|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **طرح نگهداشت و افزایش تولید 27 مخزن** | | | | | | | |
| **CALCULATION NOTE FOR PSV SIZING**  **نگهداشت و افزایش تولید میدان نفتی بینک** | | | | | | | |
| D05 | APR.2023 | IFA | M.Aryafar | M.Fakharian | M.Mehrshad |  |
| D04 | DEC.2022 | IFA | M.Aryafar | M.Fakharian | M.Mehrshad |  |
| D03 | OCT.2022 | IFA | M.Aryafar | M.Fakharian | M.Mehrshad |  |
| D02 | APR.2022 | IFA | M.Aryafar | M.Fakharian | M.Mehrshad |  |
| D01 | JAN.2022 | IFA | M.Aryafar | M.Fakharian | M.Mehrshad |  |
| D00 | SEP.2021 | IFC | M.Aryafar | M.Fakharian | Sh.Ghalikar |  |
| **Rev.** | **Date** | **Purpose of Issue/Status** | **Prepared by:** | **Checked by:** | **Approved by:** | **CLIENT Approval** |
| **Class:** 2 | | **CLIENT Doc. Number:** F0Z-708742 | | | | |
| **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** | **D05** |  | **PAGE** | **D00** | **D01** | **D02** | **D03** | **D04** | **D05** |
| **1** | X | X | X | X | X | X | **66** |  |  |  |  |  |  |
| **2** | X | X | X | X | X | X | **67** |  |  |  |  |  |  |
| **3** | X |  |  |  |  |  | **68** |  |  |  |  |  |  |
| **4** | X |  |  |  |  |  | **69** |  |  |  |  |  |  |
| **5** | X | X | X |  |  |  | **70** |  |  |  |  |  |  |
| **6** | X | X | X |  |  |  | **71** |  |  |  |  |  |  |
| **7** | X | X | X |  |  |  | **72** |  |  |  |  |  |  |
| **8** | X | X |  |  |  |  | **73** |  |  |  |  |  |  |
| **9** | X |  | **X** |  |  |  | **74** |  |  |  |  |  |  |
| **10** | X |  |  |  |  |  | **75** |  |  |  |  |  |  |
| **11** | X |  |  |  |  |  | **76** |  |  |  |  |  |  |
| **12** | X |  | X | X | X | X | **77** |  |  |  |  |  |  |
| **13** | X |  | X | X | X | X | **78** |  |  |  |  |  |  |
| **14** | X |  | **X** | **X** | **X** | **X** | **79** |  |  |  |  |  |  |
| **15** |  |  |  |  |  |  | **80** |  |  |  |  |  |  |
| **16** |  |  |  |  |  |  | **81** |  |  |  |  |  |  |
| **17** |  |  |  |  |  |  | **82** |  |  |  |  |  |  |
| **18** |  |  |  |  |  |  | **83** |  |  |  |  |  |  |
| **19** |  |  |  |  |  |  | **84** |  |  |  |  |  |  |
| **20** |  |  |  |  |  |  | **85** |  |  |  |  |  |  |
| **21** |  |  |  |  |  |  | **86** |  |  |  |  |  |  |
| **22** |  |  |  |  |  |  | **87** |  |  |  |  |  |  |
| **23** |  |  |  |  |  |  | **88** |  |  |  |  |  |  |
| **24** |  |  |  |  |  |  | **89** |  |  |  |  |  |  |
| **25** |  |  |  |  |  |  | **90** |  |  |  |  |  |  |
| **26** |  |  |  |  |  |  | **91** |  |  |  |  |  |  |
| **27** |  |  |  |  |  |  | **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](#_Toc102160464)

[2.0 Scope 5](#_Toc102160465)

[3.0 NORMATIVE REFERENCES 5](#_Toc102160466)

[3.1 Local Codes and Standards 5](#_Toc102160467)

[3.2 International Codes and Standards 5](#_Toc102160468)

[3.3 The Project Documents 5](#_Toc102160469)

[3.4 ENVIRONMENTAL DATA 5](#_Toc102160470)

[4.0 PSV SIZING 5](#_Toc102160471)

[4.1 FIRE; External Fire on the Unwetted Surface of Vessel 6](#_Toc102160472)

[4.2 FIRE; External Fire on the wetted Surface of Vessel 7](#_Toc102160473)

[4.3 BLOCKED OUTLET 9](#_Toc102160474)

[5.0 RELIEF LOAD SUMMARY TABLE 11](#_Toc102160475)

[ATTACHMENT: SOFTWARE REPORT 14](#_Toc102160476)

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, a New Gas Compressor Station (adjacent to existing Binak GCS) shall be constructed to gather of 15 MMSCFD (approx.) associated gases and compress & transfer them to Siahmakan GIS.

**GENERAL DEFINITION**

The following terms shall be used in this document.

|  |  |
| --- | --- |
| CLIENT: | National Iranian South Oilfields Company (NISOC) |
| PROJECT: | Binak Oilfield Development – Surface Facilities; New Gas Compressor Station |
| 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**

The scope of this document is to provide sizing calculation of Pressure Safety Valves’s of BINAK New GCS unit.

1. **NORMATIVE REFERENCES**

## Local Codes and Standards

* 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-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
* BK-GCS-PEDCO-120-PR-PF-0001 Process Flow Diagram (PFD)
* BK-GCS-PEDCO-120-PR-PI-0002~25 Piping & Instrumentation Diagram

## ENVIRONMENTAL DATA

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

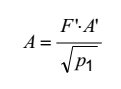
1. **PSV SIZING**

Following two over pressure scenarios are recognized for Kashan gas compressor station, which PSV’s are considered to protect relevant equipments & pipings against pressure increasing.

* FIRE (UNWETTED)
* FIRE (WETTED)
* BLOCKED OUTLET

## FIRE; External Fire on the Unwetted Surface of Vessel

According to API 521 2007, The discharge areas for pressure-relief devices on vessels containing super-critical fluids, gases or vapors exposed to open fires can be estimated using Equation 1.

(1)

Where

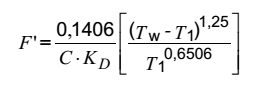
A is the effective discharge area of the valve, expressed in SI units (square inches);

A′ is the exposed surface area of the vessel, expressed in SI units (square feet);

P1 is the upstream relieving absolute pressure, expressed in SI units (psi);

NOTE: p1 is the set pressure plus the allowable overpressure plus the atmospheric pressure.

F′ can be determined using Equation (2). If calculated using Equation (2) and the result is less than 0,01, then use a recommended minimum value of F′ =0,01. If insufficient information is available to use Equation (2), then use F′ =0,045.

 (2)

Where

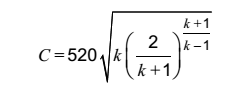
KD is the coefficient of discharge (obtainable from the valve manufacturer);

NOTE: A KD value of 0.975 is typically used for preliminary sizing of pressure-relief valves (see API RP 520-1 or ISO 4126).

Tw is the recommended maximum wall temperature of vessel material

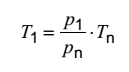
T1 is the gas absolute temperature, at the upstream relieving pressure, determined from Equation (4), expressed in °R.

C is given by Equation (3):

 (3)

Where

k is the specific heat ratio (Cp/Cv) of gas or vapor at relieving conditions;

 (4)

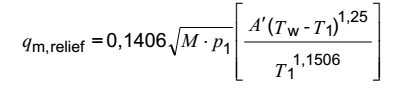
where

pn is the normal operating gas absolute pressure, expressed in SI units (psi);

Tn is the normal operating gas absolute temperature, expressed in SI units (°R).

The recommended maximum vessel wall temperature, Tw, for the usual carbon steel plate materials is 593 °C (1 100 °F).

The relief load, qm, relief, expressed in pounds per hour, can be calculated from equation (5)

 (5)

Where M is the relative molecular mass of the gas.

## FIRE; External Fire on the wetted Surface of Vessel

The amount of heat absorbed by a vessel exposed to an open fire is markedly affected by the type of fuel feeding the fire, the degree to which the vessel is envel-oped by the flames (a function of vessel size and shape), and fireproofing measures.

Adequate drainage is necessary to control the spread of major spills from one area to another and to control surface drainage and refinery waste water. This can be accomplished by the strategic use of sewers and trenches with adequate capacity and/or by using the natural slope of the land.

Where adequate drainage and firefighting equipment do not exist, Equation 6 should be used

 (6)

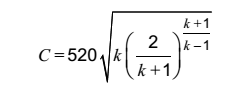
Qtotal: heat absorption (input) to the wetted surface (BTU/hr)

F: Environment factor. (Values for various types of installation are shown in Table 5 API 521)

A: Total wetted surface, in square feet (see 3.15.1.1 and Table 4 API 521.)

W required flow through the device from Equations (vessel containing liquid): (7)

According to API 521 2007, The discharge areas for pressure-relief devices on vessels containing super-critical fluids, gases or vapours exposed to open fires can be estimated using Equation 8.

 (8)

Where

A required effective discharge area of the device, in2

W required flow through the device from Equations (7), lb/hr.

C coefficient determined from Equations (3).

Kd effective coefficient of discharge. For preliminary sizing, use the following values:

0.975 When a pressure relief valve is installed with or without a rupture disk in combination,

0.62 When a pressure relief valve is not installed and sizing is for a rupture disk

P1 upstream relieving pressure, psia. This is the set pressure plus the allowable overpressure plus atmospheric pressure.

Kb capacity correction factor due to back pressure. The back pressure correction factor applies to balanced bellows valves only. For conventional and pilot operated valves, use a value for Kb equal to 1.0

Kc combination correction factor for installations with a rupture disk upstream of the pressure relief valve

1.0 When a rupture disk is not installed,

0.9 When a rupture disk is installed in combination with a pressure relief valve and the combination does not have a published value.

T relieving temperature of the inlet gas or vapour, R (°F + 460)

Z compressibility factor

M molecular weight of the gas or vapour at inlet relieving conditions.

## BLOCKED OUTLET

The absolute pressure ratio of the pressure at the nozzle exit at sonic velocity (Pcf) to the inlet pressure (P1) is called the critical pressure ratio. Pcf is known as critical flow pressure and can be estimated using the following equation (API 520):

|  |  |
| --- | --- |
|  | (9) |

If the pressure downstream of the nozzle is less than or equal to the critical flow pressure Pcf, then critical flow will occur and following procedure will be used to determine the required effective discharge area of the device.

According to API-520 2007, Pressure relief devices in gas or vapor service that operate at closed outlet conditions are sized using Equations (10). This equations is used to calculate the effective discharge area, A, required to achieve a required flow rate through a pressure relief device. A pressure relief valve that has an effective discharge area equal to or greater than the calculated value of A is then chosen for the application from API-526.

 (10)

Where

A required effective discharge area of the device, in2

W required flow through the device, lb/hr.

C coefficient determined from Equations (3).

Kd effective coefficient of discharge. For preliminary sizing, use the following values:

0.975 When a pressure relief valve is installed with or without a rupture disk in combination,

0.62 When a pressure relief valve is not installed and sizing is for a rupture disk

P1 upstream relieving pressure, psia. This is the set pressure plus the allowable overpressure plus atmospheric pressure.

Kb capacity correction factor due to back pressure. The back pressure correction factor applies to balanced bellows valves only. For conventional and pilot operated valves, use a value for Kb equal to 1.0

Kc combination correction factor for installations with a rupture disk upstream of the pressure relief valve

1.0 When a rupture disk is not installed,

0.9 When a rupture disk is installed in combination with a pressure relief valve and the combination does not have a published value.

T relieving temperature of the inlet gas or vapour, R (°F + 460)

Z compressibility factor

M molecular weight of the gas or vapor at inlet relieving conditions.

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.

1. **RELIEF LOAD SUMMARY TABLE**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| PSV No.  D05 | PSV-2111/2112 | PSV-2113/2114 | | PSV-2121A/B/C | | PSV-2122,2123A/B/C | | PSV-2131 A/B/C | |
| Service | V-2104 | V-2105 | | V-2101 A/B/C | | C-2101A/B/C | | V-2102A/B/C | |
| Fire | YES | - | | - | | - | | YES | |
| Other | - | Blocked Outlet | | Blocked Outlet | | Blocked Outlet | | - | |
| Fluid & State | HC | HC | | HC | | HC | | HC | |
| Operating Pressure (Barg) | 5.3 | 5.1 | | 4.9 | | 19.0 | | 18.1 | |
| Normal Temperature (°C) | 32.0 | 36.92 | | 36.78 | | 124.8 | | 60 | |
| Relief Temperature (°C) | 284 | 36.92 | | 60 | | 124.8 | | 208.3 | |
| P set, Barg | 9.00 | 9.00 | | 22.00 | | 22.00 | | 22.00 | |
| Required massflow (kg/hr) | 37247.28 | 17833.11 | | 2166.00 | | 8664.00 | | 982.27 | |
| Specific Heat Ratio (Cp/Cv) | 1.223 | 1.246 | | 1.457 | | 1.225 | | 1.278 | |
| Molecular Weight (kg/Kmol) | 48.1 | 24.52 | | 24.55 | | 24.52 | | 24.52 | |
| Compressibility Factor | 0.954 | 0.954 | | 0.822 | | 0.964 | | 0.936 | |
| Total Back Pressure ( Barg ) | 3.4 | 1.2 | | 0.5 | | 0.9 | | 3.4 | |
| Allowable Over Pressure (%) | 21 | 10 | | 10 | | 10 | | 21 | |
| Calculated Discharge Area (mm2) | 4134 | 2240.6 | | 107.25 | | 539.85 | | 59.62 | |
| Required Discharge Area (mm2) | 8742 | 3421.19 | | 153.938 | | 1017 | | 153.93 | |
| Orifice Designation | Q | N | | E | | J | | D | |
| Body size | 6” × 8” | 4" × 6” | | 1” × 2” | | 2” × 3” | | 1” × 2” | |
| Capacity exceed % | 66 | 25 | | 17.9 | | 54.9 | | 20.49 | |
| P&ID Number | BK-GCS-PEDCO-120-PR-PI-0004 (3/1) | BK-GCS-PEDCO-120-PR-PI-0005 (1/1) | | BK-GCS-PEDCO-120-PR-PI-0006 (1~3) | | BK-GCS-PEDCO-120-PR-PI-0007 (1~3) | | BK-GCS-PEDCO-120-PR-PI-0009 (1~3) | |
| PSV No. | PSV-2132,2133A/B/C | | PSV-2141/2142 | PSV-2201  (NOTE) | PSV-2211 | | PSV-2271 | | PSV-2293 | |
| Service | C-2102A/B/C | | V-2103 | V-2203 | V-2204 | | V-2205 | | V-2107 | |
| Fire | - | | - | YES | YES | | YES | | YES | |
| Other | Blocked Outlet | | Blocked Outlet | - | - | | - | | - | |
| Fluid & State | HC | | HC | Air | N2 | | HC | | TEG | |
| Operating Pressure (Barg) | 54.80 | | 53.9 | 8.0 | 8.0 | | 4.9 | | 0.1 | |
| Normal Temperature (°C) | 142.3 | | 60  D05 | 65 | 60 | | 36.78 | | AMB | |
| Relief Temperature (°C) | 142.3 | | 60 | 201.7 | 323.4 | | 182.6 | | 335.9 | |
| P set, Barg | 62.0 | | 62.0 | 12.5 | 12.5 | | 9.0 | | 3.5 | |
| Required massflow (kg/hr) | 8664 | | 17252.5 | 1071.8 | 500.39 | | 174.5 | | 2098.01 | |
| Specific Heat Ratio (Cp/Cv) | 1.278 | | 1.461 | 1.416 | 1.4 | | 1.245 | | 1.083 | |
| Molecular Weight (kg/Kmol) | 24.52 | | 24.56 | 28.95 | 28.00 | | 18.02 | | 143.6 | |
| Compressibility Factor | 0.923 | | 0.823 | 0.99 | 1.00 | | 0.975 | | 0.646 | |
| Total Back Pressure ( Barg ) | 1.0 | | 1.0 | 0.0 | 0.5 | | 3.2 | | 0.1 | |
| Allowable Over Pressure (%) | 10 | | 10 | 21 | 21 | | 21 | | 21 | |
| Calculated Discharge Area (mm2) | 193.67 | | 311 | 113.24 | 54.241 | | 28.75 | | 275 | |
| Required Discharge Area (mm2) | 397.60 | | 629.01 | 153.95 | 153.9 | | 153.9 | | 397.6 | |
| Orifice Designation | G | | H | E | D | | D | | G | |
| Body size | 1 1/2" × 3” | | 2 " × 3” | 1" × 2” | 1” × 2” | | 1” × 2” | | 1 1/2" × 3” | |
| Capacity exceed % | 68.66 | | 66.12 | 11.67 | 32.44 | | 136 | | 18.8 | |
| P&ID Number | BK-GCS-PEDCO-120-PR-PI-0010 (1~3) | | BK-GCS-PEDCO-120-PR-PI-0012 (1/1) | BK-GCS-PEDCO-120-PR-PI-0015 (2/2) | BK-GCS-PEDCO-120-PR-PI-0016 (1/1) | | BK-GCS-PEDCO-120-PR-PI-0022 (1/1) | | BK-GCS-PEDCO-120-PR-PI-0025 | |

NOTE: 2 X 100 PSVs, ONE Duty ONE Standby

D05

**ATTACHMENT: SOFTWARE REPORT**