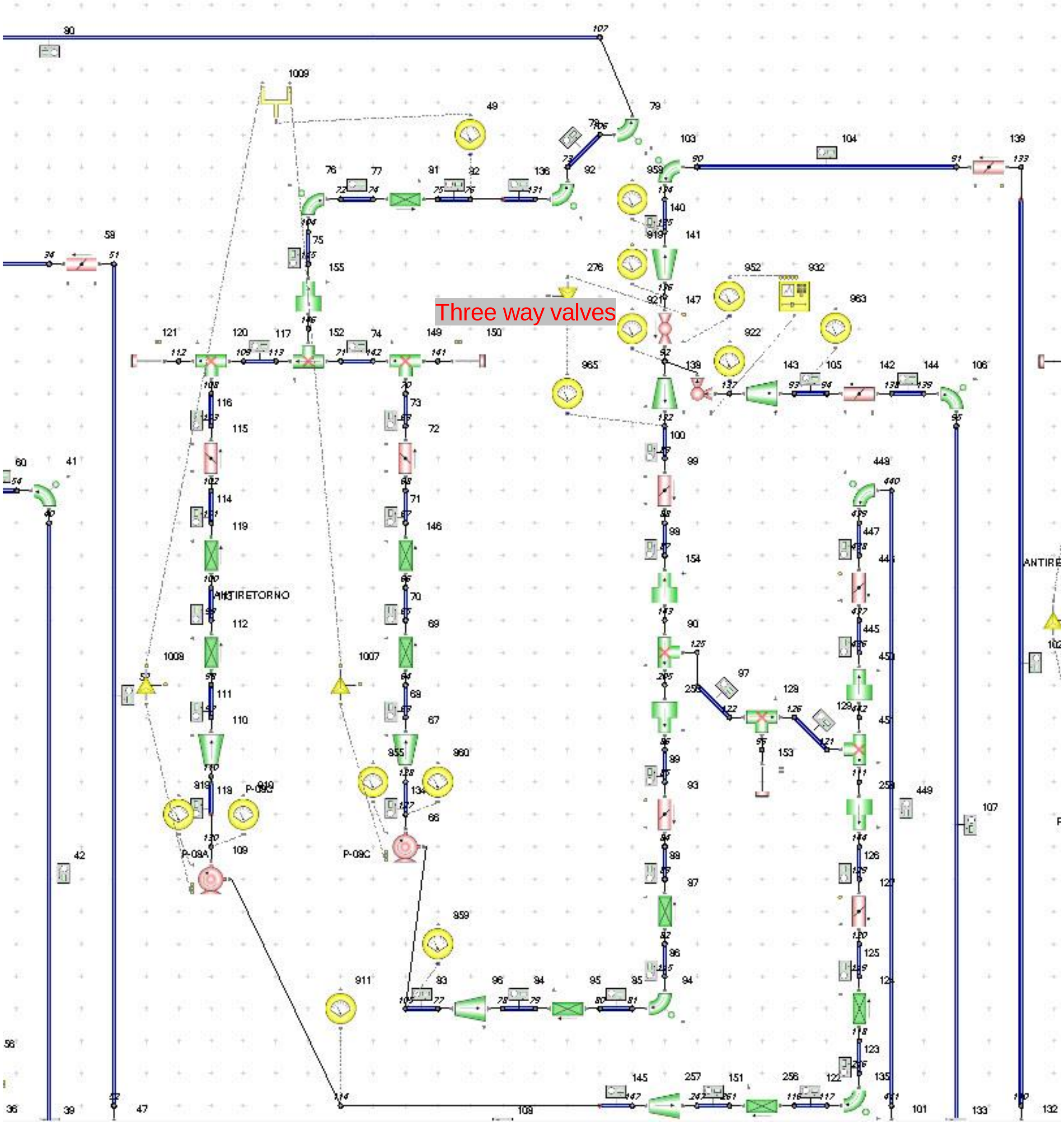


Figure F.2 Pumping P08 ring

F.3. P09

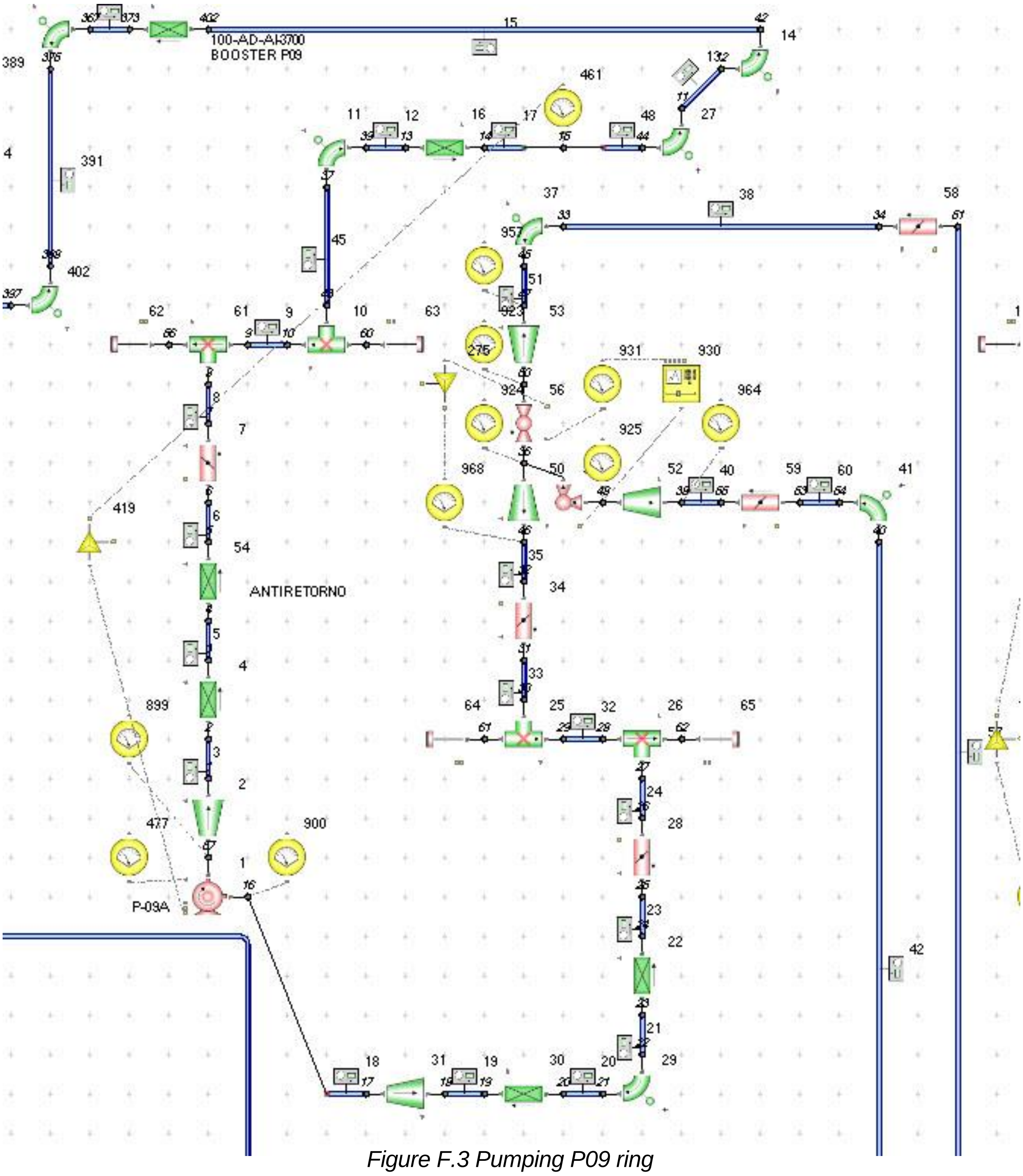


Figure F.3 Pumping P09 ring

F.4. P10

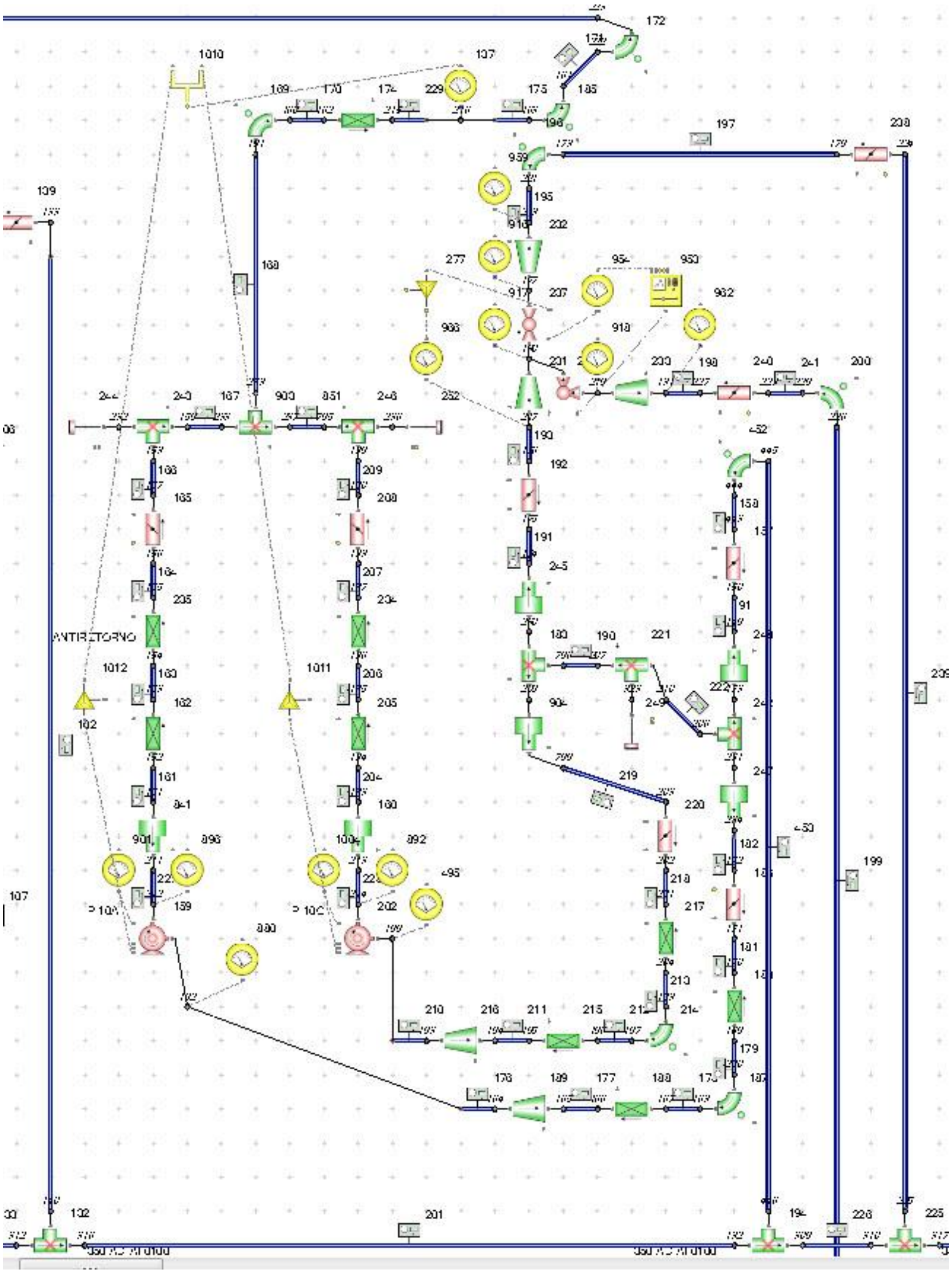


Figure F.4 Pumping P10 ring

F.5. P11

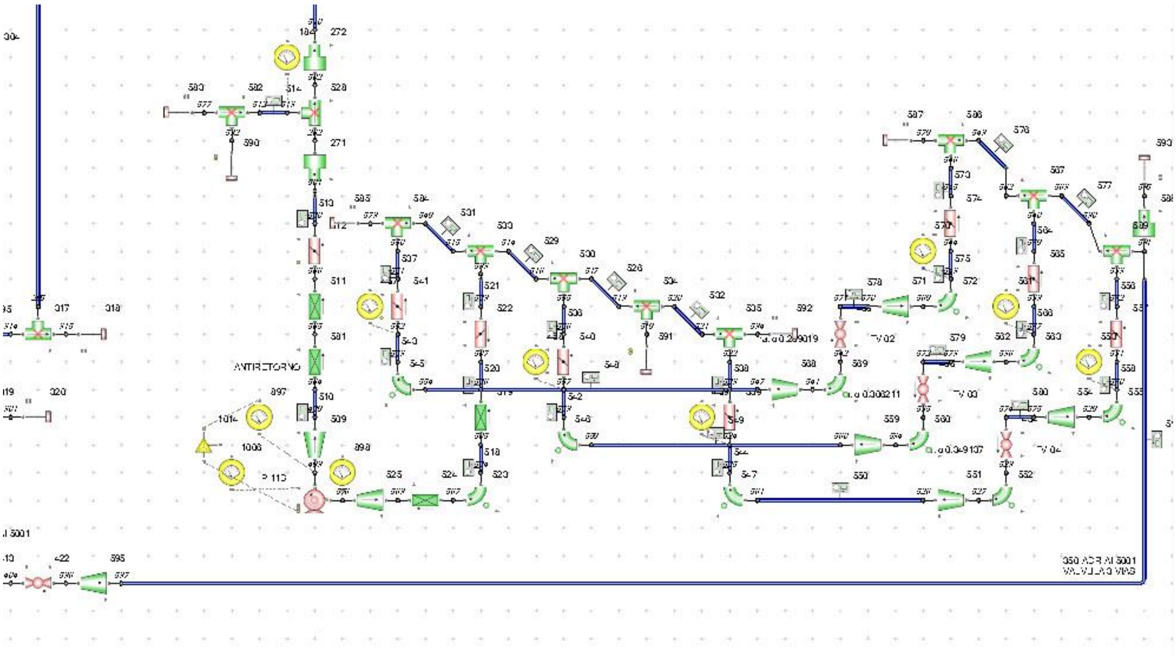
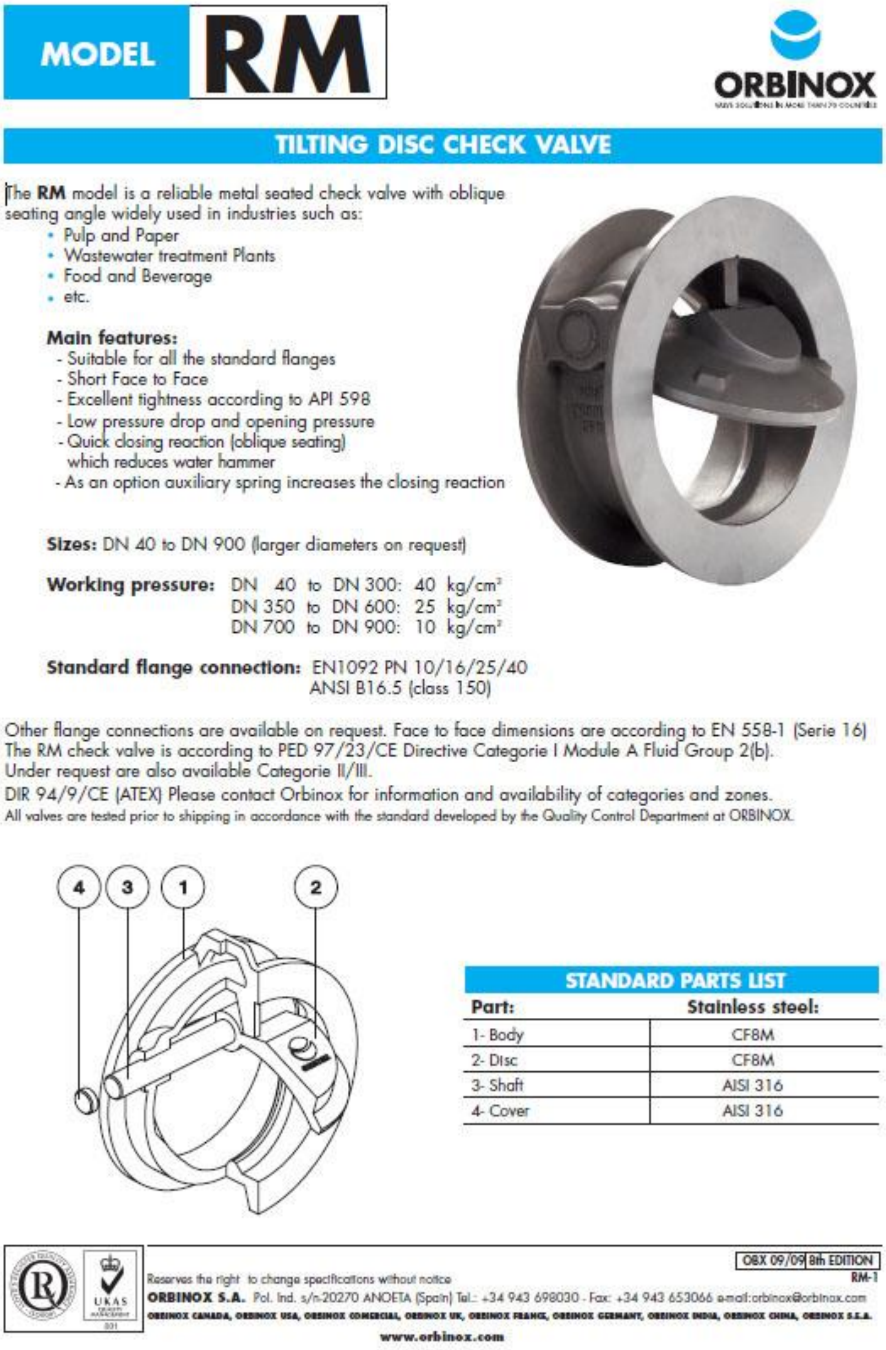


Figure F.5 Pumping P11 ring

G. Tilting disc check valve



MODEL **RM**

ORBINOX

TILTING DISC CHECK VALVE

The **RM** model is a reliable metal seated check valve with oblique seating angle widely used in industries such as:

- Pulp and Paper
- Wastewater treatment Plants
- Food and Beverage
- etc.

Main features:

- Suitable for all the standard flanges
- Short Face to Face
- Excellent tightness according to API 598
- Low pressure drop and opening pressure
- Quick closing reaction (oblique seating) which reduces water hammer
- As an option auxiliary spring increases the closing reaction

Sizes: DN 40 to DN 900 (larger diameters on request)

Working pressure:
DN 40 to DN 300: 40 kg/cm²
DN 350 to DN 600: 25 kg/cm²
DN 700 to DN 900: 10 kg/cm²

Standard flange connection:
EN1092 PN 10/16/25/40
ANSI B16.5 (class 150)

Other flange connections are available on request. Face to face dimensions are according to EN 558-1 (Serie 16)
The RM check valve is according to PED 97/23/CE Directive Categorie I Module A Fluid Group 2(b).
Under request are also available Categorie II/III.
DIR 94/9/CE (ATEX) Please contact Orbinox for information and availability of categories and zones.
All valves are tested prior to shipping in accordance with the standard developed by the Quality Control Department at ORBINOX.

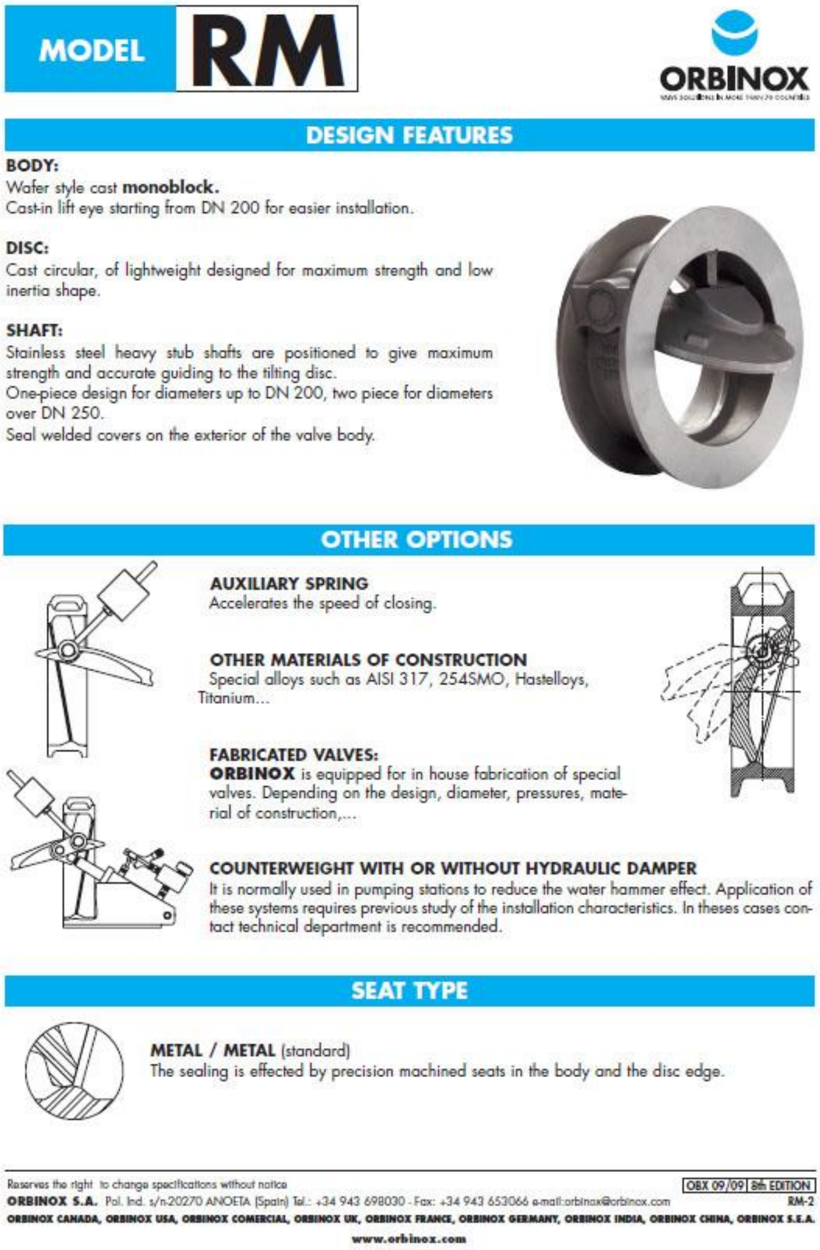
STANDARD PARTS LIST

Part:	Stainless steel:
1- Body	CF8M
2- Disc	CF8M
3- Shaft	AISI 316
4- Cover	AISI 316

OBX 09/09 8th EDITION
RM-1

Reserves the right to change specifications without notice
ORBINOX S.A. Pol. Ind. s/n-20270 ANOETA (Spain) Tel.: +34 943 698030 - Fax: +34 943 653066 e-mail:orbinox@orbinox.com
ORBINOX CANADA, ORBINOX USA, ORBINOX COMERCIAL, ORBINOX UK, ORBINOX FRANCE, ORBINOX GERMANY, ORBINOX INDIA, ORBINOX CHINA, ORBINOX S.E.A.
www.orbinox.com

Figure G.1 Technical description of the non-return valves



MODEL **RM**

ORBINOX

DESIGN FEATURES

BODY:
Wafer style cast **monoblock.**
Cast-in lift eye starting from DN 200 for easier installation.

DISC:
Cast circular, of lightweight designed for maximum strength and low inertia shape.

SHAFT:
Stainless steel heavy stub shafts are positioned to give maximum strength and accurate guiding to the tilting disc.
One-piece design for diameters up to DN 200, two piece for diameters over DN 250.
Seal welded covers on the exterior of the valve body.

OTHER OPTIONS

AUXILIARY SPRING
Accelerates the speed of closing.

OTHER MATERIALS OF CONSTRUCTION
Special alloys such as AISI 317, 254SMO, Hastelloys, Titanium...

FABRICATED VALVES:
ORBINOX is equipped for in house fabrication of special valves. Depending on the design, diameter, pressures, material of construction,...

COUNTERWEIGHT WITH OR WITHOUT HYDRAULIC DAMPER
It is normally used in pumping stations to reduce the water hammer effect. Application of these systems requires previous study of the installation characteristics. In theses cases contact technical department is recommended.

SEAT TYPE

METAL / METAL (standard)
The sealing is effected by precision machined seats in the body and the disc edge.

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RM-2
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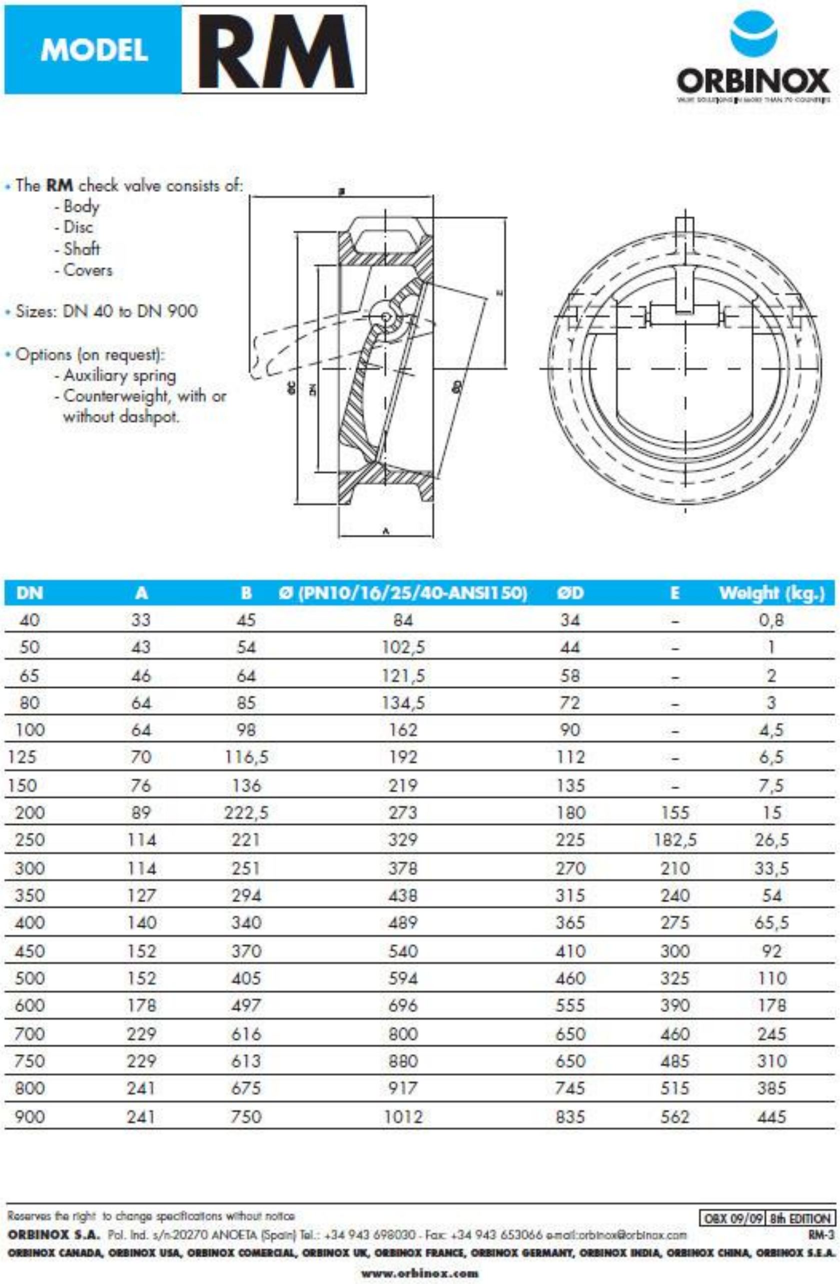
Figure G.2 Technical description of the non-return valves



MODEL RM

ORBINOX
VALVE SOLUTIONS IN MORE THAN 70 COUNTRIES

- The **RM** check valve consists of:
  - Body
  - Disc
  - Shaft
  - Covers
- Sizes: DN 40 to DN 900
- Options (on request):
  - Auxiliary spring
  - Counterweight, with or without dashpot.

DN	A	B	Ø (PN10/16/25/40-ANSI150)	ØD	E	Weight (kg.)
40	33	45	84	34	-	0,8
50	43	54	102,5	44	-	1
65	46	64	121,5	58	-	2
80	64	85	134,5	72	-	3
100	64	98	162	90	-	4,5
125	70	116,5	192	112	-	6,5
150	76	136	219	135	-	7,5
200	89	222,5	273	180	155	15
250	114	221	329	225	182,5	26,5
300	114	251	378	270	210	33,5
350	127	294	438	315	240	54
400	140	340	489	365	275	65,5
450	152	370	540	410	300	92
500	152	405	594	460	325	110
600	178	497	696	555	390	178
700	229	616	800	650	460	245
750	229	613	880	650	485	310
800	241	675	917	745	515	385
900	241	750	1012	835	562	445

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Figure G.3 Technical description of the non-return valves

H. *Transient simulations with the adjusted model*

H.1. Start-up and effect of pumps P07, P08, P09 and P10

Analyzing the simulations, it has been verified that the start of the pumps don't generate significant perturbations in the other pumping lines. As a consequence, the following figures will only be related to the pumping rings when their pumps are started.

H.1.1. Start-up of P07 pump

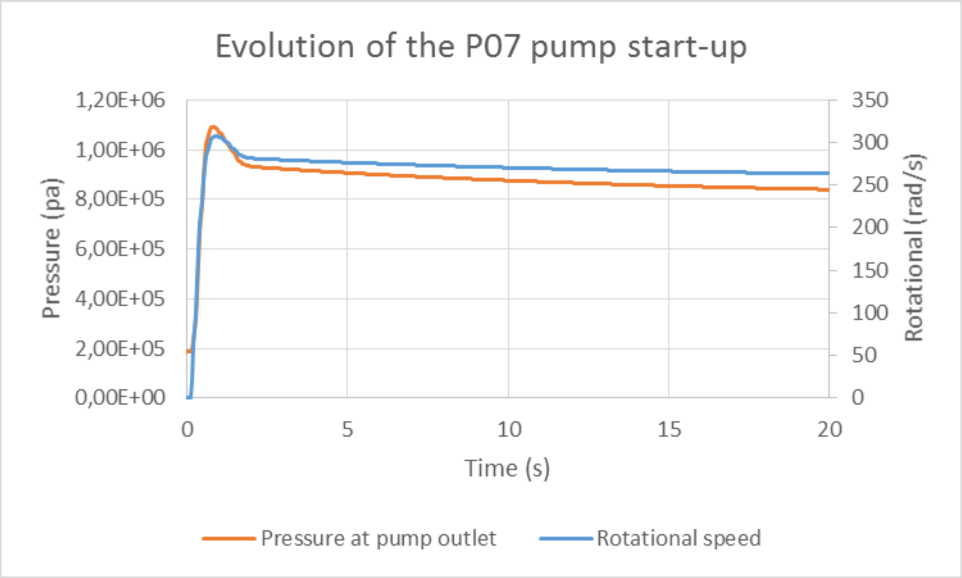


Figure H.1 Evolution during P07 pump start-up

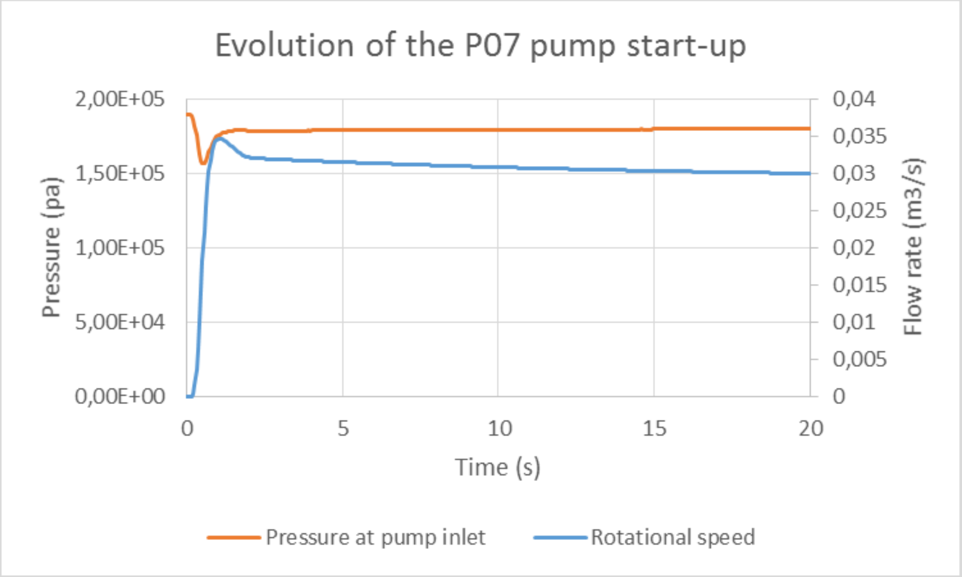


Figure H.2 Evolution during P07 pump start-up

H.1.2. Start-up of P08 pumps

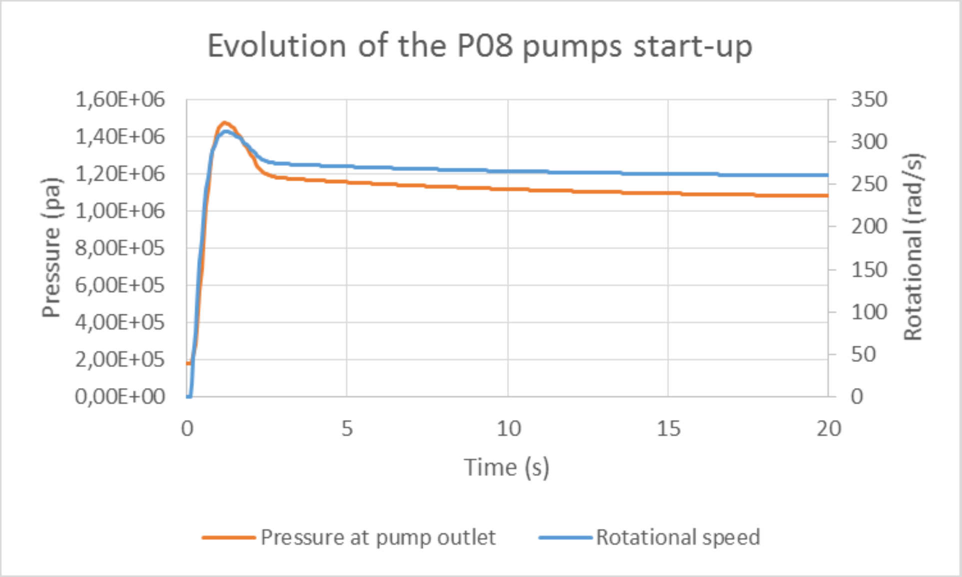


Figure H.3 Evolution during P08 pump start-up

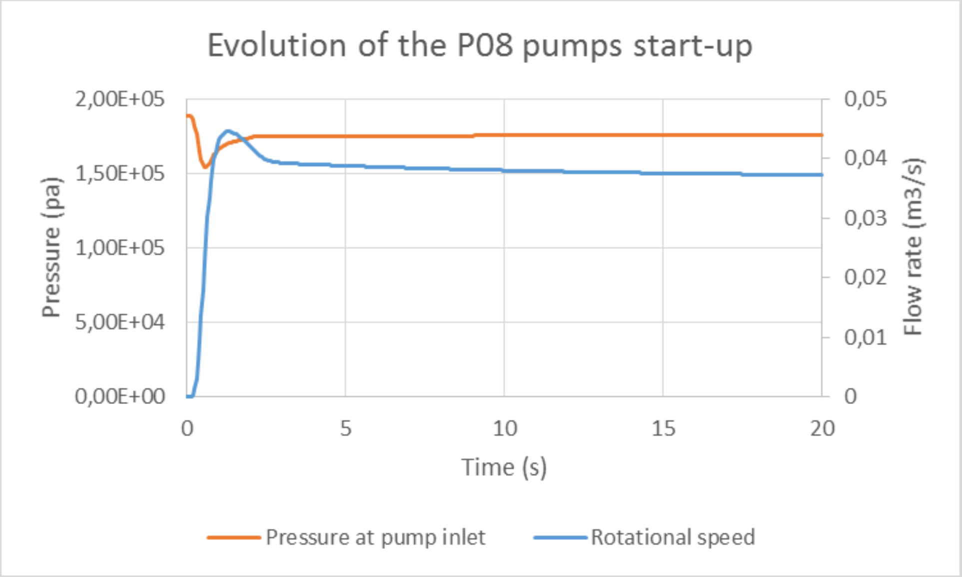


Figure H.4 Evolution during P08 pump start-up

H.1.3. Start-up of P09 pump

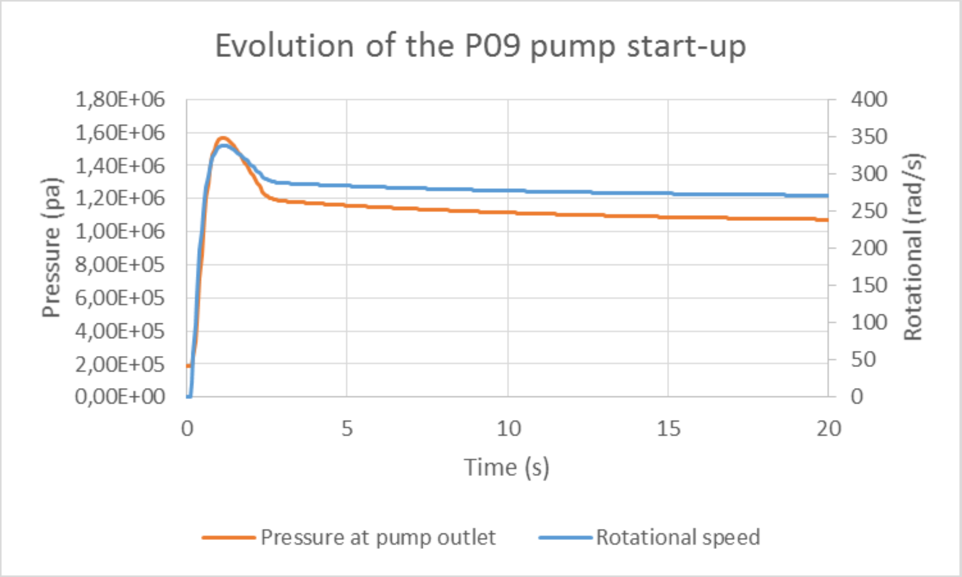


Figure H.5 Evolution during P09 pump start-up

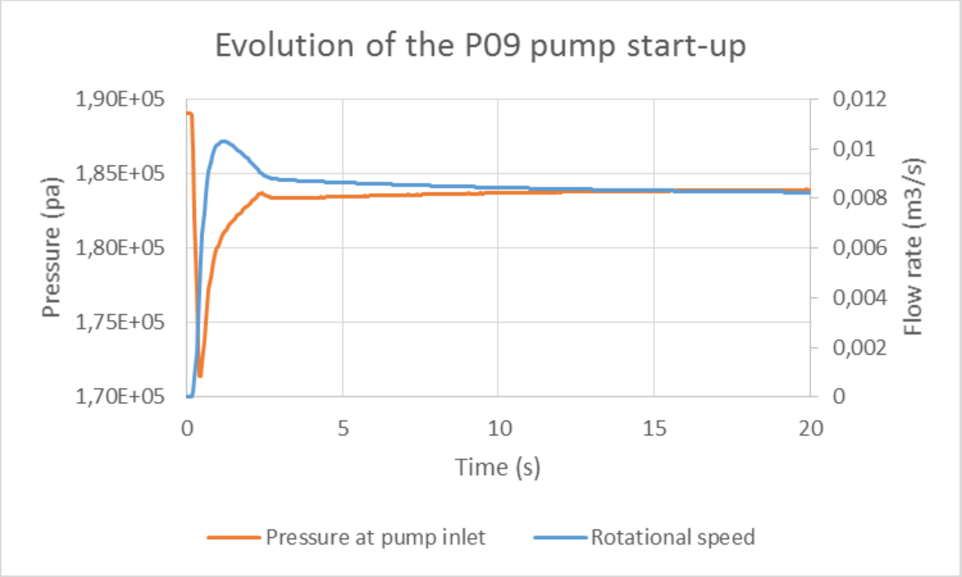


Figure H.6 Evolution during P09 pump start-up

H.1.4. Start-up of P10 pumps

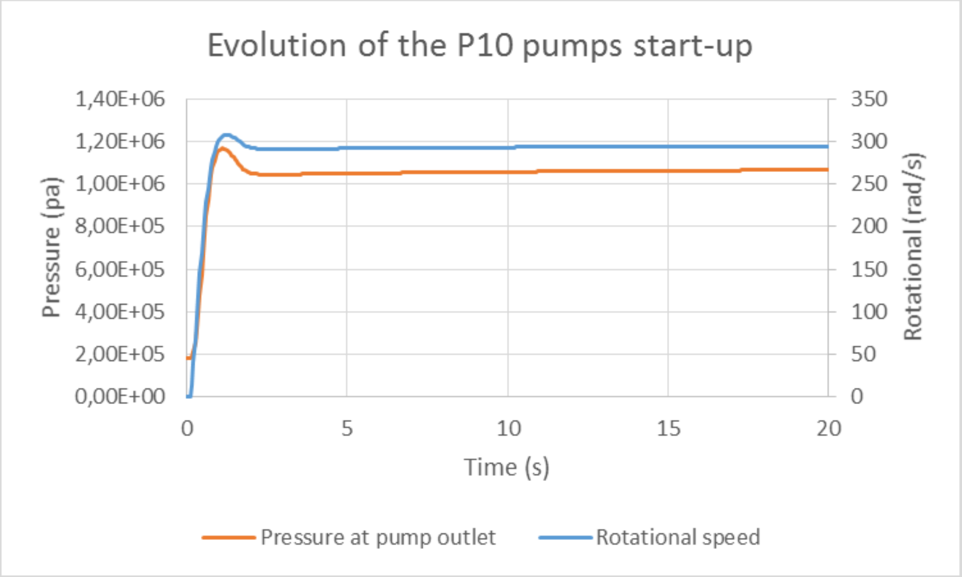


Figure H.7 Evolution during P10 pump start-up

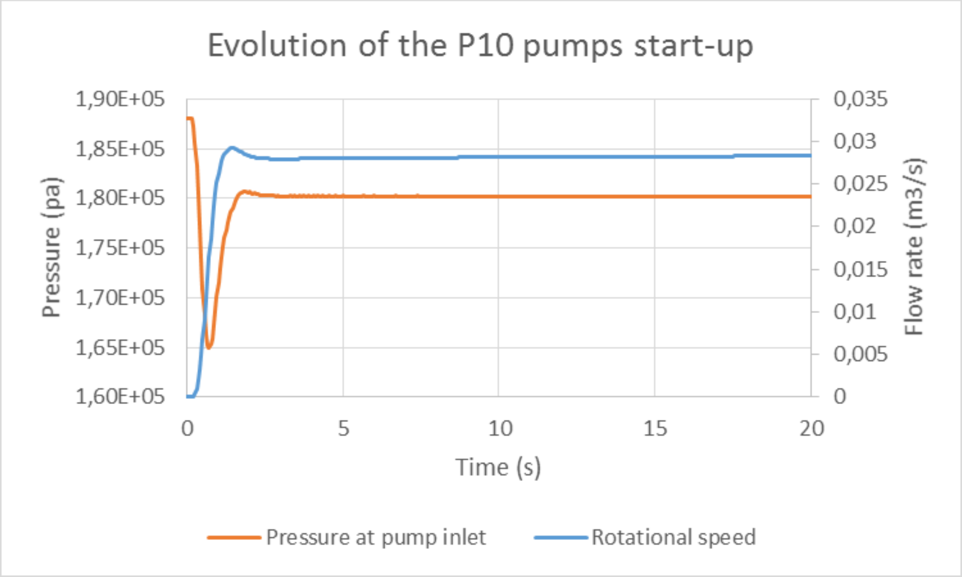


Figure H.8 Evolution during P10 pump start-up

H.2. Shut-down of P07 pump

H.2.1. Perturbations in P07 pumping line

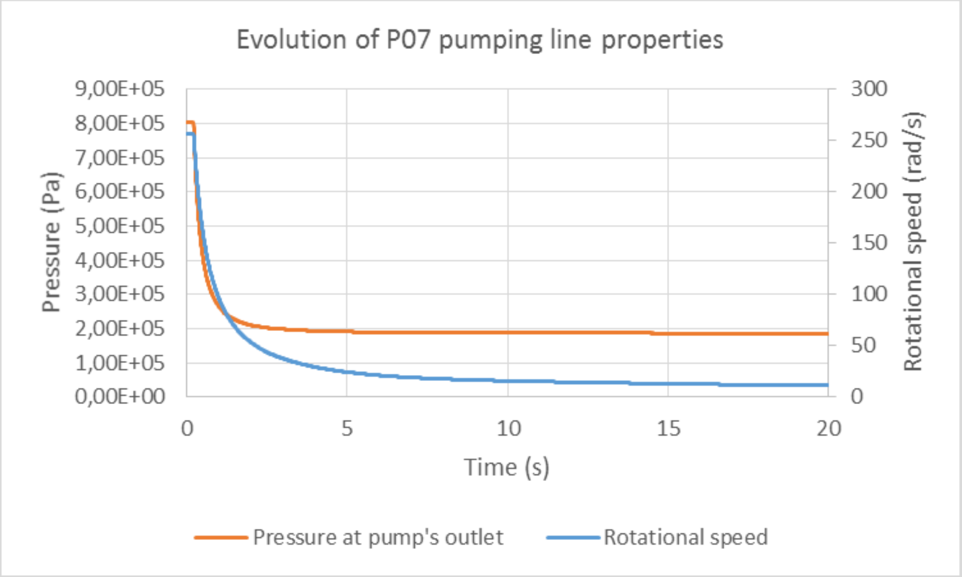


Figure H.9 Evolution during P07 pump start-up

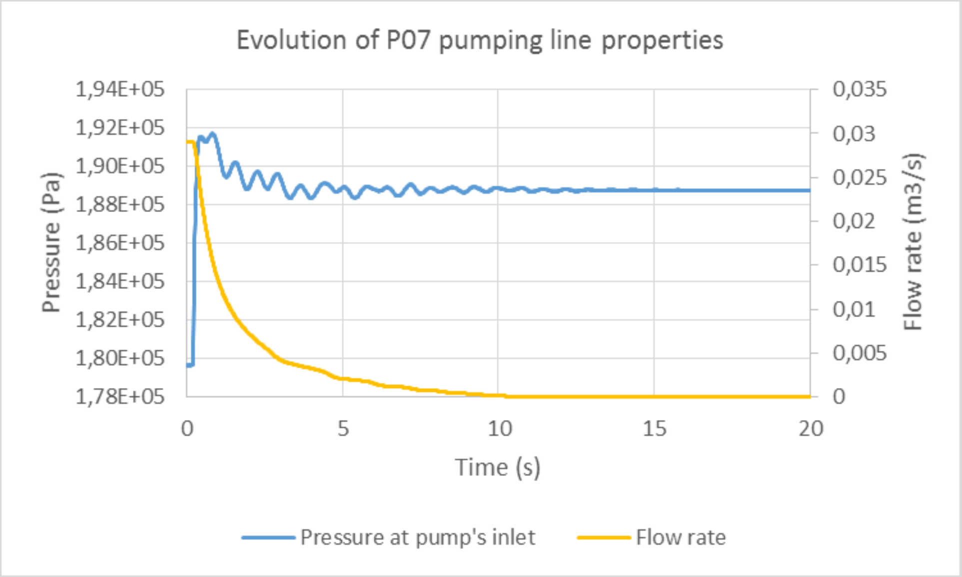


Figure H.10 Evolution during P07 pump start-up

H.2.2. Perturbations in P08 pumping line

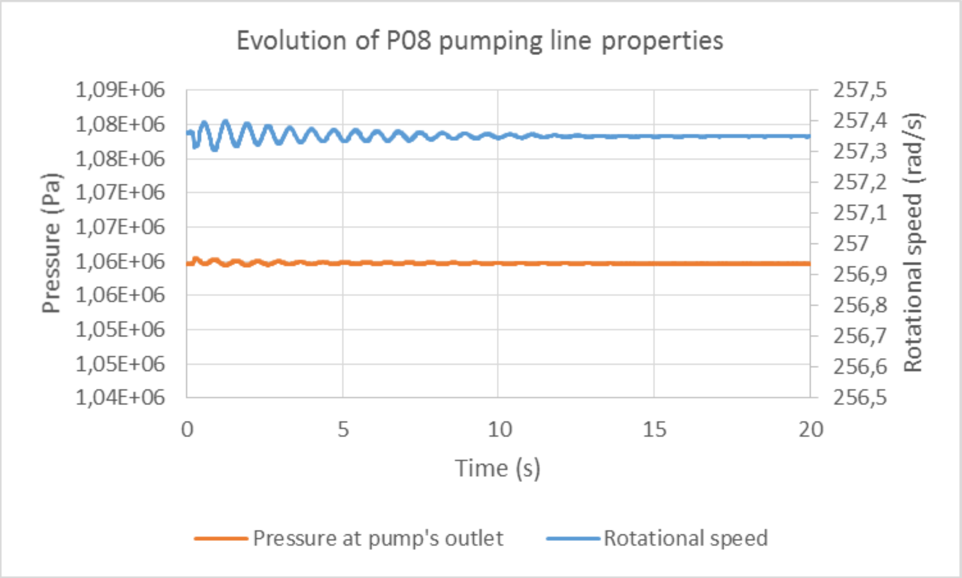


Figure H.11 Evolution during P07 pump start-up

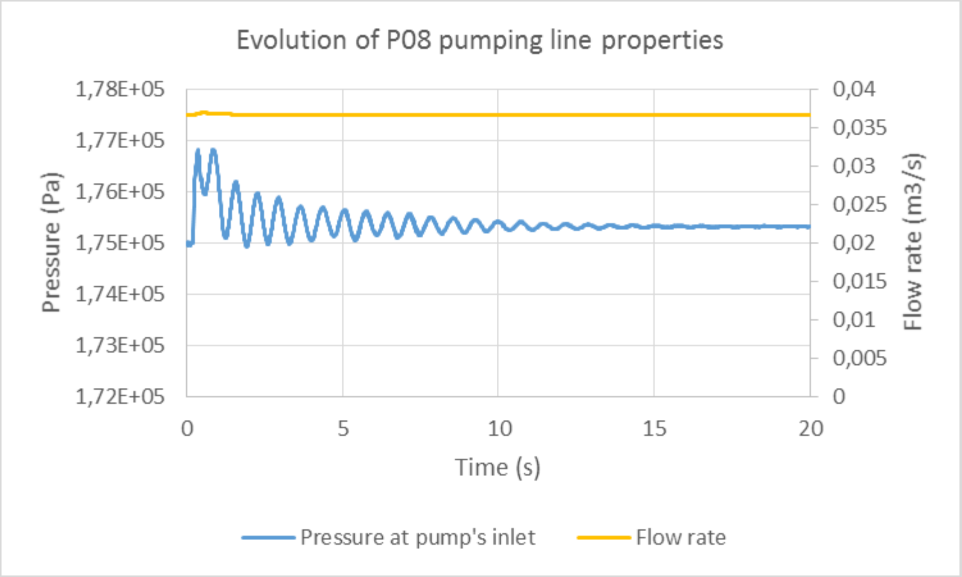


Figure H.12 Evolution during P07 pump start-up

H.2.3. Perturbations in P09 pumping line

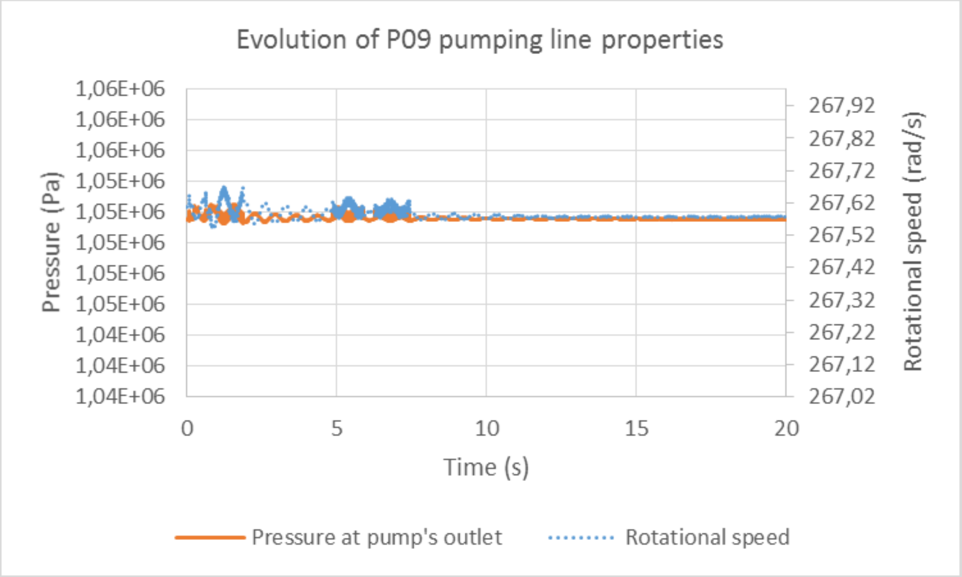


Figure H.13 Evolution during P07 pump start-up

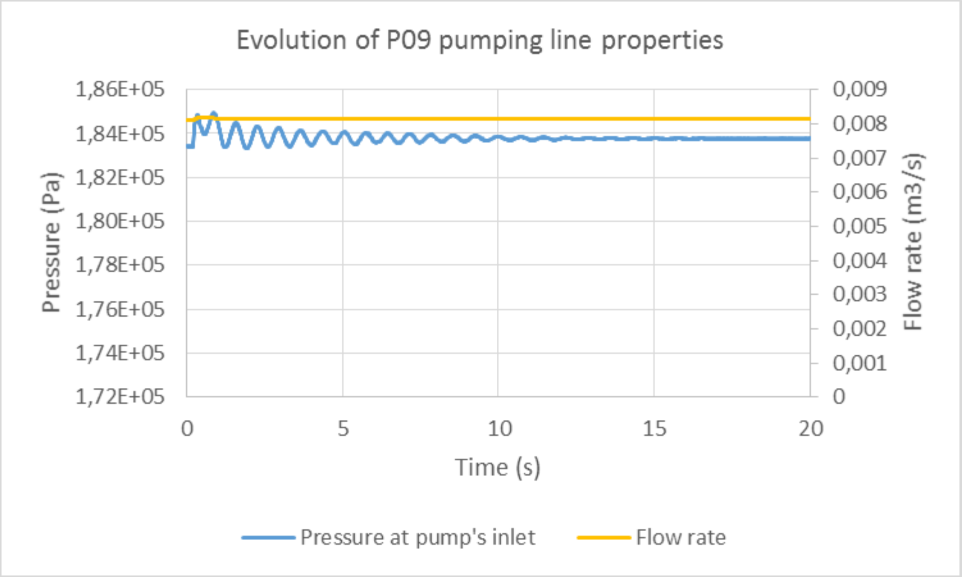


Figure H.14 Evolution during P07 pump start-up

H.2.4. Perturbations in P10 pumping line

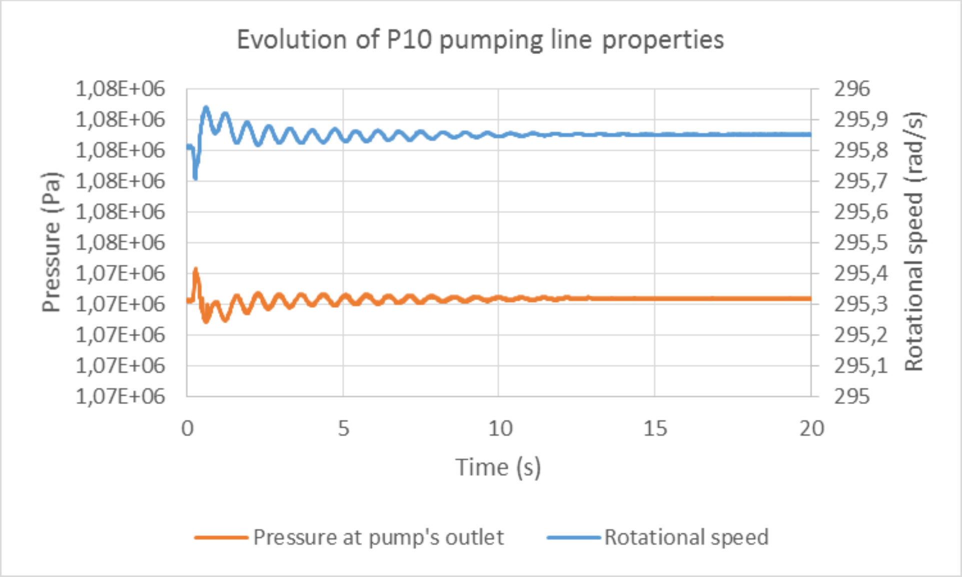


Figure H.15 Evolution during P07 pump start-up

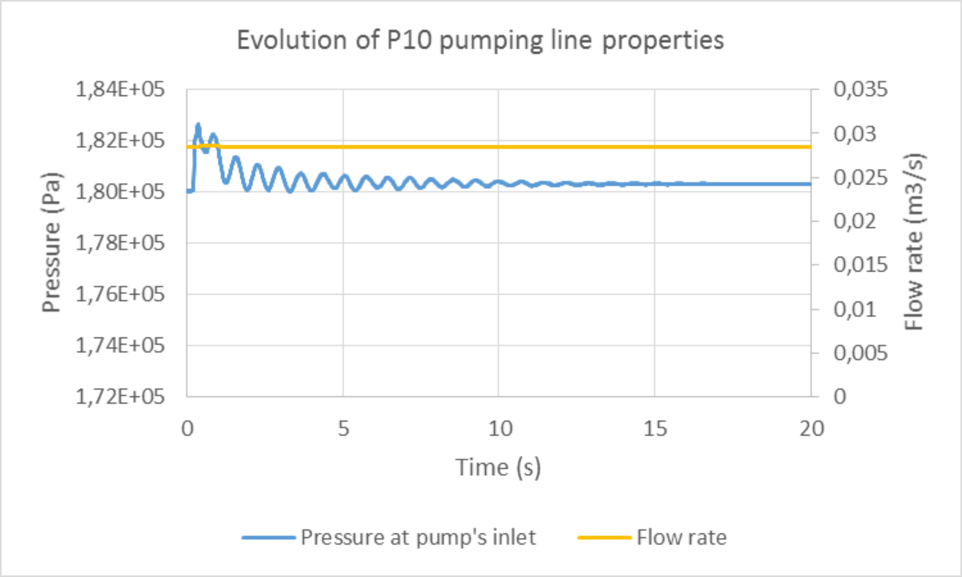


Figure H.16 Evolution during P07 pump start-up

H.2.5. Perturbations in P11 pumping line

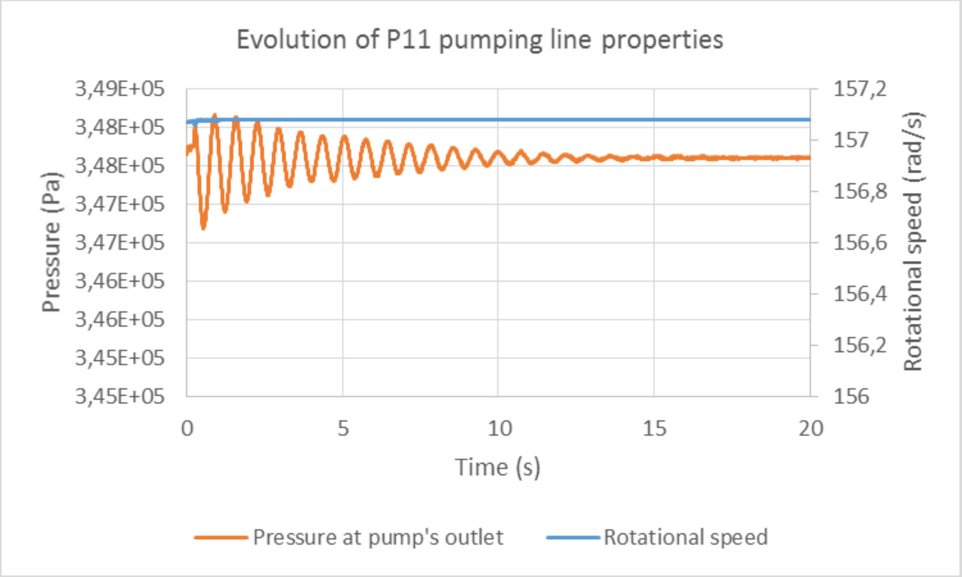
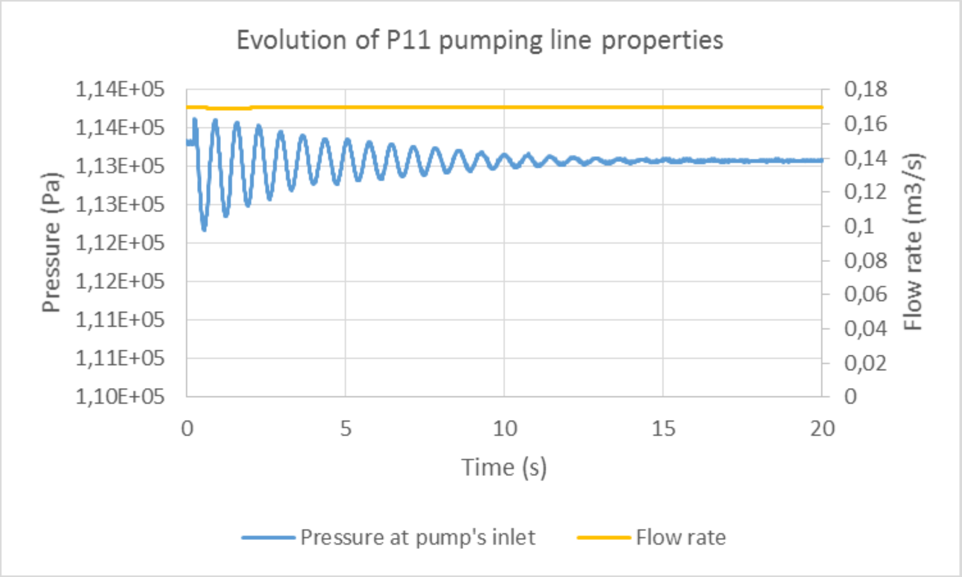


Figure H.17 Evolution during P07 pump start-up



H.3. Shut-down of P08 pumps (both two pumps simultaneously)

The stop of P08 pumps produce perturbations in the other pumping lines.

H.3.1. Perturbations in P07 pumping line

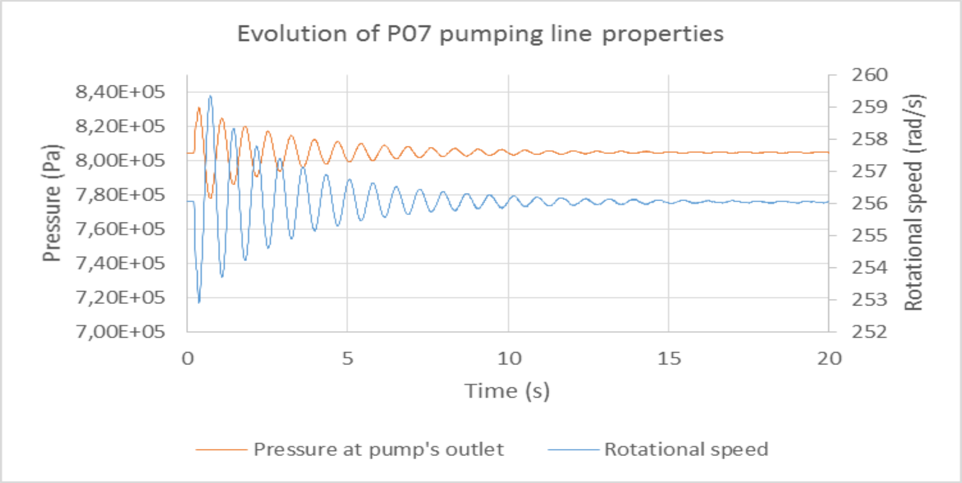


Figure H.18 Evolution during P08 pumps start-up

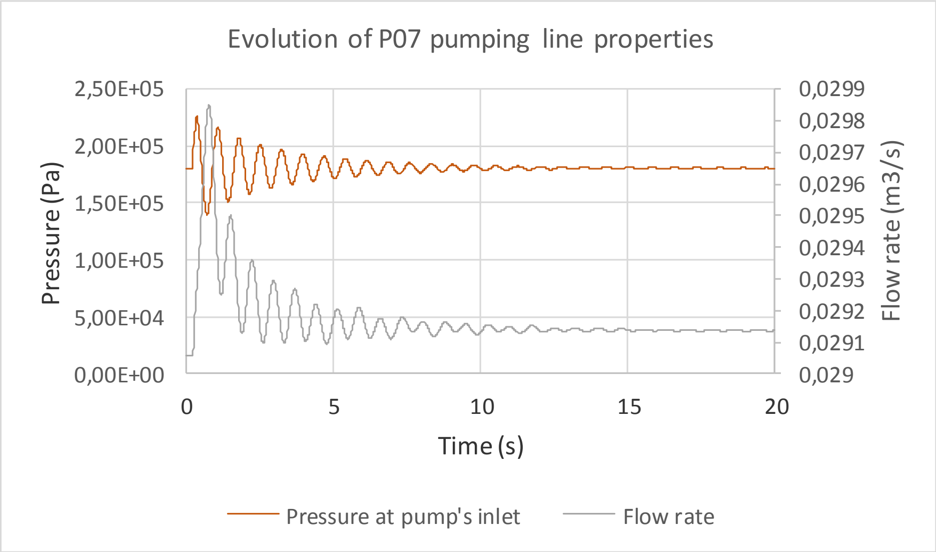


Figure H.19 Evolution during P08 pumps start-up

H.3.2. Perturbations in P09 pumping line

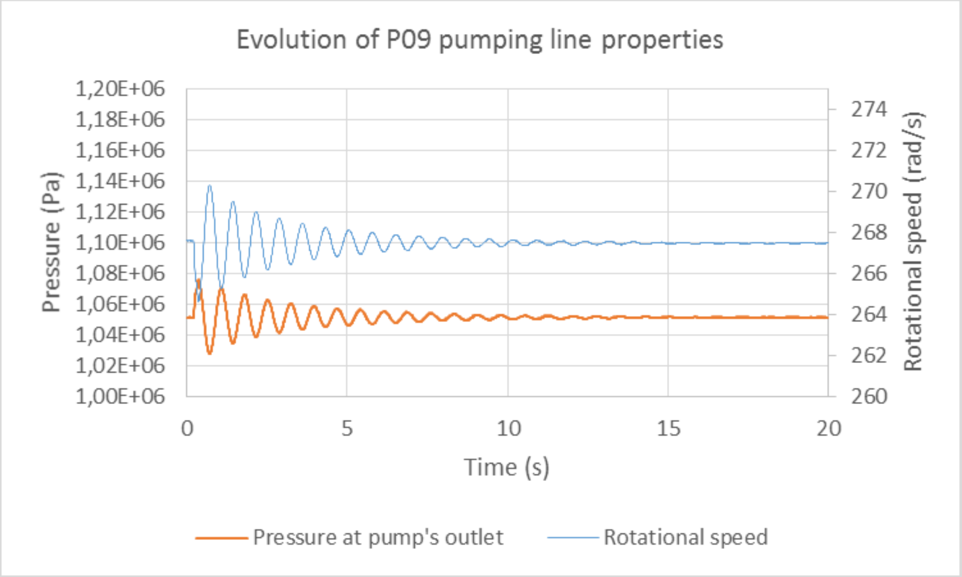


Figure H.20 Evolution during P08 pumps start-up

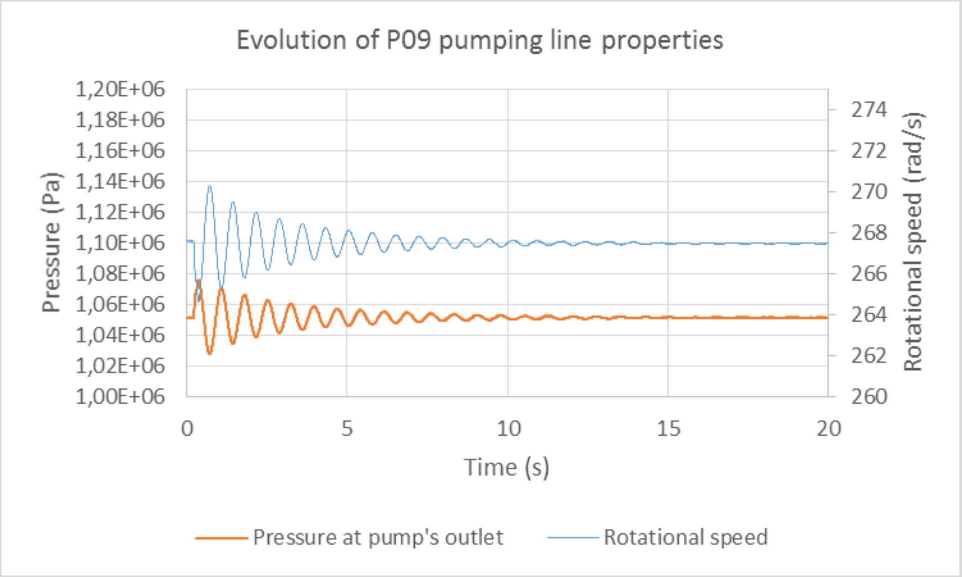


Figure H.21 Evolution during P08 pumps start-up

H.3.3. Perturbations in P10 pumping line

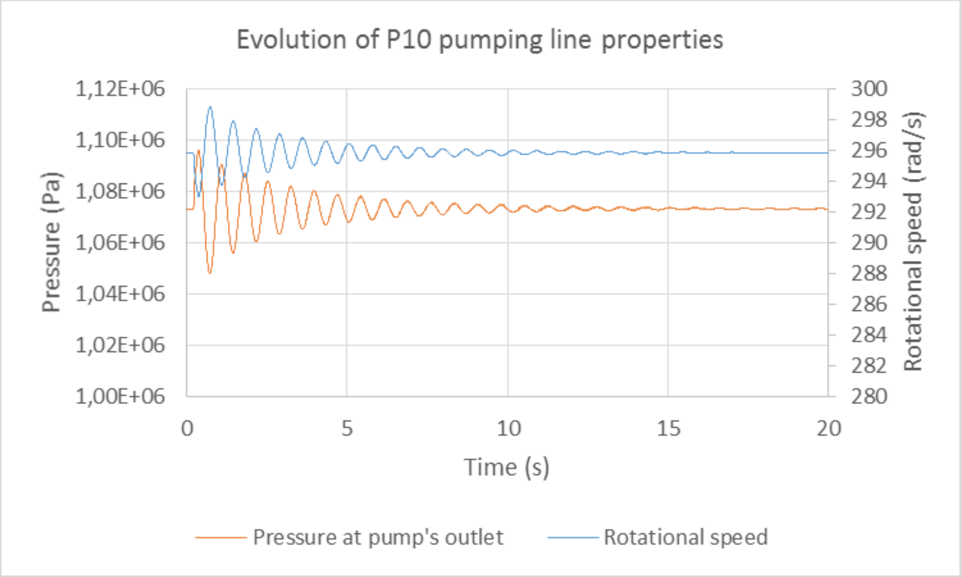


Figure H.22 Evolution during P08 pumps start-up

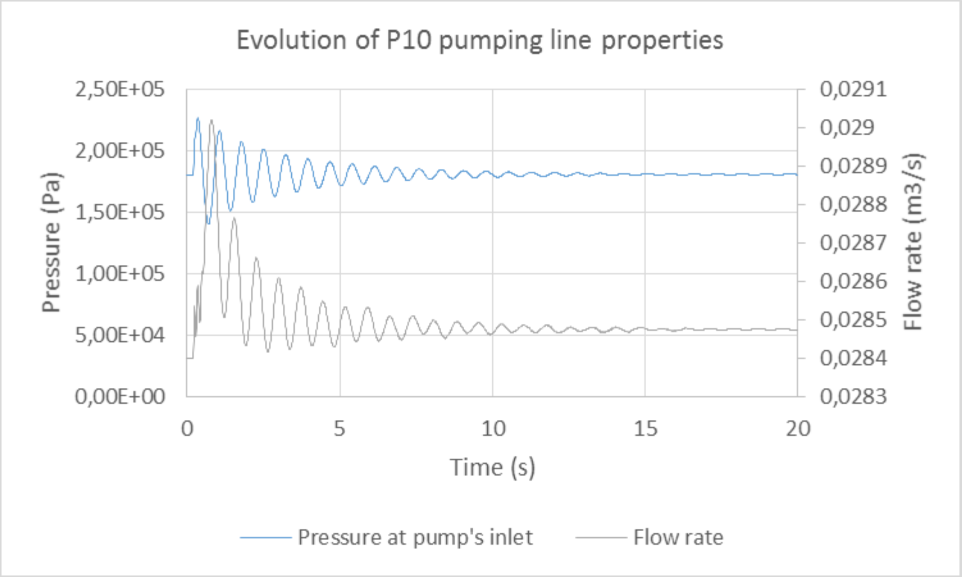


Figure H.23 Evolution during P08 pumps start-up

H.4. Shut-down of P09 pump

H.4.1. Perturbations in P09 pumping line

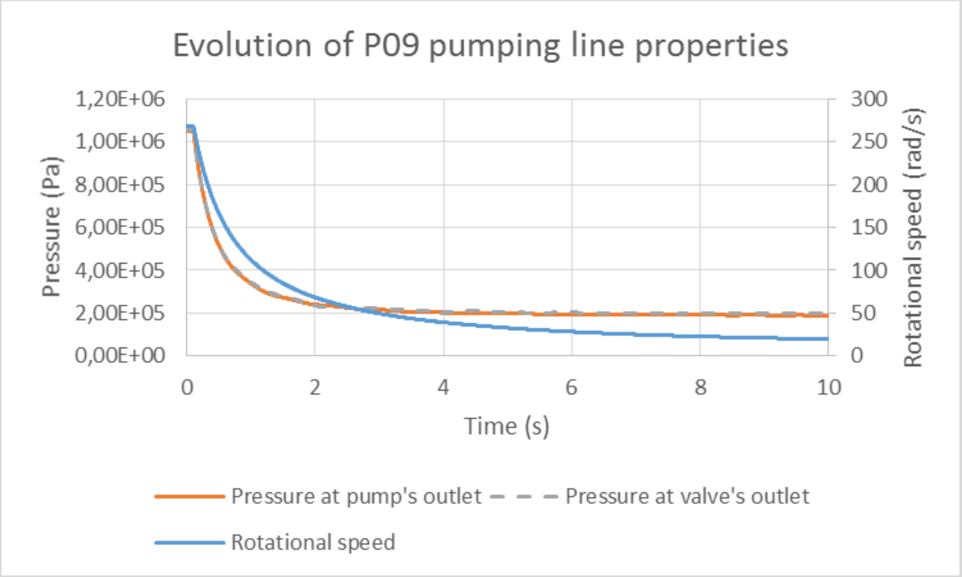


Figure H.24 Evolution during P09 pump start-up

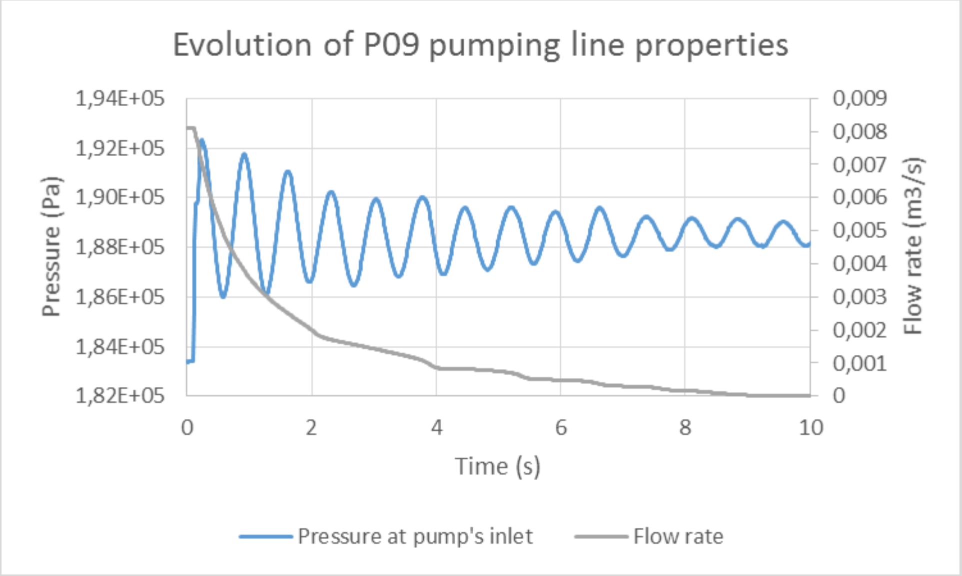


Figure H.25 Evolution during P09 pump start-up

H.4.2. Perturbations in P07 pumping line

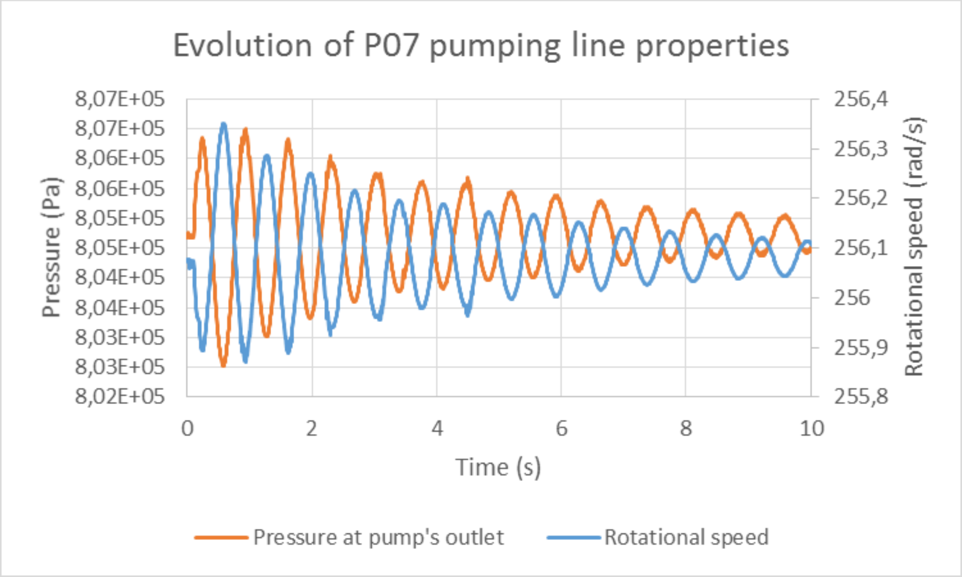


Figure H.26 Evolution during P09 pump start-up

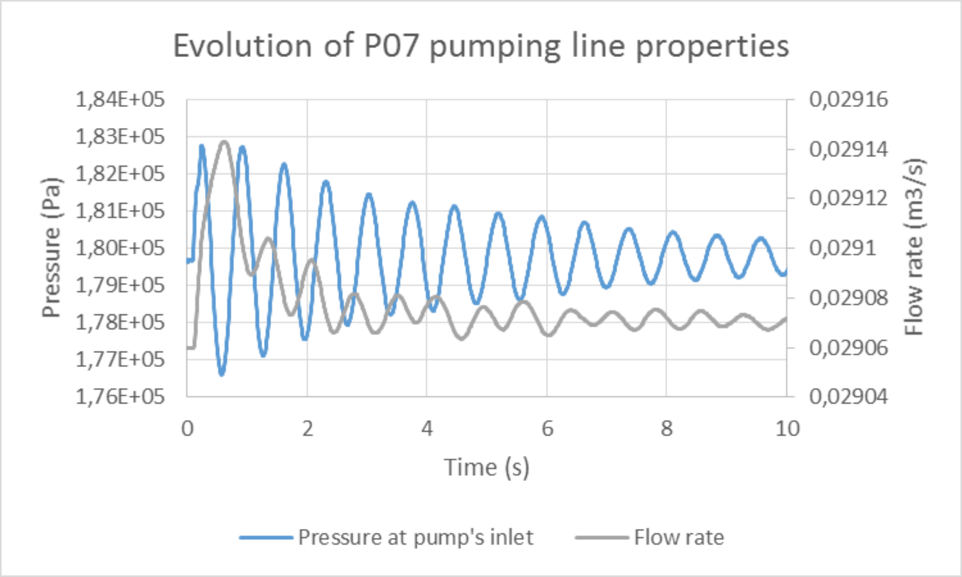


Figure H.27 Evolution during P09 pump start-up

H.4.3. Perturbations in P08 pumping line

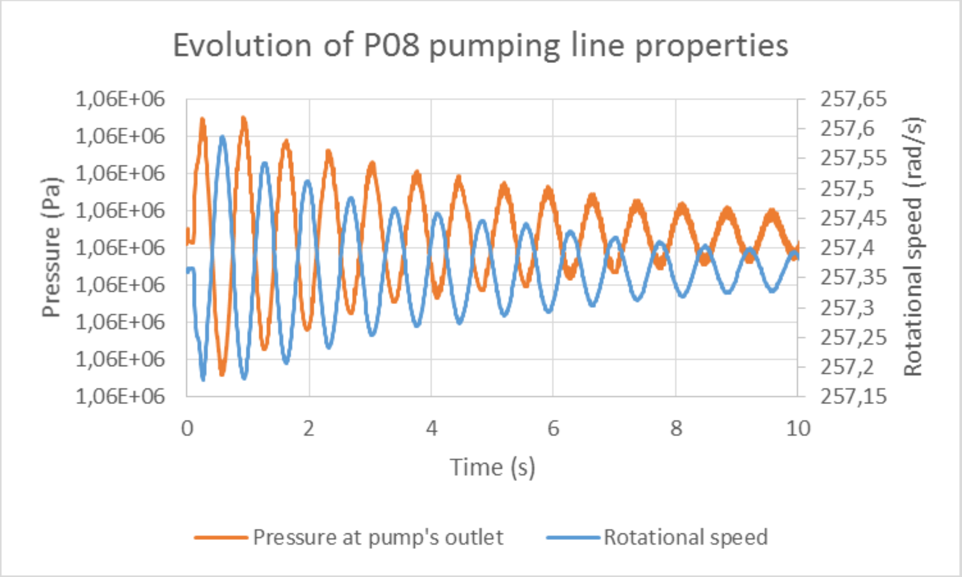


Figure H.28 Evolution during P09 pump start-up

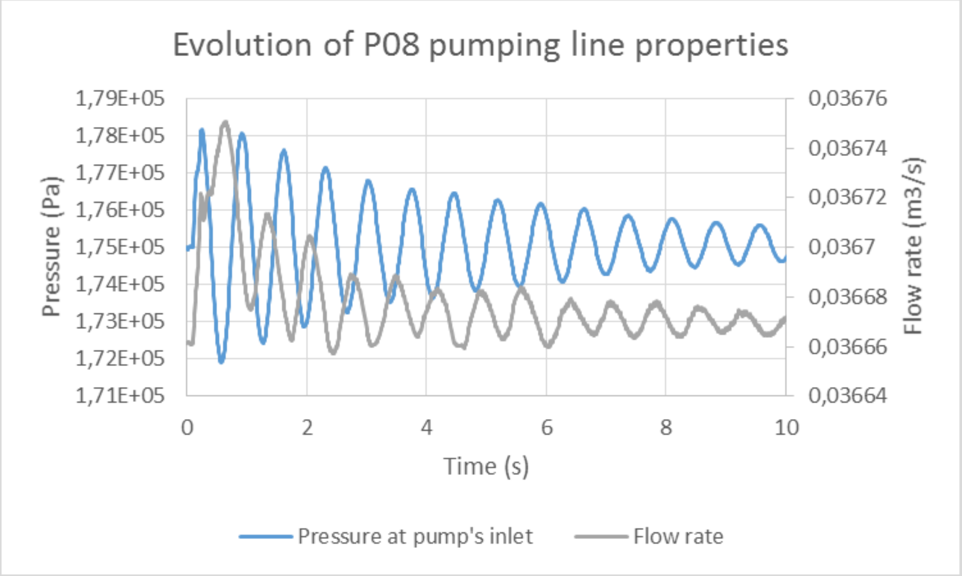


Figure H.29 Evolution during P09 pump start-up

H.4.4. Perturbations in P10 pumping line

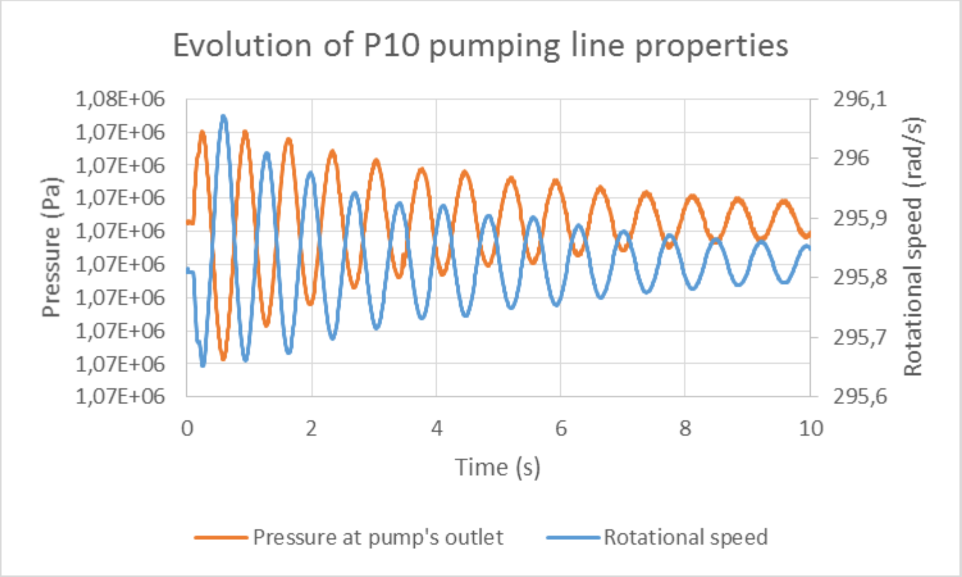


Figure H.30 Evolution during P09 pump start-up

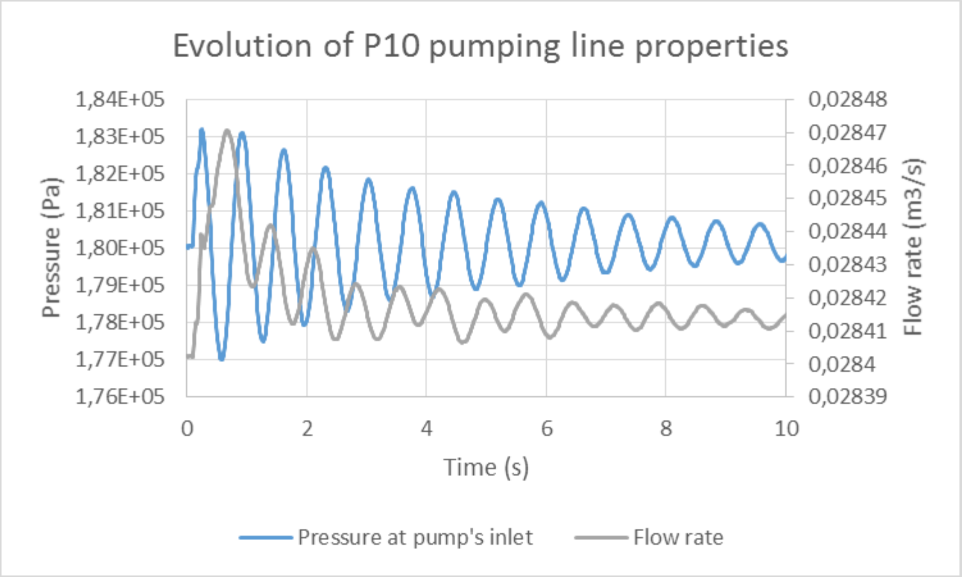


Figure H.31 Evolution during P09 pump start-up

H.4.5. Perturbations in P11 pumping line

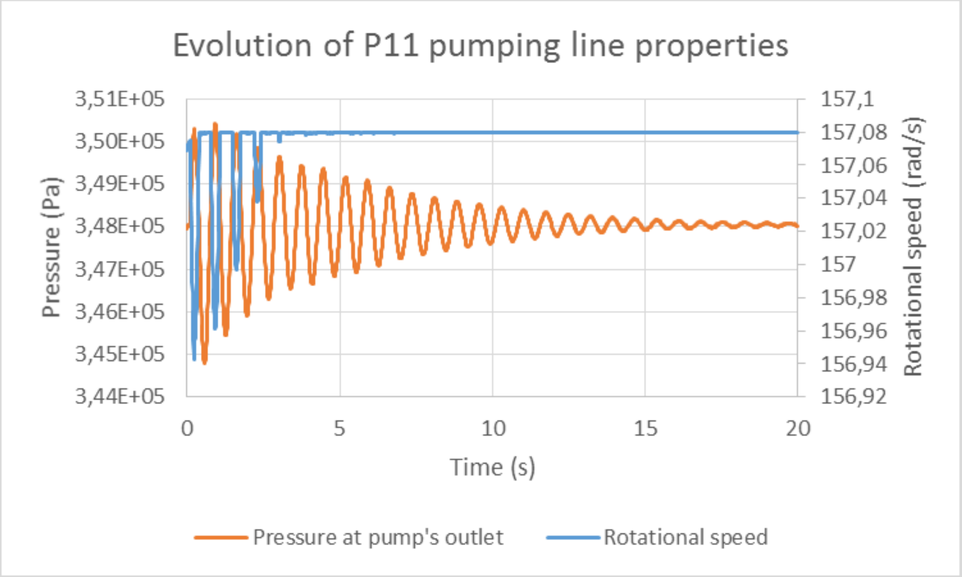


Figure H.32 Evolution during P09 pump start-up

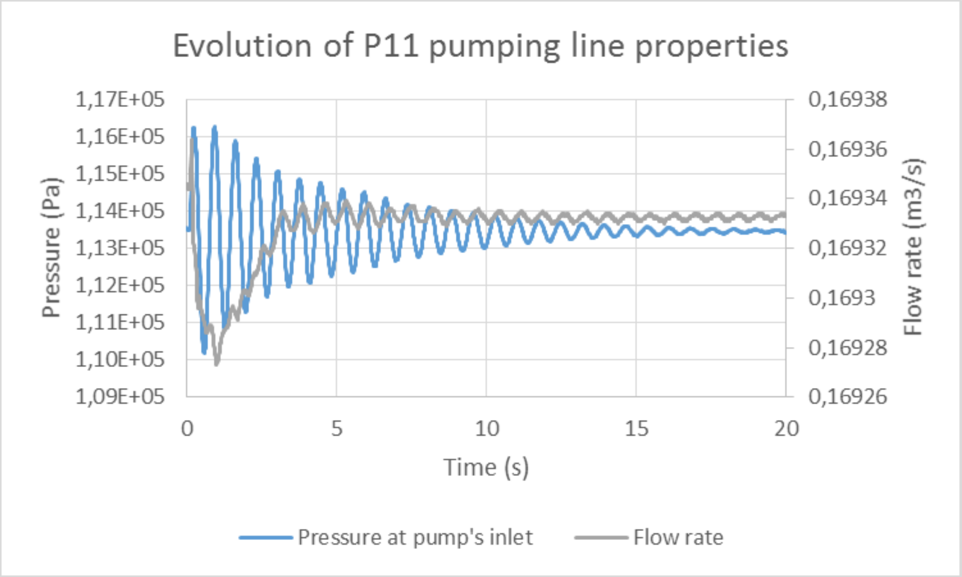


Figure H.33 Evolution during P09 pump start-up

H.5. Shut-down of P10 pump (both two pumps simultaneously)

H.5.1. Perturbations in P10 pumping line

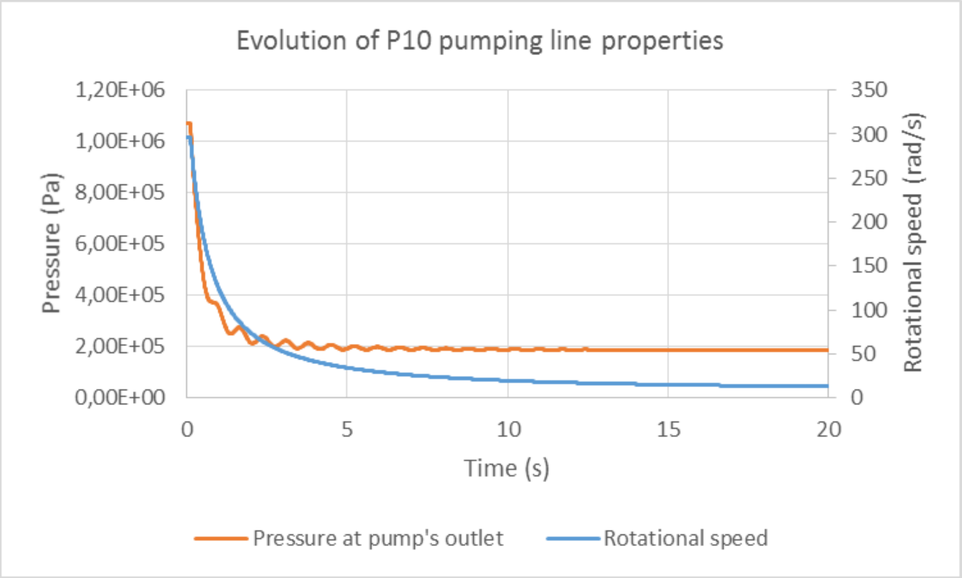


Figure H.34 Evolution during P10 pumps start-up

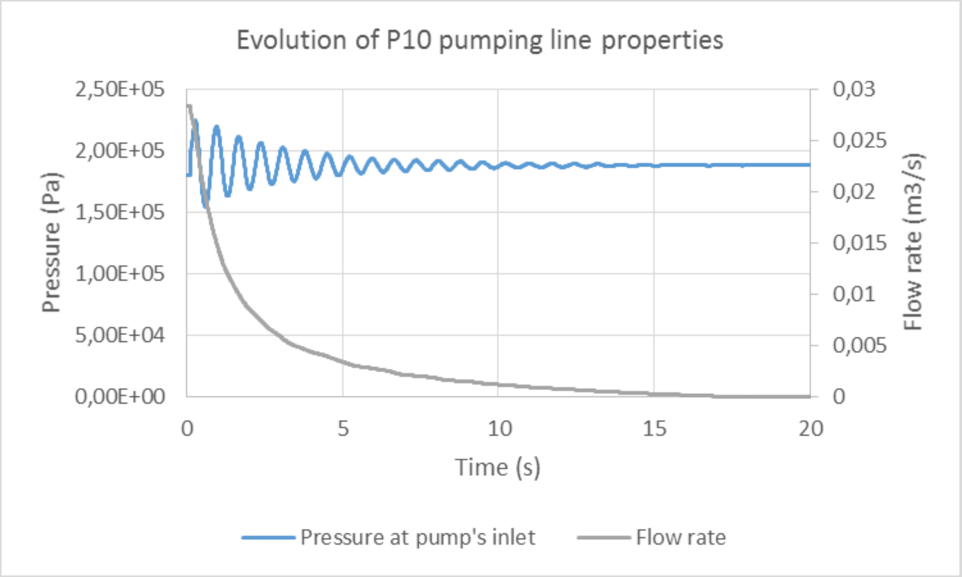


Figure H.35 Evolution during P10 pumps start-up

H.5.2. Perturbations in P07 pumping line

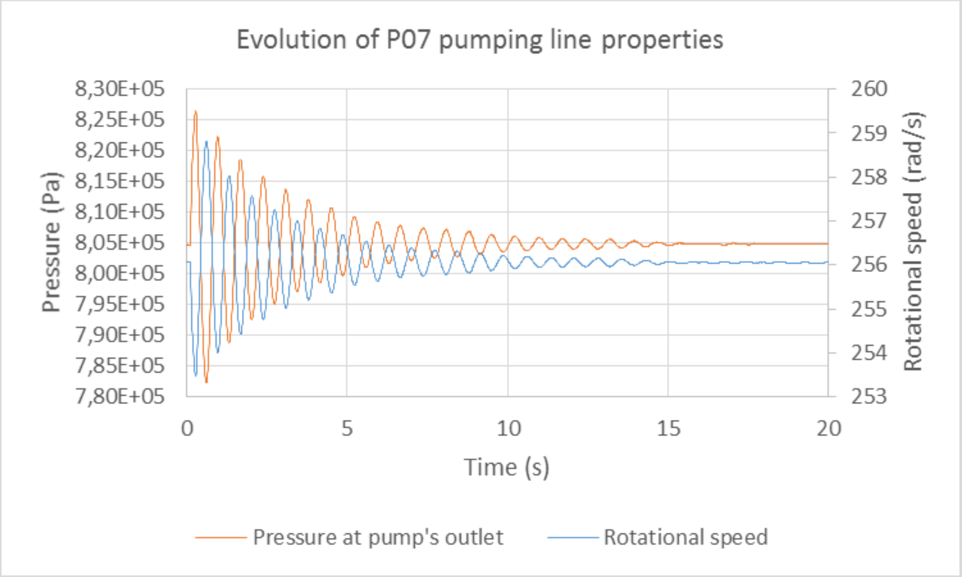


Figure H.36 Evolution during P10 pumps start-up

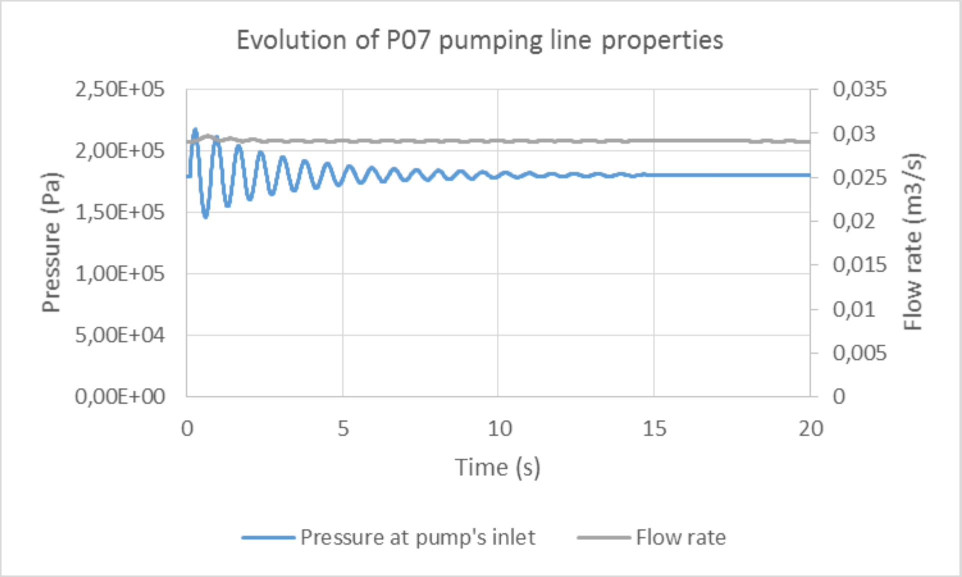


Figure H.37 Evolution during P10 pumps start-up

H.5.3. Perturbations in P08 pumping line

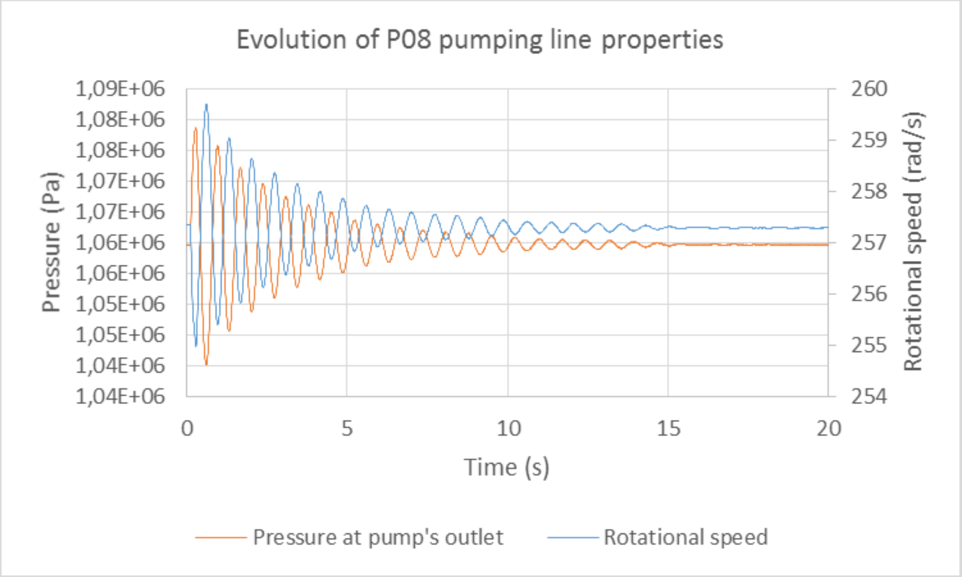


Figure H.38 Evolution during P10 pumps start-up

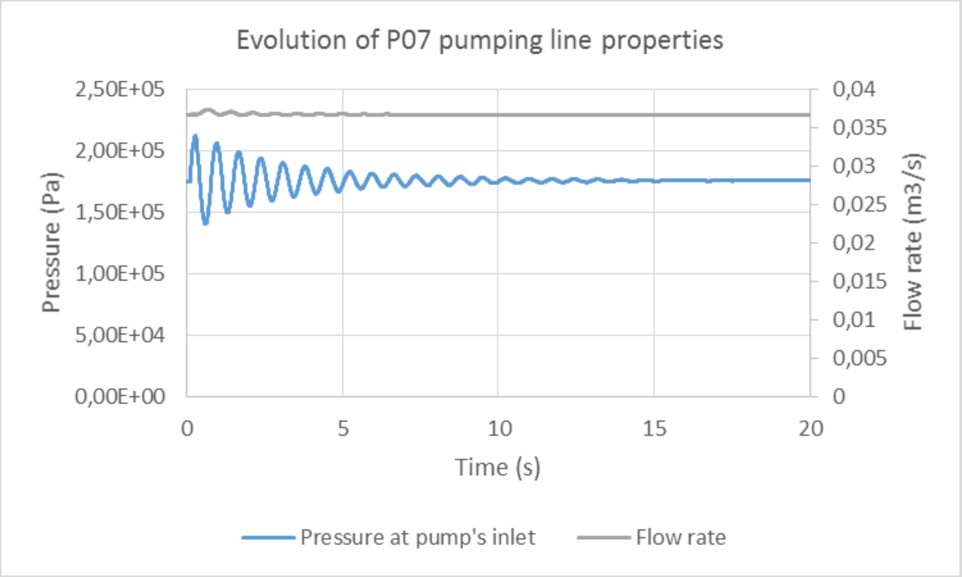


Figure H.39 Evolution during P10 pumps start-up

H.5.4. Perturbations in P09 pumping line

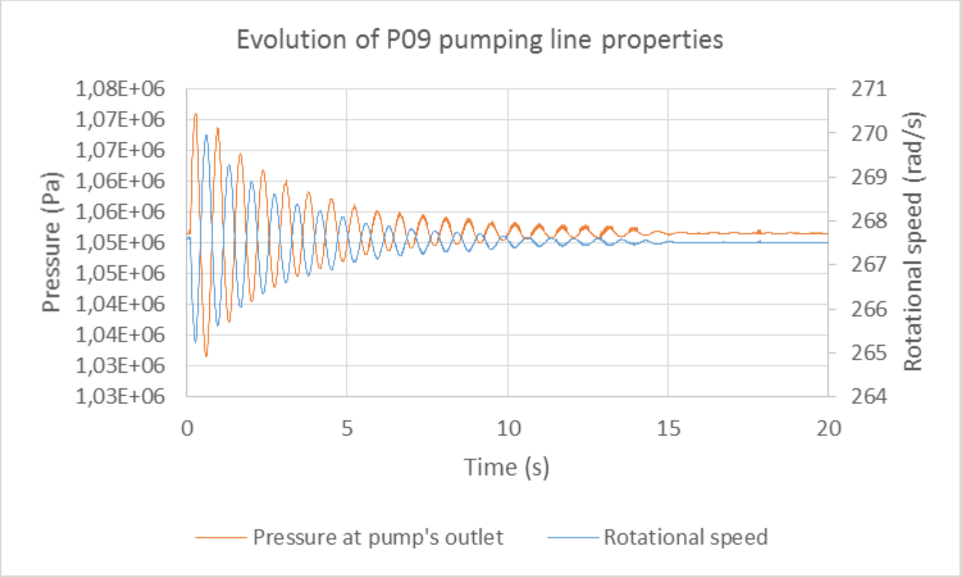


Figure H.40 Evolution during P10 pumps start-up

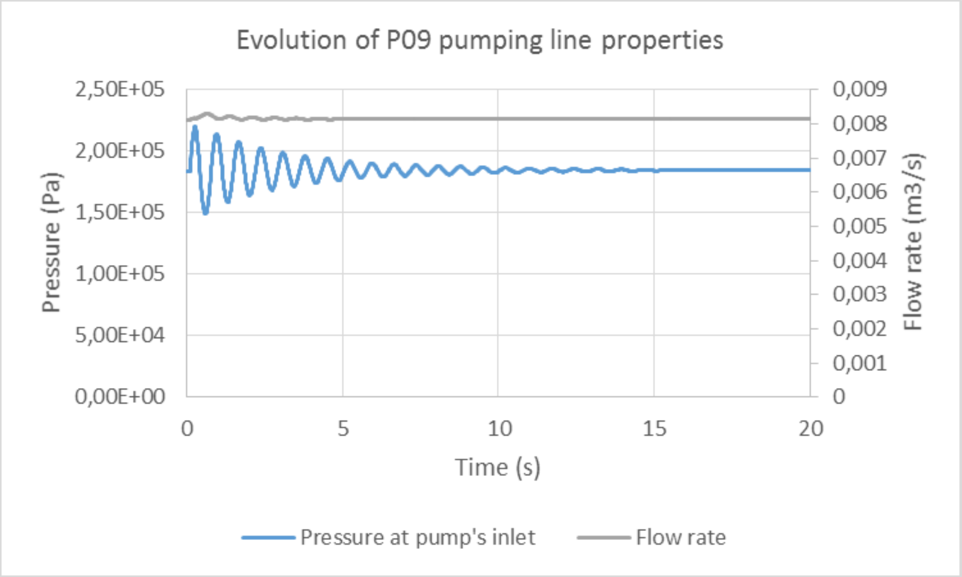


Figure H.41 Evolution during P10 pumps start-up

H.5.5. Perturbations in P11 pumping line

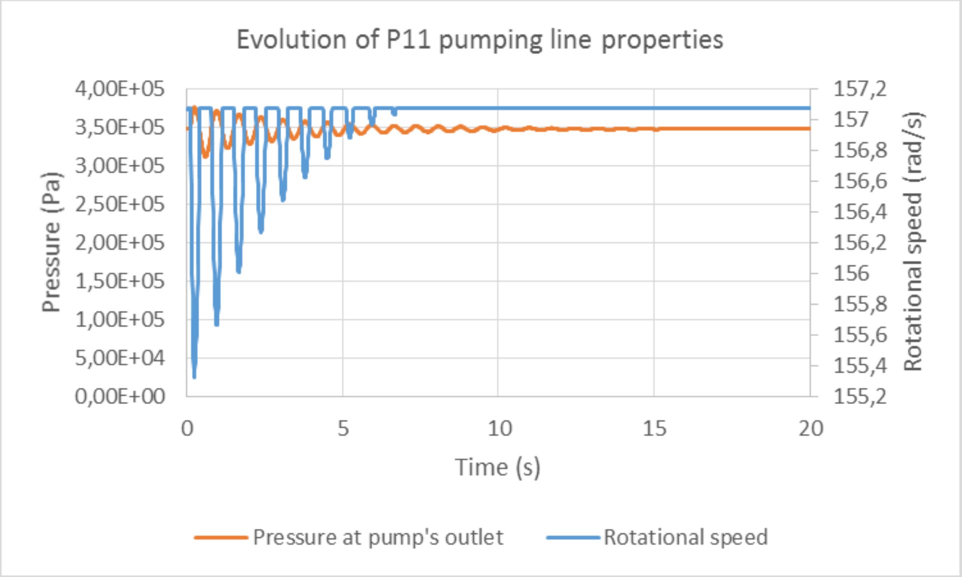


Figure H.42 Evolution during P10 pumps start-up

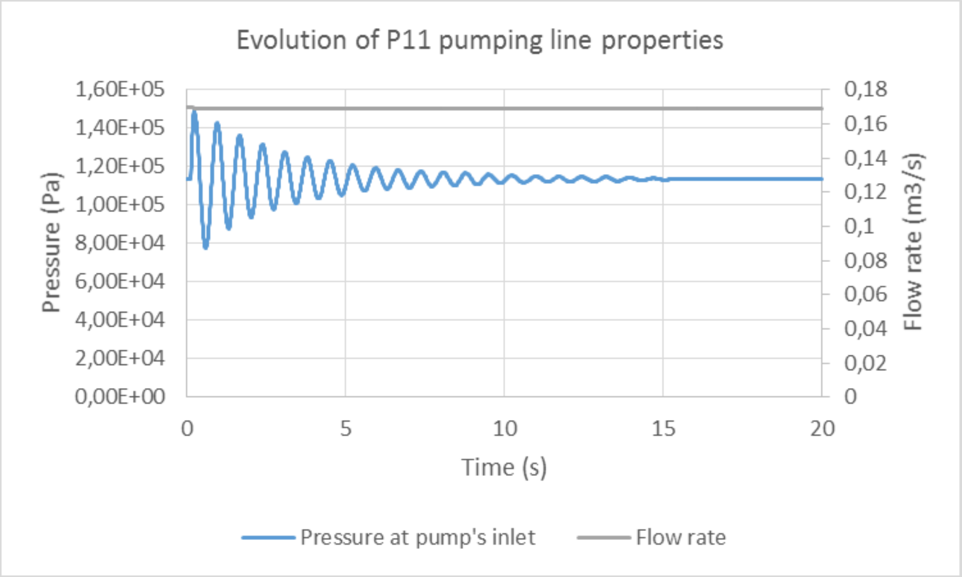
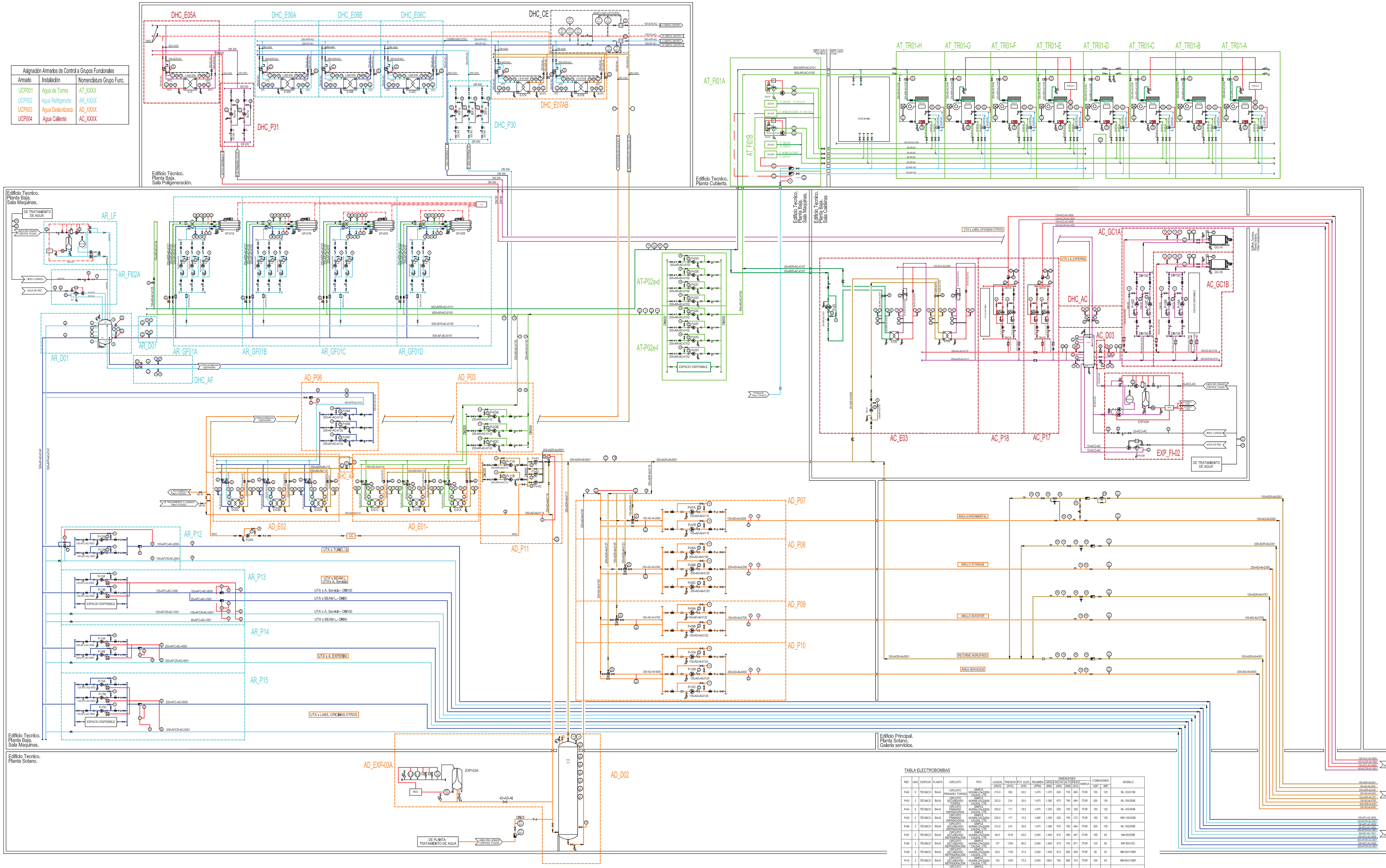


Figure H.43 Evolution during P10 pumps start-up

I. Construction drawing

The following construction drawings has been helpful to adjust the Flowmaster model.

Asignación Armarios de Control a Grupos Funcionales		
Armario	Instalación	Nomenclatura Grupo Func.
UCP001	Agua de Torres	AT_XXXX
UCP002	Agua Refrigerada	AR_XXXX
UCP003	Agua Desionizada	AD_XXXX
UCP004	Agua Caliente	AC_XXXX



◩	CONTADOR DE AGUA
PIRO	PIROSTATO
═	PLACA DE ORIFICIO
⋈	VÁLVULA EQUILIBRADO
P/~	VARIADOR DE FRECUENCIA
▷	REDUCCIÓN CONCENTRICA
▶	BOMBA DE IMPULSIÓN
MM	MANGUITO METÁLICO
MG	MANGUITO DE GOMA
F	FILTRO
Y	FILTRO TIPO "Y"
⋈	VÁLVULA DE SEGURIDAD
⋈	VÁLVULA DE ASIENTO
◺	VÁLVULA DE RETENCIÓN
⋈	VÁLVULA DE CORTE
⋈	VÁLVULA CONTROL DE POTENCIA
⋈	VÁLVULA DE PRESIÓN DIFERENCIAL
⋈	VÁLVULA CONTROL
⋈	VÁLVULA MANTENEDORA DE PRESIÓN
⋈	VÁLVULA DE PRESIÓN DIFERENCIAL
⋈	VÁLVULA DE CONTROL DE 3 VíAS
⋈	VÁLVULA TODO/NADA
⋈	VÁLVULA TODO/NADA DE 3 VíAS
SLC 100	SONDA CONDUCTIVIMETRICA
ET 100	TRANSMISOR ENERGIA
FT 100	TRANSMISOR DE CAUDAL
WT 100	TRANSMISOR DE PESO
PC 100	CONTROL DE PRESIÓN
PT 100	TRANSMISOR DE PRESIÓN
PI 100	INDICADOR DE PRESIÓN
TC 100	CONTROL DE TEMPERATURA
TT 100	TRANSMISOR DE TEMPERATURA
TI 100	INDICADOR DE TEMPERATURA
SÍMBOLO *SYMBOL*	DESIGNACIÓN
	SIMBOLOGIA

AD	IMPULSIÓN AGUA DESIONIZADA
ADR	RETORNO AGUA DESIONIZADA
AC	IMPULSIÓN AGUA CALIENTE CLIMATIZACIÓN
ACR	RETORNO AGUA CALIENTE CLIMATIZACIÓN
AC	AIRE COMPRIMIDO
AF	IMPULSIÓN AGUA FRÍA
AFR	RETORNO AGUA FRíA
AR	IMPULSIÓN AGUA REFRIGERACIÓN TORRE
ARR	RETORNO AGUA REFRIGERACIÓN TORRE
—— · ——	LÍNEA ELÉCTRICA CONTROL
SÍMBOLO	DESIGNACIÓN
SIMBOLOGIA	

TABLA ELECTROBOMBAS

REF.	UDS.	EDIFICIO	PLANTA	CIRCUITO	TIPO	CAUDAL (M3/H)	PRESION (KPA)	POT. ELEC. (KW)	REGIMEN (RPM)	DIMENSIONES LARGO (MM)	ANCHO (MM)	ALTO (MM)	PESO (KG)	MARCA	CONEXIONES ASP.	IMP.	MODELO
P-02	8	TÉCNICO	BAJA	CIRCUITO PRIMARIO TORRES	SIMPLE, NORMA.EN-22858 CAUDAL CTE.	215,0	302	30,0	1.475	1.370	620	735	483	ITUR	150	125	NL-125/315B
P-03	3	TÉCNICO	BAJA	CIRCUITO SECUNDARIO TORRES	SIMPLE, NORMA.EN-22858 CAUDAL CTE.	323,0	214	30,0	1.475	1.360	670	780	484	ITUR	200	150	NL-150/250B
P-04	6	TÉCNICO	BAJA	CIRCUITO PRIMARIO ENFRIADORAS	SIMPLE, NORMA.EN-22858 CAUDAL CTE.	250,0	171	18,5	1.475	1.250	520	705	328	ITUR	150	125	NL-125/250B
P-05	4	TÉCNICO	BAJA	CIRCUITO PRIMARIO ENFRIADORAS	SIMPLE, NORMA.EN-22858 CAUDAL CTE.	225,0	171	15,0	1.460	1.250	520	705	272	ITUR	150	125	NM-125/250B
P-06	3	TÉCNICO	BAJA	CIRCUITO SECUNDARIO ENFRIADORAS	SIMPLE, NORMA.EN-22858 CAUDAL CTE.	312,0	214	30,0	1.475	1.360	670	780	484	ITUR	200	150	NL-150/250B
P-07	2	TÉCNICO	BAJA	CIRCUITO SECUNDARIO REFRIGERACIÓN	SIMPLE, NORMA.EN-22858 CAUDAL CTE.	84,0	1010	45,0	3.000	1.400	610	580	447	ITUR	100	65	NM-65/250B
P-08	3	TÉCNICO	BAJA	CIRCUITO SECUNDARIO REFRIGERACIÓN	SIMPLE, NORMA.EN-22858 CAUDAL CTE.	127	1340	90,0	3.000	1.840	915	745	871	ITUR	125	80	INP-80/315C
P-09	2	TÉCNICO	BAJA	CIRCUITO SECUNDARIO REFRIGERACIÓN	SIMPLE, NORMA.EN-22858 CAUDAL CTE.	38,0	1150	37,0	3.000	1.400	610	605	400	ITUR	80	50	NM-50/315BR
P-10	3	TÉCNICO	BAJA	CIRCUITO SECUNDARIO REFRIGERACIÓN	SIMPLE, NORMA.EN-22858 CAUDAL CTE.	104	1030	75,0	3.000	1800	740	660	743	ITUR	100	65	NM-65/315BR
P-11	2	TÉCNICO	BAJA	CIRCUITO SECUNDARIO REFRIGERACIÓN	SIMPLE, NORMA.EN-22858 CAUDAL CTE.	646,0	230	75,0	1.500	2.450	1.065	930	1182	ITUR	250	250	INP-250/300C
P-12	2	TÉCNICO	BAJA	CIRCUITO SECUNDARIO CLIMATIZACIÓN	SIMPLE, NORMA.EN-22858 CAUDAL VAR.	34,4	280	7,5	1.500	1.000	470	570	183	ITUR	80	50	NL-50/315B
P-13	2	TÉCNICO	BAJA	CIRCUITO SECUNDARIO CLIMATIZACIÓN	SIMPLE, NORMA.EN-22858 CAUDAL VAR.	34,0	280	7,5	1.500	1.000	470	570	183	ITUR	80	50	NL-50/315B
P-14	2	TÉCNICO	BAJA	CIRCUITO SECUNDARIO CLIMATIZACIÓN	SIMPLE, NORMA.EN-22858 CAUDAL VAR.	248,7	300	30,0	1.500	1.370	620	735	483	ITUR	150	125	NL-125/315B
P-15	3	TÉCNICO	BAJA	CIRCUITO SECUNDARIO CLIMATIZACIÓN	SIMPLE, NORMA.DIN-24255 CAUDAL VAR.	83,0	300	15,0	1.500	1.100	520	665	238	ITUR	100	80	IN-80/315B
P-16	4	TÉCNICO	BAJA	CIRCUITO PRIMARIO CALOR	SIMPLE, NORMA.DIN-24255 CAUDAL CTE.	68,0	70	2,2	1.500	750	440	470	87	ITUR	100	80	IN-80/160B
P-17	2	TÉCNICO	BAJA	CIRCUITO SECUNDARIO CALOR	SIMPLE, NORMA.DIN-24255 CAUDAL VAR.	48,5	300	7,5	3.000	880	390	362	105	ITUR	65	40	IN-40/160B
P-18	2	TÉCNICO	BAJA	CIRCUITO SECUNDARIO CALOR	SIMPLE, NORMA.DIN-24255 CAUDAL VAR.	42,0	350	7,5	3.000	880	390	362	105	ITUR	65	40	IN-40/160B
P-19	1	TÉCNICO	BAJA	CIRCUITO PUESTA EN MARCHA	SIMPLE, NORMA CAUDAL CTE.	13,0	150	1,5	1.500	900	390	440	104	ITUR	65	40	NM-40/200B
P-20	1	TÉCNICO	BAJA	CIRCUITO PUESTA EN MARCHA	DOBLE IN LINE CAUDAL CTE.	13,0	150	2,2	1.500	440	714	592	180	ITUR	50	50	ETALINE Z 50-250/224.2
P-21	1	TÉCNICO	BAJA	CIRCUITO RELLENADO FUGAS	SIMPLE IN LINE CAUDAL CTE.	1,0	450	0,55	2.900	160	210	538	17	ITUR	25	25	DPVS 2-50
P-50	2	PRINCIPAL	SOTANO	CIRCUITO GENERAL	SIMPLE, NORMA.DIN-24255 CAUDAL CTE.	45,0	200	5,5	1.455	1.000	470	515	147	ITUR	80	65	IN-65/250B
P-51	1	PRINCIPAL	SOTANO	CIRCUITO REF. RACKS	DOBLE, INLINE. CAUDAL VAR.	8,6	150	1,5	1.400	440	650	548	130	ITUR	40	40	ETALINE Z 40-250/154,2

TABLA DEPOSITOS INERCIA

REF.	UDS.	EDIFICIO	PLANTA	CIRCUITO	VOL. (L)	MARCA	MODELO
DI-01	1	TECNICO	BAJA	FRIO	17.000	SIPAC	—
DI-02	1	TECNICO	BAJA	REFRIGERACIÓN	40.000	SIPAC	—
DI-03	1	TECNICO	BAJA	CALOR	2.300	SIPAC	—
DI-04	1	PRINCIPAL	SOTANO	FRIO	1.500	LAPESA	MV-15001

TABLA CALDERAS

REF.	UDS.	EDIFICIO	PLANTA	SERVICIO	POT.CAL. (KW)	ENT-SAL. AGUA (ºC)	POT. ELEC. (KW)	DIMENSIONES LARGO (MM)	ANCHO (MM)	ALTO (MM)	MARCA	MODELO	PESO (KG.)
GC-01	2	TECNICO	BAJA	CALEFACCIÓN	695,2	50-40	1,5	1.055	1.040	1.663	ADISA	MEGADINOX 750 BT	619

TABLA SISTEMA DE EXPANSIÓN, DESGASIFICACIÓN, RELLENADO

REF.	UDS.	EDIFICIO	PLANTA	CIRCUITO	PRESION V.S (BAR)	VOL. (L)	POT. ELEC. (KW)	MARCA	MODELO
EXP-01	1	TECNICO	BAJA	FRIO	3,0	1000	1,1	PNEUMATEX	TRANSFERO TG 1000/TPV 4.2
EXP-02	1	TECNICO	BAJA	CALOR	3,0	400	1,1	PNEUMATEX	TRANSFERO TG 400/TPV 4.2
EXP-03	1	TECNICO	BAJA	REFRIGERACIÓN	3,0	1500	1,5	PNEUMATEX	COMPRESSO GC 1500 INOX/CF 10.2-6
EXP-05	1	PRINCIPAL	SOTANO	GENERAL	3,0	46	—	PNEUMATEX	PNU-140
EXP-06	1	PRINCIPAL	SOTANO	RACKS	3,0	15	—	PNEUMATEX	PND-25

TABLA INTERCAMBIADORES

REF.	UDS.	EDIFICIO	PLANTA	SERVICIO	POT.FRIG. (KW)	ENT-SAL. AGUA 1º (ºC)	ENT-SAL. AGUA 2º (ºC)	P. CARGA AGUA 1º (KPA)	P. CARGA AGUA 2º (KPA)	DIMENSIONES LARGO (MM)	ANCHO (MM)	ALTO (MM)	Nº PLACAS	PESO (KG.)	MARCA	CONEXION
EX-01	3	TECNICO	BAJA	TORRES-REFRIGERACIÓN	1.815,0	20-24,8	26,8-22	40	40	2.250	609	1.353	231	2.590	CIPRIANI	150
EX-02	3	TECNICO	BAJA	ENFR.-REFRIGERACIÓN	1.815,0	7-12	26,8-22	50	50	1.250	609	1.353	93	1.739	CIPRIANI	150
EX-03	2	TECNICO	BAJA	PUESTA A REGIMEN	150,0	50-40	15-25	45	49	265	200	320	9	170	CIPRIANI	32
EX-04	1	PRINCIPAL	BAJA	COMPUTING ROOM	50,0	7-12	20-15	46	45	165	200	470	9	170	CIPRIANI	32
EX-05	1	TECNICO	BAJA	DHC-CALOR	1.440,0	90-75	40-50	20,9	48,03	740	530	1.060	53	466,6	CIPRIANI	100
EX-06	3	TECNICO	BAJA	DHC-FRIO	1.090,0	6-11	12-7	49,25	49,06	1.750	609	2.218	279	2.090,3	CIPRIANI	150
EX-07	2	TECNICO	BAJA	DHC-REFRIGERACIÓN	1.815,0	6-16	26,8-22	14,53	50,36	1.250	609	1.322	131	1.033,7	CIPRIANI	150

TABLA TORRES DE REFRIGERACIÓN

REF.	UDS.	EDIFICIO	PLANTA	SERVICIO	POT.FRIG. (KW)	TEMP. BH. AIRE (ºC)	ENT-SAL. AGUA (ºC)	POT. ELEC. (KW)	DIMENSIONES LARGO (MM)	ANCHO (MM)	ALTO (MM)	PESO (KG.)	MARCA	CONEXION IMP.	RET.	MODELO
TR-01	8	TECNICO	CUBIERTA	CONDENSACIÓN	1.250,0	26	35-30	30,0	6.400	2.400	3.780	6.400	TEVA	150	200	TVC-817

DIRECTORIO

NOMBRE FICHERO

Item	Revisión	Fecha	Dibujado	Visado
G	PLANO AS BUILT	17-09-09	R.R.G.	D.X.
F	Agregar valvulería en tubos agua desionizada en galería	13-04-09	R.R.G.	D.X.
E	Agregar válvulas de corte en tubos inoxidable: 0127, 0125, 0123, 0121	12-12-08	R.R.G.	D.X.
D	Modificar posición valvula 3 vías en retorno DN 350	03-12-08	R.R.G.	D.X.
C	Revisión general	09-10-08	R.R.G.	D.X.
B	Revisión general	28-01-08	R.R.G.	D.X.
A	Revisión general	16-08-07	R.R.G.	D.X.

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
Dibujado	ABRIL 2006	F.RANGEL	
Proyectado	ABRIL 2006	J.M. RIMBAU	
Revisado	ABRIL 2006	J.M. RIMBAU	
Aprobado	ABRIL 2006	F. VELARDE	

Coordinador General del Proyecto
ALFONS PERDRIX

Escala
S/E

Sustituye a
Sustituido por
Archivo N.

COFELY
GDF SUEZ

	Fecha	Nombre
Dibujado	06/02/2008	R.R.G.
Revisado	06/02/2008	D.X.

Aprobacion por MASTER:
FECHA:

V.B. CELLS

CELLS
BLOC C3, EDIFICI CIÈNCIES
CAMPUS UAB 08193
BELLATERRA (Spain)

ALBA

Life cicle

Size: A1
Doc No.
DWG No. I.25201.00568.132

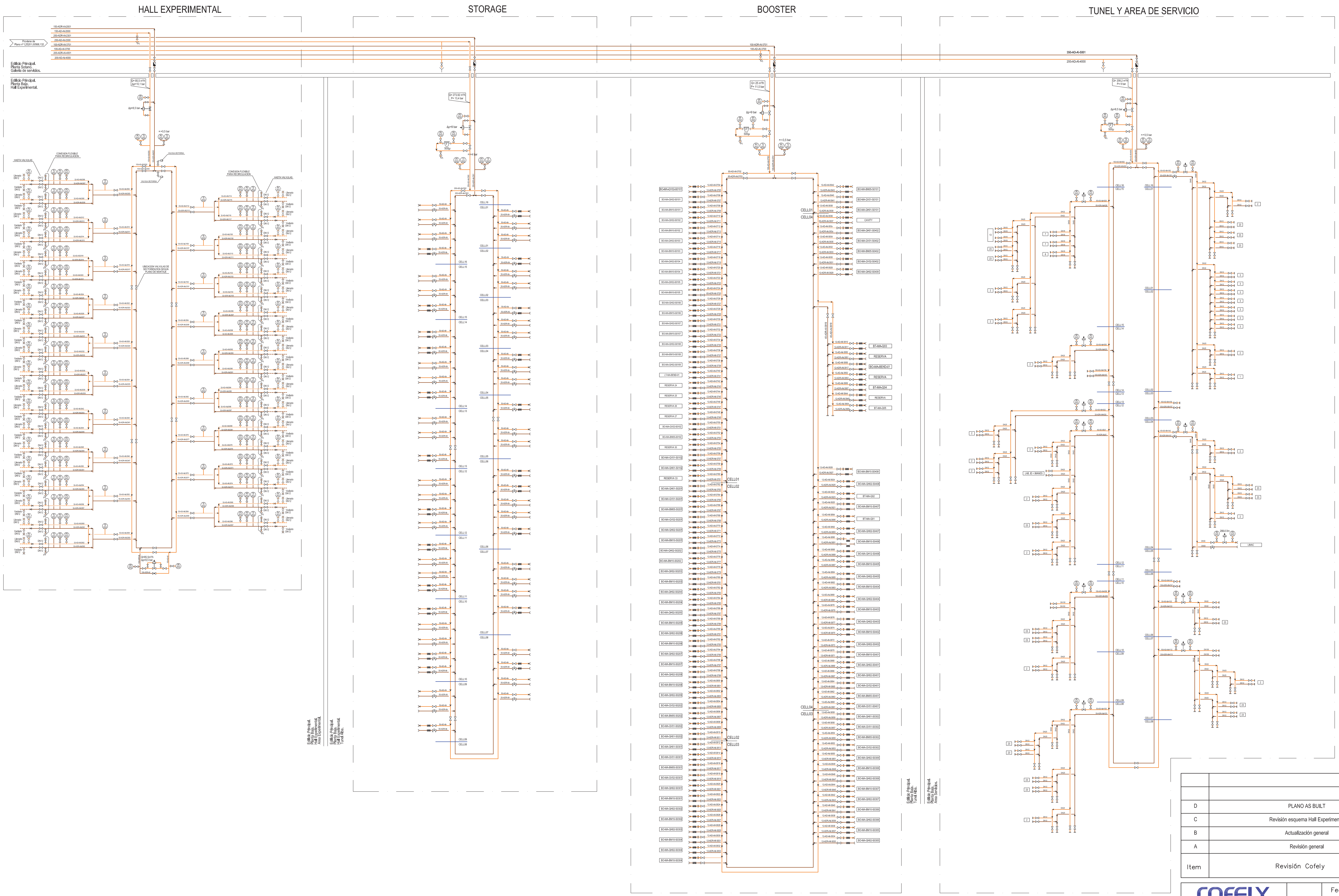
Titulo
EDIFICIO TECNICO/PRINCIPAL.
PRODUCCIÓN DE ENERGÍA.
ESQUEMA DE PRINCIPIO.
GRUPOS FUNCIONALES.

Nombre del proyecto
PROYECTO DEL CELLS

Serie	Tema	Rev.
2 10	2 01	2

Referencia 91A/04 AS

master INGENIERIA ARQUITECTURA



CODIFICACION LINEAS

350-AFR-AC1-1035

- DIAMETRO NOMINAL mm
- FLUIDO
- ESPEC. TUBO
- NUMERO DE LINEA

AI	ACERO INOXIDABLE AISI-316L
AC	ACERO AL CARBONO SEGUN DIN-2440-2448
CU	COBRE
SÍMBOLO	*DESIGNACIÓN*

SIMBOLOGÍA

AD	IMPULSIÓN AGUA DESIONIZADA
ADR	RETORNO AGUA DESIONIZADA
SÍMBOLO	*DESIGNACIÓN*

SIMBOLOGÍA

◩	CAUDALIMETRO MASICO
C	CAUDALIMETRO SWIRL (OPCIONAL)
=	PLACA DE ORIFICIO
⋈	VALVULA REGULACION
▷	REDUCCIÓN CONCENTRICA
WWW	AMORTIGUADOR VIBRACIONES
F	FILTRO
⋈	VÁLVULA DE CORTE
⋈	VÁLVULA CONTROL
⋈	VÁLVULA DE CONTROL DE 3 VíAS
⋈	VÁLVULA TODO/NADA
⋈	VÁLVULA TODO/NADA DE 3 VíAS
FT 100	TRANSMISOR DE CAUDAL
FS 100	INTERRUPTOR DE CAUDAL
TT 100	TRANSMISOR DE TEMPERATURA
SÍMBOLO	*DESIGNACIÓN*

SIMBOLOGIA

D	PLANO AS BUILT	05-11-09	R.R.G.	D.X.
C	Revisión esquema Hall Experimental	05-09-08	R.R.G.	D.X.
B	Actualización general	30-04-08	R.R.G.	D.X.
A	Revisión general	24-04-08	R.R.G.	D.X.
Item	Revisión Cofely	Fecha	Dibujado	Visado

COFELY
GDF SUEZ

	Fecha	Nombre
Dibujado	26/02/2007	R.R.G.
Revisado	26/02/2007	D.X.

Aprobacion por MASTER:
FECHA:

V.B. CELLS

CELLS
BLOC C3, EDIFICI CIÈNCIES
CAMPUS UAB 08193
BELLATERRA (Spain)

ALBA

Life cicle

Size A1

Doc No. I.25201.00568.029

Titulo

ESQUEMA DE DISTRIBUCION.
AGUA REFRIGERACION.

Nombre del proyecto
PROYECTO DEL CELLS

2 07 | 1 01 | 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^.

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Autorizada por

Objeto

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Dibujado	ABRIL 2006	F.RANGEL	
Proyectado	ABRIL 2006	J.M. RIMBAU	
Revisado	ABRIL 2006	J.M. RIMBAU	
Aprobado	ABRIL 2006	F. VELARDE	

Coordinador General del Proyecto
ALFONS PERDRIX

Escala
S/E

Sustituye a
Sustituido por
Archivo N.

DIRECTORIO
NOMBRE FICHERO