PETROPERU

Talara Refinery Modernization Project

TECNICAS REUNIDAS

PROJECT NO.: 02070

SITE INFORMATION & UTILITIES MAIN CONDITIONS

PETROPERU — Consorcio PMC Talara CPT

PROYECTO DE MODERNIZACIÓN REFINERÍA TALARA

CALIFICACIÓN DEL DOCUMENTO:

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- ☐ 2. APROBADO CON COMENTARIOS
- ☐ 3. NO APROBADO
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NOMBRE Lina Reyes / Francisco España CARGO Ingenieros de Procesos FIRMA	NOMBRE Ángel Rodríguez CARGO Gerente de Ingeniería FIRMA

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DOCUMENT TITLE

SITE INFORMATION & UTILITIES MAIN CONDITIONS

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1. SITE INFORMATION

Site information has been mainly taken from Section 4 of the Environmental Impact Study for the Talara Refinery Modernization (dated on 2009 December), as prepared by Walsh Peru SA for PETROPERU. In case you need more details from those presented here, please consult the above referred document.

1.1 GEOGRAPHIC LOCATION

City of Talara is located by the sea in the far northern department of Piura in northern Peru, at Lat. -4.58 And Long. -81.28.

Geographic location of the meteorology stations near Talara are shown on table 1.1

Table 1.1 Meteorology stations near Talara

Estación	Coordenadas UTM WGS 84		Altitud msnm
	Este	Norte	
El Alto operada por SENAMHI	475,956	9,528,393	311
CORPAC de Talara	450,111	9,452,845	90
Refinería Talara	453,804	9,456,532	50

Source: *Talara Refinery Modernization Environmental Impact Study, Dec. 2009, Walsh sect. 4.1.1.2*

SENAMHI station, named EL ALTO, is located in the district EL ALTO, province of Talara, department of Piura; and CORPAC station is situated in the district of Pariñas, province of Talara, department of Piura.

1.2 ATMOSPHERIC PRESSURE

Table 1.2 presents the average monthly distribution of atmospheric pressure in the period 2003 to 2006 in Talara. It shows that the highest values occur in the months of July, August and September, while the lowest occur in the summer, with its minimum of 1,006 hPa (hectopascal) in March.

Table 1.2 Atmospheric pressure (hPa) monthly variations in Talara (1)

Mes	Ene.	Feb.	Mar.	Abr.	May.	Jun.	Jul.	Ago.	Set.	Oct.	Nov.	Dic.	Anual
Presión (hPa)	1,008	1,007	1,006	1,008	1,008	1,009	1,010	1,010	1,010	1,009	1,008	1,007	**1,008**

Fuente: Petroperú, Refinería Talara (2003 – 2005).
Note 1: *For design atmospheric pressure conditions see item 1.8. Environmental Conditions*
Source: *Talara Refinery Modernization Environmental Impact Study, Dec. 2009, Walsh sect 4.1.1.2.*

1.3 TEMPERATURES

Table 1.3 presents the average monthly variation of air temperature in the period from 1950 to 2006; such information was measured at the CORPAC station in Talara and shows that the month of March is the hottest month in Talara.

Table 1.3 Air temperature monthly variation (º C) in Talara (1)

Mes	Ene.	Feb.	Mar.	Abr.	May.	Jun.	Jul.	Ago.	Set.	Oct.	Nov.	Dic.	Anual
T. Max.	30.1	31.5	31.9	30.2	28.1	26.9	25.1	25	25.2	25.3	27.0	29.0	27.9
T. Min.	20.1	22	23.0	20.2	19.7	17.1	16.1	15.6	15.7	15.8	17.0	18.9	18.4

Fuente: SENAMHI y Aeropuerto de Talara operada por CORPAC.
Período: 1950- 2006
Note 1: *For design temperatures conditions see item 1.8. Environmental Conditions*
Source: *Talara Refinery Modernization Environmental Impact Study, Dec. 2009, Walsh, sect. 4.1.1.2*

1.4 RELATIVE HUMIDITY

This parameter varies around 77% the most part of the year. Table 1.4 shows the average monthly variation of the relative humidity recorded in Talara, in the period 2003 to 2005.

Table 1.4 Relative humidity monthly variation in Talara (1)

Mes	E	F	M	A	M	J	J	A	S	O	N	D	Prom. Anual
H.R. (%)	77	79	76	69	77	77	84	90	92	88	80	81	81
H.R. Min (%)	56	57	54	51	56	59	66	70	74	69	64	66	62
H.R. Max (%)	86	89	89	81	84	87	94	98	98	96	87	96	90

Fuente: Petroperú, Refinería Talara (2003 – 2005). H.R.; Humedad relativa media mensual H.R. Min: Humedad relativa mínima media mensual H.R. Max: Humedad relativa máxima media mensual
Note 1: *For design relative humidity conditions see item 1.8. Environmental Conditions*
Source: *Talara Refinery Modernization Environmental Impact Study, Dec. 2009, Walsh, sect. 4.1.1.2*

1.5 WIND

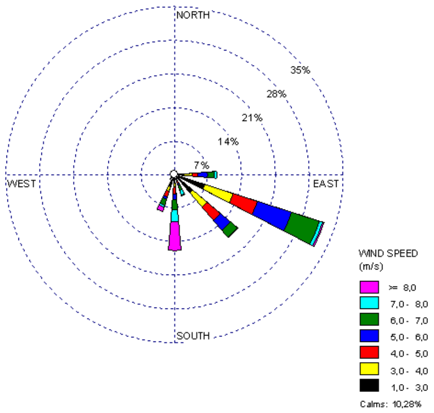
Peruvian E.020 National Code "Loads" specifies a design speed of wind in Talara, up to 10 m above ground and for a return period of 50 years:
80 km/h, what is equivalent to 22.22 m/s, according to the wind map of Peru included in the Annex 2 of the E.020 Code.

This is the basic value for calculations of wind pressure forces acting on Equipment and Structures up to 10 m above ground. For higher heights, as Peruvian E.020 National Code Loads indicates, the value for calculations of wind pressure forces will depends on the design speed of wind at height h>10 m, $Vh = V (h/10)^{0.22}$ (being V = 80 Km/h). Note that for the structures not included in the table 4 of the Peruvian E.020 code, there will be used wind forces calculated as per American ASCE code, according to the document 02070-

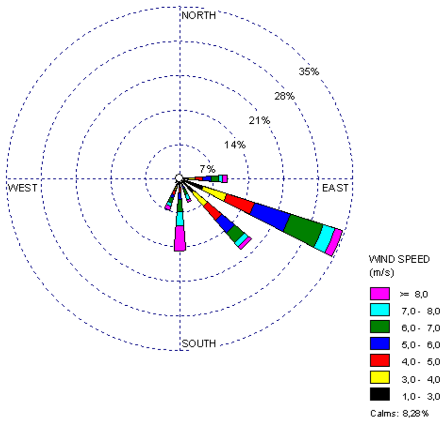
GEN-CIV-001, point 7.4. For slender structures the wind loads from chapter 12.4 will be multiplied by 1.2 according to the 12.2 chapter (Type 2 building), Peruvian Code E.020.

Figure 1.5 shows the seasonal behavior of the winds in the area of the Talara Refinery. In summer, the prevailing wind directions are: ESE (wind speed 6-7 m/s), SE, W, E, SSW. In autumn, the predominant wind directions are: ESE (wind speed greater than 8 m/s), SE, W, SSE, E, SSW. In winter, the predominant wind directions are: ESE (wind speed greater than 8 m/s), SSE, S, SSE, E and during spring, predominant winds are ESE direction (wind speed greater than 8 m/s), SSE, S, SSE.

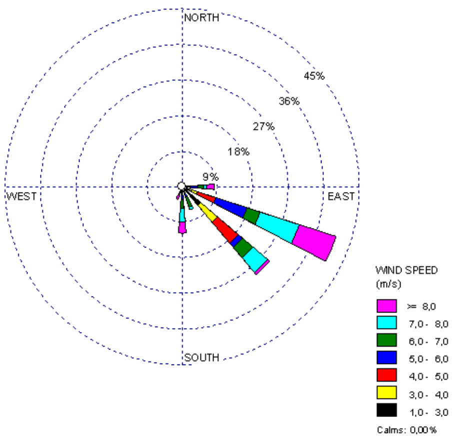
Figure 1.5 Wind Rose in the Talara Refinery Station



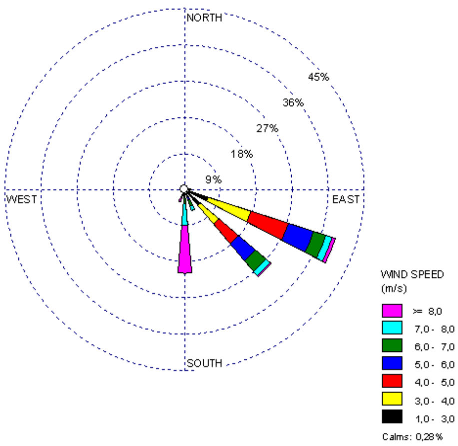
Wind Rose – Refinery Talara
Summer



Wind Rose – Refinery Talara
Autumn



Wind Rose – Refinery Talara
Winter



Wind Rose – Refinery Talara
Spring

Note:
Extracted from Talara Refinery Modernization Environmental Impact Study - Walsh Sect. 4.1.1.2

1.6 RAINFALL

In the period 1969-2006 at Station CORPAC of Talara, the values of average annual precipitation or "normal" have been 124.8 mm, with high records of 983 mm (7.9 times the normal value) occurred in 1983, and 1154 mm (9.2 times the normal value) happened in 1998, which took place precisely during “El Niño” events. See Table 1.6-1.

SENAMHI data for the Weather Stations “El Alto” and “La Esperanza” are shown in Annex A.

Table 1.6-1 Values of annual rainfall

Precipitación anual en Talara (P)	
Año	**P (mm)**
1969	0.0
1970	10.0
1971	3.7
1972	133.6
1973	44.0
1974	2.5
1975	136.8
1976	44.7
1977	74.8
1978	0.0
1979	0.0
1980	5.0
1981	58.7
1982	37.3
1983	983.0
1984	0.0
1985	89.5
1986	10.0
1987	303.2
1988	0.0
1989	120.8
1990	0.0
1991	0.5
1992	27.5
1993	8,0
1994	108.0
1995	0.2
1996	30.8
1997	269.0
1998	1,154.0
1999	134.3
2000	66.0

Precipitación anual en Talara (P)	
Año	**P (mm)**
2001	369.9
2002	318.0
2003	29,8
2004	36.5
2005	44.1
2006	89.6
Promedio	**124.8**
Max	**1,154.0**
Min	**0.0**

Fuente: Estación CORPAC Talara
Periodo: 1969-2006
Source: *Talara Refinery Modernization Environmental Impact Study, Dec. 2009, Walsh, sect. 4.1.1.2*

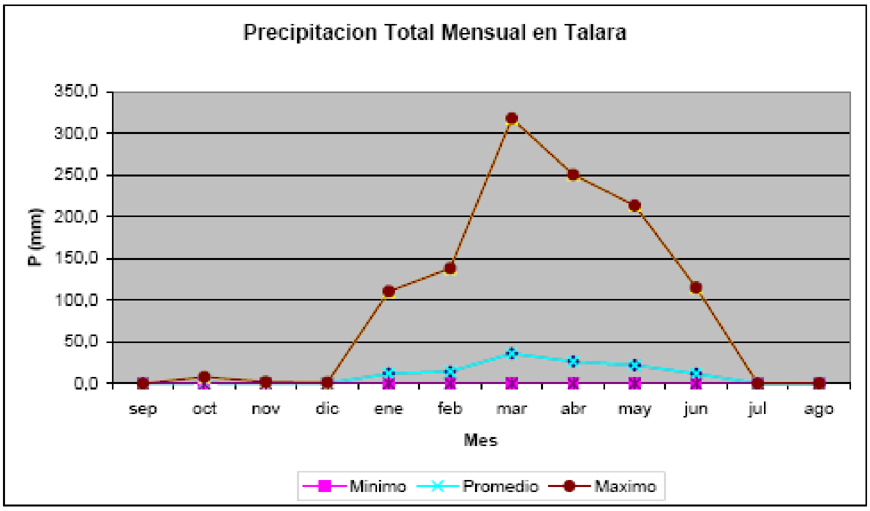
In relation to seasonal rainfall, the months of highest rainfall are February, March, April and May with 79.8% of the total precipitation per year, while the lowest rainfall occur during the months of August, September, October, November and December, with 0.8% of the annual total value, The other months are transitional between these two previous periods. See Table 1.6-2 and Figure 1.6.

Table 1.6-2 Monthly rainfall (mm) in Talara

Meses	Sep.	Oct.	Nov.	Dic.	Ene.	Feb.	Mar.	Abr.	May.	Jun.	Jul.	Ago.
Prom	0.0	0.7	0.2	0.1	12.2	14.6	36.1	26.5	22.1	12.0	0.0	0.0
Min	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Máx.	0.0	8.0	2.0	1.3	110.6	138.3	318.2	250.8	213.7	115.3	0.2	0.3

Fuente: CORPAC
Periodo: 1969-2006
Source: *Talara Refinery Modernization Environmental Impact Study, 2009 Dec, Walsh, sect. 4.1.1.2*

Figure 1.6 Monthly rainfall in the period 1969-2006 Talara



Fuente: Elaboración propia con datos de precipitación mensual en Talara operada por CORPAC
Período: 1969-2006
Source: *Talara Refinery Modernization Environmental Impact Study, Dec. 2009, Walsh, sect. 4.1.1.2*

Based on data received from SENAMHI underground sewer water systems are developed considering the following values:

During Normal Rainfall Season (without "El Niño"):
Maximum rainfall per hour: 72 mm/h

During "El Niño":
During first 30 minutes: 50mm
During first hour: 120 mm
During first 24 hours: 220 mm

Above information according to 02070-GEN-CIV-DBD-450.

1.7 SEISMICITY

The western edge of South America is a typical region of collision of tectonic plates, which are characterized by high activity from the seismological point of view. The Peruvian territory includes part of it, being more frequent seismic activity associated with subduction of the Nazca oceanic plate, which is subducted beneath the South American continental plate, generating high-magnitude earthquakes at different depths. A second kind of seismic activity is produced by cortical breaks that occur along faults in the Andean mountains, but they generate earthquakes of lesser magnitude and frequency.

The South American plate, originated in the Atlantic mid-ocean chain, is moving westward at an average speed of 2 centimeters per year and meets on its western bank with the Nazca plate. On the other hand, the Nazca plate is originated in the meso-eastern Pacific Ocean chain, moving towards the East with an average speed of 8 cm per year, subducting the South American plate at a rate of convergence of about 10 centimeters per year. The collision of these plates results in cortical intense friction contact zone (Benioff plane) with steady accumulation of energy, which is then released by earthquakes. These are generally much more violent as they are in shallower origin.

As the regional seismic activity is mainly related to cortical friction caused by the subduction process above mentioned, it turns out that there are more intense earthquakes on the coast, decreasing gradually towards the mountains and jungle regions where subduction and cortical friction become increasingly profound. Remote areas of eastern suffer few seismic events, precisely because of the great depth at which you can find the subduction plane in this region, compared to what happens on the coast.

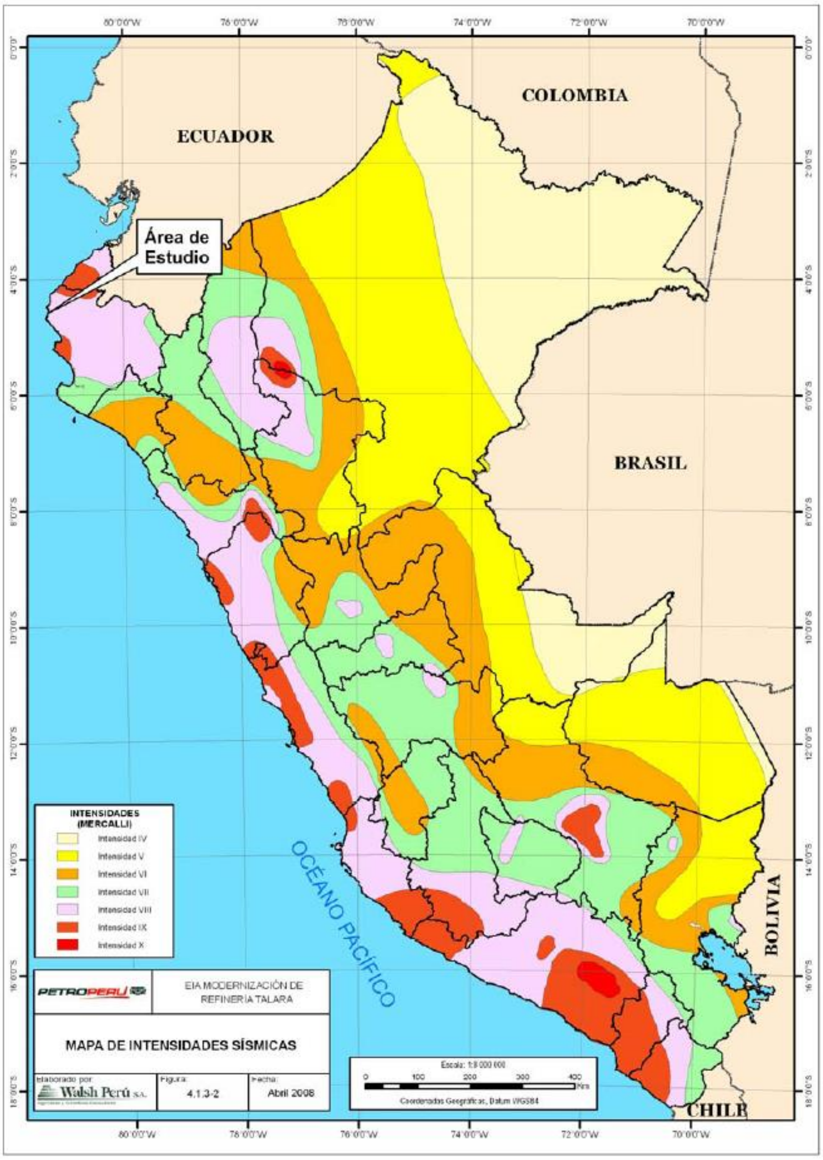
According to the National Civil Defense Institute (INDECI), the assessment area is located in an area of intensity VIII on the Earthquake Intensity Map, which is based on the Modified Mercalli Scale (Figure 1.7). Consequently, it is located in an area of high seismic risk, both by the frequency of movements, its intensity, and because their "hypocenter" are located at shallow depth in the crust.

Peruvian E.030 National Code “Earthquake-resistant Design” specifies basic parameters for earthquake loads in Talara, which is located in the Zone 3, exposed to the strongest seismic loads in the national territory - according to the Figure 1 and the Annex 1 of the E.030 Code. For each zone there is assigned a Z factor as indicated in Table 1 of the Code.

This factor is interpreted as the peak ground acceleration with a 10% chance of being exceeded in 50 years. For the Zone 3 the value of the Z factor is 0.4. This is the basic value for calculations of earthquake forces acting on Structures and Equipment. The other coefficients necessary for seismic design, depending mainly on type of structure and the particular characteristics of soil, are defined in the E.030 Code.

More details about the seismic loads, including seismic spectrum etc, are included in 02070-GEN-CIV-DBD-001.

Figure 1.7 Map of Seismic Intensity



Note:
Taken from Talara Refinery Modernization Environmental Impact Study - Walsh - Section 4.1.3.5

1.8 ENVIRONMENTAL CONDITIONS

Below it can be seen the environmental conditions considered in the basic designs:

Dry Bulb Temperature, ºC (ºF)	32.2 (90)
Maximum Temperature, ºC (ºF)	36.1 (97)
Maximum Design Temperature, ºC (ºF)	32.2 (90)
Minimum Temperature, ºC (ºF)	12.8 (55)
Cooling Temperature , ºC (ºF)	12.8 (55)
Minimum Design Temperature, ºC (ºF)	12.8 (55)

Relative Humidity, %	Average: 80
	Maximum: 90
	Design: 85
Barometric Pressure, mbar	Minimum: 1011
	Maximum: 1014
	Average: 1012

Source: *"Preliminary Process Design Questionnaire. FEED-EPC Contractor. Talara Refinery Modernization Project, July, 2010."*

1.9 SOIL DATA

The soils in the area of indirect influence of the Talara Refinery Modernization Project are located in landscapes of plains and hills, mainly giving rise to soils of marine and residual origin.

The potential for land use is established under the Rules of Land Classification for Increased Usability by the Ministry of Agriculture (DS N º 062-75-AG), with additions made by ONERN (1980).

From the standpoint of lithology, soils of the study area are of marine, "colluvio-alluvial" and residual origin. Marine soils are products of the sedimentation of materials that came to the marine environment and its subsequent exposure by lifting the seabed; the "colluvio-alluvial" soils are the product of the deposition of materials carried by water currents, low-mileage, and the sloped ground, forming "colluvio-alluvial" deposits and foothills deposits.

Finally, the residual ones are developed from materials derived from the change on site of the sedimentary and metamorphic rocks.
Ecological conditions in the area make the soils to fit to a hot moisture regime, (in other words, soils are dry the most part of the year or may be wet ground somewhere for less than 90 consecutive days), and to have a high temperature scheme (with an annual average temperature over 22 ºC).

According to the genesis of the soil, where the topography is essential for the formation of soils, it has been established different categories according slope, which are presented in Table 1.9-1.

The sub-group of soil, as determined according the soil classification system of Soil Taxonomy (2006), are shown in Table 1.9-2 and consociations (soil mapping units) identified in the area, are shown in Table 1.9 -3.

Table 1.9-1 Soils categories according slope

Symbol	Slope (%)	Category
A	0 - 2	Flat or near to flatness
B	2 - 4	Slightly sloped
C	4 - 8	Moderately sloped
D	8 - 15	Highly sloped
E	15 - 25	Moderately steep
F	25 - 50	Steep
G	50 - 75	Highly steep
H	> 75	Extremely steep

Source: *Talara Refinery Modernization Environmental Impact Study, Dec. 2009, Walsh, sect. 4.1.6.1*

Table 1.9-2 Classification of the soils according to Soil Taxonomy

Orden	Suborden	Gran Grupo	Subgrupo	Nombre
ENTISOLS	Orthents	Torriorthents	Typic Torriorthents	Cono
			Lithic Torriorthents	Vencedores
	Psamments	Torripsamments	Typic Torripsamments	Angolo
ARIDISOLS	Salids	Haplosalids	Typic Haplosalids	Chatarra
	Calcids	Haplocalcids	Lithic Haplocalcids	Pozo

Source: *Talara Refinery Modernization Environmental Impact Study, Dec. 2009, Walsh, sect. 4.1.6.1*

Table 1.9-3 Consociations identified in the area

Consociation	*Symbol*	*Fraction (%)*	*Slope*
Angolo	*An*	*100*	*B* *C* *D*
Chatarra	*Cha*	*100*	*A*
Cono	*Co*	*100*	*C* *D*
Pozo	*Po*	*100*	*C* *D* *F*
Vencedores	*Ve*	*100*	*F*
Misceláneo Playa	*MPy*	*100*	*A*
Misceláneo Cauce	*MCa*	*100*	*A* *B*

Note:
Taken from Talara Refinery Modernization Environmental Impact Study - Walsh Section 4.1.6.1

In the designs of the foundations and all underground systems, the code E050 “Suelos y Cimentaciones” should be taken into account”.

For more information about the conditions of the soils at Talara Refinery, and also about soil contamination, it is essential to consult the document “ESTUDIO GEOTÉCNICO 1ª FASE, MODERNIZACIÓN DE LA REFINERÍA DE TALARA, TALARA - PIURA” - MyM Consultores.

1.10 SEA WATER DATA

1.10.1 Oceanographic Parameters

A. Sea Surface Temperature (SST)

The surface temperature off the Peruvian coast is characterized by an increase in westerly and northerly direction, resulting in zonal gradients, which are very intense in summer.

The phenomenon “El Niño” is defined as the presence of abnormally warm waters along the west coast of South America. It is one of the most spectacular events that occur in the ocean and atmosphere, with intervals between 3 and 10 years, with great impact on climate and the ecosystem. This phenomenon has been studied intensively since the end of 1972 in its oceanographic, meteorological and hydrological components, knowing now that is not only a local event, but part of a complex system of air-sea interaction in the tropical region of the earth.

Table 1.10-1 shows the multi-year monthly average SST for Talara in the period from March 29 to May 17, 2008.

Table 1.10-1 Multi-year monthly average SST for Talara

MONTH	TSM, ºC
January	20.1
February	22.7
March	22.2
April	20.6
May	19.9
June	19.2
July	18.6
August	17.6
September	17.6
October	18.2
November	18.5
December	19.2

Fuente: *Empresa SMECS*

Source: *Talara Refinery Modernization Environmental Impact Study, Dec. 2009, Walsh, sect. 4.1.10.3*

B. Salinity

The distribution of salinity varies from 35.1 parts per thousand as average value for the coastal part to 35.3 parts per thousand for the ocean.

1.10.2 Ocean elements

A. Tides

Tides are semi-diurnal type, with an average height of 1.22 meters, of syzygies or "spring tides" reach average values of 1.58 meters.

In berth Nro.4 it is installed one of the tidal measure gauges of the National Coastal Network, with the establishment of the Port of 3 hours and 15 minutes. As the maritime areas of Punta Arenas and Talara are very close together, the behavior of the tides is the same in both sea areas.

B. Waves

The wave's average height in the bay is between 0.5 to 1.5 meters, while sea roughness can reach values up to 3 meters.

Recent studies have revealed that the average height of waves in the area is:

a) Significant height: 1.29 meters at 20 meters depth and 1.35 meters at 10 meters depth.

b) To the maximum significant wave height: 2.55 meters at 20 meters depth and 2.69 meters at 10 meters depth.

On average basis, there are waves in the surf zone with significant wave height of 1.53 meters, being the average maximum height recorded of 1.90 meters and with an average wave height of 1.02 meters (significant period of 12.6 seconds).

The breaking wave is mixed, enclosing type, i.e. breaking in one blow the whole train of waves, and surfing type in a lower percentage rate. The width of the surf zone ranges from approximately 50 to 60 meters, with a group of 3 to 4 surf waves.

Wave off Punta Arenas

The surge is the most constant factor (speaking about direction), However since the swell type waves travel long distances in various directions and usually from a depth of 100 meters the refraction phenomenon takes place, this causes variations in the direction of orthogonal wave front.

The sea ground morphology leads to wave fronts from the south west having an impact perpendicular to the isobaths of 100 meters, so they suffer no refraction in deep water, starting just his refraction phenomenon eastbound on the contour of 50 meters, which makes the front of waves passing through the contour of 20 meters with a direction of approximately 050º, while the front wave from the west suffers a slight refraction north on the ridge of 100 meters then a counter-refraction against eastward from the barrier of 50 meters, so that influence a direction of about 070º on the mooring area of Punta Arenas.

So in the area where the Offshore Terminal of Punta Arenas is located, the fronts of waves, originating in the Southeast Pacific, affect the mooring more frequently from the direction 230º, while the wave's front, from the Pacific West, arrives, less frequently, from a direction approximately 250 º.

This wave swell, impacting on the coastal corner called "Punta Arenas" is bent slightly to the north, leading to the formation of a breaking stream running from south to north.

Moreover, the wave striking on Punta Talara is diffracted due to the sudden change in direction of the isobaths of 10 meters and mainly to the angular shape of the profile of the coast, causing the formation of a breaking stream running from north to south.

Note that both Punta Capullana and Punta Pariñas, among them the sea area of Punta Arenas is located, are the most westernly points in the American Continent, so the behavior of waves in this area is similar to an area of open sea, where sea conditions occur on the level 2 of the Beaufort scale. The effect of waves is thereof enhanced without changing significantly the orthogonal direction.

For more information regarding Marine Climate & Waves, see Doc. Nº V-020702305-B483-001-A, issued on Oct, 20 2011.

1.10.3 Typical Composition of Seawater

Table 1.10-2 is a summary of the typical quality of sea water, whereas in Table 1.10-3, results available of a previous analysis of seawater is presented. [***Source:*** *"Preliminary Process Design Questionnaire. FEED-EPC Contractor. Talara Refinery Modernization Project, July, 2010."*]

Furthermore, a new analysis was performed by Tecnoambiente, see Doc. Nº V-0207023210-001-A "Seawater and Marine Bed Characterization Survey", to support detailed Engineering development.

Table 1.10-2 Sea Water typical quality

		Sea Water	
Parameter	**Unit**	**Maximum**	**Minimum**
Conductivity	µS/cm	52000	48000
Iron	ppm Fe	0.40	0.20
Copper	ppm Cu	0.20	0.05
Sodium	ppm $CaCO_3$	26000	22000
Silica	ppm SiO_2	2.0	1.0
Chlorides	ppm Cl	22000	18000
M-Alkalinity	ppm $CaCO_3$	150	100

Source: *"Preliminary questionnaire for process design. FEED-EPC Contractor. Talara Refinery Modernization Project, July, 2010."*

Table 1.10-3 Available Sea Water Analysis

Parameter	Unit	Value
pH		7.8
Hardness	ppm $CaCO_3$	7170
Total Solids	ppm	36500
Dissolved Silica	ppm	1.5
Chloride	ppm	21000
Conductivity	µS/cm	48000
P-Alkalinity	ppm	0
M-Alkalinity	ppm	130
Iron (Fe^{+3})	ppm	0.23
Residual Chlorine	ppm	0.5-1.0
Oil and Grease	ppm	1
Content of sand	ppm	15
Dissolved Oxygen	ppm	8.0

Source: *"Preliminary Process Design Questionnaire. FEED-EPC Contractor. Talara Refinery Modernization Project, July, 2010."*

Table 1.10-4 Sea Water Ionic Balance

Ionic Balance		
Calcium (Ca^{+2})	ppm (meq/L)	900 (1) (45)
Magnesium (Mg^{+2})	ppm (meq/L)	1200 (98)
Sodium (Na^{+})	ppm (meq/L)	11407(2) (496)
Potassium (K^{+})	ppm (meq/L)	360(3) (9)
Total Cations	**meq/L**	**648**
Chloride (Cl^{-})	ppm (meq/L)	21000 (592)
Sulfate (SO_4^{2-})	ppm (meq/L)	2600 (54)
Bicarbonate (HCO_3^{-})	ppm (meq/L)	155 (2)
Total Anions	**meq/L**	**648**

Notes:

(1) Based on the results of 7170 ppm CaCO3 as hardness, and subtracting the magnesium content (1200 ppm = 4920 ppm CaCO3).

(2) Adjusting Sodium value from 11239 ppm to 11407 ppm, in order to close the balance. However, sea water contains other cations than those shown in the balance, being able to close the balance.

(3) Considering Potassium average value from the analysis of samples taken in Punta Arenas, item 4.1.12.4.1 Environmental Impact Study prepared by Walsh.Perú SA

Source: *TR production, based on:*

- *"Preliminary Process Design Questionnaire. FEED-EPC Contractor. Talara Refinery Modernization Project, July, 2010"*
- *"Environmental Study Impact, Dec. 2009 - Walsh sect 4.1.12.4.1"*

1.10.4 Red Tides

Red tides, also known as algal blooms, hemotalasia, watering or purges of the sea are observed and described in different parts of the world characterized by being discolorations in the sea of irregular length, due to exponential growth of phytoplankton, ciliate or flagellate.

Consulted sources report three events In Peruvian coast: first during 1986, second during 1997and third during summer 2004.

Above mentioned information is not conclusive, further studies not included on TR FEED scope of work will be performed to determine mitigation for this phenomena.

Source: ***MAREAS ROJAS EN LA COSTA PERUANA DURANTE EL VERANO – OTOÑO DEL 2004 -*** *Sonia Sánchez, P. Villanueva y N. Jacobo. - Área de Fitoplancton y Producción Primaria- Instituto del Mar del Perú*

January, 2002, IMARPE –Instituto del Mar del Perú –*pilot monitoring study of Chincha-Pisco zone.*

1.11 SOLAR RADIATION

The radiant energy coming from Sun reaches our planet as electromagnetic waves, and is named as solar radiation (RS in Spanish) or isolation. RS are the climate element responsible of almost physic changes on the system Earth-Atmosphere. Table 1.11 presents the solar radiation monthly values from 2003 to 2005.

It can be seen that lowest values are presented on winter, about 220 W/m^2 (Watts per square meter), on June and July. The highest values correspond to the summer months, with a maximum of 255 W/m2 in March, which is the hottest month in Talara.

Table 1.11 Monthly Solar radiations (W/m^2)

Mes	Ene.	Feb.	Mar.	Abr.	May.	Jun.	Jul.	Ago.	Set.	Oct.	Nov.	Dic.	Anual
RS (W/m^2)	227	225	255	249	228	220	220	222	226	227	226	227	**229**

Source: *Petroperú, Talara refinery (2003-2005) included in Talara Refinery Modernization Environmental Impact Study, Dec. 2009, Walsh, sect. 4.1.1.2*

2. UTILITIES CONDITIONS

Information on the conditions of utilities has been extracted from the Master Job Specification (MJS), the Preliminary Process Design Questionnaire, while another part has been established as part of the basic engineering development for Auxiliary Services (Utilities) and applies for new units and existing facilities of the Talara Refinery Modernization Project.

2.1 STEAM

2.1.1 Steam Generation/Supply Conditions (New Facilities)

Pressure	Source/Destination	Pressure, psig (kg/cm^{2}g)				Temperature (ºC)			
		Min.	Normal	Max.	Design	Min.	Normal	Max.	Design
Very High Pressure	B.L. Producer	1150 (80.8)	1200 (84.4)	1250 (87.8)	1300 (91.4)	505	515	525	550
	B.L. Process Units	1100 (77.3)	1150 (80.9)	1200 (84.4)		500	510	520	
High Pressure	B.L. Producer	540 (38.0)	600 (42.2)	630 (44.3)	700 (49.2)	325	370	400	425
	B.L. Process Units	510 (35.9)	570 (40.0)	600 (42.2)		288	343	371	
Medium Pressure	B.L. Producer	160 (11.2)	180 (12.6)	200 (14.1)	250 (17.6)	230	250	290	320
	B.L. Process Units	130 (9.1)	150 (10.5)	170 (12.0)		188	221	277	
Low Pressure	B.L. Producer	45 (3.2)	50 (3.5)	60 (4.2)	150 (10.5)	180	200	220	250
	B.L. Process Units	42 (3.0)	47 (3.3)	50 (3.5)		150	160	180	

Note: All values at battery limit and at grade
Source: *TR production, based on "Preliminary Process Design Questionnaire. FEED-EPC Contractor. Talara Refinery Modernization Project, July, 2010"*

2.1.2 Steam Generation/Supply Conditions (Existing Refinery)

Pressure	Source/ Destination	Pressure, psig (kg/cm^{2}g)				Temperature (ºC)			
		Min.	Normal	Max.	Design	Min.	Normal	Max.	Design
High Pressure	B.L. Producer	-	600 (42.2)	-	700 (49.2)	-	335	-	360
Medium Pressure	B.L. Producer	-	125 (8.8)	-	250 (17.6)	-	178	-	371
Low Pressure	B.L. Producer	-	10 (0.7)	-	150 (10.5)	-	115	-	260

Note: The steam system integration between existing facilities and new facilities at different pressure levels could be found at Doc. Nº 02070-SGV-PRO-DBD-001.
Source: *TR production based on "Operation Manual for Industrial Services Unit. Rev 1. March, 2007"*

2.1.3 Steam Properties (New Facilities)

Property	Unit	Treatment	Normal	Maximum
Conductivity@25ºC	µS/cm	Phosphate	≤ 0.3	≤ 0.55
		All Volatiles	≤ 0.15	≤ 0.25

Source: *GEK 72281 A. Table V.A & VII.A.*

2.2 CONDENSATE

2.2.1 Condensate Generation Conditions

Pressure level	Source/Destination	Pressure, psig (kg/cm²g)				Temperature (ºC)			
		Min.	Normal	Max.	Design	Min.	Normal	Max.	Design
Boiler continuous blowdown	HHP Boiler Drum	1220 (85.8)	1270 (89.4)	1320 (92.8)	1385 (97.5)	300	303	305	330
	MP Blowdown Tank	160 (11.2)	180 (12.6)	200 (14.1)	250 (17.6)	188	193	198	223
Boiler continuous blowdown	MP BlowdownTank	160 (11.2)	180 (12.6)	200 (14.1)	250 (17.6)	188	193	198	223
	LP Blowdown Tank	45 (3.2)	50 (3.5)	60 (4.2)	150 (10.5)	145	148	153	178
Boiler intermittent blowdown	HHP Boiler Drum	1220 (85.8)	1270 (89.4)	1320 (92.8)	1385 (97.5)	300	303	305	330
	ATM Blowdown Tank	0 (0)	0 (0)	0 (0)	50 (3.5)	100	100	100	125
HP Process Generators continuous blowdown	HP Generators	610 (42.9)	670 (47.1)	700 (49.2)	770 (54.2)	255	261	263	288
	MP Blowdown Tank	160 (11.2)	180 (12.6)	200 (14.1)	250 (17.6)	188	193	198	223
HP Process Generators intermittent blowdown	HP Generators	610 (42.9)	670 (47.1)	700 (49.2)	770 (54.2)	255	261	263	288
	ATM Blowdown Tank	0 (0)	0 (0)	0 (0)	50 (3.5)	100	100	100	125
HP Condensate	Condensate from Steam Consumers	229 (16.1)	555 (39)	585 (41.2)	700 (49.2)	204	249	252	425
	MP Separator Flash Tank	160 (11.2)	180 (12.6)	200 (14.1)	250 (17.6)	188	193	198	320
MP Condensate	Condensate from Steam Consumers	88 (6.2)	135 (9.5)	229 (16.1)	250 (17.6)	165	181	204	320
	LP Separator Flash Tank	45 (3.2)	50 (3.5)	60 (4.2)	150 (10.5)	145	148	153	250
LP Condensate	Condensate from Steam Consumers	35 (2.5)	42 (3.0)	88 (6.2)	150 (10.5)	138	143	165	250
	ATM Separator Flash Tank	0 (0)	0 (0)	0 (0)	50 (3.5)	100	100	100	125
Condensate from excess steam	LS Header	42 (3.0)	47 (3.3)	50 (3.5)	150 (10.5)	150	160	180	250
	Condenser	3 (0.2)	5 (0.4)	7 (0.5)	50 (3.5)	105	108	111	250
Cold condensate	Pumped from condensation turbines	32 (2.2)	40 (2.8)	51 (3.6)	150 (10.5)	39	50	52	85
Clean / "potentially oily" Condensate	Pumped from flash tanks	-	80 (5.6)	116 (8.2)	196 (13.8)	90	108	111	151

Source: *TR production based on "Preliminary Process Design Questionnaire. FEED-EPC Contractor. Talara Refinery Modernization Project, July, 2010" and TR production.*

Note 1: For boilers and process generators blowdown, it has been considered estimation for drum operation pressure [produced steam pressure plus an increase of 70 psi (5 kg/cm²g)] and saturation conditions for temperature

Note 2: For sources, pressure and temperature conditions have been estimated upstream steam trap or upstream condensate discharge control valve.

Note 3: Pressure in Units Battery Limit for HP condensate header/MP condensate header/LP condensate header: 215/74/21psig (15.1/5.2/1.5 kg/cm²g), assuming 1/1/1 kg/cm² for header pressure drop

Note 4: Pressure values for cold condensate and clean/potentially oily condensate in the Units Battery Limit (at grade)

2.2.2 Condensate Quality for BFW Production (Polishing Outlet)

Properties	Unit	Maximum
pH		7
Conductivity@25ºC	µS/cm	< 0.2
Oil and Grease (O&G)	ppm (weight)	< 0.5
Iron	ppb (weight)	< 20
Copper	ppb (weight)	< 3

Source: *TR production, based on normative EN-12952:2003: "Water tube boilers and auxiliary installations. Requirements for boiler feedwater and boiler water quality"*

2.3 BOILER FEED WATER

2.3.1 Supply Conditions

Pressure level	Pressure, psig (kg/cm²g)				Temperature (ºC)			
	Min.	Normal	Max.	Design	Min.	Normal	Max.	Design
Very High Pressure for Cogeneration (HHP)	1119 (78.7)	1528 (107.4)	1778 (125.0)	1947 (136.9)	100	115	120	150
Very High Pressure for Process Units (HHP)	1152 (81.0)	1283 (90.2)	1310 (92.1)	1860 (130.8)				
High pressure (HP)	790 (55.5)	850 (59.8)	900 (63.3)	1272 (89.4)				
Medium Pressure (MP)	285 (20.0)	305 (21.4)	325 (22.9)	478 (33.6)				
Low Pressure (LP)	60 (4.2)	75 (5.3)	90 (6.3)	150 (10.5)				

Source: *TR production based on "Preliminary Process Design Questionnaire. FEED-EPC Contractor. Talara Refinery Modernization Project, July, 2010" and TR production.*

2.3.2 Boiler Feed Water Properties

On table below it is shown the Boiler Feed Water to be used in the Steam Boilers and Process Heat Boilers.

Parameter	Unit	Minimum	Normal	Maximum
pH @ 25ºC		9.0	9.3	9.6
Conductivity @ 25ºC	µS/cm			< 0.2
Total Hardness	ppm $CaCO_3$	ND	ND	ND
Total Organic Carbon (TOC)	ppm (w)			< 0.2
Oil & Grease (O & G)	ppm (w)			< 0.2
Iron	ppb (w)			< 10
Copper	ppb (w)			< 10
Oxygen	ppb (w)		3	< 7 (1)

Note: (1) Value obtained after Mechanical Deareation.

2.4 WATER SYSTEMS

2.4.1 Sea Water

2.4.1.1 Supply Conditions for New Facilities

	Pressure (psig)	Pressure (kg/cm^2 g)	Temperature, (ºC) (1)(2)
Minimum	75	5.3	18
Normal	85	6.0	20
Maximum	100	7.0	23 (3)
Design Conditions	179	12.6	60

Notes:

(1) Temperature values based on SST, see item 1.10.1

(2) Only for design purposes of the Reverse Osmosis membranes at the Desalination plant, a range of 15-24.6ºC (min./max. temperature for seawater feed to the R.O process) has been agreed between TR and Petroperú.

(3) Intake depth axis at -15m and 18ºC, see Doc. Nº V-0207023210-001-A “Seawater and Marine Bed Characterization Survey” issued August 1st, 2012, Chapter 5.3.1.

(4) Density @ Supply Conditions 1020 kg/m^3 (23ºC)

Source: *TR production based on hydraulic calculation.*

2.4.1.2 Supply Conditions for Existing Facilities

	Pressure (psig)	Pressure (kg/cm^2 g)	Temperature, (ºC) (1)
Minimum	65	4.6	18
Normal	70	4.9	20
Maximum	75	5.3	23
Design Conditions	94	6.6	50

Notes:

(1) Temperature values based on SST, see item 1.10.1

Sources: *TR production, based on Preliminary Process Design Questionnaire. FEED-EPC Contractor. Talara Refinery Modernization Project, July, 2010, Operation Manual for Industrial Services Unit. Rev 1. March, 2007 and Operation Manual for Liquid Loading Dock, April, 2008*

2.4.1.3 Return Conditions for New Facilities

	Pressure (psig)	Pressure (kg/cm^2 g)	Temperature, (ºC) (1)
Minimum	35	2.5	
Maximum			33
Design Conditions	179	12.6	60

Notes:

(1) Maximum temperature for all steam turbine surface condensers is 38ºC

Source: *TR production based on hydraulic calculation.*

2.4.1.4 Return Conditions for Existing Facilities

	Pressure (psig)	Pressure (kg/cm^2 g)	Temperature, (ºC) (1)
Minimum	Atm	Atm	
Maximum			38
Design Conditions	94	6.6	50

Notes:

(1) Maximum temperature for FCC Unit is 43.3ºC on Lean Oil Cooler.

Source: *TR production based on "Preliminary Process Design Questionnaire". FEED-EPC Contractor. Talara Refinery Modernization Project, July, 2010, "Operation Manual for Industrial Services Unit". Rev 1. March, 2007 and "Operation Manual for Liquid Loading Dock, April, 2008"*

2.4.1.4 Sea Water Typical Composition

Refers to Table 1.10.2 for detailed.

2.4.1.5 Sea Water Return Composition

Refers to item 3.2 for detailed.

2.4.2 Closed Circuit Cooling Water

2.4.2.1 Supply Conditions

	Pressure (psig)	Pressure (kg/cm² g)	Temperature (ºC)
Minimum	70	4.9	22
Normal	80	5.6	24
Maximum	85	6.0 (2)	27
Design Conditions	189	13.3	70

Notes:

(1) Density @ Supply Conditions 996.5 kg/m³

(2) 7.2 kg/cm²g at CWC BL

Source: *TR production based on hydraulic calculation.*

2.4.2.2 Return Conditions for New Facilities

	Pressure (psig)	Pressure (kg/cm² g)	Temperature (ºC)
Minimum	35	2.5	
Maximum			37
Design Conditions	189	13.3	70

Notes:

(1) 2.5 kg/cm²g at CWC BL

Source: *TR production based on hydraulic calculation.*

2.4.2.3 Make-up Water (Process Water I) Composition for Closed Circuit Cooling System

		Process Water I	
Source		Reverse Osmosis, 2º Pass	
Use		Low salinity circuits	
Parameter	**Unit**	**Minimum**	**Maximum**
pH	-----	5.4	5.7
Conductivity	µS/cm	10.3	11.1
Chlorides (Cl⁻)	ppm	0	1.1
Total Dissolved Solids (TDS)	ppm	4.2	<5
Iron	ppm	0.01	0.03
Silica	ppm	0.01	0.05
Total hardness	ppm	0	1

Source: *TR production based on "Preliminary Process Design Questionnaire. FEED-EPC Contractor. Talara Refinery Modernization Project, July, 2010" and TR production.*

2.4.2.4 Closed Circuit Cooling Water Composition

Parameter	Unit	Value
Conductivity	μS/cm	<3000
pH	--	8.4 - 9.0
Iron (total)	ppm Fe	<1
Corrosion rate	mil/year	1 (Coupon)
Chlorides	ppm Cl	<100
Hydrocarbon	ppm	<5
Molibdate	ppm MnO_4	200 - 300

Source: *TR production based on proposed closed cooling water treatment using Process Water I as make –up.*

2.4.2.5 Temperature for Selection of Air Cooling versus Water Cooling Exchange

Process outlet temperature using air coolers is:

Dry bulb temperature + 15ºC = 36ºc + 15ºC = 51ºC

Note: UOP will use 36 ºC + 11ºC = 47ºC, as a break point between air coolers and trim coolers

2.4.3 Potable Water

2.4.3.1 Supply Conditions

	Pressure (psig)	Pressure (kg/cm² g)	Temperature (ºC)
Minimum	60	4.2	19
Normal	70	4.9	20-24
Maximum	120	8.5	30
Design Conditions	150	10.5	60

Source: *TR production based on "Preliminary Process Design Questionnaire. FEED-EPC Contractor. Talara Refinery Modernization Project, July, 2010" and TR production.*

2.4.3.2 Quality

Quality of drinking water will comply with current Peruvian regulations, more specifically "Reglamento de Calidad del Agua de Consumo Humano de Perú (1995)"

For detailed information about drinking water requirements please refer to the project document "Water Systems Conceptual Design Basis" (Doc Nº 02070-STA-PRO-DBD-001), or the above regulation.

2.4.4 Process Water

2.4.4.1 Supply Conditions for New Facilities

Process Water I (Industrial use water)

	Pressure (psig)	Pressure (kg/cm² g)	Temperature (ºC)
Minimum	60	4.2	19
Normal	70	4.9	20-24
Maximum	120	8.4	30
Design Conditions	135	9.5	60

Source: *TR production based on "Preliminary Process Design Questionnaire. FEED-EPC Contractor. Talara Refinery Modernization Project, July, 2010" and TR production.*

Process Water II (General use water)

	Pressure (psig)	Pressure (kg/cm² g)	Temperature (ºC)
Minimum	30	2.1	19
Normal	50	3.5	20-24
Maximum	80	5.5	30
Design Conditions	90	6.4	60

Source: *TR production based on "Preliminary Process Design Questionnaire. FEED-EPC Contractor. Talara Refinery Modernization Project, July, 2010" and TR production.*

2.4.4.2 Qualities and Uses for New Facilities

	Units	Process Water I		Process Water II	
Source		Second Pass RO		First Pass RO + Remineralization	
Main use		Industrial use		General use	
Parameter		Minimum	Maximum	Minimum	Maximum
pH	-----	5.4	5.7	8.2	8.3
Conductivity@ 25ºC	µS/cm	10.3	11.1	254	354
Chloride (Cl^-)	ppm	0	1.1	44.6	77.8
Total Dissolved Solids (TDS)	mg/L	4.2	< 5	140	195
Iron	ppm	0.01	0.03	0.01	
Silica	ppm	0.01	0.05	0.01	0.06
Hardness	ppm $CaCO_3$	0.0		60	65
Alkalinity	ppm $CaCO_3$	-		77	460
Langelier Index LSI	-	-		- 0.5	0.5

Source: *TR production based on "Preliminary Process Design Questionnaire". FEED-EPC Contractor. Talara Refinery Modernization Project, July, 2010"*

2.4.4.3 Supply Conditions for Existing Facilities and New Flare

Process Water I (Deleted)

Process Water II (General use water)

	Pressure (psig)	Pressure (kg/cm² g)	Temperature (ºC)
Minimum *(Note 1)*	120	8.4	19
Normal	125	8.8	20-24
Maximum	180	12.7	30
Design Conditions	205	14.5	60

Note 1: *At the flare stack base, pressure will be around 4.2 to 6.6 kg/cm²g*
Reference: *"Preliminary Process Design Questionnaire". FEED-EPC Contractor. Talara Refinery Modernization Project, July, 2010"*
Source: *TR production based on "Operation Manual for Industrial Services Unit. Rev 1. March 2007"*

2.4.4.4 Supply Conditions for Tablazo New Facilities

Process Water II (Deleted)

2.4.5 Demineralized Water

2.4.5.1 Supply Conditions

	Pressure (psig)	Pressure (kg/cm² g)	Temperature (ºC)
Minimum	70	6.0	19
Normal	114	8.0	20-24
Maximum	148	10.4	30
Design Conditions	195	13.7	60

Source: *TR production based on hydraulic calculation*
Reference: *"Preliminary Process Design Questionnaire". FEED-EPC Contractor. Talara Refinery Modernization Project, July, 2010"*

2.4.5.2 Quality and Use

	Units	Demineralized Water	
Source		Demineralization plant	
Use		To Deareator for Boiler Feed Water	
Parameter	**Unit**	Minimum	Maximum
pH (1)	-----	5.8	7.0
Conductivity @ 25ºC (2)	µS/cm	0	< 0.2
Sodium	ppm	0	< 0.01
Total Dissolved Solids (TDS)	mg/L	Nil	
Iron	ppm	0.01	< 0.02
Copper	ppm		< 0.003
Silica	ppm	0.01	< 0.02
Hardness	ppm	0	

Notes
(1) Range coming from dissolved CO_2 in stored demineralized water (CO_2 coming from atmosphere)
(2) Measured at the demineralization plant outlet. Atmospheric CO_2 will increase the conductivity value in stored demineralized water
Source: *TR production based on DM2 design*

2.4.6 Fire Water

Fire Water Supply Conditions

	Pressure (psig)	Pressure (kg/cm² g)	Temperature (ºC)
Minimum	142	10	18
Normal	170	12.0	25
Maximum	210	14.8	30
Design Conditions	228	16	70

Source: *TR production as per Doc. Nº* 02070-FWS-INS-DBD-001

2.4.7 New Waste Water Treatment Plants

2.4.7.1 Industrial Waste Water Treatment Plant (WWS)

Temperature of effluents from different process units and utilities flowing to the new WWS facilities must be as low as possible, and shall never exceed 40ºC.

Supply Conditions for Wastewater Feed

	Pressure, psig	Pressure, kg/cm² g	Temperature, ºC
Minimum		Gravity	20-25
Normal			33
Maximum			40(1)
Design Conditions			70

Note:

(1) Higher temperature for low flow streams are permitted, but main hot streams shall be cooled at each process plant or facility.

Source: *TR production*

Treated Industrial Effluent Outfall Conditions

	Pressure, psig	Pressure, kg/cm^2 g	Temperature, ºC
Minimum		Gravity	18
Maximum			39
Design Conditions			70

Source: *TR production based on hydraulic calculations*

Applicable limits for industrial water effluents are included on Section 3.2 of this document.

2.4.7.2 Sanitary Waste Water Treatment Unit (SA2)

Feedstock Conditions

	Pressure, psig	Pressure, kg/cm^2 g	Temperature, ºC
Minimum	Atm.	Atm.	20-25
Maximum			38
Design Conditions	125	8.8	70

Source: *TR production*

Treated Effluent Conditions (for irrigation or disposal)

	Pressure, psig	Pressure, kg/cm^2 g	Temperature, ºC
Minimum	7.5 (1)/ 51.33(2)	0.5 (1)/3.5(2)	20-25
Maximum			35
Design Conditions	125	8.8	70

Note:

(1) Disposal to ocean by gravity flow.
(2) Irrigation

Source: *TR production*

Applicable limits for sanitary wastewater effluents are also included on Section 3.2 of this document.

2.5 GAS SYSTEMS

2.5.1 Instruments Air

2.5.1.1 Supply Conditions for New Facilities

	Pressure (psig)	Pressure (kg/cm² g)	Temperature (ºC)
Minimum	85	6.0	30
Normal	105	7.2	36
Maximum	125	8.8	45
Design Conditions	150	10.5	100

Source: *TR production, based on "Preliminary Process Design Questionnaire. FEED-EPC Contractor. Talara Refinery Modernization Project, July, 2010"*

2.5.1.2 Instruments Air Quality

Parameter	Value
Dust Content, Oils and Grease	Nil
Dew Point at Normal Operating Pressure, ºC	-20

Source: *TR production, based on "Preliminary Process Design Questionnaire. FEED-EPC Contractor. Talara Refinery Modernization Project, July, 2010"*

2.5.1.3 Existing Facilities Instruments Air Conditions(1)

	Pressure (psig)	Pressure (kg/cm² g)	Temperature (ºC)
Minimum	50	3.5	19
Normal	60	4.2	28
Maximum	90	6.3	30
Design Conditions	100	7.0	93

Note:

(1) Existing facilities will remain in place.

Sources:

- *Technical Specification ONO-739-0011-OU.*
- *TR production, based on "Preliminary Process Design Questionnaire. FEED-EPC Contractor. Talara Refinery Modernization Project, July, 2010"*

2.5.2 Plant Air

2.5.2.1 Supply Conditions for New Facilities

	Pressure (psig)	Pressure (kg/cm^2 g)	Temperature (ºC)
Minimum	95	6.7	32
Normal	115	8.0	40
Maximum	125	8.8	45
Design Conditions	150	10.5	100

Source: *TR production, based on "Preliminary Process Design Questionnaire. FEED-EPC Contractor. Talara Refinery Modernization Project, July, 2010"*

2.5.2.2 Plant Air Quality

Parameter	Value
Oil and Grease Content (1)	0

Note:

(1) It is required for regeneration of catalysts

Source: *TR production, based on "Preliminary Process Design Questionnaire. FEED-EPC Contractor. Talara Refinery Modernization Project, July, 2010"*

2.5.2.3 Existing Facilities Plant Air Conditions

Deleted. Existing facilities will not supply Plant Air.

2.5.3 Nitrogen

2.5.3.1 Supply Conditions

Parameters	Nitrogen
Temperature, ºC	Ambient (32ºC)
Minimum pressure, kg/cm^{2}g (psig)	7.0 (100)
Normal pressure, kg/cm^{2}g (psig)	8.0 (114)
Maximum pressure, kg/cm^{2}g (psig)	8.8 (125)
Design Temperature (Min/Max), ºC (Note 1)	12.8 / 93
Design Pressure, kg/cm^{2}g (psig) (Note 1)	10.5 (150)

Note 1: OSBL Design Temperatures and Pressure. The design conditions inside battery limits of NIS-Z-001 will depend on Vendor process conditions.

Source: *TR production*

2.5.3.2 Nitrogen Quality

Quality:	99.9-99.99% N_2 purity Maximum 10 ppm O_2 Maximum Water Dew Point -40 ºC at Normal Pressure

Source: *TR production*

2.5.4 Hydrogen

2.5.4.1 Supply Conditions

Supply conditions (operation/design) at PHP battery limits:

Operating pressure, kg/cm²g (psig)	20 (285)
Operating Temperature (ºC)	38
Design pressure, kg/cm²g (psig)	27.6 (392)
Design Temperature (ºC)	80

Note:
(1) Deleted

Source: *TR production based on Haldor Topsoe Doc. Nº 4341455 Rev. 1*

2.5.4.2 Hydrogen Quality

Component	Units	Specification
H_2	mol%	99.5 (min)
$N_2 + CH_4$	ppmv	Balance
$CO + CO_2$	ppmv	20 (max)

Source: *TR production based on Haldor Topsoe Doc. Nº 4341455 Rev. 1*

2.6 FUELS & FLUSHING OIL SYSTEMS

2.6.1 Refinery Fuel Gas (RFG)

2.6.1.1 Supply Conditions

It is considered that at least 15% of the heat supply to furnaces and boilers will be provided by Refinery Fuel Gas, if they are consuming Low BTU Gas.

Condition	Pressure (psig)	Pressure (kg/cm^2 g)	Temperature (ºC)
Minimum	40	2.8	19
Normal	57	4.0	38
Maximum	71	5.0	60
Design Conditions	150	10.5	80

Source: *TR production.*

2.6.1.2 Refinery Fuel Gas (RFG) Composition

Component	Normal Operation %Molar (Note 1)	Operation during FCK shutdown % Molar (Note 2)
Methane	42.05	41.30
Ethane	11.40	8.52
Ethylene	3.43	2.49
Propene	0.46	0.37
Propane	0.63	0.60
1,3-Butadiene	0.01	0.00
1-Butene	0.09	0.06
i-Butene	0.78	5.45
3M-1-butene	0.01	0.01
2M-1-butene	0.00	0.00
i-Butane	0.40	2.27
i-Pentane	0.09	0.36

Component	Normal Operation %Molar (Note 1)	Operation during FCK shutdown % Molar (Note 2)
n-Butane	0.36	1.22
n-Pentane	0.31	0.53
n-Hexane	0.07	0.11
n-Heptane	0.04	0.05
n-Nonane	0.00	0.00
n-C11	0.00	0.00
H_2S	0.00	0.00
COS	0.00	0.00
M-Mercaptan	0.00	0.00
Hydrogen	26.81	24.75
H_2O	0.68	0.44
HCN	0.00	0.00
Nitrogen	2.75	1.96
CO	2.62	1.55
CO_2	7.00	7.94
Oxygen	0.01	0.01
Total	**100.00**	**100.00**
LHV BTU/SCF (kcal/kg)	796.9 (9199)	954.7 (9406)
Peso Molecular	18.19	21.29
Punto de Rocío de HC a presión normal, ºC	-5	-1

Note 1: *RFG Composition considering FCK (EMRE) Case 32.4 CCR (Two Crudes) and FCC (UOP) Case 5 (light charge operation with distillates), where minimum refinery gas and butane is produced and maximum consumptions of RFG and FXG in units has been considered.*

Note 2: *RFG Composition during FCK shutdown considering FCC (UOP) Case 5 (light charge operation with distillates).*

Source: *TR production.*

2.6.2 Natural Gas

2.6.2.1 Supply Conditions

Condition	Pressure (psig)	Pressure (kg/cm^2 g)	Temperature (ºC)
Minimum	50	3.5	19
Normal	70	4.9	30
Maximum	100	7.0	32
Design Conditions	150	10.5	80

Source: *"Preliminary Process Design Questionnaire. FEED-EPC Contractor. Talara Refinery Modernization Project, July, 2010" and TR production.*

2.6.2.2 Natural Gas Composition

Component	% Molar
C1	93.08
C2	5.95
C3	0.01
C4	0.02
C5	0.33
O_2	0.04
N_2	0.08
CO	0.00
CO_2	0.49
H_2O	0.00
Total	**100.0**
LHV BTU/SCF (kcal/kg)	955.8 (11705)
HHV BTU/SCF (kcal/kg)	1059.5 (12979)
Specific Gravity	0.5948
Molecular Weight	17.21

Source: *"Preliminary Process Design Questionnaire. FEED-EPC Contractor. Talara Refinery Modernization Project, July, 2010"*

2.6.3 Pilot Gas

2.6.3.1 Supply Conditions

Condition	Pressure (psig)	Pressure (kg/cm^2 g)	Temperature (ºC)
Minimum	30	2.1	19
Normal	35	2.5	30
Maximum	40	2.8	32
Design Conditions	65	4.6	80

Source: *TR production*

2.6.3.2 Composition

Same composition of Natural Gas (See 2.6.2.2)

2.6.4 Low BTU Gas (FXG)

2.6.4.1 Supply Conditions

If furnaces and boilers are consuming Low BTU Gas, then it is considered that 85% of heat supply will be provided by this fuel

Condition	Pressure (psig)	Pressure (kg/cm^2 g)	Temperature (ºC)
Minimum	8.5	0.60	40
Normal	12.0	0.85	50
Maximum	13.4	0.94	55
Design Conditions	61	4.8	80

Source: *TR production based on EMRE information*

2.6.4.2 Low BTU Gas (FXG) Composition

Component	% Molar	
	Case 32.4 CCR (2Crudes)	Case 27.3 CCR (3 Crudes)
CO	22.112	25.145
CO_2	6.466	4.170
COS	0.002	0.002
H_2	19.542	15.386
H_2O	6.166	5.285
H_2S	0.001	0.001
N_2	44.887	49.180
CH_4	0.824	0.833
Total	**100.0**	**100.0**
LHV BTU/SCF (kcal/kg)	131.7 (1194)	130.1 (1141)
Molecular Weight	23.25	24.05

Source: *EMRE*

2.6.5 Hydrotreated Light Naphtha

2.6.5.1 Supply Conditions

Hidrotreated light Naphtha	Minimum	Normal	Maximum	Design Conditions
Supply pressure, kg/cm²g (psig)	-	25.3 (360)	-	36.8 (524)
Supply temperature, ºC	-	38	-	85

Source: *TR production based on Cogeneration Unit requirement.*

2.6.5.2 Hydrotreated Light Naphtha Composition

Flow rate, wt %	HYDROTREATED LIGHT NAPHTHA			
	Case 1 - SOR	Case 1 - EOR	Case 2 - SOR	Case 2 - EOR
n-Butane	0.2	0.2	0.02	0.02
i-Butane	0.01	0.01	0	0
n-Pentane	31.04	31.04	8.64	8.64
i-Pentane	5.95	5.95	12.86	12.86
2,2 -Methyl-Butane	0.31	0.31	0.34	0.34
2,3- Methyl-Butane	1.8	1.8	1.42	1.42
2 -Methyl-Pentane	9.75	9.75	9.48	9.48
3 -Methyl-Pentane	7.19	7.19	6.33	6.33
n-Hexane	19.19	19.19	20.8	20.8
Cycle-Pentane	5.03	5.03	4.99	4.99
Methyl-Cycle-Pentane	8.43	8.43	14.31	14.31
Cycle-Hexane	7.3	7.3	15.78	15.78
Benzene	1.81	1.81	3.03	3.03
n-Heptane	0.03	0.03	0.01	0.01
2-Methyl-Hexane	0.48	0.48	0.37	0.37
3-Methyl-Hexane	0.23	0.23	0.13	0.13
3-Ehtyl-Pentane	0.01	0.01	0	0
2,2,3-Mehtyl-Butane	0.04	0.04	0.06	0.06
2,2-Dimethyl-Pentane	0.16	0.16	0.3	0.3
2,4-Dimethyl-Pentane	0.23	0.23	0.63	0.63
3,3-Dimethyl-Pentane	0.04	0.04	0.06	0.06
2,3-Dimethyl-Pentane	0.14	0.14	0.08	0.08
1,1-Methyl-Cycle-Pentane	0.37	0.37	0.18	0.18
1-Cis-2-Methyl-Cycle-Pentane	0.01	0.01	0	0
1-Trans-2-Methyl-Cycle-Pentane	0.1	0.1	0.07	0.07
1-Cis-3-Methyl-Cycle-Pentane	0.1	0.1	0.07	0.07
1-Trans-3-Methyl-Cycle-Pentane	0.05	0.05	0.03	0.03
Mehtyl-Cycle-Heptane	0.01	0.01	0	0
Total	100	100	100	100
Total (kg/h)	24 528	24 527	11 979	11 979
MW (kg/kmol)	79.25	79.25	81.23	81.23
Specific Gravity	0.672	0.672	0.693	0.693

Source: *Axens*

2.6.5.3 Hydrotreated Light Naphtha Properties

Properties	Value
Gravity API @ 15.6ºC	79.4
Density, @ 15ºC, kg/m^3	672
Density, @ 38ºC, kg/m^3	660
Flash Point, ºC (1)	-49 / -30
Dynamic Viscosity @ 37.8ºC, cP	0.27
Sulfur, ppmw	< 50
Specific Heat , kcal/kg ºC	1.456
Net Heating Value (LHV) kcal/kg	10500

Note: (1) Depend on method

Source: *TR based on Axens documents*

2.6.6 Fluidized Bed Coke, Coke Fines and Wet Coke

2.6.6.1 Fluidized Bed Coke, Coke Fines and Wet Coke Properties (1)

Parameter	Units	Fluidized Bed Coke	Coke Fines	Wet Coke
Particle Density	kg/m^3	1362	1762	1858
Bulk Density				
Uncrushed	kg/m^3	801	481	---
Crushed	kg/m^3	897	721	---
Humidity	% peso	< 1	< 1	55
Volatile	% peso	1-3	2-7	9-13
Gross Heating Power Value	kcal/kg	7957	7778	7484
Net Heating Power Value	kcal/kg	7904	7726	7431
Heat Capacity	kcal/kg ºC	0.35	0.35	0.35

Notes: (1) Only as a reference in case it will be used

Source: *EMRE*

2.6.6.2 Fluidized Bed Coke, Coke Fines and Wet Coke Composition (1)

Parameter	Units	Case 32.4 CCR (2 Crudes)			Case 27.3 CCR (3 Crudes)		
		Fluidized Bed Coke	Coke Fines	Wet Coke	Fluidized Bed Coke	Coke Fines	Wet Coke
Carbon	% wt	94.27	91.91	87.09	94.88	92.99	89.15
Hydrogen		1.00	1.00	1.00	1.00	1.00	1.00
Oxygen		0.80	0.80	0.80	0.80	0.80	0.80
Nitrogen		0.69	0.69	0.69	0.75	0.75	0.75
Sulphur		1.28	1.28	1.28	1.01	1.01	1.01
Nickel		0.58	1.44	1.76	0.50	1.17	1.43
Vanadium		1.38	2.87	7.37	1.10	2.28	5.86
Iron		-	-	-	-	-	-
Sodium		-	-	-	-	-	-
Calcium		-	-	-	-	-	-
Total		**100.00**	**100.00**	**100.0**	**100.0**	**100.0**	**100.0**

Notes: (1) Only as a reference in case it will be used

Source: *EMRE*

2.6.7 Flushing Oil

2.6.7.1 Supply Conditions

Flushing Oil	Minimum	Normal	Maximum	Design Conditions
Supply header pressure, kg/cm^{2}g(psig)	2.2 (31.3)	6.1 (86.8)	13.1 (187)	17.8 (253.2)
Supply header temperature, ºC	20	43	52	85

Notes:

(1) Minimum pressure condition at Unit Battery limits (OSBL)

Source: *TR production based on hydraulic calculation*

2.6.7.2 Flushing Oil Properties

Properties	TKS-T-004 Case 1	TKS-T-004 Case 2
Density, kg/m^3	840 @ 52ºC	857 @ 43ºC
Viscosity, cP	4.0 @ 52ºC	6.2 @ 43ºC

Source: *TR production*
Case 1: Based on mixture of products coming from process units
Case 2: Typical Quality of Cochan's Diesel supplied by PP

2.7 RELIEF SYSTEMS

2.7.1 Hydrocarbons Relief Systems

2.7.1.1 Design Conditions

System	Design conditions	
	Max./Min. Pressure, kg/cm² g (Note 1)	Max. / Min. temperature, °C (Notes 2, 5)
Hydrocarbon (Notes 3,4)	3.5 / -1.0	343 / -5 (Headers) 343 / 193 (Drums)
Heavy Hydrocarbon (Notes 4,5)	3.5 / -1.0	397 / 12.8 (Headers) 397 / 193 (Drums)

Notes

(1) Maximum/Minimum pressure conditions for relief headers Offsite Battery Limits (OSBL). Inside Battery Limits (ISBL) will depend on relief products conditions. For vessels, full vacuum (FV) shall apply.
(2) Maximum/Minimum temperature conditions Offsite Battery Limits (OSBL). Inside Battery Limits (ISBL) will depend on relief products conditions.
(3) Hydrocarbon system corresponds to the main hydrocarbon flare systems with high / low molecular weight flare headers that discharge to FB2-D-001 and, FB2-D-002.
(4) The temperature of 193°C is due to the condition of steam cleaning (steam-out).
(5) System includes heavy hydrocarbon collectors who download the FB2-D-010.

Source: *TR production*

2.7.1.2 Operating Conditions

System	Operating conditions	
	Max./Avg/Normal Pressure, kg/cm² g	Normal temperature, °C
Hydrocarbon & Heavy Hydrocarbon	1.0 / 0.3 / 0.015 (Notes 1,2,3)	38 (Note 4)

Notes:

(1) Maximum average operating pressure condition corresponds to the total backpressure at Units Battery Limits (ISBL) for the hydrocarbon flare systems design case (Power Failure).
(2) Average operating pressure condition expected corresponding to the hydrocarbon flare systems during minor relief cases inside Battery Limits (ISBL).
(3) Normal operating pressure condition when there is not relief in the flare system.
(4) Normal operating temperature condition when there is not relief in the flare system.

Source: *TR production*

2.7.2 Sour Gases Relief Systems

2.7.2.1 Design Conditions

Design conditions	
Max./Min. Pressure, kg/cm² g (Note 1)	**Max/Min. temperature, ºC (Notes 2,3)**
3.5 / -1.0	250 / 12.8 (Headers) 250 / 193 (Drums)

Notes:

(1) Maximum/Minimum pressure conditions for relief headers Offsite Battery Limits (OSBL). Inside Battery Limits (ISBL) will depend on relief products conditions. For vessels, full vacuum shall apply.

(2) Maximum/Minimum temperature conditions Offsite Battery Limits (OSBL). Inside Battery Limits (ISBL) will depend on relief products conditions.

(3) The temperature of 193°C is due to the condition of steam cleaning (steam-out).

Source: *TR production*

2.7.2.2 Operating Conditions

Operating conditions	
Max./Avg./Normal Pressure, kg/cm² g	**Normal temperature, ºC**
1.0 / 0.3 / 0.01 (Note 1,2,3)	113 (Notes 4,5)

Notes:

(1) Maximum average operating pressure condition corresponds to the total backpressure at Units Battery Limits (OSBL) for the acid flare system design case (Control Valve Failure – Gas Blow-By).

(2) Average operating pressure condition expected corresponding to the acid flare system during minor relief cases at Units Battery Limits (OSBL).

(3) Normal operating pressure condition when there is not relief in the acid flare system.

(4) Normal operating temperature condition when there is not relief in the flare system.

(5) Acid flare headers will be steam traced and insulated to avoid ammonium bisulfides/bicarbonates deposition. Headers temperature shall keep higher than 85ºC to avoid the deposition of those compounds.

Source: *TR production*

2.7.3 Low BTU Gas Relief Systems

2.7.3.1 Design Conditions

Design conditions	
Max./Min. Pressure, kg/cm² g (Note 1)	Max/ Min. temperature, ºC (Note 2, 3)
3.5 / -1.0	343 / 12.8 (Headers) 343 / 193 (Drums)

Notes:
(1) Maximum/Minimum pressure conditions for relief headers Offsite Battery Limits (OSBL). Inside Battery Limits (ISBL) will depend on relief products conditions. For vessels, full vacuum shall apply.
(2) Maximum/Minimum temperature conditions Offsite Battery Limits (OSBL). Inside Battery Limits (ISBL) will depend on relief products conditions.
(3) The temperature of 193°C is due to the condition of steam cleaning (steam-out).

Source: *TR/EMRE production*

2.7.3.2 Operating Conditions

Operating conditions	
Max./Normal Pressure, kg/cm² g	Normal temperature, ºC
0.8 -1.2 / 0.3 (Notes 1,2, 4)	50 (Note 3)

Notes:
(1) Maximum operating pressure condition corresponds to the total backpressure at Units Battery Limits (OSBL) for the LBG flare system design scenario (FCK Upset Case).
(2) Normal operating pressure condition when there is not relief in the LBG flare system.
(3) Normal operating temperature condition when there is not relief in the LBG flare system.
(4) Maximum pressure of 0.8 kg/cm² correspond to 65% of LBG (Flexigas) production and 1.2 kg/cm² to 100% LBG production.
Source: *TR production*

2.8 CHEMICALS

2.8.1 Caustic 15% (weight)

2.8.1.1 Supply Conditions

	Pressure (psig)	Pressure (kg/cm2 g)	Temperature (ºC)
Minimum	70	4.9	20
Normal	74	5.2	36
Maximum	124	8.7	48
Design Conditions	164	11.5	85

Source: *TR production based on hydraulic calculations.*

2.8.1.2 Caustic 15% wt. Properties

Parameter	Unit	Value
NaOH Concentration	% (wt)	15
Baumé degrees @20ºC	ºBe	20.4
Density@20ºC	kg/m^3	1163
Viscosity@20ºC	cP	2.8

Source: *TR production based on commercial properties*

2.8.2 Caustic 50% (weight)

2.8.2.1 Existing facilities supply conditions

	Pressure (psig)	Pressure (kg/cm^2 g)	Temperature (ºC)
Minimum	-	-	-
Normal	60	4.2	20
Maximum	-	-	-
Design Conditions	166	11.7	66

Note 1: Deleted
Source: *"Operation Manual for Treatment Plant. March 2002"*

2.8.2.2 Caustic 50% wt Properties

Parameter	Unit	Value
NaOH Concentration	% (wt)	50
Baumé degrees @20ºC	ºBe	49.7
Density@20ºC	kg/m3	1525
Viscosity@20ºC	cP	70
Total Alkalinity (as Na_2O)	% w/w	38- 39
Iron (as Fe)	ppmw	≤ 5
Sodium Chloride (as NaCl)	% w/w	≤ 0.02
Sodium Carbonate (as Na_2CO_3)	% w/w	≤ 0.25
Sodium Sulfate (as Na_2SO_4)	% w/w	≤ 0.02

Source: *Commercial Properties for Caustic Soda 50% wt. and from Quimpac S.A Technical Specifications http://www.quimpac.com.pe/soda.html*

2.8.3 Caustic 40% (weight)

2.8.3.1 Supply Conditions

	Pressure (psig)	Pressure (kg/cm^2 g)	Temperature (ºC)
Minimum	30	2.1	20
Normal	53	3.7	47
Maximum	80	5.6	56
Design Conditions	195	13.7	85

Source: *TR production based on hydraulic calculations.*

2.8.3.2 Caustic 40% wt Properties

Parameter	Unit	Value
NaOH Concentration	% (wt)	40
Baumé degrees @20ºC	ºBe	43.6
Density@20ºC	kg/m^3	1430
Viscosity@20ºC	cP	38

Source: *TR production.*

2.8.4 Sulfuric Acid 98% (weight)

2.8.4.1 Supply Conditions

	Pressure (psig)	Pressure (kg/cm^2 g)	Temperature (ºC)
Minimum	43	3.0	20
Normal	68	4.3	32
Maximum	94	5.2	40
Design Conditions	114	8.0	85

Source: *TR production based on hydraulic calculations.*

2.8.4.2 Sulfuric Acid 98% wt. Properties

Parameter	Unit	Value
Concentration H_2SO_4	% (wt)	98
Density@20ºC	kg/m^3	1836
Viscosity@20ºC	cP	23

Source: *Commercial Properties for Sulfuric Acid 98% wt*

2.8.5 Commercial Sodium Hypochlorite 10.4-16% (weight)

2.8.5.1 Supply Conditions (1)

	Pressure (psig)	Pressure (kg/cm^2 g)	Temperature (ºC)
Minimum	14	1.0	15
Normal	85	6.0	20-24
Maximum	142	10	36
Design Conditions	174	12.2	60

Note 1: Values for STA-Z-001 (Water Treatment System)
Note 2: Deleted
Source: *TR production based on hydraulic calculations.*

2.8.5.2 Sodium Hypochlorite Properties

Parameter	Unit	Value
Concentration Cl_2	% (wt)	10.4-16
pH	-	11 - 13
Density@20ºC, 15%	kg/m^3	1160 -1260
Viscosity@15ºC	cP	5

Source: *Typical properties for Commercial Sodium Hypochlorite*

2.8.6 Sodium Hypochlorite produced by Electrochlorination

DELETED FOR VALUE ENGINEERING

2.8.7 Sodium Carbonate Solution 3% (weight)

DELETED FOR VALUE ENGINEERING

2.9 ELECTRICITY

Below it can be found the electrical specifications to be considered in basic designs, as per agreement in Doc. Nº 2070-MOM-ELE-TR-PP-CPT-002:

User / Consumer	Power (kW)	Rated Voltage (Vac)	Use Voltage (Vac)	Phase	Frequency (Hz)	Remarks
Motors	< 0.37	240	230	1	60	
	0.37-150	480	460	3		Direct Start or Y- D, till 750 kW for VSD or Soft Starters
	150-3000	4160	4000	3		Direct Start or Y- D, from 750 kW for VSD or Soft Starters
	>3000	13800	13200	3		
Lighting (Process areas & OSBL)		240 3 phase	230 2 phase	-	60	Electrical feed from 480/240 Vac trafos
Electrical heaters for motor cubicles. Electrical heaters for motors (75 kW or above)		240	230	1	60	Electrical feed from 480/240 Vac trafos
Instruments		208/120	110	1	60	Single phase feeders, RS-ST-RT plus neutral
Power sockets in buildings		240 3 phase	230	1	60	phase to phase
Medium Voltage Primary Distribution		33000	33000	3	60	

Source: *TR production*

3. EMISSIONS

3.1 EMISSIONS TO THE ATMOSPHERE

Legislation to be accomplished.

Emissions to the atmosphere from Talara refinery facilities must fulfill the below legislation (sorted by priority).

1. Legislation D.S. Nº 014-2010-EM
2. IFC World Bank Agency "Environmental Guidelines", section for Petroleum refineries emissions.

On table below it can be seen the values for main contaminants parameters.

Maximum allowable limits for air emissions (Exhaust stacks)

Parameter	D.S. 014-2010-MINAM For Petroleum Refining Activities	IFC EHS Guidelines for Petroleum Refining (2007)
Particulate Matter	50 mg/Nm³	50 mg/Nm³
Volatile Organic Compounds (VOC's) (benzene included)	20 mg/Nm³	
H_2S	10 mg/Nm³	10 mg/Nm³
SOx	500 mg/Nm³ (For other units)	500 mg/Nm³ (For other units)
	150 mg/Nm³ (For sulphur recovery units)	150 mg/Nm³ (For sulphur recovery units)
NOx	450 mg/Nm³	450 mg/Nm³
Nickel	1 mg/Nm³	1 mg/Nm³
Vanadium	5 mg/Nm³	5 mg/Nm³

mg/Nm³: milligram per normal cubic meter (0ºC and 1 atmosphere and dry basis and 3% of oxygen excess)

Sources: ** IFC World Bank Agency "Environmental Guidelines"*

*** Decreto Supremo Nº 014-2010-EM*

3.2 EMISSIONS TO WATER

Liquid effluents from refinery, after treatment if necessary, will be sent to the sea, according to requirements described in DUTY SPEC for the new Waste Water Treatment Plant, document Nº 02070-WWS-ECO-SPE-001. See table below.

Refinery Effluent Requirements	D.S. 037-2008-MINAM LPM for Hydrocarbons Subsector		World Bank (2)	
Contaminants	**LMP**	**Unit**	**LMP (1)**	**Unit**
Total Petroleum Hydrocarbon (TPH)	20	mg/L	--	--
Chloride In rivers, lakes, reservoirs In estuaries	 500 2000	mg/L	--	--
Hexavalent Chromium	0.1	mg/L	0.05	mg/L
Total Chromium	0.5	mg/L	0.5	mg/L
Total Mercury	0.02	mg/L	0.02	mg/L
Cadmium	0.1	mg/L	--	--
Arsenic	0.2	mg/L	--	--
Phenols for refinery effluents FCC	0.5	mg/L	0.2	mg/L
Sulfides for refinery effluents FCC	1	mg/L	1	mg/L
Biochemical Oxygen Demand, BOD5	50	mg/L	30	mg/L
Chemical Oxygen Demand (COD)	250	mg/L	150	mg/L
Residual Chlorine	0.2	mg/L	--	--
Ammoniacal Nitrogen	40	mg/L	--	--
Total Coliforms	<1000	NMP/100 mL	--	--
Fecal Coliforms	<400	NMP/100 mL	--	--
Total Phosphorus	2	mg/L	2	mg/L
Barium	5	mg/L	--	--
pH	6-9	--	6-9	--
Oil and Grease	20	mg/L	10	mg/L
Lead	0.1	mg/L	0.1	mg/L
Temperature Rise	<3	ºC	<3 (3)	ºC
Total Suspended Solids , TSS	(4)	--	30	mg/l
Copper	(4)	--	0.5	mg/l
Iron	(4)	--	3	mg/l
Total Cyanide	(4)	--	1	mg/l
Free Cyanide	(4)	--	0.1	mg/l
Nickel	(4)	--	0.5	mg/l
Vanadium	(4)	--	1	mg/l
Benzene	(4)	--	0.05	mg/l

Refinery Effluent Requirements	D.S. 037-2008-MINAM LPM for Hydrocarbons Subsector		World Bank (2)	
Contaminants	LMP	Unit	LMP (1)	Unit
Benzo (a) pyrene	(4)	--	0.05	mg/l
Total Nitrogen	(4)	--	10 (2)	mg/l

Notes:

Those parameters that have no assigned value should be reported when available analysis.
Total nitrogen, equivalent to the sum of total Kjeldahl nitrogen (organic nitrogen ammonia), nitrogen as nitrate and nitrite-nitrogen (NO)
MPN/100mL: Most probable number of 100 mL

(1) Assumed for integrated refinery
(2) World Bank, Environmental, Health, and Safety Guidelines for Petroleum Refining, April 30th, 2007"
(3) At the edge of a scientifically established mixing zone which takes into account ambient water quality, water use, potential receptors and assimilative capacity.
(4) ND: No limit available

Source: *"Environmental Design Basis" (PP-02070-C-306 Rev 01)*

4. MEASUREMENT UNITS

The following measurement units shall be used for project´s documents (P&ID´s, PFD´s, MSD´s):

PARAMETER	UNIT
Temperature	ºC
Pressure	kg/cm^{2}g or psig (Secondary unit)
Pressure (vacuum)	mm Hg
Weight	kg
Volume	m^3
Mass flow rate	kg/h
Volumetric flow rate	m^3/h (act) and Sm^3/h (Note 1)
Enthalpy	kcal/h
Duty	Gcal/h (Note 2)
Energy	kW
Transfer rate	kcal/m^2.ºC.h
Fouling factor	m^2.ºC.h/kcal
Viscosity	cP
Equipment size	mm
Tube length	km, m and mm
Pipe diameter	inch
Nozzles	inch
NOTES:	

1. Add Nm^3/h for compressors and/or when it is necessary for equipment design
2. Millions of kcal/h

NORMALIZED CONDITIONS:

Standard: 760 mm Hg @ 15.6ºC

Normal: 760 mm Hg @ 0ºC

ANNEX A

SENAMHI
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OFICINA GENERAL DE ESTADISTICA E INFORMATICA

ESTACION : EL ALTO / 000209 / DRE-01
PARAMETRO : PRECIPITACION MAXIMA EN 24 HORAS (mm)

LAT. 4 ° 16' "S" DPTO. PIURA
LONG. 81 ° 13' "W" PROV. TALARA
ALT. 252 msnm DIST. EL ALTO

AÑO	ENE.	FEB.	MAR.	ABR.	MAY.	JUN.	JUL.	AGO.	SET.	OCT.	NOV.	DIC.
2001	4.7	0.0	26.0	6.2	0.0	0.0	0.0	0.0	0.0	0.0	7.3	0.0
2002	0.0	16.8	19.0	44.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6
2003	7.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
2004	0.0	3.3	0.3	0.0	1.5	0.0	2.8	0.0	0.0	0.0	0.0	0.8
2005	0.0	0.0	4.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2006	2.6	53.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	S/D	S/D
2007	S/D	0.0	13.0	2.6	0.6	0.0	0.0	0.2	0.0	0.0	0.0	0.0
2008	36.7	15.2	5.9	0.8	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0
2009	9.2	9.8	7.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2010	0.0	57.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

S/D= Sin Dato
T = Traza

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OFICINA GENERAL DE ESTADISTICA E INFORMATICA

ESTACION : EL ALTO / 000209 / DRE-01 LAT. : 4 ° 16 ' "S" DPTO. : PIURA
PARAMETRO : PRECIPITACION TOTAL MENSUAL (mm) LONG. : 81 ° 13 ' "W" PROV. : TALARA
ALT. : 252 msnm DIST. : EL ALTO

AÑO	ENE.	FEB.	MAR.	ABR.	MAY.	JUN.	JUL.	AGO.	SET.	OCT.	NOV.	DIC.
1963	0.0	0.0	6.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1964	2.0	1.1	7.2	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.1	0.0

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ESTACION : EL ALTO / 000209 / DRE-01 LAT. : 4 ° 16' "S" DPTO. : PIURA
PARAMETRO : PRECIPITACION TOTAL MENSUAL (mm) LONG. : 81 ° 13' "W" PROV. : TALARA
ALT. : 252 msnm DIST. : EL ALTO

AÑO	ENE.	FEB.	MAR.	ABR.	MAY.	JUN.	JUL.	AGO.	SET.	OCT.	NOV.	DIC.
1972	10.0	10.0	597.2	18.8	13.0	3.0	0.0	0.0	0.3	0.0	0.0	0.0
1973	82.0	60.0	38.0	9.0	1.0	2.0	0.0	0.0	0.0	1.0	0.0	2.0

S/D= Sin Dato INFORMACION PREPARADA PARA : JOSE CORRALES

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OFICINA GENERAL DE ESTADISTICA E INFORMATICA

ESTACION : EL ALTO / 000209 / DRE-01
PARAMETRO : PRECIPITACION TOTAL MENSUAL (mm)

LAT. 4 ° 16' "S" DPTO. PIURA
LONG. 81 ° 13' "W" PROV. TALARA
ALT. 252 msnm DIST. EL ALTO

AÑO	ENE.	FEB.	MAR.	ABR.	MAY.	JUN.	JUL.	AGO.	SET.	OCT.	NOV.	DIC.
1977	0.0	84.9	19.5	7.5	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0
1978	0.0	13.0	23.0	2.0	2.0	0.0	2.0	0.0	1.0	0.0	2.0	0.0

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OFICINA GENERAL DE ESTADISTICA E INFORMATICA

ESTACION : LA ESPERANZA / 000230 / DRE-01 LAT. : 4 ° 55 ' "S" DPTO. : PIURA
PARAMETRO : PRECIPITACION MAXIMA EN 24 HORAS (mm) LONG. : 81 ° 4 ' "W" PROV. : PAITA
ALT. : 6 msnm DIST. : COLAN

AÑO	ENE.	FEB.	MAR.	ABR.	MAY.	JUN.	JUL.	AGO.	SET.	OCT.	NOV.	DIC.
2001	8.7	1.2	14.5	9.3	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.6
2002	0.0	1.8	20.2	22.4	0.0	0.0	0.0	0.0	0.0	0.9	0.2	0.5
2003	1.9	8.6	0.4	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.3	1.3
2004	1.5	0.3	0.2	0.0	0.2	0.0	1.5	0.0	0.0	1.0	0.0	5.3
2005	0.5	0.1	1.5	0.3	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0
2006	0.4	3.5	10.0	0.0	0.0	0.0	0.0	0.0	0.3	0.1	0.8	4.1
2007	3.7	0.0	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2008	7.5	72.0	7.1	2.6	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2009	8.7	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
2010	0.0	59.5	14.0	2.4	3.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0

S/D= Sin Dato
T = Traza

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ESTACION : 000230 / LA ESPERANZA/DRE-01 LONG : 81° 04'1 'W' DPTO. : PIURA
PARAMETRO : PRECIPITACION TOTAL MENSUAL (mm) LAT : 04° 55'1 'S' PROV. : PAITA
ALT : 6 msnm DIST. : COLAN

AÑO	ENE	FEB	MAR	ABR	MAY	JUN	JUL	AGO	SET	OCT	NOV	DIC
1969	0.5	10.2	30.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1970	0.0	0.0	2.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1972	0.0	0.6	186.5	7.0	0.0	0.3	0.0	0.0	0.5	0.0	0.0	2.0
1973	24.8	4.2	5.3	2.8	0.0	0.2	0.0	0.0	1.9	0.0	0.0	0.0
1976	39.9	22.5	0.0	0.0	0.7	0.2	0.0	0.3	0.0	0.1	S/D	0.0
1977	0.0	28.1	3.1	1.4	0.0	0.2	0.0	0.0	1.4	0.0	0.0	0.0
1978	0.0	0.3	12.3	1.2	0.1	2.4	0.0	0.0	0.0	0.0	0.0	0.0
1982	0.0	0.0	0.0	0.5	3.0	0.0	0.0	0.0	1.6	0.0	1.3	1.0
1983	145.7	83.3	285.5	505.8	529.9	261.5	0.3	0.0	0.0	4.0	0.0	3.3
1986	5.9	3.3	0.5	2.9	1.2	0.0	0.0	0.0	0.0	0.2	2.1	0.0
1987	10.2	45.7	25.3	13.8	0.0	0.0	0.0	0.0	0.0	1.0	0.1	0.0
1991	0.4	2.0	0.5	2.4	0.0	0.0	0.0	0.0	0.0	0.0	1.0	2.4
1992	0.0	13.4	77.8	73.6	0.0	0.2	0.0	S/D	0.0	0.0	0.0	S/D
1997	0.5	2.8	0.4	1.2	0.0	0.1	0.0	0.0	0.0	2.7	1.6	81.9
1998	307.6	223.6	296.7	24.8	4.2	20.3	0.0	0.0	0.0	0.0	1.1	0.0

S/D = Sin Dato.

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ESTACION : LA ESPERANZA / 000230 / DRE-01
PARAMETRO : PRECIPITACION TOTAL MENSUAL (mm)

LAT. : 4 ° 55 ' "S" DPTO. : PIURA
LONG. : 81 ° 4 ' "W" PROV. : PAITA
ALT. : 6 msnm DIST. : COLAN

AÑO	ENE.	FEB.	MAR.	ABR.	MAY.	JUN.	JUL.	AGO.	SET.	OCT.	NOV.	DIC.
1995	3.9	8.8	0.0	0.9	0.0	S/D	0.0	0.0	0.1	S/D	1.9	0.2

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