



**BAND-E-KARKHEH**  
**PRODUCTION FACILITIES BASIC DESIGN**  
**PHASE I**

**PROCESS BASIS OF DESIGN**

B4					
B3					
B2					
B1					
B0	18-July-2011	ISSUED FOR APPROVAL	A.N	R.A	N.KH
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**Band-E-Karkheh Phase-1 Production Facilities Basic Design**

DOCUMENT NO:

BKH-GOSP-PR-GN-0006

PAGE Number

Page 2 of 16



## Revision Sheet

Rev. PAGE	B0	B1	B2	B3	B4	Rev. PAGE No.	B0	B1	B2	B3	B4	Rev. PAGE No.	B0	B1	B2	B3	B4	B4
01	X					40						79						
02	X	X				41						80						
03	X					42						81						
04	X					43						82						
05	X					44						83						
06	X	X				45						84						
07	X					46						85						
08	X					47						86						
09	X					48						87						
10	X					49						88						
11	X					50						89						
12	X					51						90						
13	X					52						91						
14	X					53						92						
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23	X					62						101						
24	X					63						102						
25						64						103						
26						65						104						
27						66						105						
28						67						106						
29						68						107						
30						69						108						
31						70						109						
32						71						110						
33						72						111						
34						73						112						
35						74						113						
36						75						114						
37						76						115						
38						77						116						
39						78						117						

**Table of Contents**

1.	GENERAL.....	5
1.1	Scope .....	5
1.2	Project data .....	5
1.3	Language and Measurement System .....	5
2.	APPLICABLE DOCUMENTS .....	6
2.1	Applicable codes.....	6
2.2	Applicable Documents.....	7
2.3	Conflicting requirements.....	7
2.4	Purpose of Documents .....	7
3.	SITE LOCATION .....	8
4.	WELLS ITEMS IN PRODUCTION FOR FULLY DEVELOPMENT PRODUCTION.....	8
4.1	Number of Wells.....	8
4.2	Well location:.....	9
4.3	Well Flow rates .....	9
4.4	Production Profiles .....	9
5.	GENERAL SITE CONDITION .....	10
5.1	Temperature.....	10
5.2	Relative Humidity .....	10
5.3	Rainfall.....	10
5.4	Barometric Pressure .....	10
5.5	Wind .....	10
5.6	Elevations .....	10
5.7	Seismic Loads.....	11
5.8	Air Conditioning.....	11
5.9	Soil Condition.....	11
6.	PROCESS DESIGN BASIS .....	12
6.1	Fluid Data & Fluid Characteristics.....	12
6.2	Hydrocarbon Composition: .....	12
6.3	Dead Oil Viscosity Data.....	14
6.4	Formation Water Composition from wells.....	14
6.5	Potable Water Properties:.....	14
7.	ARTIFICIAL LIFT METHOD: .....	15
8.	TURN DOWN RATIO.....	15
9.	FEED AND PRODUCT.....	15
10.	SOFTWARE.....	16
11.	UNITS OF MEASUREMENT.....	16
12.	STANDARD CONDITION .....	17
13.	NUMBERING PROCEDURE .....	17
14.	PROCESS LIFE TIME.....	17
15.	Distribution of Flow .....	17
15.1	Unit brief identification: .....	18
15.2	Unit Specification and Limitation: .....	18
16.	UTILITY CONDITIONS .....	20



## Band-E-Karkheh Phase-1 Production Facilities Basic Design



DOCUMENT NO:

PAGE Number

BKH-GOSP-PR-GN-0006

Page 4 of 16

16.1	Fire Water .....	20
16.2	Instrument and plant air.....	20
16.3	Nitrogen.....	21
16.4	Waste Water System .....	21
16.5	Potable & Service Water.....	22
16.6	Flare System .....	22
16.7	Chemical Package .....	22
16.8	Fuel gas .....	22
16.9	Fuel Oil System .....	22
16.10	Closed and Open Drains .....	22
16.11	Hot oil package: .....	23
16.12	Control System .....	23
16.13	Power Generation .....	23
16.14	Electricity .....	23
17.	ENVIRONMENTAL ASPECTS.....	24
17.1	Environmental Noise Limit .....	24
17.2	Emission to air limitations .....	24

## 1. GENERAL

### 1.1 Scope

The petroleum engineering and development department of national Iranian oil company (PEDEC) has planned to develop the green Band-e-Karkheh oil field. The Band-e-Karkheh Field (BKH) is part of the Mehr Block which lies in the main producing area of the Central Zagros fold belt. The BKH field is located north-west of Ahwaz in Khuzestan province, onshore western Iran. The reservoir is an elongate anticline structure, immediately adjacent to the giant Ahwaz Field, which is less than 15km to the southeast.

Because of lack of data, and production ambiguities, the field development is defined in 2 phases:

#### Phase A (Early production phase) including:

1. Drilling & repair of 3 oil producing wells (BKH\_2, 5 and 7).
2. EPC of one Gathering center and first stage separation with crude transportation pipeline to Ahwaz- 3 production unit for more treatment.
3. Preparation of MDP for phase B

#### Phase B named as phase 1 (Fully development phase) including:

1. Drilling of more new wells (14 oil producing and 1 water disposal)
2. EPC of oil production, desalination, stabilization, sweetening and gas re-pressurizing & transportation facilities

The phase A basic design and EPC contractor tendering were finished and is under EPC activities execution.

This document is prepared by Pars Consulting Engineers (PCE) according to basic design of Phase 1 (Phase B) facilities which is awarded to this company by PEDEC.

### 1.2 Project data

Project name: Band-E-Karkheh Production Facilities

Client: National Iranian Oil Company (NIOC)

Site location: north-west of Ahwaz in Khuzestan province

Contract number: -----

### 1.3 Language and Measurement System

All engineering and design data including technical information of all quotation should be in SI unit otherwise specific unit which is specified in section 11. For more information about applicable units that will be used in this project see section 11. All drawings, instruction for installation, operating manuals, maintenance manuals, and vendor and sub-vendors documents shall be in English language.

## 2. APPLICABLE DOCUMENTS

### 2.1 Applicable codes

The standards approved by the Company and other international codes are as follows IPS standards:

Table 1: IPS Standards

Spec No.	Description
IPS-E-PR-170	Process flow diagram
IPS-E-PR-190	Layout and Spacing
IPS-E-PR-200	Basic engineering design data
IPS-E-PR-230	Piping & instrumentation diagrams (P&IDs)
IPS-E-PR-250	Performance guarantee
IPS-E-PR-308	Numbering System
IPS-E-PR-310	Process design of water system
IPS-E-PR-330	Process design of compressed air system
IPS-E-PR-410	Process design of hot oil & tempered water circuit
IPS-E-PR-700	Process design of crude oil electro static Desalter
IPS-E-PR-730	Process design of waste water treatment and recovery system
IPS-E-PR-735	Process design of waste water treatment and disposal system
IPS-E-PR-750	Process design of compressor
IPS-E-PR-771	Process Requirements of Heat Exchanging Equipment
IPS-E-PR-785	Process Requirements of air cooled heat exchanger
IPS-E-PR-810	Process Requirements of furnace
IPS-E-PR-830	Process Design of valves and control valves
IPS-E-PR-850 & 880	Process Design of gas-liquid separators
IPS-E-PR-420	Process design of heat tracing and winterizing
IPS-E-PR-440	Process Design of Piping Systems (Process Piping and Pipelines)
IPS-E-ME-100	Atmospheric Above Ground Welded Steel Storage Tanks
IPS-G-ME-220	Shell & Tube Heat Exchangers
IPS-E-PR-460	Process Design of Flare & Blow down Systems
IPS-E-PR-730	Process Design of Plant Produced water Treatment & Recovery Systems
IPS-E-SF-140	Foam Generating and Proportioning Systems
IPS-E-SF-220	Fire Water Distribution and Storage Facilities
IPS-E-SF-220	Fire Fighting Sprinkler Systems
IPS-E-GN-100	Units
IPS-C-PI-100	Plant Piping Systems
IPS-E-ME-100	Atmospheric Above Ground Welded Steel Storage Tanks
IPS-M-PM-200	Reciprocating Compressors for Process Services
IPS-M-PM-220	Positive Displacement Compressors, Rotary Other International Standards
IPS-G-ME-220	Shell & Tube Heat Exchangers
IPS-E-RP 521	Guide for Pressure-Relieving and Depressuring Systems

Except where otherwise stated, for the design, construction, assembly and test, reference shall be made to the following international codes and standards.

Table 2: International Codes and Standards

Spec No.	Description
API 610	Centrifugal Pumps for Petroleum, Petrochemical and Natural Gas Industries
API RP 521	Guide for Pressure-Relieving and Depressurizing Systems
API RP 520 Pt.1	Sizing, Selection, And Installation of Pressure-Relieving Devices In Refineries-sizing and selection
API RP 520 Pt.2	Sizing, Selection, And Installation of Pressure-Relieving Devices In Refineries-Installation
ANSI B16.5	Steel Pipe Flanges and Fittings

Spec No.	Description
API STD 661	Air Cooled Exchangers For General Refinery Service
API STD 674	Positive Displacement Pumps-Reciprocating
TEMA	Standards Of The Tubular Exchanger Manufacturers Association
ASME/ANSI B31.3 & B31.4 & B36.10	Process Piping
NFPA & IPS & API	Safety and Fire Protection
ASME SEC.VIII Div.1, 2	Pressure Vessels
API 650,AWWA M 42	Water Storage Tanks

**Note:** Iranian petroleum standard (IPS) shall be considered as the basis for designing all process facilities. Any deviation from IPS shall be approved by N.I.O.C.

## 2.2 Applicable Documents

Table 3: Applicable Documents

Doc. No.	Description
88603-BKH-BDP-00-PR-DC-01	Process Design Criteria
88603-BKH-BDP-00-PR-RP-03	Process Plant Identification and Numbering System
88603-BKH-BDP-00-PR-RP-01	Heat & Material Balance /Process Flow Diagram
88603-BKH-BDP-00-PR-PI-01~10	Piping & Instrument Diagram (P&IDs)

## 2.3 Conflicting requirements

If any difference and/or conflict between the documents listed in this specification should occur, the most stringent requirement prevails.

Any ambiguity or conflict shall be referred to the purchaser and approved solution shall be applied.

## 2.4 Purpose of Documents

This document defines all the basic design data for the surface production facilities for the Band-E-Karkheh (BKH) field development. The data is reproduced from the Ilam Reservoir Analysis PVT report. It is intended that the Design Basis is a live document that will evolve and additional information may be added as the engineering definition is developed.

- All data and specification will be finalized during detail engineering phase by client
- NO data is submitted for calculation of Wax & Asphaltenes condition by client during basic stage, because of lack of data no calculation will be done on Wax & Asphaltenes. For conservative condition according to subsurface study and oil behavior it is possible to formation of Wax & Asphaltenes. Therefore requirement package will considered during detail stage.
- Below study shall be done during detail stage by EPC contractor:
  - Wax and Asphaltenes condition and related simulation, sediment condition study
  - Corrosion study depend on fluid composition
  - Flow assurance study
  - Chemical selection report (finalized by vendor or supplier)

At the basic phase of the development of this field it is expected that the infrastructure associated with the field will comprise:

1. An in-field production gathering system & flow line network study

2. Central Processing Facility (CPF) including separation facilities, oil Desalter, oil stabilizer, metering system...
3. An in-field water disposal system
4. A water supply system to the CPF from the Karkheh River
5. A crude oil export pipeline from the CPF to the Gharb Booster Station
6. A gas export pipeline from the CPF to NGL-3200

### 3. SITE LOCATION

Band-e-Karkheh Field (BKH) is part of the Mehr Block. The BKH field is located north-west of Ahwaz in Khuzestan province, onshore western Iran. Site location zone will be described according to below point:

Table 4: Site Location

POINT	EAST	NORTH
11	3521222	236592
22	3511898	226363
33	3467269	262940
44	3478545	275506
55	3492703	265243
66	3490677	262842

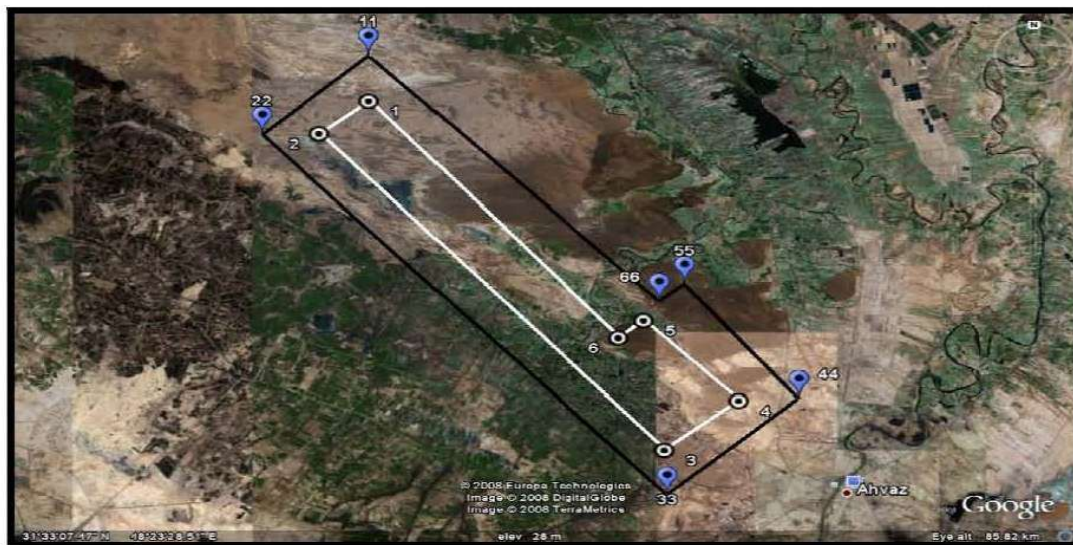


Figure 1: Site Location

### 4. WELLS ITEMS IN PRODUCTION FOR FULLY DEVELOPMENT PRODUCTION

#### 4.1 Number of Wells

No. of 14 wells with three existing wells (totally 17 wells) will be considered for fully development production (Phase-1).

The total number of production wells for the design base is 17 for initial field life which is from Ilam & Sarvak Production wells.



#### 4.2 Well location:

Below table shown the location of wells:

No.14 wells is considered for phase-1 which is collected to three available wells and will be send to band-E-Karkheh production plant

One water disposal well has been nominally located away from the Central Process Facility for conducting water from separation area to disposal well.

#### 4.3 Well Flow rates

The BKH production wells are expected to be completed according to above items and operate at max. Operating Production rate (Max: 30000 STB/Day @ outlet of plant which is delivered to boosting station) .water cuts is considered for inlet fluid facility 50. The maximum production design oil and water flow rate at inlet of PU depend on reverse and back calculation by software for reaching to aim flow rate

The Target flow rate is considered for phase-1(fully development) is 30000 oil Stb/Day which is reserved in storage tank & transferred to boosting station.

The planned guide capacity (PGC) shall be considered Min. 1.1~1.2 times planned guide rate (PGR). [PGC= PGR x (1.1~1.2)]

Therefore equipment sizing should be submitted base on below consideration:

Table 5: Well Flow Rates

Well no.	Max. Flow Rate (STB/Day)
BKH-01~17 (Each Well)	2500
Oil Production (Stb/Day)	30000
Oil Feed Flow Rate (Stb/Day)	32500
Total Water Flow Rate(Stb/Day):	30000
Total considered oil & water flow rate (Stb/Day)	62500
PGR=1.2 X PGC	75000

#### 4.4 Production Profiles

Method of production and related specification such as artificial device for covering production rate will be finalized by sub-surface section. The CPF will be designed to meet the above capacities & the facilities will be designed on the following production data.

Table 6: Production Data

Item	Design capacity
Oil production rate (STB/D)	2500 for each well is considered
Water cut (%)	50
Oil Production Target Capacity (Stb/Day)	30000
Peak Liquid Production (Stb/day)	62500 x 1.2

For design purposes, the facilities have been oversized to take into consideration peak production flow rates that could be reached as it has been identified by reservoir simulations for alternative cases.

The test separator design capacity given below is based on typical design capacity for commercially available test separator. The conceptual study sizing basis assumes for maximum production rate from a single well with the same GOR.( SP-100 which is considered in early production phase could be considered as test separator in fully development phase-1).

## 5. GENERAL SITE CONDITION

### 5.1 Temperature

Maximum recorded air temperature	54°C
Minimum recorded air temperature	-4 °C
Average Dry bulb temperature	24 °C
Average Weather Dew Point temperature	5.7 °C
Maximum temperature for mechanical, civil & structural design	54°C
Equipment exposed to sunlight	85°C
Design air temperature for Air coolers	Max.:54°C
Max. Indoor temperature for isolated buildings with low ventilation and no heating source	42°C
Min. Indoor temperature for isolated buildings with low ventilation and no cooling source	10 °C

### 5.2 Relative Humidity

Maximum Relative Humidity	95%
Minimum Relative Humidity	10%
Maximum Average Relative Humidity	75%
Minimum Average Relative Humidity	22%

### 5.3 Rainfall

Average annual	200 mm
Maximum Average annual	460 mm
Design Snow Load	Hold kg/m <sup>2</sup>
Maximum in one month	160mm
Design rainfall intensity	50 mm/h*

\*Since rainfall intensity is not available, rate of 50 mm/h is used based on section 5.7.2 of IPS-E-CE-380.

### 5.4 Barometric Pressure

Maximum barometric pressure at ground level	1010 mbar
Average barometric pressure at ground level	1000 mbar
Minimum barometric pressure at ground level	990 mbar

### 5.5 Wind

Maximum wind velocity (km/hr)	130
Prevailing wind direction	270° West and North West
Direction of Max. prevailing speed	315°

- Mist & Dusty weather is reported at site location. Special provisions are required for dust storms

### 5.6 Elevations

Site :	Band-E-Karkheh
Altitude above Sea Level (m)	150
Ground Water Level (m)	approximately 2 meters

5.7 **Seismic Loads**

Zone condition	UBC 97 ZONE4
Importance factor	1.0
Seismic Acceleration (m/s <sup>2</sup> )	0.35g

5.8 **Air Conditioning**

Design data for air conditioning are as follows:

Dry bulb temperature in summer	25±2 °C
Dry bulb temperature in winter	22±1 °C
Relative humidity	50±5 %

5.9 **Soil Condition**

Summer Ground Condition	32 °C
Winter Ground Condition	10 °C
Soil Thermal Conductivity	1 w/m.c

## 6. PROCESS DESIGN BASIS

### 6.1 Fluid Data & Fluid Characteristics

Several DSTs have been taken from the BKH-2 well Ilam Reservoir. The BKH key general fluid characteristics are based on the BKH-2.

Table 7: Reservoir Properties

[Summary of Assumed Reservoir Oil Properties (Preliminary data from BKH-2 well)]

PROPERTY	UNIT	VALUE
Initial reservoir pressure	Bara	441.7
Initial reservoir temperature	°C	111
Reference depth	m	3665
Gravity	°API	24
Gas / Oil ratio (GOR)	SCF/bbl	250
Bo	Bbl/rb	1.56
Pbp	Bara	196
H2S in reservoir fluid	ppm wt	30
Sulphur	ppm wt	3.9%
CO2	mol %	3.5
Elemental sulphur	mol %	Hold
Wax	Wt %	5.3
Wax appearance temperature	°C	Note 1
Asphaltenes	Wt %	11.8
BETX	-	Hold

**Note:** A wax appearance temperature of 40°C has been assumed and all above data shall be confirmed during detailed design.

**For avoiding wax and Asphaltenes in flow line below assumption is considered during basic phase:**

- **Chemical Injection facility and anti deposit according to chemical consumption list.**
- **Corrosion allowance : 3.2 mm for flow line and separator**
- **Requirement of NACE-MR-0175 & ISO-15156-2 for material selection**
- **Underground flow line**

### 6.2 Hydrocarbon Composition:

The composition or design is based on the DST2a and is derived from a review of PVT and composition data from the laboratory analysis performed compositional analysis. This composition is presented below on a dry basis. The compositions used in the simulations will be water saturated and have the requisite volumes of hydrate inhibitor added.

Below table show well (BKH-2) composition which is considered for process surface facilities and shall be finalized during FEED or Detail engineering.

Table 8: Composition of Well fluid

Composition of Well fluid	
Component	Mol % (SUMMER & WINTER CASE)
H2O	0.00
H2S	0.00
Nitrogen	0.419874
CO2	0.769769
Methane	17.22483
Ethane	8.46746
Propane	7.36779
i-Butane	1.639508
n-Butane	4.128761
i-Pentane	0.979706
n-Pentane	2.89913
n-Hexane	5.39838
C7+*	50.70479

Table 9: Preliminary Fluid Characterization

Preliminary Fluid Characterization							
Component	Mol wt	Liq. density [Kg/m <sup>3</sup> ]	Crit. T [C]	Crit. P [Psig]	Accentric factor	Normal Tb [C]	Crit. V [m <sup>3</sup> /kg mol]
BKH-2-C7+	316.09	906.67	483.9	294.7	0.6108	285.21	0.7039

- Data in Extrapolated from BKH-2 test report and lumped, could be considered for other wells, all data shall be checked during detail engineering phase.
- Dead-oil water emulsion viscosity and live oil viscosity are not currently available. Further studies will be carried out to determine the potential for emulsions and worst condition flow in pipeline of facilities. The design of the CPF will allow for any potential emulsions.
- Thermodynamic Model: Peng Robinson
- Max. Water cut 50% is considered.
- There is not any PVT reported about existing H2S in Band-E-Karkheh field. But with respect to experience of nearby field (Bangestan group) it is assumed that crude oil will be sour. So in Detail engineering all data especially H2S concentration will be finalized during FEED.

### 6.3 Dead Oil Viscosity Data

Viscosity data of the BKH oil is presented below:

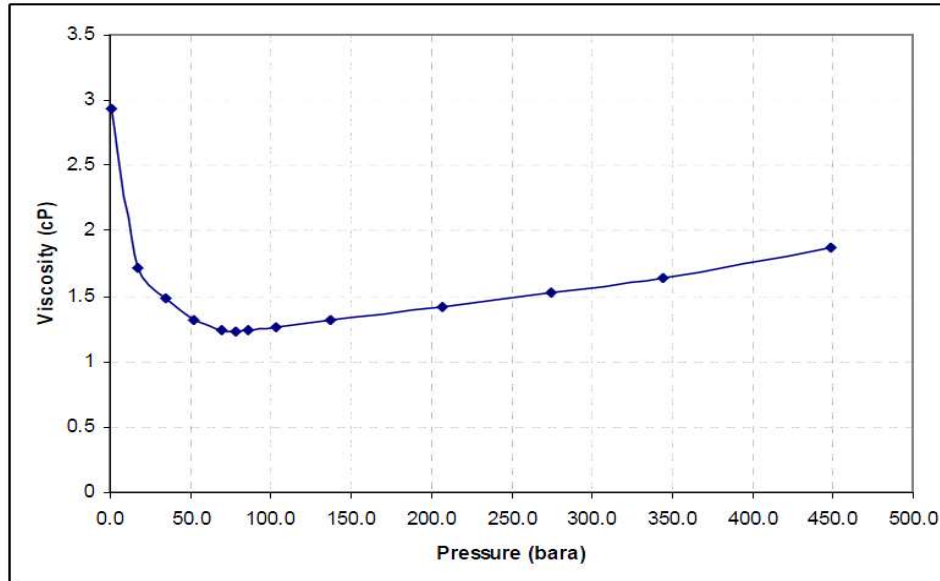


Figure 2: Viscosity Data at Reservoir Temperature

### 6.4 Formation Water Composition from wells

The formation water composition is taken from the BKH-2 Well, Ilam reservoir:

Table 10: Formation Water Composition From well

Reservoir	Ilam
Depth (m)	
Specific Gravity @ 15.6/15.6 deg C	1.14
Total Dissolved Solids, TDS (g/l)	226-264
pH Value	4-5.1
Resistivity (Ohm-m)	0.05
H2S (ppm)	None
Na+ (g/l)	68-72
Ca++ (g/l)	8-10
Mg++ (g/l)	0.9
K+ (g/l)	2.6-3.2
Sr++++ (g/l)	0.4-0.46
Total Fe+++ (mg/l)	170-260
Cl- (g/l)	121-131
SO4-- (ppm)	0-0.9
CO3-- (ppm)	None
HCO3- (g/l)	3.5
Zn (mg/l)	1-2
Mn (mg/l)	3
Ba (mg/l)	0-2

### 6.5 Potable Water Properties:

The major desirable characteristics of potable water shall be based on W.H.O and Iranian water organization standards. The W.H.O. indicative values are given as:

Table 11: Potable Water Properties

Sr.	Parameter	Unit	Specification
1.	PH		6.5-8.5
2.	Turbidity	NTU	< 2
3.	TDS	mg/l	<400
4.	Total Hardness	mg/l as CaCO3	80~120
5.	Ca Hardness	mg/l as CaCO3	60~80
6.	Mg Hardness	mg/l as CaCO3	73-97
7.	Chlorides	mg/l as Cl-	250
8.	Bicarbonate	mg/l as CaCO3	80~120
9.	Chlorine	mg/l as Cl-	0.1
10	Copper	mg/l	<1

Table 12: The Iranian National Standard No. 1053 for drinking water, issued by Iranian Institution of standard & Industrial Research is presented in following table:

TEST		Max. Desired Limit ( mg / lit )
Total Dissolved Solids	-	500
Total Hardness	CaCO3	150
Permanent Hardness	CaCO3	-
Total Alkalinization	CaCO3	-
Temporary Alkalinization	CaCO3	0
Sodium	Na <sup>+</sup>	-
Calcium	Ca <sup>++</sup>	75
Magnesium	Mg <sup>++</sup>	50
Sulphate	SO <sub>4</sub> <sup>-</sup>	200
Chloride	Cl <sup>-</sup>	200
Total Iron	-	0.3
Manganese	Mn <sup>++</sup>	0.05
Nitrate	NO <sub>3</sub> <sup>-</sup>	0
Ammonia	NH <sub>3</sub>	0.002
Phosphates	P	0.1
Fluoride	F <sup>-</sup>	0
pH	-	7 ~ 8.5
Turbidity	-	5

#### 7. ARTIFICIAL LIFT METHOD:

For expanding the rate of production artificial lift method could be considered by sub-surface facility study and method will be approved by client. The process data and well head pressure depending on project artificial lifting method.

#### 8. TURN DOWN RATIO

Production unit and facilities shall be capable to work at "Crude oil transfer pumps" Minimum flow.

#### 9. FEED AND PRODUCT

Specification of tie in lines, incorporating feed and products, has been summarized based on Phase-1 (fully development stage) production & will be submitted in P&ID'S.

Process conditions and specification at battery limits of this project will be submitted in PFD.  
Product Specification depends on process facility application and in early production gas shall be removed from live oil.

## 10. SOFTWARE

Aspen-HYSYS version 7.1 is used for the process simulation and Pipesim software (Version 2008.1) is used for pipeline simulation and hydraulic studies.

## 11. UNITS OF MEASUREMENT

SI or METRIC Units may be used for calculation; however, all final results shall be presented in SI units.  
All equipment specification, sizes, etc. which are issued for client's approval shall be in SI units.  
Process flow Diagrams and materials balances may be presented in SI Units.  
All piping sizes will be in English units.

Temperature	°C (°K)
Pressure	Barg, kpa (psig)
Weight (mass)	Kg (lb)
Volume (liquids)	m <sup>3</sup> (ft <sup>3</sup> )
Volume(gases)	Nm <sup>3</sup> or Sm <sup>3</sup> (ft <sup>3</sup> )
Density	kg/m <sup>3</sup>
Flow (liquids)	kg/h (lb/hr)
Water	m <sup>3</sup> /h (ft <sup>3</sup> /h)
Hydrocarbon Condensate or Liquid	STBD
Chemical	LPM
Flow (gases)	kg/h (lb/hr)
Natural gas	MMSCMD (MMSCFD)
Air/Nitrogen	m <sup>3</sup> /h, Nm <sup>3</sup> /h or Sm <sup>3</sup> /hr (ft <sup>3</sup> /h)
Power	kW
Heat transfer coefficient	W/m <sup>2</sup> .°C
Heat capacity (Specific Heat)	kJ/kg.°C
Thermal Conductivity	W/m.°C
Viscosity	CP
Length, Diameter	m or mm(In)
Pipe Sizes ,	In
Nozzle Sizes	In
Velocity	m/s
Heat Duty	kW
Enthalpy	kJ/kg
Flange Rating	lb
Voltage	V
Current	A
Impedance	Ohm
Capacitance	Farad
Other electrical units	See IEC



## 12. STANDARD CONDITION

Pressure: 1.013 Bara  
Temperature: 15.6 °C

## 13. NUMBERING PROCEDURE

Numbering of equipment, instrumentation equipment, line pipe and technical document must be based on IPS Standard or as per document: "Process Plant Identification and Numbering System"

## 14. PROCESS LIFE TIME

All equipments shall be designed for minimum service life of 30 years.

## 15. Distribution of Flow

All production wells shall be routed to the inlet manifold which shall be designed for Peak production rate by considering water cut .The base case for production plant is considering three phase separator, oil desalting facilities, oil stabilizer and H<sub>2</sub>S removal tower will be designed with a total oil liquids production rate. Gas and liquid transferring line shall be sized based on project requirement and criteria and liquid fluid will be send to boosting station & gas will be send to NGL 3200 by compression stage.

For process facilities, Flow lines, the planned guide capacity (PGC) shall be considered Min. 1.1 times planned guide rate (PGR). [PGC= PGR x (1.1~1.2)]

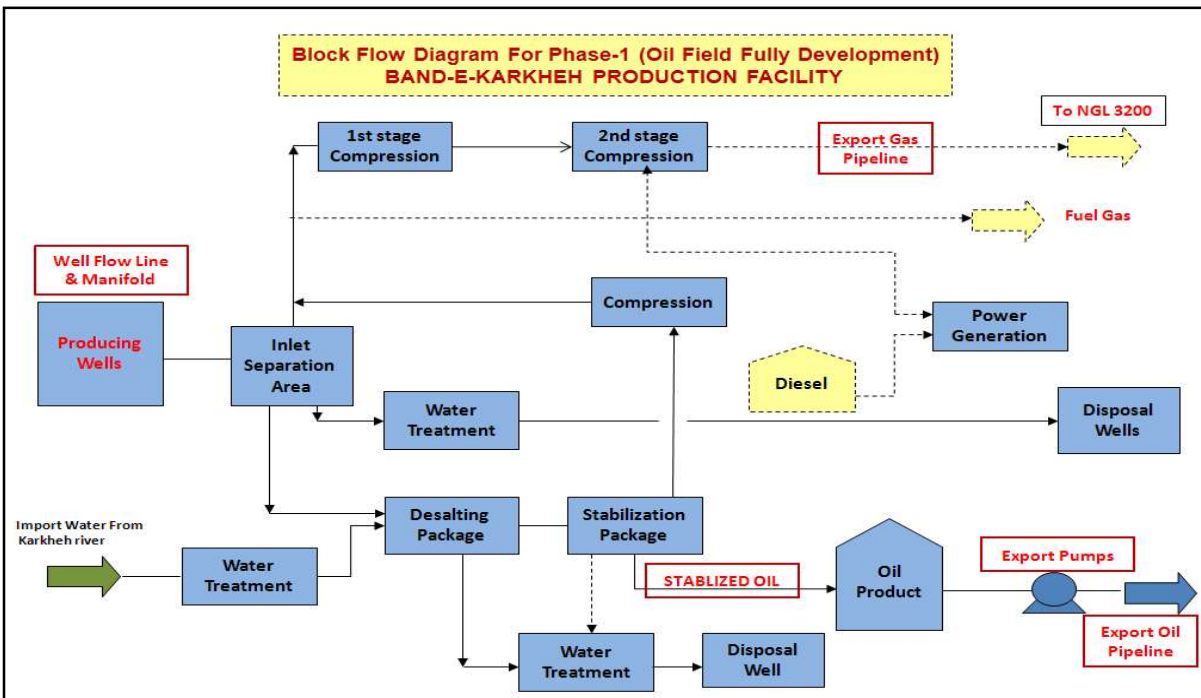


Figure 3: Block Flow Diagram

According to the well field configuration best case flow line study gathered case shall be implemented.

### 15.1 Unit brief identification:

#### Main Units:

Main unit which is called process unit and will be described as follow:

#### **Unit 10**

Including:

- Main Flow Line and Manifold
- Separation Area Including 1<sup>st</sup> & 2<sup>nd</sup> Separators & Test Separator
- Crude Desalting Package
- Crude Oil Stabilization Package
- Storage tanks
- Crude Oil Metering Package
- Main Pipeline and Launcher/Receiver Trap
- Hot oil package
- Gas Re-Pressurizing & Transportation Facilities
- Main Pipeline and Launcher/Receiver Trap
- Export Gas Metering Package Including Prover
- Fuel gas supply system
- chemical packages in Process plant

Off site utility facilities including of:

#### **Unit 20**

- Instrument air package
- Nitrogen package

#### **Unit 30**

- Raw Water / Potable Water supply & Treatment Package

#### **Unit 40**

- Produced Water Treatment Package

#### **Unit 50**

- Flare & Burn Pit Package
- Drainage System (Open & Close Drain System)

### 15.2 Unit Specification and Limitation:

#### 15.2.1 Overall:

- Plant oil production rate at normal case: **30,000 Stb/day**
- Predicted gas flow rate based on GOR at normal case :**7.5~8 MMSCFD**
- **PGR=1.1~1.2 x PGC**
- **Wells water cut=30%**
- **Production gathering system & process facilities will be supplied to NACE MR0175/ISO 15156 to cover any eventuality of souring of the reservoir or break through into the sourer Sarvak formation**
- **Chemical injection facilities are required on the wellhead and a separation area stage (study on type and dosing rate shall be finalized by vendor).**

#### 15.2.2 Oil and gas separator device:

For separation gas & water from oil two stage three phase separators is considered .plant stage consisted of stabilizer and storage tank. Separator pressure is considered based on **max.oil recovery** system and shall be specified in process flow diagram and related study.

Because of available water in entering fluid & high volume water cut it is recommended to consider three phase separator for 1<sup>st</sup> & 2<sup>nd</sup> stage .separator stage pressure is mentioned in process flow diagram by considering maximum recovery factor .all data shall be finalized in detail stage.

#### 15.2.3 Oil Treatment in Desalter specification

- Oil is dehydrated and salts removed in a min. 2 stage electrostatic Desalter (Finalized by Vendor).
- Salt in crude: **14 ppm**
- BS&W: **< 0.025% vol.**
- Water supply : **From Karkheh River**

#### 15.2.4 Oil Stabilization and H2S Removal Package:

- Reid Vapor Pressure (RVP): **< 8 Psia**
  - Residual H2S : **< 20 ppm (wt)**
- The RVP specification is the primary factor in sizing the stabilizer due to the low H<sub>2</sub>S content in the well fluids. However, it is noted that the stabilizer is currently designed to provide performance by considering sum of mole fraction of methane & ethane shall be set to zero in summer and winter case.
  - Hot oil is used to provide the required duty for the Reboiler. Further studies on the Asphaltenes will be required to determine maximum temperatures allowable to prevent cooking the Asphaltenes. Operating the stabilizer at a lower pressure could be considered during the detail stage phase. It is to note that experience and normal industry practices indicate that a maximum temperature of 210°C is possible before the Asphaltenes coke up the stabilizer.
  - Oil export will take the northern route around Ahvaz to GHARB Boosting station. Delivered pressure is considered to sink is min.150 Psig/max.:500 Psig , 30 psig). The oil will have an RVP & H<sub>2</sub>S specification.

#### 15.2.5 LP and HP Gas Compression

- The compressors stages are designed for the peak production rate resulting in a total associated gas rate of 6.5~8 MMSCFD (over design safety factor on flow rate is considered 20%) i.e. a rate of approximately 10 MMSCFD. Each compressor package including of suction scrubber, compressor, after cooler .The Gas Compressor & Driver Selection Study shall be finalized during detail stage.
- The pressure profile has been determined to provide compressor discharge temperatures which are predicted to be below the 150°C threshold that is generally accepted as ensuring reliable compressor operation.
- Compressor ratio shall be considered according to general design practice and IPS standard. Peak flow rate and gas compression power requirements have been established for the LP and HP Compressors based on the 'Hysys' process simulation data. A single operating case has been considered for the sizing and selection of the compressors, this being based on the plateau oil production.

- Necessity of H<sub>2</sub>S removal system or package in production plant shall be finalized by client during detail stage. At this project delivered gas is considered NGL 3200. Delivered pressure is considered to sink is min.650 Psig/max.:700 Psig

#### 15.2.6 Test separator:

- Test separators shall be installed at the CPF to enable testing all the production wells individually.

#### 15.2.7 Produced Water Specification

- Produced water and wastewater shall be re-injected into the Ilam and/or Asmari reservoir for disposal. No. of disposal wells depend on reservoir study and criteria. The oil in water specification for produced water disposal is <40 mg/l. Treatment package and specification shall be accordance to environmental limitation and reservoir specification
- The produced water will be disposed of separately to the wastewater until further tests have been carried out to determine any potential scaling problems.

#### 15.2.8 Tankage Area:

- Oil after stabilizing shall be reserved into storage tank for reservation. At current stage oil will be send to GHARB boosting station via. Pump and related pipeline.
- No. of storage and capacity shall be finalized by client during detail stage.

#### 15.2.9 Chemical Injection package and specification:

Appropriated chemical injection for likely wax, Asphaltenes, scales,... Is considered based on UFD diagrams and injected to appropriated location. Type, dosing rate, process specification and volume shall be finalized by package supplier.

### 16. UTILITY CONDITIONS

#### 16.1 Fire Water

Fire water tank with related safety system is considered for fully development phase with below consideration:

Fire water will be supplied from Karkheh River. Raw water flows from well to the fire water tank.

- **Supply Pressure, (Barg):** 10-10.5
- **Design Pressure, (Barg):** 12.5
- **Design Temperature, (°C):** 85

#### 16.2 Instrument and plant air

A new instrument and utility air system is required. The consumption of the instrument and utility air on Band-E-Karkheh fully development phase is mainly for instrumentation and also pneumatic systems.

Instrument and Plant air will be supplied by air compressor package that shall be considered for this unit.

Compressed air package for this unit including air filter, air compressor (oil free), after cooler, air receiver, air drier package and controls will be supplied with following condition:

Table 13: Potable Water Properties

	Instrument air	Plant air
Max. Supply temperature,(°C)	65	65
Min pressure;(Barg)	6	6
Normal pressure; (Barg)	8	7.5
Max. pressure;(Barg)	10	10
Max allowable working Temperature, (°C)	150	150
Max allowable working Pressure, (Barg)	10	10

Oil free air shall be provided for both instrument and service system, 15 minutes hold-up for air is provided during electric Power failure.

The Compressed air is required in the complex for following usages:-

- As Instrument Air
- As Plant Air for regeneration and other users.
- As Service Air for hose stations and for other requirements of the complex.

Compressed air required for all of the above uses is generated at a centralized location in the plant and distributed to the various users through headers. There will be a common surge/knock-out drum for both plant and instrument air in the compressed air system.

Ambient air conditions for design of air compressors are as above table (site condition).

The dew point of the instrument air downstream the Air dryers must be -40°C at standard conditions.

### 16.3 Nitrogen

Usage is intermittent consumption for purging, blanketing during start-up/shut-down periods or maintenance activities.

Nitrogen will be supplied by bottle or process package depend on process requirement .type of process package or QTY of N<sub>2</sub> bottle shall be studied by EPC contractor.

Below criteria and limitation should be considered for selection and design of package:

<b>Oxygen content</b>	10 ppmv max.
<b>Carbon dioxide content</b>	1 ppmv max.
<b>Water content</b>	1 ppmv max.
<b>Oil content</b>	0 ppmv max.
<b>Other hydrocarbons</b>	0 ppmv max.
<b>Temperature normal</b>	Amb.
<b>Design</b>	-4/ 85°C for all parts exposed to solar radiation
<b>Pressure Design</b>	max./nor./min.: 12 Barg/ 9 Barg/ 8 Barg
<b>Max. Allowable pressure drop</b>	1.3 Bar for whole package

### 16.4 Waste Water System

Required and allowable specification of effluent from waste water treatment system shall be as follows:

- **Diameter of solid:** below 10 micron
- **Oil in water:** 10 ppm
- **SRB:** 10#/mlit

Treated water must be injected to disposal wells which are defined by subsurface facility study. Injection flow rate considered based on heat and material balance & max. Required well head pressure of water injection to wells shall be finalized in detail stage by EPC contractor. The produced water and wash water are treated and disposed of down disposal wells. It is currently

unknown whether the waters are compatible. In order to avoid potential scaling and blocking of the disposal wells as a base case the water will be treated separately and disposed of in different wells.

#### 16.5 Potable & Service Water

The raw water flows from Karkheh River to the water treatment package which is installed in production & desalting unit for providing potable water according to W.H.O standard is considered.

Fresh water will be supplied from Karkheh River. Information on the quality of water from the Karkheh River and the amount of treatment required shall be finalized during Detail Stage. The water will be delivered to the CPF using a pumping station located at the river. Preliminary treatment has been provided as part of the detail engineering study and includes a reverse osmosis package, vacuum de-aeration package and Ultra Violet (UV) ozonation package.

Service & plant waters are provided from fresh water tank which is considered in process plant.

#### 16.6 Flare System

New LP&HP flare stack will be supplied for this unit & compression unit for emergency flaring of hydrocarbons. Flare system are included flare K.O. drum, flare ignition system and flare stack.

#### 16.7 Chemical Package

Chemical considered in this project consist of according to below items:

- Corrosion/Scale Inhibitor Package
- Wax & Asphaltting Inhibitor Package
- Demulsifier Package
- DRA Injection Package

Detail of chemical package and dosing rate shall be studied by vendor supplier at detail stage.

- For Desalter package required chemical package shall be finalized by vendor such as oxygen scavenger, biocide, anti-foam, scale inhibitor, h/c soluble

#### 16.8 Fuel gas

Fuel Gas will be supplied from separated gas in 1<sup>st</sup> stage separator (llam separator) and other facilities shall be considered.

For backup system fuel gas cylinders with appropriate device shall be considered for flare & burn pit package ignition system and flare purging backup.

QTY and volume of cylinders shall be finalized during detailed design based on vendor data.

#### 16.9 Fuel Oil System

Fuel oil is required for providing diesel power generation to emergency and essential equipment when the normal power supply is not available and for diesel fire water pumps.

#### 16.10 Closed and Open Drains

A closed drain system will be provided to collect hydrocarbon liquids drains. Any gas purged and relieved sends to flare k.o drums

Oil in off-spec storage tank will be recycled to the process.

Open drains have been provided for maintenance and wash water. These are collected and routed to the water treatment facilities or API separator.

#### 16.11 Hot oil package:

The heating medium used is assumed to be hot oil in order to provide the required duty for the in stabilizer Reboiler.

Based on process simulation required hot oil flow rate and duty shall be studied by considering reaching the process specification in tower and oil outlet stream such as RVP & H<sub>2</sub>S concentration.

Hot oil package detail shall be finalized by vendor supplier.

For calculating the total required Oil, the following consumptions are considered:

- Boiling point of oil shall be higher than 250°C
- Heat capacity of oil is considered 2.8 Kj/Kg.°C
- The maximum oil rate is depending on required Reboiler duty which is mentioned in process duty spec and H&M.
- About 40% over design factor is used for oil system calculation.

All of these data shall be finalized during detail design phase by EPC Contractor/ Hot oil package Vendor.

#### 16.12 Control System

A control system using equipment proven in the international oil industry will be used for the field. This system will be based upon the use of smart field devices for both process control and safety systems, with dedicated controllers/logic solvers for each function, i.e. DCS controller subsystem for Process Control, redundant PLCs for ESD. This will provide commonality of spares across project control and safety devices, enhanced diagnostics for maintenance, and familiarity for maintenance personnel.

The DCS will be housed in a number of field equipment rooms which are connected by both ESD and process control networks to the central control room at the DCS

#### 16.13 Power Generation

Required power will be supply by client from power network and it is not required to consider power generation plant which is installed in the process plant.

The power rate will be specified in process load list and finalized by client.

Additionally an emergency diesel generator shall also be provided for emergency condition

#### 16.14 Electricity

The following voltage levels shall be selected for the electrical system at rated frequency of 50 Hz. Electrical equipments shall be anyway suitable for operation with voltage variations ranging within  $\pm 5\%$  of rated values. AC electrical equipment shall be anyway suitable for operation with frequency variations ranging within  $\pm 5\%$  of rated values.

The applicable voltage levels, frequencies and neutral systems shall be as follows:

- MV power system: 6 kV
- MV distribution system: 6 kV
- Emergency Generation System: 400 V
- Motors up to 150 kW (included): 400 V ,3 ph ,3 wires
- Motors above 150 kW: 6 kV ,3ph ,3 wire

- Motors less than 0,37kW:230 V ,1ph ,2 wires
- Instruments (critical supply from ups): 230 ,50 HZ
- Lighting system and outlets: 230\400 V,50 HZ
- Safety lights in MV substation: 110 VDC (+10%, -15%)
- Safety lights in other areas: 230\400 V ,50 HZ, 3/5 wires
- Communication system: 230 V 1ph, 50 HZ
- Electrical control and protections of MV switchgears: 110 VDC (+10%, -15%)
- Electrical control of 400 V motor starters: 230V ,50 HZ

## 17. ENVIRONMENTAL ASPECTS

### 17.1 Environmental Noise Limit

Environmental noise limits are generally different depending on the time of day. The more stringent of the two different time periods shall be the basis of the design since the operating mode of the plant does not change between the day and night.

Table 14: Noise limits summary

Total Noise limit -Leq		
Category of zoning	Daytime(dBA) (7am-10pm)	Night Time(dBA) (10pm-7am)
Residential	55	45
Industrial	80	80

The limits taken as reference for this project are those underlined in the table above. Consequently as an alternative, the noise level at the plant fence shall not exceed 75 dBA.

### 17.2 Emission to air limitations

Based on Iranian Petroleum Standard (Engineering Standard for Air Pollution Control), for emission limits the following figures can be considered:

Table 15: Emission to air limitations

Pollutant		
H2S	10 mg/m3	6.62 ppm
Carbon monoxide 150 ppm	0.1 (vol %)	150 ppm
Sulfur oxide	0.2 (vol %)	800 ppm
Particles	50 (mg/m3)	-
Hydrocarbons	20% opacity	-
Photochemical	30 mg/m3	-
Non photochemical	300 mg/m3	-
Nitrogen Oxides	-	210 ppm