|  |
| --- |
| **طرح نگهداشت و افزایش تولید 27 مخزن** |
| **CALCULATION BOOK FOR (CV,PSV,PUMP&LINE SIZING)-EXTENSIION OF BINAK B/C MANIFOLD** **نگهداشت و افزایش تولید میدان نفتی بینک** |
|  |  |  |  |  |  |  |
| D03 | OCT.2023 | IFA | M.Aryafar | M.Fakharian | S.Faramarzpour |  |
| D02 | OCT.2022 | IFA | M.Aryafar | M.Fakharian | M.Mehrshad |  |
| D01 | AUG.2022 | IFA | M.Aryafar | M.Fakharian | M.Mehrshad |  |
| D00 | FEB. 2022 | IFC | M.Aryafar | M.Fakharian | M.Mehrshad |  |
| **Rev.** | **Date** | **Purpose of Issue/Status** | **Prepared by:** | **Checked by:** | **Approved by:** | **CLIENT Approval** |
| **Class: 2** | **CLIENT Doc. Number: F0Z-707918** |
| **Status:** | **IDC: Inter-Discipline Check****IFC: Issued For Comment** **IFA: Issued For Approval****AFD: Approved For Design** **AFC: Approved For Construction** **AFP: Approved For Purchase****AFQ:** Approved For Quotation **IFI: Issued For Information****AB-R: As-Built for CLIENT Review** **AB-A: As-Built –Approved** |

**REVISION RECORD SHEET**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **PAGE** | **D00** | **D01** | **D02** | **D03** | **D04** |  | **PAGE** | **D00** | **D01** | **D02** | **D03** | **D04** |
| **1** | X | X | X | X |  | **66** |  |  |  |  |  |
| **2** | X | X | X | X |  | **67** |  |  |  |  |  |
| **3** | X |  |  |  |  | **68** |  |  |  |  |  |
| **4** | X |  |  |  |  | **69** |  |  |  |  |  |
| **5** | X |  |  |  |  | **70** |  |  |  |  |  |
| **6** | X | X | X | X |  | **71** |  |  |  |  |  |
| **7** | X | X | X | X |  | **72** |  |  |  |  |  |
| **8** | X | X | X | X |  | **73** |  |  |  |  |  |
| **9** | X | X | X | X |  | **74** |  |  |  |  |  |
| **10** | X | X | X | X |  | **75** |  |  |  |  |  |
| **11** | X | X | X | X |  | **76** |  |  |  |  |  |
| **12** | X | X | X | X |  | **77** |  |  |  |  |  |
| **13** | X | X | X |  |  | **78** |  |  |  |  |  |
| **14** | X | X | X |  |  | **79** |  |  |  |  |  |
| **15** | X | X | X |  |  | **80** |  |  |  |  |  |
| **16** | X | X | X |  |  | **81** |  |  |  |  |  |
| **17** | X | X | X |  |  | **82** |  |  |  |  |  |
| **18** | X | X | X |  |  | **83** |  |  |  |  |  |
| **19** | X | X | X |  |  | **84** |  |  |  |  |  |
| **20** | X | X | X |  |  | **85** |  |  |  |  |  |
| **21** | X | X | X |  |  | **86** |  |  |  |  |  |
| **22** | X | X | X |  |  | **87** |  |  |  |  |  |
| **23** | X | X | X |  |  | **88** |  |  |  |  |  |
| **24** | X | X | X |  |  | **89** |  |  |  |  |  |
| **25** | X | X | X |  |  | **90** |  |  |  |  |  |
| **26** | X | X | X |  |  | **91** |  |  |  |  |  |
| **27** | X | X | X |  |  | **92** |  |  |  |  |  |
| **28** |  |  |  |  |  | **93** |  |  |  |  |  |
| **29** |  |  |  |  |  | **94** |  |  |  |  |  |
| **30** |  |  |  |  |  | **95** |  |  |  |  |  |
| **31** |  |  |  |  |  | **96** |  |  |  |  |  |
| **32** |  |  |  |  |  | **97** |  |  |  |  |  |
| **33** |  |  |  |  |  | **98** |  |  |  |  |  |
| **34** |  |  |  |  |  | **99** |  |  |  |  |  |
| **35** |  |  |  |  |  | **100** |  |  |  |  |  |
| **36** |  |  |  |  |  | **101** |  |  |  |  |  |
| **37** |  |  |  |  |  | **102** |  |  |  |  |  |
| **38** |  |  |  |  |  | **103** |  |  |  |  |  |
| **39** |  |  |  |  |  | **104** |  |  |  |  |  |
| **40** |  |  |  |  |  | **105** |  |  |  |  |  |
| **41** |  |  |  |  |  | **106** |  |  |  |  |  |
| **42** |  |  |  |  |  | **107** |  |  |  |  |  |
| **43** |  |  |  |  |  | **108** |  |  |  |  |  |
| **44** |  |  |  |  |  | **109** |  |  |  |  |  |
| **45** |  |  |  |  |  | **110** |  |  |  |  |  |
| **46** |  |  |  |  |  | **111** |  |  |  |  |  |
| **47** |  |  |  |  |  | **112** |  |  |  |  |  |
| **48** |  |  |  |  |  | **113** |  |  |  |  |  |
| **49** |  |  |  |  |  | **114** |  |  |  |  |  |
| **50** |  |  |  |  |  | **115** |  |  |  |  |  |
| **51** |  |  |  |  |  | **116** |  |  |  |  |  |
| **52** |  |  |  |  |  | **117** |  |  |  |  |  |
| **53** |  |  |  |  |  | **118** |  |  |  |  |  |
| **54** |  |  |  |  |  | **119** |  |  |  |  |  |
| **55** |  |  |  |  |  | **120** |  |  |  |  |  |
| **56** |  |  |  |  |  | **121** |  |  |  |  |  |
| **57** |  |  |  |  |  | **122** |  |  |  |  |  |
| **58** |  |  |  |  |  | **123** |  |  |  |  |  |
| **59** |  |  |  |  |  | **124** |  |  |  |  |  |
| **60** |  |  |  |  |  | **125** |  |  |  |  |  |
| **61** |  |  |  |  |  | **126** |  |  |  |  |  |
| **62** |  |  |  |  |  | **127** |  |  |  |  |  |
| **63** |  |  |  |  |  | **128** |  |  |  |  |  |
| **64** |  |  |  |  |  | **129** |  |  |  |  |  |
| **65** |  |  |  |  |  | **130** |  |  |  |  |  |

**CONTENTS**

[1.0 INTRODUCTION 4](#_Toc92726567)

[2.0 Scope 5](#_Toc92726568)

[3.0 NORMATIVE REFERENCES 5](#_Toc92726569)

[3.1 Local Codes and Standards 5](#_Toc92726570)

[3.2 International Codes and Standards 5](#_Toc92726571)

[3.3 The Project Documents 5](#_Toc92726572)

[3.4 ENVIRONMENTAL DATA 5](#_Toc92726573)

[3.5 Order of Precedence 5](#_Toc92726574)

[4.0 CONTROL VALVE SIZING 6](#_Toc92726575)

[4.1 Software 6](#_Toc92726576)

[4.2 Case Study 6](#_Toc92726577)

[4.3 SIZING 6](#_Toc92726578)

[4.4 DETAILS OF CALCULATION RESULT 6](#_Toc92726580)

[ATTACHMENT 1 6](#_Toc92726581)

[5.0 PSV SIZING CALCULATION REPORT 7](#_Toc92726582)

[5.1 software 7](#_Toc92726583)

[ATTACHMENT 2 13](#_Toc92726584)

[6.0 PUMP CALCULATION REPORT 13](#_Toc92726585)

[ATTACHMENT 3 13](#_Toc92726586)

1. **INTRODUCTION**

Binak oilfield in Bushehr province is a part of the southern oilfields of Iran, is located 20 km northwest of Genaveh city.

With the aim of increasing production of oil from Binak oilfield, an EPC/EPD Project has been defined by NIOC/NISOC and awarded to Petro Iran Development Company (PEDCO). Also PEDCO (as General Contractor) has assigned the EPC-packages of the Project to "Hirgan Energy - Design and Inspection" JV.

As a part of the Project, construction of well location, access road, wellhead facilities (with electric power supply) for W007S shall be done. In addition, construction of new flowline from aforementioned well location to Binak B/C unit (with extension of relevant manifold) are in the Project scope of work.

**GENERAL DEFINITION**

The following terms shall be used in this document.

|  |  |
| --- | --- |
| CLIENT:  | National Iranian South Oilfields Company (NISOC)  |
| PROJECT: | Binak Oilfield Development – Construction of Well Location, Wellhead Facilities, Electrification Facilities, Flowlines for W007S and Extension of Binak B/C Manifold  |
| EPD/EPC CONTRACTOR (GC): | Petro Iran Development Company (PEDCO) |
| EPC CONTRACTOR: | Joint Venture of : Hirgan Energy – Design & Inspection(D&I) Companies |
| VENDOR: | The firm or person who will fabricate the equipment or material. |
| EXECUTOR:  | Executor is the party which carries out all or part of construction and/or commissioning for the project. |
| THIRD PARTY INSPECTOR (TPI): | The firm appointed by EPD/EPC CONTRACTOR (GC) and approved by CLIENT (in writing) for the inspection of goods. |
| SHALL: | Is used where a provision is mandatory. |
| SHOULD: | Is used where a provision is advisory only. |
| WILL:  | Is normally used in connection with the action by CLIENT rather than by an EPC/EPD CONTRACTOR, supplier or VENDOR. |
| MAY:  | Is used where a provision is completely discretionary. |

1. **Scope**

This document covers calculation report such as Pump Calculation, PSV Sizing and Control Valve Calculation for Extension of Binak Manifold.

1. **NORMATIVE REFERENCES**

## Local Codes and Standards

* IPS-E-IN-160 Engineering Standard for Control Valves
* IPS-M-IN-160 Material Standard for Control Valves
* IPS-E-PR-830 Process design of valves and control valves
* IPS-E-PR-450 Process Design Of Pressure Relieving systems inclusive safety relief valves
* IPS-E-PR-460 Process Design Of Flare And Blowdown Systems

## International Codes and Standards

* API RP 553 Refinery Valves and Accessories for Control and Safety Instrumented Systems
* API-STD-520 Sizing, Selection and Installation of Pressure Relieving Devices in Refineries, Part 1-Sizing and Selection
* API-STD-521 Pressure Relieving and Depressuring Systems
* API-STD-526 Flanged Steel Pressure Relief Valves

## The Project Documents

* BK-GNRAL-PEDCO-000-PR-DB-0001 Process Basis of Design
* BK-GNRAL-PEDCO-000-PR-DC-0001 Process Design Criteria

## ENVIRONMENTAL DATA

Refer to "Process Basis of Design; Doc. No. BK-GNRAL-PEDCO-000-PR-DB-0001"

## Order of Precedence

In case of any conflict between the contents of this document or any discrepancy between this document and other project documents or reference standards, this issue must be reported to the CLIENT. The final decision in this situation will be made by CLIENT.

1. **CONTROL VALVE SIZING**

## Software

* The software using for sizing Control Valves is Fisher.

## Case Study

 Three cases have been considered for control valve sizing:

* Case 1: Maximum operating flow is equal to 110% of normal operating flow.
* Case 2: Normal operating flow.
* Case 3: Minimum operating flow is equal to min operating flow

Note: It should be noted that the special conditions, related to each control valve is taken into account.

## SIZING

D03

* The below table contains the details sizing for the control vales that installed in Manifold.



## DETAILS OF CALCULATION RESULT

**ATTACHMENT 1**

**(SOFTWARE RESULT)**

1. **PSV SIZING CALCULATION REPORT**

## software

The software using for sizing Pressure safety valve is valve star. Pressure safety valve sizing report have been reported as following attachment.

|  |  |  |
| --- | --- | --- |
| PSV No. | PRV-1701A | PRV-1701A |
| Service | CRUDE OILD03 | CRUDE OIL |
| Fire | YES | - |
| Block outlet  | - | YES |
| Fluid & State | GAS & OIL / 2 PHASE | GAS & OIL / 2 PHASE |
| Operating Pressure (Barg) | 12.78 | 12.78 |
| Normal Temperature (°C) | 46.19 | 46.19 |
| P set, Barg | 93 | 93 |
| Required massflow (kg/hr) | 2094 | 11347.034 |
| Specific Heat Ratio (Cp/Cv) | 1.005 | 1.005 |
| Molecular Weight (kg/Kmol) | 77.41 | 77.41 |
| Compressibility Factor  | - | - |
| Total Back Pressure ( Bar ) | 1.5 | 1.5 |
| Allowable Over Pressure (%) | 21 | 10 |
| Discharge area, cm2 | 1.53 | 1.539 |
| Orifice Designation | D | E |
| Body size | 1” × 2” | 1” × 2” |
| P&ID Number | BK-W007S-PEDCO-110-PR-PI-0001 (3/6,4/6) | BK-W007S-PEDCO-110-PR-PI-0001 (3/6,4/6) |
| PSV No. | PRV-1701BD03 | PRV-1701B |
| Service | CRUDE OIL | CRUDE OIL |
| Fire | YES | - |
| Block outlet  | - | YES |
| Fluid & State | GAS & OIL / 2 PHASE | GAS & OIL / 2 PHASE |
| Operating Pressure (Barg) | 12.78 | 12.78 |
| Normal Temperature (°C) | 31.6 | 31.6 |
| P set, Barg | 93 | 93 |
| Required massflow (kg/hr) | 2161 | 17421.909 |
| Specific Heat Ratio (Cp/Cv) | 1.007 | 1.007 |
| Molecular Weight (kg/Kmol) | 39.09 | 39.09 |
| Compressibility Factor  | - | - |
| Total Back Pressure ( Bar ) | 1.5 | 1.5 |
| Allowable Over Pressure (%) | 21 | 10 |
| Discharge area, cm2 | 1.53 | 2.54 |
| Orifice Designation | D | F |
| Body size | 1 " × 2” | 1 1/2" × 2” |
| P&ID Number | BK-W007S-PEDCO-110-PR-PI-0001 (4/6) | BK-W007S-PEDCO-110-PR-PI-0001 (4/6) |

|  |  |  |
| --- | --- | --- |
| PSV No. | PRV-1701 C | PRV-1701C |
| ServiceD03 | CRUDE OIL | CRUDE OIL |
| Fire | YES | - |
| Block outlet  | - | YES |
| Fluid & State | GAS & OIL / 2 PHASE | GAS & OIL / 2 PHASE |
| Operating Pressure (Barg) | 12.78 | 12.78 |
| Normal Temperature (°C) | 46.19 | 46.19 |
| P set, Barg | 93 | 93 |
| Required massflow (kg/hr) | 2081 | 11347.034 |
| Specific Heat Ratio (Cp/Cv) | 1.005 | 1.005 |
| Molecular Weight (kg/Kmol) | 77.41 | 77.41 |
| Compressibility Factor  | - | - |
| Total Back Pressure ( Bar ) | 1.5 | 1.5 |
| Allowable Over Pressure (%) | 21 | 10 |
| Discharge area, cm2 | 1.53 | 1.539 |
| Orifice Designation | D | E |
| Body size | 1” × 2” | 1” × 2” |
| P&ID Number | BK-W007S-PEDCO-110-PR-PI-0001 (3/6,4/6) | BK-W007S-PEDCO-110-PR-PI-0001 (3/6,4/6) |

|  |  |  |
| --- | --- | --- |
| PSV No. | PRV-1701D | PRV-1701D |
| Service | CRUDE OILD03 | CRUDE OIL |
| Fire | YES | - |
| Block outlet  | - | YES |
| Fluid & State | GAS & OIL / 2 PHASE | GAS & OIL / 2 PHASE |
| Operating Pressure (Barg) | 12.78 | 12.78 |
| Normal Temperature (°C) | 44.41 | 44.41 |
| P set, Barg | 93 | 93 |
| Required massflow (kg/hr) | 2130 | 29036.515 |
| Specific Heat Ratio (Cp/Cv) | 1.007 | 1.007 |
| Molecular Weight (kg/Kmol) | 39.09 | 39.09 |
| Compressibility Factor  | - | - |
| Total Back Pressure ( Bar ) | 1.5 | 1.5 |
| Allowable Over Pressure (%) | 21 | 10 |
| Discharge area, cm2 | 1.53 | 3.97 |
| Orifice Designation | D | G |
| Body size | 1” × 2” | 1 1/2” × 3” |
| P&ID Number | BK-W007S-PEDCO-110-PR-PI-0001 (4/6,5/6) | BK-W007S-PEDCO-110-PR-PI-0001 (4/6,5/6) |

|  |  |  |
| --- | --- | --- |
| PSV No. | PRV-1701E | PRV-1701E |
| Service | CRUDE OILD03 | CRUDE OIL |
| Fire | YES | - |
| Block outlet  | - | YES |
| Fluid & State | GAS & OIL / 2 PHASE | GAS & OIL / 2 PHASE |
| Operating Pressure (Barg) | 12.78 | 12.78 |
| Normal Temperature (°C) | 44.41 | 44.41 |
| P set, Barg | 93 | 93 |
| Required massflow (kg/hr) | 2140 | 29036.515 |
| Specific Heat Ratio (Cp/Cv) | 1.007 | 1.007 |
| Molecular Weight (kg/Kmol) | 39.09 | 39.09 |
| Compressibility Factor  | - | - |
| Total Back Pressure ( Bar ) | 1.5 | 1.5 |
| Allowable Over Pressure (%) | 21 | 10 |
| Discharge area, cm2 | 1.53 | 3.97 |
| Orifice Designation | D | G |
| Body size | 1” × 2” | 1 1/2” × 3” |
| P&ID Number | BK-W007S-PEDCO-110-PR-PI-0001 (4/6,5/6) | BK-W007S-PEDCO-110-PR-PI-0001 (4/6,5/6) |

|  |  |  |
| --- | --- | --- |
| PSV No. | PRV-1701F | PRV-1701F |
| Service | CRUDE OILD03 | CRUDE OIL |
| Fire | YES | - |
| Block outlet  | - | YES |
| Fluid & State | GAS & OIL / 2 PHASE | GAS & OIL / 2 PHASE |
| Operating Pressure (Barg) | 12.78 | 12.78 |
| Normal Temperature (°C) | 41.77 | 41.77 |
| P set, Barg | 93 | 93 |
| Required massflow (kg/hr) | 2137 | 11614.606 |
| Specific Heat Ratio (Cp/Cv) | 1.007 | 1.007 |
| Molecular Weight (kg/Kmol) | 39.09 | 39.09 |
| Compressibility Factor  | - | - |
| Total Back Pressure ( Bar ) | 1.5 | 1.5 |
| Allowable Over Pressure (%) | 21 | 10 |
| Discharge area, cm2 | 1.53 | 1.539 |
| Orifice Designation | D | E |
| Body size | 1" × 2” | 1" × 2” |
| P&ID Number | BK-W007S-PEDCO-110-PR-PI-0001 (5/6) | BK-W007S-PEDCO-110-PR-PI-0001 (5/6) |

**ATTACHMENT 2**

**(SOFTWARE RESULT)**

1. **PUMP** **CALCULATION REPORT**



Note 1: According to item 141 at HAZAP Study Report, piping class downstream of sump pump to header A/B should be 300#.

Detail of pump calculation are given in the attached file:

**ATTACHMENT 3**

**(SOFTWARE RESULT)**

1. **LINE SIZING**

Since most multiphase pipelines operate at high-pressure conditions, pressure drop is usually not a governing criterion in selecting a diameter. However, pressure drop may have to be considered for some long flow lines from wells and in most multiphase pipelines. If the available pressure drop allows, the flow velocity shall in general be sufficiently high to prevent liquid accumulation in the pipelines. It is recommended that a minimum flow velocity shall be maintained to keep liquids moving in the line and thus minimize terrain induced slugging of separator or other process equipment. Also, the flow velocity shall in general be kept low enough to prevent problems with erosion, corrosion, noise, vibration, etc. However, in some cases the maximum allowable velocity would be calculated by corrosion/erosion criteria.

* **Corrosion**

For corrosion resistant material (SS, Special alloys ...), no limitation of flowing velocity up to 100 m/s and no requirement for corrosion allowance.

For non-corrosion resistant material, in corrosive fluid service, corrosion allowance for a design service life and corrosion inhibitor injection is required. The flowing velocity is limited by the inhibitor film integrity.

Note that it is not often economical to use corrosion resistant alloys, thus, corrosion inhibitors are widely used as an alternative to protect the lines by formation of a protective layer inside the internal surface. However product and inhibitor layers will not protect the pipe by turbulence and shear stress. Therefore the flow velocity will be limited by the inhibitor film integrity. Where at velocities more than 6 m/sec the integrity of the inhibitor film may be broken by turbulence and result in no protection. In addition corrosion allowance will be added to pipe thickness for assurance. Determination of corrosion allowance for deep-water pipelines should be made using the corrosion inhibitor availability model reflecting actual performance and realistic inhibitor availability, rather than arbitrary inhibitor effectiveness criteria.

* **Erosion**

For Duplex, SS or alloy material, the flowing velocity must be limited to:

* 100 m/s in single phase vapor lines and multiphase lines in stratified flow regimes (65m/s for 13% Cr material ),
* 20 m/s in single phase liquid lines and multiphase lines in annular, bubble or hydrodynamic slug flow regime,
* 70 m/s in multiphase lines in mist flow regimes.

For Carbon Steel material:

* In case of continuous injection of corrosion inhibitor, the inhibitor film ensures a lubricating effect which drifts the erosion velocity limit. The corrosion inhibitor erosion velocity limit will be calculated taking into account the inhibitor film wall shear stress.
* In case of uninhibited fluid, the API RP 14 E recommendation should apply:

The flowing velocity must be maintained below the erosional limit:



Ve: erosional velocity in m/s

: Gas/liquid mixture density at flowing conditions in kg/m3

The multiphase mixture density  can be determined by the following equation:

$$ρ\_{m}=\frac{m\_{m}}{\frac{m\_{L}}{ρ\_{L}}+ \frac{m\_{G}}{ρ\_{G}}} $$

Where:

m m :total mass flow rate, kg/sec $(m\_{m}=m\_{L}+m\_{G} )$

m L :liquid mass flow rate, kg/sec

m G :Gas mass flow rate, kg/sec

C: empirical constant equal to 122.045 to 152.556 for continuous flow. “C” value up to 244 can be considered on peak flow rate only in case of absence of abrasive (solid) particles such as sand.

It is widely accepted in the industry that above simple criterion is inadequate, where it is for clean service (non-corrosive and sand free) and the limits should be reduced if sand and the limits should be reduced if sand or corrosive conditions are present.

Note:

If solids production is anticipated, fluid velocities should be significantly reduced.



Detail of line sizing are given in the attached file:

**ATTACHMENT 4**

**(SOFTWARE RESULT)**