COMPANY : PT. PERTAMINA PATRA NIAGA
CONTRACTOR : PT. PP (PERSERO), Tbk
PROJECT TITLE : Pembangunan Dermaga Kapasitas 50,000 DWT di Fuel Terminal Biak
LOCATION : Kabupaten Biak Numfor, Papua Barat, Indonesia.
CONTRACT NO :
JOB NO : 723002

PT. PERTAMINA PATRA NIAGA

☐ APPROVED

☐ APPROVED WITH COMMENT

☐ NOT APPROVED

DATE	CHECKED	APPROVED

REVISION CONTROL SHEET

REV. NO.	DATE	DESCRIPTION
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1. PENDAHULUAN

Untuk dapat menjawab peningkatan permintaan BBM, fasilitas terminal distribusi harus memiliki kapasitas yang memadai yang perlu dikembangkan. Fasilitas tersebut sangat penting untuk dapat mengantarkan produk "BBM" ke konsumen akhir. Oleh karena itu, agar semua proses pendistribusian dapat berjalan dengan lancar, PERTAMINA membutuhkan pembangunan dan pembangunan fasilitas untuk TBBM Biak, Papua Barat.

PT. PERTAMINA (PERSERO) bermaksud untuk melaksanakan pembangunan Dermaga baru berkapasitas 3.500 DWT – 50.000 DWT dalam rencana pembangunan Terminal BBM Biak bertujuan antara lain:

Peningkatan ketahanan stok BBM, khususnya di Papua bagian utara, seperti program peningkatan kebutuhan BBM satu harga oleh pemerintah. Mendukung program pemerintah sebagai Proyek Strategi Nasional pembangunan infrastruktur di Kawasan Timur Indonesia (KTI) Mengurangi beban operasional TBBM Wayame sehingga total keandalan pasokan BBM di wilayah Maluku – Papua semakin baik. Mengurangi risiko operasional yang berdampak pada ekonomi, politik dan keamanan wilayah Maluku – Papua serta meningkatkan ketersediaan layanan BBM/BBK kepada pemegang saham.

Gambar 1.1. Gambaran Lokasi TBBM Biak, Papua.

1.1. TUJUAN

Dokumen *Hydraulic dan Line Sizing* ini bertujuan untuk mengevaluasi data ukuran pipa dan desain pompa guna memenuhi kebutuhan proses dan *sizing criteria* proyek.

1.2. DESKRIPSI PROYEK

Lokasi pengerjaan EPC pembangunan Terminal BBM Biak terletak di Kabupaten Biak Numfor, Papua Barat, Indonesia.

PT PERTAMINA (Persero) berencana membangun Dermaga di Terminal BBM Biak dan fasilitas pendukung lainnya yang direncanakan sebagai fasilitas docking/tambat kapal dan juga sebagai area loading. Kapal yang akan beroperasi adalah tanker 3.500 DWT sampai dengan 50.000 DWT.

Gambar 1.2. *Plot Plant* Dermaga TBBM Biak.

Lingkup pekerjaan TBBM Biak untuk pembangunan dermaga dengan kapasitas 50.000 DWT meliputi pelaksanaan umum kegiatan *Engineering, Procurement, Construction* (EPC) mengacu pada dokumen teknis (RKS, BoQ, FEED).

Menyiapkan Detail Engineering Design (DED) berdasarkan dokumen FEED, pekerjaan konstruksi sipil dan struktur dermaga (*Trestle, Jetty Head, Breasting Dolphin (4 Unit), Mooring Dolphin (4 Unit), Catwalk* dan *Steel Structure, Tugboat Jetty, Fire Pump Platform* dan *Shelter* serta *Guard House*), pekerjaan perpipaan dan mekanik, keselamatan kerja dan sistem proteksi kebakaran, pekerjaan kelistrikan dan instrumentasi, pekerjaan pengujian, inspeksi dan *commissioning*.

2. DEFINISI

Definisi berikut akan berlaku di seluruh dokumen Hydraulic & Line Sizing :

PROYEK:
Pembangunan Dermaga Kapasitas 50,000 DWT di Fuel Terminal Biak

PERUSAHAAN :
PT. Pertamina Patra Niaga

KONTRAKTOR:
PT. PP (Persero) Tbk

VENDOR/PABRIKAN/SUBKONTRAKTOR:
Semua organisasi/perorangan yang ditunjuk oleh KONTRAKTOR untuk melaksanakan semua pekerjaan yang ditentukan dalam lingkup kerja pada proyek yang dimaksud.

3. REFERENSI

Daftar dokumen dibawah ini adalah sebagai acuan bagi **KONTRAKTOR** untuk memenuhi seluruh standar dan spesifikasi yang telah ditentukan untuk menyelesaikan **PROYEK**.

Tabel 1 - Referensi Dokumen

BIAK-DB-10-001-A4	Process Design Basis
BIAK-PID-10-002-A3	Piping & Instrumentation Diagram Jetty – 1 (Existing)
BIAK-PID-10-003-A3	Piping & Instrumentation Diagram Jetty – 2 (New)
BIAK-PID-10-004-A3	Piping & Instrumentation Diagram Valve Matrix Onshore
API RP 14E	Offshore Production Platform Piping System

4. KRITERIA DESAIN

4.1 *LINE SIZING*

Kecepatan aliran dalam pipa umumnya harus dijaga cukup rendah untuk mencegah masalah erosi, lonjakan tekanan *water hammer*, kebisingan, getaran, *electrostatic discharge*, dan *reaction forces*. Kecepatan maksimum yang direkomendasikan dan *pressure drop* untuk kriteria penentuan ukuran pipa dapat dilihat dalam tabel di bawah ini.

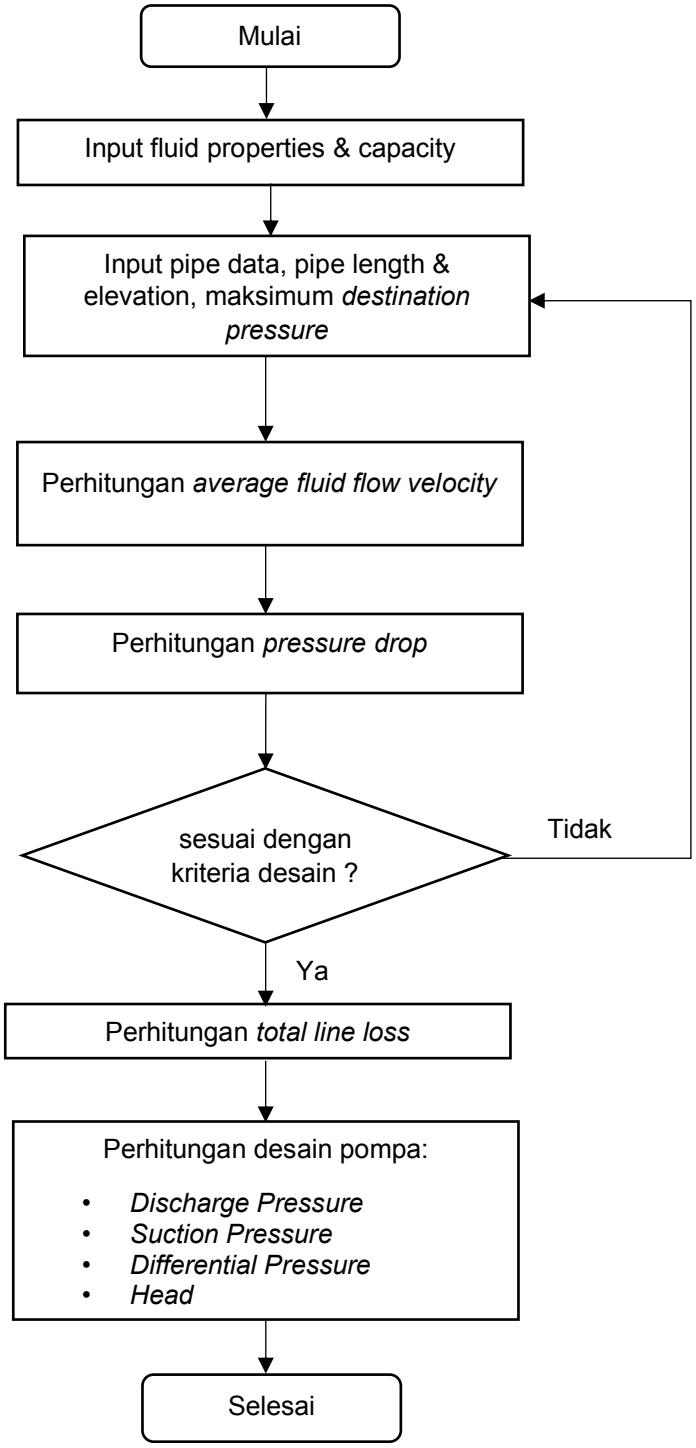
Tabel 2 – Kriteria *Line Sizing*

No	Produk	*Maximum Pressure Drop*/ 100 m (kgf/cm^2/100 m)	*Maximum Velocity* (m/s)
1	Pump Suction		
	(a) Saturate liquid	0.12	0.6 – 1.8
	(b) Sub-cool liquid	0.23	1.2 – 2.5
2	Pump Discharge		
	(a) General BBM	0.46	4.57
	(b) Avtur	0.46	3.0

Terdapat juga persyaratan kecepatan minimum yaitu 0,91 m/s untuk meminimalkan penimbunan pasir dan padatan lainnya (API RP 14E). Jika hasil perhitungan kecepatan aliran general BBM dalam pipa melebihi nilai maksimum nya yaitu 4,57 m/s dengan jarak aliran pipa tidak jauh dan nilai *pressure drop* yang tidak signifikan, maka kecepatan aliran BBM tersebut masih dalam kategori *acceptable.*

5. METODE PERHITUNGAN

Metode perhitungan *Hydraulic & Line Sizing* ditentukan dengan merujuk pada diagram alir di bawah ini:



A) Sebelum perhitungan hidrolik, beberapa data perlu dimasukkan, yaitu sifat-sifat fluida, data pipa, panjang pipa, dan elevasi, serta maksimum *destination pressure.* Untuk maksimum *destination pressure* yang diinput yaitu sebesar 1 atm atau 0 kg/cm^{2}g sesuai dengan tekanan di *storage tank*.

B) Selanjutnya, dilakukan perhitungan kecepatan rata-rata aliran fluida, dan hasil perhitungan ini kemudian digunakan untuk menentukan *pressure drop* per 100 m.

C) Hasil dari kedua perhitungan, yaitu kecepatan dan *pressure drop*, kemudian dibandingkan dengan kriteria desain, di mana kecepatan maksimum adalah 4,57 m/s, dan *pressure drop* maksimum per 100 m adalah 0,46 bar. Sementara itu, kecepatan minimum yang diperlukan adalah 0,91 m/s untuk meminimalkan pengendapan pasir dan padatan lainnya (API RP 14E).

D) Jika hasilnya kurang atau melebihi kriteria desain, ukuran pipa harus disesuaikan hingga sesuai dengan kriteria desain. Setelah hasil perhitungan sesuai dengan kriteria desain, nilai dari total *line loss* kemudian dihitung.

E) Hasil perhitungan total *line loss* dapat digunakan untuk melakukan perhitungan desain pompa, termasuk *discharge pressure, suction pressure, differential pressure,* dan *head*.

5.1 KEBUTUHAN DATA UNTUK PERHITUNGAN POMPA

A) Kondisi Operasi:
- Fluid condition
- Pumping temperature
- Vapor pressure at pumping temperature
- Specific gravity
- Viskositas
- Kapasitas

B) Material Pipa

5.2 KECEPATAN RATA-RATA

Kecepatan rata-rata dihitung melalui persamaan berikut:

$$V_l = \frac{0.012 Q_l}{d_1^2} \quad \text{..... (Eq. 5.1)}$$

dimana:

V_l = *Average liquid flow velocity*, ft/s

Q_l = *Liquid flow rate, barrels/day*

d_l = *Pipe inside diameter, inche*

5.3 *PRESSURE DROP*

Pressure drop dihitung dengan persamaan Fanning berikut:

$$\Delta P_l = \frac{0.00115 S_g Q_l^2 f_m}{ID^5} \quad \text{..... (Eq. 5.2)}$$

dimana:

ΔP_l = *Pressure drop*, psi/100 ft

f_m = *Moody friction factor, dimensionless* (*Friction Factor Chart*, figure 2.3 API 14E)

Q_l = *Liquid flow rate, barrels/day*

S_g = *Liquid specific gravity, dimensionless*

ID = *Pipe inside diameter, inches*

Moody *friction factor* dihitung menggunakan pendekatan korelasi Colebrook.

5.4 *DIFFERENTIAL PRESSURE*

Differential pressure dihitung melalui persamaan berikut:

$$\Delta P = Discharge\ Pressure - Suction\ Pressure \quad \text{..... (Eq. 5.3)}$$

dimana:

ΔP = *Differential pressure*, kg/cm^2

5.5 *HEAD*

Head Pompa dihitung melalui persamaan berikut:

$$H = \frac{\Delta P}{(10^3 \times S_g)} \times 10^4 \quad \text{..... (Eq. 5.4)}$$

dimana:

H = *Head*, m

ΔP = *Differential pressure*, kg/cm^2

S_g = *Liquid specific gravity, dimensionless*

5.6 *HYDRAULIC POWER*

Hydraulic power pompa dihitung melalui persamaan berikut:

$$Hydraulic\ Power\ (kW) = \frac{H \times Q \times S_g}{367.2} \quad \text{..... (Eq. 5.5)}$$

dimana:

H = *Head*, m

Q = *Capacity pressure*, m^3/h

S_g = *Liquid specific gravity, dimensionless*

5.7 *NPSHA (NET POSITIVE HEAD AVAILABLE)*

NPSHA pompa dihitung melalui persamaan berikut:

$$NPSHA = \frac{10}{S_g} \times (P - Pv) + Hs - HI - Ha \quad \text{..... (Eq. 5.6)}$$

dimana:

S_g = *Liquid specific gravity, dimensionless*

P = *Drum Pressure*, kg/cm^2

Pv = *Vapor Pressure*, kg/cm^2

Hs = *Net Height*, m

HI = *Line Loss*, m

Ha = *Acceleration Loss, m* (di dalam kasus sentrifugal atau rotary, Ha dapat diabaikan)

5.8 *MAXIMUM SHUT-OFF PRESSURE*

Maximum shut-off pressure pompa dihitung melalui persamaan berikut:

$$\text{Max. Shut Off Press} = Max.Suc.Press + 1{,}2 \times \Delta P \quad \text{..... (Eq. 5.7)}$$

dimana:

ΔP = *Differential pressure,* kg/cm^2

Maximum shut-off pressure pompa harus dikonfirmasi dengan informasi dari pihak vendor.

6. HASIL PERHITUNGAN

6.1 HASIL PERHITUNGAN *LINE SIZING*

Tabel 3 – Hasil Perhitungan *Line Sizing*

No	Line No.	PID No.	Service	Vol Flow, kL/hr	ID, mm	Result		Criteria		Status	Remarks
						Vel, m/s	DP/100m, bar	Vel, m/s	DP/100m, bar		
1	20"-P-A1A-002	723002-CD-000-PRO-PID-003	Pertalite to Storage Tank	2000	488,95	2,959	0,089	4,57	0,460	OK	From Jetty-2, Size is based on ITB
2	20"-PX-A1A-002	723002-CD-000-PRO-PID-003	Pertamax to Storage Tank	2000	488,95	2,959	0,089	4,57	0,460	OK	From Jetty-2, Size is based on ITB
3	20"-S-A1A-002	723002-CD-000-PRO-PID-003	Solar to Storage Tank	2000	488,95	2,959	0,118	4,57	0,460	OK	From Jetty-2, Size is based on ITB
4	10"-K-A1A-002	723002-CD-000-PRO-PID-003	Kerosine to Storage Tank	500	254,51	2,730	0,223	4,57	0,460	OK	From Jetty-2, Optimum Size is based on ITB
5	10"-AV-A1B-002	723002-CD-000-PRO-PID-003	Avtur to Storage Tank	500	254,51	2,730	0,221	3,00	0,460	OK	From Jetty-2, Optimum Size is based on ITB

No	Line No.	PID No.	Service	Flow, kL/hr	ID, mm	Result		Criteria		Status	Remarks
						Vel, m/s	DP/100m, bar	Vel, m/s	DP/100m, bar		
6	6"-BS-A1A-102	723002-CD-000-PRO-PID-003	Bio Solar to Jetty-2	138	154,05	2,057	0,243	4,57	0,460	OK	From Jetty-2, Optimum Size is based on ITB
7	10"-P-A1A-001	723002-CD-000-PRO-PID-002/003	Pertalite to Storage Tank	500	254,51	2,730	0,167	4,57	0,460	OK	From Jetty-1 (TP-005A/B), Optimum Size is based on ITB
8	10"-PX-A1A-001	723002-CD-000-PRO-PID-002/003	Pertamax to Storage Tank	300	254,51	1,638	0,062	4,57	0,460	OK	From Jetty-1 (TP-006A/B), Size is based on ITB
9	10"-S-A1A-001	723002-CD-000-PRO-PID-002/003	Solar to Storage Tank	500	254,51	2,730	0,223	4,57	0,460	OK	From Jetty-1 to solar storage tank (TP-003A/B)
10	10"-K-A1A-001	723002-CD-000-PRO-PID-002/003	Kerosine to Storage Tank	500	254,51	2,730	0,223	4,57	0,460	OK	From Jetty-1 to kerosine storage tank(TP-001A/B)
11	10"-AV-A1B-001	723002-CD-000-PRO-PID-002/003	Avtur to Storage Tank	200	254,51	1,092	0,042	3,00	0,460	OK	From Jetty-1 to avtur storage tank (TP-002A/B)
12	6"-BS-A1A-101	723002-CD-000-PRO-PID-002	Bio Solar to Jetty-1	150	154,05	2,236	0,283	4,57	0,460	OK	To Jetty-1 (TP-004A/B)

No	Line No.	PID No.	Service	Flow, kL/hr	ID, mm	Result		Criteria		Status	Remarks
						Vel, m/s	DP/100m, bar	Vel, m/s	DP/100m, bar		
13	10"-MP-A1A-001	723002-CD-000-PRO-PID-003	Multi Product to Storage Tank	1000	254,51	5,460	0,815	4,57	0,460	Acceptable	From Jetty-2
14	10"-MP-A1A-002	723002-CD-000-PRO-PID-003	Multi Product to Storage Tank	1000	254,51	5,460	0,815	4,57	0,460	Acceptable	From Jetty-2
15	10"-S-A1A-004	723002-CD-000-PRO-PID-002/003	Solar to Jetty-1	300	254,51	1,638	0,087	4,57	0,460	OK	To Jetty-1 (TP-003A/B)
16	10"-PX-A1A-001	723002-CD-000-PRO-PID-002	Pertamax to Jetty-2 header	300	254,51	1,638	0,062	4,57	0,460	OK	from Jetty-1 to Jetty-2 header (TP-006A/B)
17	10"-K-A1A-002	723002-CD-000-PRO-PID-003	Kerosene to Jetty-2	500	254,51	2,730	0,223	4,57	0,460	OK	To Jetty-2
18	20"-S-A1A-002	723002-CD-000-PRO-PID-003	Solar to Storage Jetty-2	2000	488,95	2,959	0,118	4,57	0,460	OK	To Jetty-2
19	20"-P-A1A-002	723002-CD-000-PRO-PID-003	Pertalite to Storage Jetty-2	2000	488,95	2,959	0,089	4,57	0,460	OK	To Jetty-2

No	Line No.	PID No.	Service	Flow, kL/hr	ID, mm	Result		Criteria		Status	Remarks
						Vel, m/s	DP/100m, bar	Vel, m/s	DP/100m, bar		
20	20"-PX-A1A-002	723002-CD-000-PRO-PID-003	Pertamax to Storage Jetty-2	2000	488,95	2,959	0,089	4,57	0,460	OK	To Jetty-2
21	10"-P-A1A-004	723002-CD-000-PRO-PID-003	Pertalite to Jetty 1	300	254,51	1,638	0,062	4,57	0,460	OK	To Jetty-1
22	10"-PX-A1A-004	723002-CD-000-PRO-PID-003	Pertamax to Jetty 1	300	254,51	1,638	0,062	4,57	0,460	OK	To Jetty-1
23	10"-S-A1A-005	723002-CD-000-PRO-PID-003	Solar to Jetty 2 (NNF)	300	254,51	1,638	0,087	4,57	0,460	OK	To Jetty-2
24	10"-P-A1A-005	723002-CD-000-PRO-PID-003	Pertalite to Jetty 2	500	254,51	2,730	0,167	4,57	0,460	OK	To Jetty-2

No	Line No.	PID No.	Service	Flow, kL/hr	ID, mm	Result		Criteria		Status	Remarks
						Vel, m/s	DP/100m, bar	Vel, m/s	DP/100m, bar		
25	10"-PX-A1A-005	723002-CD-000-PRO-PID-003	Pertamax to Jetty 2	500	254,51	2,730	0,167	4,57	0,460	OK	To Jetty-2
26	4"-SW-C1A-102	723002-CD-000-PRO-PID-003	Service water to Jetty-2	65,99	102,26	2,232	0,450	4,57	0,460	OK	To Jetty-2

6.2 HASIL PERHITUNGAN DESAIN *MULTI PRODUCTS STRIPPING PUMP*

Berdasarkan metode perhitungan yang telah dijelaskan sebelumnya, maka didapatkan hasil perhitungan desain *multi products stripping pump* sebagai berikut.

Tabel 4 – Hasil Perhitungan *Multi Product Stripping Pump*

Kondisi Operasi	Data Sheet ITB	Hasil Perhitungan	*Selected Design*
Kapasitas (m^3/h)	10	10	10
Suction Pressure (kg/cm^2g)	0,07	-0,14	-0,14
Discharge Pressure (kg/cm^2g)	5,14	5,12	5,20
Differential Pressure (m)	60	57,5	60
NPSHA (m)	2,9	2,9	2,9

6.3 HASIL PERHITUNGAN DESAIN *AVTUR STRIPPING PUMP*

Berdasarkan metode perhitungan yang telah dijelaskan sebelumnya, maka didapatkan hasil perhitungan desain *avtur stripping pump* sebagai berikut.

Tabel 5 – Hasil Perhitungan *Avtur Stripping Pump*

Kondisi Operasi	Data Sheet ITB	Hasil Perhitungan	*Selected Design*
Kapasitas (m^3/h)	10	10	10
Suction Pressure (kg/cm^2g)	0,07	-0,2	-0,2
Discharge Pressure (kg/cm^2g)	5,14	4,75	4,84
Differential Pressure (m)	60	58,9	60
NPSHA (m)	2,9	9,79	9,79

7. LAMPIRAN – LAMPIRAN

7.1 LAMPIRAN PERHITUNGAN *LINE SIZING*

No.	LINE No.				P&ID No.	SERVICE	FLUID PROPERTIES			PIPE DATA			RESULT		CRITERIA		STATUS	REMARKS
	Size	Serv.	Spec.	Seq.			Vol Flow, kL/hr	rho, kg/m3	visc, cP	rough, micr	SCH	ID, mm	Vel, m/s	ΔP/100m, bar	Vel, m/s	ΔP/100m, bar		
1	20"-	-P-	-A1A-	002	723002-CD-000-PRO-PID-003	Pertalite to Storage Tank	2000	770,000	0,63	50	STD	488,95	2,959	0,089	4,57	0,460	OK	From Jetty-2, Size is based on ITB
	18"-	-P-	-A1A-	002	723002-CD-000-PRO-PID-003	Pertalite to Storage Tank	2000	770,000	0,63	50	STD	438,15	3,685	0,156	4,57	0,460	OK	From Jetty-2, Optimum Size
	16"-	-P-	-A1A-	002	723002-CD-000-PRO-PID-003	Pertalite to Storage Tank	2000	770,000	0,63	50	STD	387,35	4,714	0,292	4,57	0,460	NOT GOOD	From Jetty-2
2	20"-	-PX-	-A1A-	002	723002-CD-000-PRO-PID-003	Pertamax to Storage Tank	2000	770,000	0,63	50	STD	488,95	2,959	0,089	4,57	0,460	OK	From Jetty-2, Size is based on ITB
	18"-	-PX-	-A1A-	002	723002-CD-000-PRO-PID-003	Pertamax to Storage Tank	2000	770,000	0,63	50	STD	438,15	3,685	0,156	4,57	0,460	OK	From Jetty-2, Optimum Size
	16"-	-PX-	-A1A-	002	723002-CD-000-PRO-PID-003	Pertamax to Storage Tank	2000	770,000	0,63	50	STD	387,35	4,714	0,292	4,57	0,460	NOT GOOD	From Jetty-2
3	20"-	-S-	-A1A-	002	723002-CD-000-PRO-PID-003	Solar to Storage Tank	2000	860,000	3,87	50	STD	488,95	2,959	0,118	4,57	0,460	OK	From Jetty-2, Size is based on ITB
	18"-	-S-	-A1A-	002	723002-CD-000-PRO-PID-003	Solar to Storage Tank	2000	860,000	3,87	50	STD	438,15	3,685	0,202	4,57	0,460	OK	From Jetty-2, Optimum Size
	16"-	-S-	-A1A-	002	723002-CD-000-PRO-PID-003	Solar to Storage Tank	2000	860,000	3,87	50	STD	387,35	4,714	0,373	4,57	0,460	NOT GOOD	From Jetty-2
4	10"-	-K-	-A1A-	002	723002-CD-000-PRO-PID-003	Kerosine to Storage Tank	500	860,000	3,87	50	S40	254,51	2,730	0,223	4,57	0,460	OK	From Jetty-2, Optimum Size is based on ITB
	8"-	-K-	-A1A-	002	723002-CD-000-PRO-PID-003	Kerosine to Storage Tank	500	860,000	3,87	50	S40	202,72	4,303	0,686	4,57	0,460	NOT GOOD	From Jetty-2
5	10"-	-AV-	-A1B-	002	723002-CD-000-PRO-PID-003	Avtur to Storage Tank	500	840,000	4,15	50	S40	254,51	2,730	0,221	3,00	0,460	OK	From Jetty-2, Optimum Size is based on ITB
	8"-	-AV-	-A1B-	002	723002-CD-000-PRO-PID-003	Avtur to Storage Tank	500	840,000	4,15	50	S40	202,72	4,303	0,678	3,00	0,460	NOT GOOD	From Jetty-2
6	6"-	-BS-	-A1A-	102	723002-CD-000-PRO-PID-003	Bio Solar to Jetty-2	138	840,000	4,15	50	S40	154,05	2,057	0,243	4,57	0,460	OK	From Jetty-2, Optimum Size is based on ITB
	4"-	-BS-	-A1A-	102	723002-CD-000-PRO-PID-003	Bio Solar to Jetty-2	138	840,000	4,15	50	S40	102,26	4,667	1,824	4,57	0,460	NOT GOOD	To Jetty-2
7	10"-	-P-	-A1A-	001	723002-CD-000-PRO-PID-002/003	Pertalite to Storage Tank	500	770,000	0,63	50	S40	254,51	2,730	0,167	4,57	0,460	OK	From Jetty-1 (TP-005A/B), Optimum Size is based on ITB
	8"-	-P-	-A1A-	001	723002-CD-000-PRO-PID-002	Pertalite to Storage Tank	500	770,000	0,63	50	S40	202,72	4,303	0,532	4,57	0,460	NOT GOOD	From Jetty-1 to Pertalite storage tank(TP-005A/B)
8	10"-	-PX-	-A1A-	001	723002-CD-000-PRO-PID-002/003	Pertamax to Storage Tank	300	770,000	0,63	50	S40	254,51	1,638	0,062	4,57	0,460	OK	From Jetty-1 (TP-006A/B), Size is based on ITB
	8"-	-PX-	-A1A-	001	723002-CD-000-PRO-PID-002	Pertamax to Storage Tank	300	770,000	0,63	50	S40	202,72	2,582	0,197	4,57	0,460	OK	From Jetty-1 (TP-006A/B), Optimum Size
	6"-	-PX-	-A1A-	001	723002-CD-000-PRO-PID-002	Pertamax to Storage Tank	300	770,000	0,63	50	S40	154,05	4,471	0,799	4,57	0,460	NOT GOOD	From Jetty-1 (TP-006A/B)

No	LINE No.	P&ID No.	SERVICE	FLUID PROPERTIES			PIPE DATA			RESULT		CRITERIA		STATUS	REMARKS
				Vol Flow, kL/hr	rho, kg/m3	visc, cP	rough, micr	SCH	ID, mm	Vel, m/s	ΔP/100m, bar	Vel, m/s	ΔP/100m, bar		
9	10"-S-A1A-001	723002-CD-000-PRO-PID-002/003	Solar to Storage Tank	500	860,000	3,87	50	S40	254,51	2,730	0,223	4,57	0,460	OK	From Jetty-1 to solar storage tank (TP-003A/B)
	8"-S-A1A-001	723002-CD-000-PRO-PID-002	Solar to Storage Tank	500	860,000	3,87	50	S40	202,72	4,303	0,686	4,57	0,460	NOT GOOD	From Jetty-1 to solar storage tank (TP-003A/B)
10	10"-K-A1A-001	723002-CD-000-PRO-PID-002/003	Kerosine to Storage Tank	500	860,000	3,87	50	S40	254,51	2,730	0,223	4,57	0,460	OK	From Jetty-1 to kerosine storage tank(TP-001A/B)
	8"-K-A1A-001	723002-CD-000-PRO-PID-002	Kerosine to Storage Tank	500	860,000	3,87	50	S40	202,72	4,303	0,686	4,57	0,460	NOT GOOD	From Jetty-1 to kerosine storage tank(TP-001A/B)
11	10"-AV-A1B-001	723002-CD-000-PRO-PID-002/003	Avtur to Storage Tank	200	840,000	4,15	50	S40	254,51	1,092	0,042	3,00	0,460	OK	From Jetty-1 to avtur storage tank (TP-002A/B)
	8"-AV-A1B-001	723002-CD-000-PRO-PID-002	Avtur to Storage Tank	200	840,000	4,15	50	S40	202,72	1,721	0,125	3,00	0,460	OK	From Jetty-1 to avtur storage tank (TP-002A/B)
	6"-AV-A1B-001	723002-CD-000-PRO-PID-002	Avtur to Storage Tank	200	840,000	4,15	50	S40	154,05	2,981	0,480	3,00	0,460	NOT GOOD	From Jetty-1 to avtur storage tank (TP-002A/B)
12	6"-BS-A1A-101	723002-CD-000-PRO-PID-002	Bio Solar to Jetty-1	150	840,000	4,15	50	S40	154,05	2,236	0,283	4,57	0,460	OK	To Jetty-1 (TP-004A/B)
	4"-BS-A1A-101	723002-CD-000-PRO-PID-002	Bio Solar to Jetty-1	150	840,000	4,15	50	S40	102,26	5,073	2,131	4,57	0,460	NOT GOOD	To Jetty-1 (TP-004A/B)
13	10"-MP-A1A-001	723002-CD-000-PRO-PID-003	Multi Product to Storage Tank	1000	860,000	3,87	50	S40	254,51	5,460	0,815	4,57	0,460	Acceptable	From Jetty-2
	12"-MP-A1A-001	723002-CD-000-PRO-PID-003	Multi Product to Storage Tank	1000	860,000	3,87	50	STD	304,80	3,807	0,333	4,57	0,460	OK	From Jetty-2.
14	10"-MP-A1A-002	723002-CD-000-PRO-PID-003	Multi Product to Storage Tank	1000	860,000	3,87	50	S40	254,51	5,460	0,815	4,57	0,460	Acceptable	From Jetty-2
	12"-MP-A1A-002	723002-CD-000-PRO-PID-003	Multi Product to Storage Tank	1000	860,000	3,87	50	STD	304,80	3,807	0,333	4,57	0,460	OK	From Jetty-2.
15	10"-S-A1A-004	723002-CD-000-PRO-PID-002/003	Solar to Jetty-1	300	860,000	3,87	50	S40	254,51	1,638	0,087	4,57	0,460	OK	To Jetty-1 (TP-003A/B)
	8"-S-A1A-004	723002-CD-000-PRO-PID-002	Solar to Jetty-1	300	860,000	3,87	50	S40	202,72	2,582	0,266	4,57	0,460	OK	To Jetty-1 (TP-003A/B)
	6"-S-A1A-004	723002-CD-000-PRO-PID-002	Solar to Jetty-1	300	860,000	3,87	50	S40	154,05	4,471	1,030	4,57	0,460	NOT GOOD	To Jetty-1 (TP-003A/B)
16	10"-PX-A1A-001	723002-CD-000-PRO-PID-002	Pertamax to Jetty-2 header	300	770,000	0,63	50	S40	254,51	1,638	0,062	4,57	0,460	OK	from Jetty-1 to Jetty-2 header (TP-006A/B)
	8"-PX-A1A-001	723002-CD-000-PRO-PID-002	Pertamax to Jetty-2 header	300	770,000	0,63	50	S40	202,72	2,582	0,197	4,57	0,460	OK	from Jetty-1 to Jetty-2 header (TP-006A/B)
	6"-PX-A1A-001	723002-CD-000-PRO-PID-002	Pertamax to Jetty-2 header	300	770,000	0,63	50	S40	154,05	4,471	0,799	4,57	0,460	NOT GOOD	from Jetty-1 to Jetty-2 header (TP-006A/B)
17	10"-K-A1A-002	723002-CD-000-PRO-PID-003	Kerosene to Jetty-2	500	860,000	3,87	50	S40	254,51	2,730	0,223	4,57	0,460	OK	To Jetty-2
	8"-K-A1A-002	723002-CD-000-PRO-PID-003	Kerosene to Jetty-2	500	860,000	3,87	50	S40	202,72	4,303	0,686	4,57	0,460	NOT GOOD	To Jetty-2
18	20"-S-A1A-002	723002-CD-000-PRO-PID-003	Solar to Storage Jetty-2	2000	860,000	3,87	50	STD	488,95	2,959	0,118	4,57	0,460	OK	To Jetty-2
	18"-S-A1A-002	723002-CD-000-PRO-PID-003	Solar to Storage Jetty-2	2000	860,000	3,87	50	STD	438,15	3,685	0,202	4,57	0,460	OK	To Jetty-2
	16"-S-A1A-002	723002-CD-000-PRO-PID-003	Solar to Storage Jetty-2	2000	860,000	3,87	50	STD	387,35	4,714	0,373	4,57	0,460	NOT GOOD	To Jetty-2

No	LINE No.	P&ID No.	SERVICE	FLUID PROPERTIES			PIPE DATA			RESULT		CRITERIA		STATUS	REMARKS
				Vol Flow, kL/hr	rho, kg/m3	visc, cP	rough, micr	SCH	ID, mm	Vel, m/s	ΔP/100m, bar	Vel, m/s	ΔP/100m, bar		
19	20"-P-A1A-002	723002-CD-000-PRO-PID-003	Pertalite to Storage Jetty-2	2000	770,000	0,63	50	STD	488,95	2,959	0,089	4,57	0,460	OK	To Jetty-2
	18"-P-A1A-002	723002-CD-000-PRO-PID-003	Pertalite to Storage Jetty-2	2000	770,000	0,63	50	STD	438,15	3,685	0,156	4,57	0,460	OK	To Jetty-2
	16"-P-A1A-002	723002-CD-000-PRO-PID-003	Pertalite to Storage Jetty-2	2000	770,000	0,63	50	STD	387,35	4,714	0,292	4,57	0,460	NOT GOOD	To Jetty-2
20	20"-PX-A1A-002	723002-CD-000-PRO-PID-003	Pertamax to Storage Jetty-2	2000	770,000	0,63	50	STD	488,95	2,959	0,089	4,57	0,460	OK	To Jetty-2
	18,0"-PX-A1A-002	723002-CD-000-PRO-PID-003	Pertamax to Storage Jetty-2	2000	770,000	0,63	50	STD	438,15	3,685	0,156	4,57	0,460	OK	To Jetty-2
	16,0"-PX-A1A-002	723002-CD-000-PRO-PID-003	Pertamax to Storage Jetty-2	2000	770,000	0,63	50	STD	387,35	4,714	0,292	4,57	0,460	NOT GOOD	To Jetty-2
21	10"-P-A1A-004	723002-CD-000-PRO-PID-003	Pertalite to Jetty 1	300	770,000	0,63	50	S40	254,51	1,638	0,062	4,57	0,460	OK	To Jetty-1
	8"-P-A1A-004	723002-CD-000-PRO-PID-003	Pertalite to Jetty 1	300	770,000	0,63	50	S40	202,72	2,582	0,197	4,57	0,460	OK	To Jetty-1
	6"-P-A1A-004	723002-CD-000-PRO-PID-003	Pertalite to Jetty 1	300	770,000	0,63	50	S40	154,05	4,471	0,799	4,57	0,460	NOT GOOD	To Jetty-1
22	10"-PX-A1A-004	723002-CD-000-PRO-PID-003	Pertamax to Jetty 1	300	770,000	0,63	50	S40	254,51	1,638	0,062	4,57	0,460	OK	To Jetty-1
	8"-PX-A1A-004	723002-CD-000-PRO-PID-003	Pertamax to Jetty 1	300	770,000	0,63	50	S40	202,72	2,582	0,197	4,57	0,460	OK	To Jetty-1
	6"-PX-A1A-004	723002-CD-000-PRO-PID-003	Pertamax to Jetty 1	300	770,000	0,63	50	S40	154,05	4,471	0,799	4,57	0,460	NOT GOOD	To Jetty-1
23	10"-S-A1A-005	723002-CD-000-PRO-PID-003	Solar to Jetty 2 (NNF)	300	860,000	3,87	50	S40	254,51	1,638	0,087	4,57	0,460	OK	To Jetty-2
	8"-S-A1A-005	723002-CD-000-PRO-PID-003	Solar to Jetty 2 (NNF)	300	860,000	3,87	50	S40	202,72	2,582	0,266	4,57	0,460	OK	To Jetty-2
	6"-S-A1A-005	723002-CD-000-PRO-PID-003	Solar to Jetty 2 (NNF)	300	860,000	3,87	50	S40	154,05	4,471	1,030	4,57	0,460	NOT GOOD	To Jetty-2
24	10"-P-A1A-005	723002-CD-000-PRO-PID-003	Pertalite to Jetty 2	500	770,000	0,63	50	S40	254,51	2,730	0,167	4,57	0,460	OK	To Jetty-2
	8"-P-A1A-005	723002-CD-000-PRO-PID-003	Pertalite to Jetty 2	500	770,000	0,63	50	S40	202,72	4,303	0,532	4,57	0,460	NOT GOOD	To Jetty-2
25	10"-PX-A1A-005	723002-CD-000-PRO-PID-003	Pertamax to Jetty 2	500	770,000	0,63	50	S40	254,51	2,730	0,167	4,57	0,460	OK	To Jetty-2
	8"-PX-A1A-005	723002-CD-000-PRO-PID-003	Pertamax to Jetty 2	500	770,000	0,63	50	S40	202,72	4,303	0,532	4,57	0,460	NOT GOOD	To Jetty-2
26	4"-SW-C1A-102	723002-CD-000-PRO-PID-003	Service water to Jetty-2	65,99	996,000	1,00	50	S40	102,26	2,232	0,450	4,57	0,460	OK	To Jetty-2
	3,0"-SW-C1A-102	723002-CD-000-PRO-PID-003	Service water to Jetty-2	65,99	996,000	1,00	50	S40	77,93	3,843	1,791	4,57	0,460	NOT GOOD	To Jetty-2

7.2 PERHITUNGAN *MULTI PRODUCTS STRIPPING PUMP*

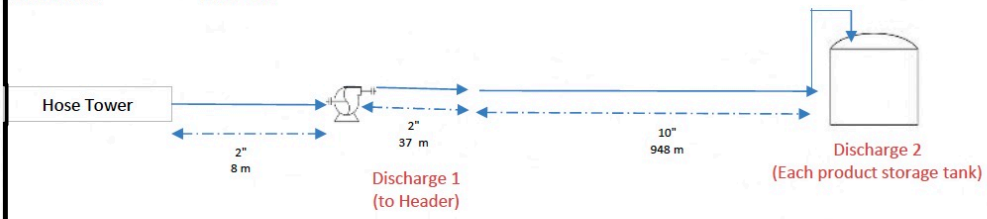
PUMP HYDRAULIC CALCULATION

CLIENT	:	PT. PERTAMINA PATRA NIAGA
PROJECT	:	PEMBANGUNAN DERMAGA KAPASITAS 50.000 DWT FUEL TERMINAL BIAK
LOCATION	:	BIAK NUMFOR, PAPUA
DOC. NO.	:	-

P&ID No.	Item No.	Service	REV
BIAK-PID-10-003-A3	P-33	Multi Product Stripping Pump	0

Suction (Lig. Level)
Max. Elev. mm 17.400 mm
Min. Elev. mm 1.700 mm

Discharge (Elev. mm)
40.000 mm



Height Skirt/Saddle	0 mm	Pump type	Positive Displacement Pump
Pedestal	0 mm		
Pump Nozzle Elev.			
Foundation Height	300 mm		
From Base Plate to Center Line			
Suction	250 mm		
Discharge	600 mm		

OPERATING CONDITIONS			SUCTION CONDITIONS		min	max
Fluid Name		Gasoline	Line Size	NPS	50,0	50,0
Fluid condition (Boiling/non boiling)		non boiling	Velocity	m/s	1,46	1,46
Temp	C	30	Actual Length	m	10,7	10,7
SGr.		0,890	Equiv. Length Total	m	11,9	11,9
Vap. Press Max	kgf/cm^{2}A	0,630	Friction Loss	Kgf/cm^2/100m	0,600	0,600
Vis. Nor. Max	cP	4,95	Tank Press. Norm/Min	Kgf/cm^{2}G	0,000	0,000
Cap. Nor	m3/h	10,00	Static Head	Kgf/cm^2	0,102	1,500
Cap. Design	m3/h	10,00	Line Loss	Kgf/cm^2	0,136	0,136
			Velocity head loss	Kgf/cm^2	0,009	0,009
			Other Loss	Kgf/cm^2 (Note 1)	0,100	0,100
			Suc. Press	Kgf/cm^{2}G	-0,143	1,255

DISCHARGE CONDITIONS		Disch. 1	Disch. 2
Line Size	mm	50,0	250,0
Velocity	m/s	1,46	0,11
Actual Length	m	48	1185
Equiv. Length Total	m	32,5	8,4
Friction Loss	Kgf/cm^2/100m	0,600	0,001
Pressure Loss			
a. Line	Kgf/cm^2	0,493	
b. Orifice/FE	Kgf/cm^2	0,000	
c. Exchanger	Kgf/cm^2	0,000	
d. other loss	Kgf/cm^2	1,000	
Control Valve	Kgf/cm^2	0,000	
Max. Desti. Press.	Kgf/cm^{2}G	0,000	
Static head	Kgf/cm^{2}G	3,480	
Disch. Press.	Kgf/cm^{2}G	4,973	

NET POSITIVE SUCTION HEAD		
Min Suc. Pressure	Kgf/cm^{2}G	-0,143
Vap. Pres.	Kgf/cm^{2}G	-0,404
Net	Kgf/cm^2	0,261
NPSHA	m	**2,93**
Selec. NPSHA	m	**2,93**

DIFFERENTIAL PRESSURE		
Disch. Pressure	Kgf/cm^{2}G	4,973
Suc. Pressure	Kgf/cm^{2}G	-0,143
Diff. Pressure	Kgf/cm^2	5,116
Head	m	**57,5**

MAX. SHUT OFF PRESSURE			
Max. Suc. Tank Press.		Kgf/cm^{2}G	0,000
Max. Liq. Static. Press.		Kgf/cm^2	1,500
Max. Suc. Pressure		Kgf/cm^{2}G	1,255
Shut. Off Press.	=	Max. Suc. P + 1.2 x Diff. P.	
	=	Kgf/cm^{2}G	**7,4** (Note 3)

Logic
suction velocity OK
discharge velocity OK

HYDRAULIC POWER				
HHP	kW	**1,39**	eff. (%)	100 (Note 2)

PUMP HYDRAULIC CALCULATION

EQUIVALENT LENGTH CALCULATION

Suction

Suction's fittings	Suction Qty	Suction Eq. Length, m
90 deg ELL long rad.	4	3,7
hard T (flow turns)	1	3,0
gate valve	1	0,6
soft T (flow straight)	2	1,8
globe valve	0	0,0
angle valve	0	0,0
swing check valve	0	0,0
plug valve	0	0,0
ball valve	0	0,0
		9,1

Discharge

Discharge's fittings	Discharge 1 Qty	Discharge 1 Eq. Length, m	Discharge 2 Qty	Discharge 2 Eq. Length, m
90 deg ELL long rad.	10	9,1	5	4,6
swing check valve	2	10,4	0	0,0
gate valve	1	0,6	2	1,2
hard T (flow turns)	1	3,0	0	0,0
soft T (flow straight)	2	1,8	1	0,9
ball valve	0	0,0	0	0,0
ball check valve	0	0,0	0	0,0
sudden enlargement d/D = 1/4	0	0,0	0	0,0
Inlet nozzle tank	0	0,0	0	0,0
		25,0		6,7

PRESSURE DROP PER 100 m CALCULATION

Suction

	Suct	
Line Class	sch80	
Nominal Size (mm)	50,0	2
SG	0,890	
Viscosity (cP)	4,95	
Flow (m3/hr)	10,00	
Flow (kg/hr)	8.900	
Line Length (m)	8	
Roughness	0,05	
ID (mm)	49,25	
Velocity (m/s)	1,46	
Max velocity (m/s)	2,5	OK
Re	12918	turbulent
f	0,0306	
Pressure Drop/100 m (kg/cm2)	0,6000	
Act. Length + 30 % margin (m)	10,71	
Equiv.Length + 30 % margin (m)	11,887	
Line Loss (kg/cm2)	0,136	
Total line loss (kg/cm2)	0,136	

***f* calculation**

	Darcy
f1	0,005
f2	0,039378
f3	0,029688
f4	0,030709
f5	0,030582
f6	0,030598
f7	0,030596

Discharge

Line Class	sch80		Line Class	STD	
Nominal Size (mm)	50,0	2	Nominal Size (mm)	250,0	10
SG	0,890		SG	0,890	
Viscosity (cP)	4,950		Viscosity (cP)	4,950	
Flow (m3/hr)	10,00		Flow (m3/hr)	20,00	
Flow (kg/hr)	8.900		Flow (kg/hr)	17.800	
Line Length (m)	37		Line Length (m)	948	
Roughness	0,05		Roughness	0,05	
ID (mm)	49,25		ID (mm)	254,50	
Velocity (m/s)	1,46		Velocity (m/s)	0,11	
Max velocity (m/s)	3	OK	Max velocity (m/s)	3	OK
Re	12918	turbulent	Re	5000	turbulent
f	0,0306		f	0,0376	
Pressure Drop/100 m (kg/cm2)	0,6000		Pressure Drop/100 m (kg/cm	0,0008	
Act. Length +30 % margin (m)	48		Act. Length +25 % margin	1185	
Equiv.Length + 30 % margin (m)	32,492		Equiv.Length + 25% margin	8,382	
Line Loss (kg/cm2)	0,483		Line Loss (kg/cm2)	0,010	
Total line loss (kg/cm2)	0,483		Total line loss (kg/cm2)	0,010	

***f* calculation**

	Darcy		Darcy
f1	0,005	*f1*	0,005
f2	0,039378	*f2*	0,054309
f3	0,029688	*f3*	0,035435
f4	0,030709	*f4*	0,037985
f5	0,030582	*f5*	0,037551
f6	0,030598	*f6*	0,037623
f7	0,030596	*f7*	0,037611

Note

1. Other loss takes unknown losses into account.
2. Hydraulic Horser Power is preliminary estimated using efficiency 100%, however it should be determined by Pump manufacture.
3. Shut-off pressure is preliminary estimated according to API 610, however actual shut-off pressure to be determined by Pump manufacture.

7.3 PERHITUNGAN *AVTUR STRIPPING PUMP*

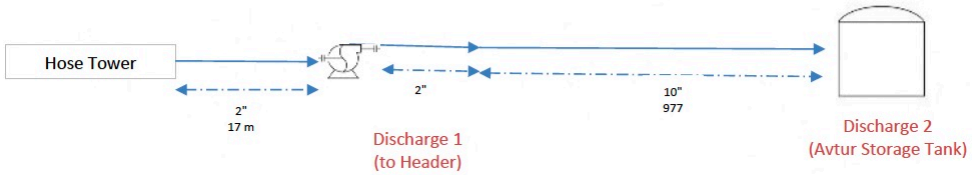
PUMP HYDRAULIC CALCULATION

CLIENT : PT. PERTAMINA PATRA NIAGA
PROJECT : PEMBANGUNAN DERMAGA KAPASITAS 50.000 DWT FUEL TERMINAL BIAK
LOCATION : BIAK NUMFOR, PAPUA
DOC. NO. : -

P&ID No.	Item No.	Service	REV
BIAK-PID-10-003-A3	P-34	Avtur Stripping Pump	0

Suction (Liq. Level)
Max. Elev. mm 17.400 mm
Min. Elev. mm 1.700 mm

Discharge (Elev. mm)
40.000 mm



Height Skirt/Saddle	0 mm	Pump type	Positive Displacement Pump
Pedestal	0 mm		
Pump Nozzle Elev.			
Foundation Height	300 mm		
From Base Plate to Center Line			
Suction	250 mm		
Discharge	600 mm		

OPERATING CONDITIONS			SUCTION CONDITIONS		min	max
Fluid Name		Avtur	Line Size	NPS	50,0	50,0
Fluid condition (Boiling/non boiling)		non boiling	Velocity	m/s	1,46	1,46
Temp	C	30	Actual Length	m	22,2	22,2
SGr.		0,840	Equiv. Length Total	m	11,9	11,9
Vap. Press Max	kgf/cm^{2}A	0,010	Friction Loss	Kgf/cm^2/100m	0,552	0,552
Vis. Nor. Max	cP	4,15	Tank Press. Norm/Min	Kgf/cm^{2}G	0,000	0,000
Cap. Nor	m3/h	10,00	Static Head	Kgf/cm^2	0,097	1,415
Cap. Design	m3/h	10,00	Line Loss	Kgf/cm^2	0,188	0,188
			Velocity head loss	Kgf/cm^2	0,009	0,009
			Other Loss	Kgf/cm^2 (Note 1)	0,100	0,100
			Suc. Press	Kgf/cm^{2}G	-0,201	1,118

DISCHARGE CONDITIONS		Disch. 1	Disch. 2
Line Size	mm	50,0	250,0
Velocity	m/s	1,46	0,11
Actual Length	m	50	1221
Equiv. Length Total	m	32,5	8,4
Friction Loss	Kgf/cm^2	0,552	0,001
Pressure Loss			
a. Line	Kgf/cm^2	0,464	
b. Orifice/FE	Kgf/cm^2	0,000	
c. Exchanger	Kgf/cm^2	0,000	
d. other loss	Kgf/cm^2	1,000	
Control Valve	Kgf/cm^2	0,000	
Max. Desti. Press.	Kgf/cm^{2}G	0,000	
Static head	Kgf/cm^{2}G	3,284	
Disch. Press.	Kgf/cm^{2}G	4,748	

NET POSITIVE SUCTION HEAD		
Min Suc. Pressure	Kgf/cm^{2}G	-0,201
Vap. Pres.	Kgf/cm^{2}G	-1,024
Net	Kgf/cm^2	0,823
NPSHA	m	**9,79**
Selec. NPSHA	m	**9,79**

DIFFERENTIAL PRESSURE		
Disch. Pressure	Kgf/cm^{2}G	4,839
Suc. Pressure	Kgf/cm^{2}G	-0,201
Diff. Pressure	Kgf/cm^2	5,040
Head	m	**60,0**

MAX. SHUT OFF PRESSURE			
Max. Suc. Tank Press.		Kgf/cm^{2}G	0,000
Max. Liq. Static. Press.		Kgf/cm^2	1,415
Max. Suc. Pressure		Kgf/cm^{2}G	1,118
Shut. Off Press.	=	Max. Suc. P + 1.2 x Diff. P.	
	=	Kgf/cm^{2}G	**7,2** (Note 3)

Logic
suction velocity **OK**
discharge velocity **OK**

HYDRAULIC POWER				
HHP	kW	**1,37**	eff. (%)	100 (Note 2)

PUMP HYDRAULIC CALCULATION

EQUIVALENT LENGTH CALCULATION

Suction

Suction's fittings	Suction Qty	Suction Eq. Length, m
90 deg ELL long rad.	4	3,7
hard T (flow turns)	1	3,0
gate valve	1	0,6
soft T (flow straight)	2	1,8
globe valve	0	0,0
angle valve	0	0,0
swing check valve	0	0,0
plug valve	0	0,0
ball valve	0	0,0
		9,1

Discharge

Discharge's fittings	Discharge 1 Qty	Discharge 1 Eq. Length, m	Discharge 2 Qty	Discharge 2 Eq. Length, m
90 deg ELL long rad.	10	9,1	5	4,6
swing check valve	2	10,4	0	0,0
gate valve	1	0,6	2	1,2
hard T (flow turns)	1	3,0	0	0,0
soft T (flow straight)	2	1,8	1	0,9
ball valve	0	0,0	0	0,0
ball check valve	0	0,0	0	0,0
sudden enlargement d/D = 1/4	0	0,0	0	0,0
Inlet nozzle tank	0	0,0	0	0,0
		25,0		6,7

PRESSURE DROP PER 100 m CALCULATION

Suction

	Suct	
Line Class	sch80	
Nominal Size (mm)	50,0	2
SG	0,840	
Viscosity (cP)	4,15	
Flow (m3/hr)	10,00	
Flow (kg/hr)	8.400	
Line Length (m)	17	
Roughness	0,05	
ID (mm)	49,25	
Velocity (m/s)	1,46	
Max velocity (m/s)	2,5	OK
Re	14543	turbulent
f	0,0298	
Pressure Drop/100 m (kg/cm2)	0,5521	
Act. Length + 30 % margin (m)	22,24	
Equiv.Length + 30 % margin (m)	11,887	
Line Loss (kg/cm2)	0,188	
Total line loss (kg/cm2)	0,188	

***f* calculation**

	Darcy
f1	0,005
f2	0,037963
f3	0,029013
f4	0,029928
f5	0,029819
f6	0,029832
f7	0,029830

Discharge

Line Class	sch80		Line Class	STD	
Nominal Size (mm)	50,0	2	Nominal Size (mm)	250,0	10
SG	0,840		SG	0,840	
Viscosity (cP)	4,150		Viscosity (cP)	4,150	
Flow (m3/hr)	10,00		Flow (m3/hr)	20,00	
Flow (kg/hr)	8.400		Flow (kg/hr)	16.800	
Line Length (m)	38		Line Length (m)	977	
Roughness	0,05		Roughness	0,05	
ID (mm)	49,25		ID (mm)	254,50	
Velocity (m/s)	1,46		Velocity (m/s)	0,11	
Max velocity (m/s)	3	OK	Max velocity (m/s)	3	OK
Re	14543	turbulent	Re	5629	turbulent
f	0,0298		f	0,0364	
Pressure Drop/100 m (kg/cm2)	0,5521		Pressure Drop/100 m (kg/cm	0,0007	
Act. Length +30 % margin (m)	50		Act. Length +25 % margin	1221	
Equiv.Length + 30 % margin (m)	32,492		Equiv.Length + 25% margin	8,382	
Line Loss (kg/cm2)	0,455		Line Loss (kg/cm2)	0,009	
Total line loss (kg/cm2)	0,455		Total line loss (kg/cm2)	0,009	

***f* calculation**

	Darcy	Darcy
f1	0,005	0,005
f2	0,037963	0,051814
f3	0,029013	0,034387
f4	0,029928	0,036715
f5	0,029819	0,036327
f6	0,029832	0,036389
f7	0,029830	0,036379

Note

1. Other loss takes unknown losses into account.
2. Hydraulic Horser Power is preliminary estimated using efficiency 100%, however it should be determined by Pump manufacture.
3. Shut-off pressure is preliminary estimated according to API 610, however actual shut-off pressure to be determined by Pump manufacture.