Process Design Basis (Basic)

REV.	Date	Purpose of Issue	ORIG.	BY	PREP'D	CHECK'D	APP'D	COMPANY APP'D
					H.H	F.M	M.A.	
02	21-Nov-2021	Issued For Approval	IOEC	-	H.H.	F.M.	M.A.	
01	12-July-2021	Issued For Approval	IOEC	-	H.H.	A.B.	M.A.	-
00	3-Dec-2020	Issued For Comment	IOEC	-	H.H.	A.B.	M.A.	-

TABULATION OF REVISED PAGES

Sheet	Revisions					
	00	01	02	03	04	05
1	X	X	X			
2	X	X	X			
3	X	X	X			
4	X		X			
5	X					
6	X	X				
7	X	X				
8	X					
9	X					
10	X		X			
11	X		X			
12	X		X			
13	X					
14	X		X			
15	X					
16	X					
17		X				
18		X	X			
19			X			

Sheet	Revisions					
	00	01	02	03	04	05

Sheet	Revisions					
	00	01	02	03	04	05

REVISION RECORD SHEET

REV. NO.	PURPOSE	LIST OF UPDATED MODIFIED SECTIONS IF ANY
00	Issued For Comment	
01	Issued For Approval	
02	Issued For Approval	Sections 7.1 , 7.2, 8, 9.3 & 9.6 revised based on OWNER comments

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1. INTRODUCTION

1.1. Development Overview

The Resalat Field previously known as Rakhsh Field, is located in the Persian Gulf, some 80 km to the South of Lavan Island, in water depth of 65-75 meters. The facilities which were originally developed in 1968 have sustained some damage due to the Iran/Iraq war and adverse climate conditions thereafter.

To increase oil production capacity from this field (adding 12,000 stock barrels per day to current production), Iranian Offshore Oil Company (IOOC) has defined new project which includes Engineering, Drilling, Procurement, Construction for following items:

- New satellite Wellhead Platform (WHP1) with totally nine (9) conductor slots.
- Development and renovation of Existing offshore complex consist of new power generation, control system, HVAC, Electrical /control room, electrical panels(LV &MV),process & utility piping, and all necessary activities which shall be done for connection to existing facilities(Tie in requirements)
- Drilling of two new production wells in R1 and three wells in WHP1 platform and Re-entry and work-over of one existing well in R1 platform.
- One 10" productions submarine pipeline from WHP1 to PP and a single submarine cable (power and data) from SP to WHP1
- Inspection, Strengthening, Modification and Repair of existing R1 complex Jackets and topsides and replacement of boatlanding and Barge Bumpers.

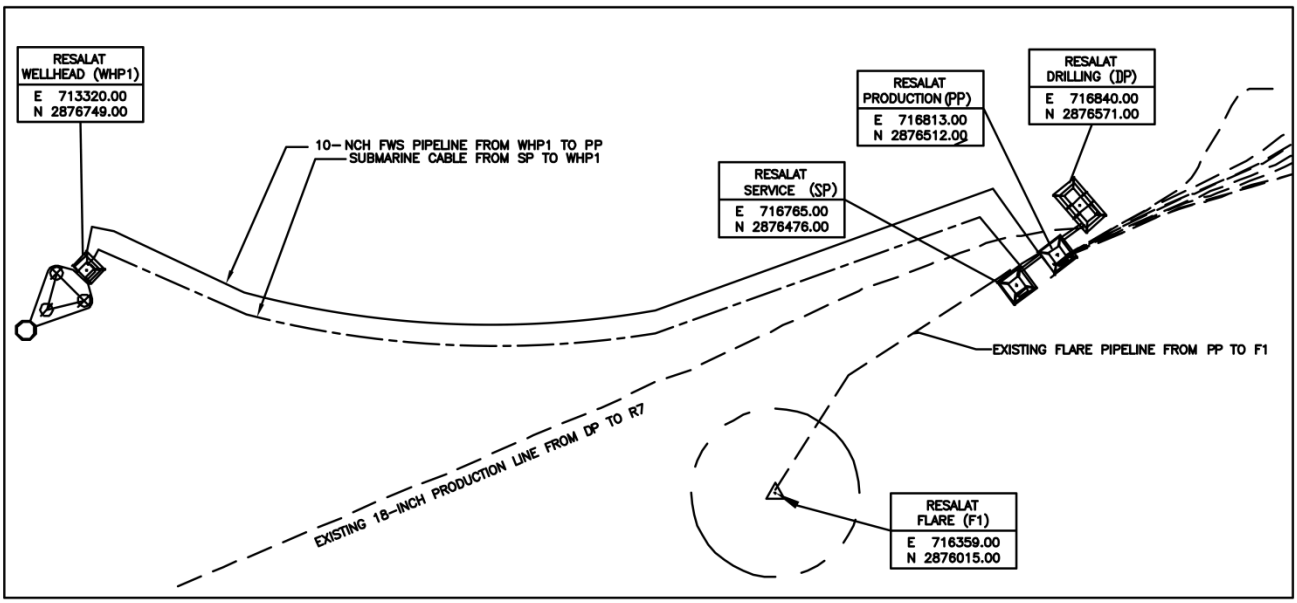

Figure 1: Resalat Development Field Layout (Datum ED 77, Zone 39, Cent. Meridian 51° East)

1.2. Purpose of Scope

This document is intended to summarize general project information, site conditions and engineering design basis which are implemented in design of Resalat Oil Field Development Project Phase 1.

1.3. Definitions

PROJECT	Resalat Oil Field Development – Phase 1
COMPANY	Iranian Offshore Oil Company (IOOC)
CONTRACTOR	Consortium of Iranian Offshore Engineering and Construction Company (IOEC) and Intelligent Solutions Inc. (ISI)
SUB-CONTRACTOR	Tehran Raymand Consulting Engineers (TRCE)
PURCHASER	Any firm who buy services, material and/or equipment for execution of the project within a dedicated contract.
SUPPLIER	Any vendor, manufacturer who supply any Service, Material or Equipment for the project
SHALL	Refer to a mandatory requirement
SHOULD	Refer to a recommendation
MAY	Refer to one acceptable course of action

2. CODES AND STANDARDS

In design of the Project all of the IPS standards relevant to process must be considered. For more information refer to List of Applicable Codes and Standards (Doc. No.: LRSL-000-PM-LI-743).

3. REFERENCE DOCUMENTS

List of Applicable Codes and Standards	LRSL-000-PM-LI-743

4. ABBREVIATIONS

MDEA	N-Methyl-di Ethanolamine

MMSCFD	Million Standard Cubic Feet per Day
ppm	Part per million

5. ENGINEERING DIMENSION UNITS

The base unit of measurements is Metric system by default excepted for lines and nozzles diameters, explained in inches (NPS). For gas flow rate MMSCFD is used beside SI unit.

Table 1. Unit of measurements

Parameter	Units
Temperature	°C
Pressure (gauge)	bar (g) psig
Pressure (absolute)	bar (a), psia
Pressure (Draft-vacuum)	mm H2O(a) or mm Hg (a)
Pressure Drop	bar
Mass	kg or tons
Volume	m^3
Length	mm for equipment dimension
	in. for pipe and nozzles diameter
Enthalpy	kJ/kg
Heat Rate	MW
Heat transfer Coefficient	$kW/(m^2.°C)$
Electrical Power	kW
Dynamic Viscosity	cP or mPa.s
Kinematic Viscosity	Cst or mm^2/s
Thermal Conductivity	kJ/h.m.°C
Heat Capacity	kJ/kg.°C
Latent Heat	kJ/kg
Molecular Weight	kg/kmol
Velocity	m/s
Area	m^2
Noise	dB (A)
Liquid Phase Concentration	mg/L, ppm wt
Vapor phase Concentration	mg/L, ppm vol
Surface Tension	mN/m

Note: Suffixes "a" and "g" is used to indicate if a given pressure is on an "absolute" or “gauge" basis.

Normal and standard conditions are given hereafter:

Normal Conditions	0°C – 1.013 bar
Standard Conditions	15.6°C – 1.013 bar

6. SOFTWARE

The package of Aspen Engineering Suite software will be used for process related simulations during Basic stage. Following parts of this package will be selected:

- Process Simulation:

  Aspen HYSYS V.10
- Flare Network Simulation:

  Aspen Flare System Analyzer V.10
- Heat Exchanger Simulation:

  Aspen Exchanger Design and Rating V.10

7. GENERAL & SITE CONDITION

7.1. Site Location

Resalat Field is located in the Persian Gulf, approximately 80 kilometers to the South of Lavan Island, in water depths of **approximately 68** meters.

7.2. Environmental Data

Table 2. Environmental Data

Temperature Data	Maximum Sea Surface Temperature	38 °C
	Minimum Sea Surface Temperature	13 °C
	Mean Sea Surface Temperature	27.0 °C
	Maximum Mid-Water Temperature	33 °C
	Minimum Mid-Water Temperature	13 °C
	Mean Mid-Water Temperature	24°C
	Maximum Seabed Temperature	27.0 °C
	Minimum Seabed Temperature	**13** °C
	Mean Seabed Temperature	21.0 °C
	Maximum Air Temperature	45.0 °C
	Minimum Air Temperature	7.0 °C
	Mean Air Temperature (Winter/Summer)	23 °C/30 °C
	Equipment Exposed to Sunlight	85.0 °C

Barometric Data	**Maximum Barometric Pressure**	**1030 mbara**
	Normal Barometric Pressure	**1010 mbara**
	Minimum Barometric Pressure	**990 mbara**
Humidity Data	Minimum Relative Humidity	**50** %
	Maximum Relative Humidity	100 %
	Mean Relative Humidity	73%
Rain Fall Data	**Maximum Rainfall in Year**	**342.4 mm**
	Maximum Rainfall in Day	**121 mm**
	Maximum Rainfall in an hour	**150 mm**
Wind Speeds	Prevailing Wind Direction	**North to West**
	Design Velocity for Process	**15.5 m/s**
	Wind speed for flare radiation and dispersion calculations	13 m/s
	Maximum Wind speed for hydrogen supplied dispersion calculations	5 m/s
	Minimum Wind speed for hydrogen supplied dispersion calculations	1 m/s
Other Data	Water Depth of Resalat Complex and WHP1	**68 m** MLW
	Seismic Loads **(Seismic acceleration in X & Y direction)**	**0.14g**

7.3. Sea Water Characteristics and Analysis

Table 16.Sea Water Characteristics and Analysis

Specific gravity		**1.023**	
PH		**8.2**	
Viscosity		**1.05 cp**	
Resistovity at 20°C		**18 ohm.m**	
Total dissolved solids		**45.56 g/l**	
Total salt content		**37.41 g/l**	
Dissolved oxygen		**8 – 10 ppm**	
Suspended solids		**0.092 g/l**	
Ca^{2+}	**0.46 g/l**	**$SO4^{2-}$**	**3.21 g/l**
MG^{2+}	**1.53 g/l**	**HCO^{3-}**	**0.11 g/l**
$CO3^{2-}$	**0.02 g/l**	**Na^{+}**	**12.29 g/l**
CI^{+}	**22.65 g/l**	**Fe^{2+} / Ba^{2+}**	**Nil**

8. PROCESS DESIGN DATA

8.1. General Overview

The feedstock of the Gas Sweetening Unit (GSU) is Sour Gas from existing separation facilities. Sour gas is treated in an absorption column where it is contacted counter currently with lean MDEA in order to remove H2S. GSU also includes a regeneration section, where H2S are removed from Rich amine. The treated Gas from GSU is routed to the existing gas scrubbers for platform fuel gas usage. **Existing gas scrubbers operating pressure is 4.5 barg based on GSU outlet condition.**

8.2. Gas Sweetening Unit (GSU) Design Capacity

Inlet sour gas flow rate to the Gas Sweetening Unit (GSU) is 1.5 MMSCFD which is considered as design capacity. As per process design criteria, minimum 10% overdesign to be considered for equipment.

8.3. Feedstock and Battery Limit Conditions

8.3.1. Gas Sweetening Unit (GSU)

Feed gas composition at GSU inlet battery limit for design purposes is listed in the table hereafter.

Table 3 shows the gas composition from existing separators.

Table 3. Sour gas composition from existing separators

Feed Composition (mole fraction)	Nitrogen	0.0168
	CO2	0.0397
	Methane	0.6374
	Ethane	0.1421
	Propane	0.0911
	n-Butane	0.0375
	n-Pentane	0.0122
	n-Hexane	0.0050
	n-Heptane	0.0009
	n-Octane	0.0004
	n-Nonane	0.0002
	Resalat C10+*	0.0000600
	Dariyan C7+*	0.0000004
	Sarvak C7+*	0.0000001
	H2S	0.0063
	H2O	0.0103
	Total	1
	Mw (g/mole)	Density (kg/m^3)
Dariyan C7+	250	832
Sarvak C7+	271	895
C10+	149	737

As a design case H2S content has been considered 10000 ppm, Table 4 shows the normalized feed gas composition with 10000 ppm H2S Content.

During production by ESP, existing separator operates in 120-130 psig and during production by gas lifting, pressure is 185 psig. However, pressure at the inlet of the gas-sweetening unit will be kept at 110 psig by inlet pressure control valve.

Table 4. GSU inlet Sour gas composition-Design Case

Feed Composition (mole fraction)	Nitrogen	0.0167
	CO2	0.0395
	Methane	0.6351
	Ethane	0.1416
	Propane	0.0908
	n-Butane	0.0374
	n-Pentane	0.0122
	n-Hexane	0.0049
	n-Heptane	0.0009
	n-Octane	0.0004
	n-Nonane	0.0001
	Resalat C10+*	0.0000598
	Dariyan C7+*	0.0000004
	Sarvak C7+*	0.0000001
	H2S	0.0100
	H2O	0.0103
	Total	1
	Mw (g/mole)	**Density (kg/m³)**
Dariyan C7+	250	832
Sarvak C7+	271	895
C10+	149	737

Feed Battery limit conditions at GSU inlet are shown in table 5:

Table 5. GSU inlet sour gas conditions

Stream	Temperature (°C)	Pressure (psig)
Inlet Sour Gas	45	110

8.3.2. Crude from WHP1

Oil from wellhead facilities in WHP1 is transferred by 10" pipeline to R1X and connected to new Pig Receiver at R1X complex, which will be connected to existing test and main separators. Fluid composition and condition at battery limit of pig receiver are shown in table 6, which is used for line sizing of new line in R1X.

Table 6. Pig Receiver inlet fluid composition

		year 1405	year 1401	year 1419
Gas Composition (Mole Fraction)	Methane	0.152	0.044	0.103
	Ethane	0.032	0.010	0.022
	Propane	0.021	0.013	0.013
	i-Butane	0.000	0.000	0.000
	n-Butane	0.011	0.012	0..0058
	i-Pentane	0.000	0.000	0.000
	n-Pentane	0.006	0.010	0.002
	n-Hexane	0.005	0.012	0.002
	n-Heptane	0.000	0.000	0.000
	n-Nonan	0.000	0.000	0.000
	n-Octane	0.000	0.000	0.000
	C7+ (Upper Sarvak)	0.028	0.107	0.009
	C7+ (Arab C)	0.000	0.000	0.000
	C7+ (Dariyan)	0.023	0.036	0.003
	Nitrogen	0.003	0.003	0.002
	CO2	0.010	0.001	0.007
	H2S	0.001	0.000	0.001
	H2O	0.707	0.753	0.830

	Mw (g/mole)	Density (kg/m^3)
C7+ (Upper Sarvak)	271.6	895
C7+ (Arab C)	215	875
C7+ (Dariyan)	249.7	832

Battery limit conditions at Pig Receiver inlet are shown in table 7:

Table 7. Pig Receiver inlet fluid conditions

	Temperature (°C)	Pressure (barg)
1405	**36.6**	**13.8**
1401	**33.7**	**10**
1419	**38.3**	**13.8**

8.3.3. Crude from new wells on DP

Crude from two new wells, ARK-18 and ARK-19, and also one re-entry well, ARK-04RE, on drilling platform in R1 complex is connected to existing manifold on drilling platform.

Table 8. Wellheads inlet fluid composition in year 1401

year 1401		ARK-18	ARK-19	ARK-04RE
Composition (Mole Fraction)	Methane	0.0636	0.0437	0.0240
	Ethane	0.0146	0.0112	0.0055
	Propane	0.0173	0.0191	0.0065
	n-Butane	0.0138	0.0246	0.0052
	n-Pentane	0.0126	0.0179	0.0048
	n-Hexane	0.0144	0.0264	0.0054
	n-Heptane	0.0000	0.0000	0.0000
	n-Octane	0.0000	0.0000	0.0000
	n-Nonane	0.0000	0.0000	0.0000
	Resalat C10+*	0.0000	0.0000	0.0000
	Dariyan C7+*	0.0000	0.2724	0.0000
	Sarvak C7+*	0.1778	0.0000	0.0672
	Nitrogen	0.0045	0.0011	0.0017
	CO2	0.0010	0.0010	0.0004
	H2S	0.0000	0.0000	0.0000
	H2O	0.6804	0.5827	0.8793

Table 9.Wellheads inlet fluid composition in year 1405

year 1405		ARK-18	ARK-19	ARK-04RE
Composition (Mole Fraction)	Methane	0.1428	0.3501	0.1259
	Ethane	0.0301	0.0741	0.0266
	Propane	0.0184	0.0478	0.0170
	n-Butane	0.0082	0.0260	0.0081
	n-Pentane	0.0036	0.0122	0.0041
	n-Hexane	0.0026	0.0127	0.0034
	n-Heptane	0.0001	0.0002	0.0001
	n-Octane	0.0000	0.0001	0.0000
	n-Nonane	0.0000	0.0000	0.0000
	Resalat C10+*	0.0000	0.0000	0.0000
	Dariyan C7+*	0.0000	0.1073	0.0000
	Sarvak C7+*	0.0209	0.0000	0.0323
	Nitrogen	0.0029	0.0063	0.0028
	CO2	0.0093	0.0230	0.0080
	H2S	0.0013	0.0032	0.0011
	H2O	0.7597	0.3369	0.7705

Table 10. Wellheads inlet fluid composition in year 1419

year 1419		ARK-18	ARK-19	ARK-04RE
Composition (Mole Fraction)	Methane	0.1196	0.2736	0.0841
	Ethane	0.0251	0.0575	0.0177
	Propane	0.0148	0.0341	0.0107
	n-Butane	0.0063	0.0150	0.0047
	n-Pentane	0.0023	0.0055	0.0019
	n-Hexane	0.0014	0.0038	0.0013
	n-Heptane	0.0001	0.0002	0.0001
	n-Octane	0.0000	0.0001	0.0000
	n-Nonane	0.0000	0.0000	0.0000
	Resalat C10+*	0.0000	0.0000	0.0000
	Dariyan C7+*	0.0000	0.0194	0.0000
	Sarvak C7+*	0.0068	0.0000	0.0092
	Nitrogen	0.0022	0.0049	0.0017
	CO2	0.0080	0.0185	0.0056
	H2S	0.0011	0.0026	0.0008
	H2O	0.8121	0.5649	0.8623

8.4. Process Turn Down Requirement

The minimum possible operating capability (turndown) is 40% of design capacity.

8.5. Product Specification

H2S content in Produced sweet gas from Gas Sweetening Unit shall be less than 10 ppm.

8.6. Sparing philosophy

For rotary equipment, following philosophy should be considered:

Table 11. Spare philosophy

Number of equipment normally in service	Spare number
1 x 100%	1 x 100%
2 x 50%	1 x 50%
3 x 33%	1 x 33%
4 x 25%	2 x 25%
5 x 20%	2 x 20%

8.7. Design life time

Design life time for the units should be 25 years.

8.8. Gas lift condition and composition

After years 1405, production will be performed by gas lifting process instead of ESPs composition of gas for gas lift is presented in below table 12

Table 12.. Gas lift fluid composition

Composition		Mole percent
Composition (Mole Fraction)	Methane	0.6671
	Ethane	0.1398
	Propane	0.0807
	n-Butane	0.0327
	n-Pentane	0.0103
	n-Hexane	0.0047
	n-Heptane	0.0005
	n-Octane	0.0002
	n-Nonane	0.0001
	Nitrogen	0.0118
	CO2	0.0454
	H2S	0.0064
	H2O	0.0001

9. UTILITIES

9.1. Fuel Gas

Fuel gas composition which is used mainly as fuel of furnace is presented in below table:

Table 13. Fuel gas composition

Fuel Gas Composition (mole fraction)	Methane	0.6335
	Ethane	0.1412
	Propane	0.0905
	n-Butane	0.0373
	n-Pentane	0.0122
	n-Hexane	0.0049
	n-Heptane	0.0009
	n-Octane	0.0004
	n-Nonane	0.0001
	Resalat C10+*	0.0000484
	Dariyan C7+*	0.0000000
	Sarvak C7+*	0.0000000
	Nitrogen	0.0167
	CO2	0.0292
	H2S	10 ppm(max)
	H2O	0.0330

Table 14. Fuel gas condition

System	Pressure (brag)		Temperature (°C)	
	Normal	Design	Normal	Design
Fuel Gas	**4.5(*)**	7 **(**)**	60	85

*** Based on GSU outlet conditions** **** to be finalized in detail design.**

9.2. Instrument Air

Instrument air for gas sweetening unit is supplied by existing instrument air system the following condition:

Table 15. Instrument Air condition

System	Pressure (brag)			Temperature (°C)	
	Min / Normal	Max / Max Working	Design	Normal	Design
Instrument Air	4/5	6/9	11	20 ~ 35	85

9.3. Demineralized Water

Demineralized water is used mainly as make-up water for GSU. Which is supplied from outside of the R1 complex and stored at Demineralized water tank.

Recommended water quality specification for the make-up is:

Table 16. Recommended demineralized water quality specification

Demineralized Water		Process Design
Oxygen Content	mg/l	< 0.05
Chloride Content	mg/l	< 1.0
Resistivity	Ohm.cm	> 300.0
Total saltiness	mg/l	2500

Operating and design conditions of demineralized water are:

Table 17. Demineralized water condition

System	Pressure (brag)		Temperature (°C)	
	Normal	Design	Normal	Design
DMW	**4**	**8.5**	AMB	85

9.4. Nitrogen

Nitrogen is considered for the usage of gas blanketing. Nitrogen is supplied by nitrogen bottle from outside of the R1 complex. (To be finalized later)

Table 18. Nitrogen condition

System	Pressure (brag)		Temperature (°C)	
	Normal	Design	Normal	Design
Nitrogen	5	7	AMB	85

9.5. Flare System

Acid gas is sent to existing flare system and mixed with other sour gas in the network and then routed to existing flare stack. **Acid gas is routed to existing 12" sub-header which is connected to the existing 18" main header.** Maximum operating pressure and design pressure are **0.3** barg and 3.5 respectively.