طرح نگهداشت و افزایش تولید 27 مخزن

CALCULATION NOTE FOR DEPRESSURIZING (MIN. DESIGN TEMPERATURE)

نگهداشت و افزایش تولید میدان نفتی بینک

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1.0 INTRODUCTION

Binak oilfield in Bushehr province is a part of the southern oilfields of Iran, is located 25 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 Fcilities; 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.

2.0 SCOPE

The purpose of this report is to present depressurizing philosophy and calculation method for

BINAK NEW gas compressor station. depressuring loads and minimum metal temperature while depressurizing will be reported in this document.

3.0 NORMATIVE REFERENCES

3.1 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

3.2 INTERNATIONAL CODES AND STANDARDS

• API-RP-521	"Guide for Pressure-Relieving and Depressurizing Systems" Fifth Edition.
• ASME Sec. I & VIII	"ASME Boiler and Pressure Vessel Codes", 1998, 2000 Addenda
• API-PBL-2510A	"Fire Protection Considerations for the Design and Operation of Liquefied, Petroleum Gas (LPG) Storage Facilities" Second Edition, December. 1996.
• API-RP-520	"Sizing, Selection and Installation of Pressure-Relieving Devices in Refineries, Part 1-Sizing and Selection", Eighth Edition, 2008.
• API STD 607	"Fire Test for Soft-Seated Quarter-turn Valves", Fourth Edition, 1998.

3.3 THE PROJECT DOCUMENTS

• Piping & Instrumentation Diagram	BK-GCS-PEDCO-120-PR-PI-0001
• Process Design Criteria	BK-GNRAL-PEDCO-000-PR-DC-0001
• ESD Philosophy	BK-GCS-PEDCO-120-PR-PH-0005

- Flare,Blow Down And Relief Philosophy — BK-GCS-PEDCO-120-PR-PH-0003

3.4 ENVIRONMENTAL DATA

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

3.5 ABBREVIATION

- ESD Emergency shutdown
- SD Shutdown
- BDV Blow down valve
- SDV Shutdown valve
- ESDV Emergency shutdown valve
- PSV Pressure Safety Valve
- BLEVE boiling-expanding- vapour explosion

4.0 GENERAL CONSIDERATIONS

4.1 PURPOSE OF DEPRESSURIZING

The purpose of the Emergency Depressurization (EDP) is to unstress equipment under fire by releasing pressure to limit the quantity released through a leak to minimize hydrocarbon inventory. The purpose of the Emergency Depressurization (EDP) is:

- To avoid escalation of initial event by preventing release of other isolated flammable inventories
- To unstress equipment under fire by releasing pressure
- To limit the quantity released through a leak
- To minimize hydrocarbon inventory.

In case of a large liquefied hydrocarbon inventory, a liquid emergency blowdown will not be provided to achieve the required reduction of pressure in the allowable period of time.

In order to limit the wall temperature and therefore possible damage of the capacities exposed to fire, liquid will be kept inside the vessel.

EDP calculations will allow determination of minimum design metal temperature (MDMT) of various facilities including Flare and Closed Drain network.

4.2 LIQUID BLOW DOWN

Emergency depressurization applies to gas systems only. There is no emergency liquid blow down system for this project.

5.0 BLOW DOWN VALVE LOCATION

5.1 ISOLATION DEFINITION

An emergency depressurization (EDP) system is defined as a group of several pieces of equipment and piping elements that can be exposed to fire and can be isolated simultaneously. These systems are limited by Shut down Valves (SDV, ESDV) but also by control valves which are Fail Close (FC): although control valves are not intended for isolation, their closure must be considered.

Multiple items of equipment may depressurize through a single BDV, however there must be a clear vapor pathway (of sufficient size) from each significant volume in the protected system to the blow down valve ; additional BDV 's for the system will otherwise be needed.

5.2 CRITERIA FOR BDV INSTALLATION

The criteria that shall be used to decide whether a Blowdown Valve (BDV) is required are summarized in the following table:

		BDV Required
PIPING	That cannot be isolated	No
	That can be isolated but not exposed to fire	No (1)
	That can be isolated and exposed to fire (5): • Flammable gas • Liquefied HC (4) • Liquid HC • Two-phase • Toxic gases	 • P > 17 barg and PV_{gas} > 100 bar. m^3 (6) • M_{gas} or M_{liq} > 2 tons of C_4 and more volatile (6) • No (3) • P > 17 barg and PV_{gas} > 100 bar. m^3 • As required for protection of personnel
VESSELS	That cannot be isolated	No
	That can be isolated but are not exposed to fire	No (2)
	That can be isolated and are exposed to fire (5): • Flammable gas • Liquefied HC (4) • Liquid HC • Two-phase • Toxic gases	 • P > 17 barg and PV_{gas} > 100 bar. m^3 (6) • M_{gas} or M_{liq} > 2 tons of C_4 and more volatile (6) • No (3) • P > 17 barg and PV_{gas} > 100 bar. m^3 • As required for protection of personnel

Notes:

(1). Except piping interconnecting equipment subject to EDP within one process unit,

regardless of pressure and volume.

(2). Except vessels between other vessels or piping within the same process unit and subject to EDP.

(3). TSV or PSV fire cases are regarded as sufficient protections.

(4). Both refrigerated or under pressure.

(5). Piping or vessels shall be considered as being possibly exposed to fire if their external surface (more than 10%) can be engulfed in a pool fire likely to last more than 3 minutes.

(6). The presence of pressurized fluid “trapped” in the network after EDP shall be avoided. The position of check valves and/or control valves failing to close shall be carefully contemplated in this respect.

(7). BDV protecting an equipment with mesh will be installed upstream the mesh

(8). Depressurization to be avoided through plate and frame exchanger.

Legend:

P: Maximum operating pressure (PSHH)

V: Internal vessels (or piping or vessel + piping) volume Vgas: Gas phase volume

Vliq/Vgas: Maximum liquid/gas volume inside vessel or piping or both (LAHH/LALL)

Mliq / Mgas Maximum: Mass of liquefied hydrocarbon liquid phase/gaseous phase inside vessel (or piping or both)

5.3 METHODOLOGY AND ASSUMPTIONS

Each emergency and depressurization system (equipment and piping within the same isolation section) is considered as a Flat-end vessel. This equivalent vessel has the same volume and surface area of the isolated system.

Volume of the system to be depressurized shall be determined by the isolation block considered here above which are ESDV, SDV and control valve FC. The volume will not take into account the possibility of non-closing of the SDV or control valve.

Equipment dimensions are taken from respective mechanical data sheets, whereas piping lengths are based on preliminary piping rout as plot plan. Purge and drain lines are neglected in the total volume.

Isolated volume thickness is determined by a surface-weighted average based on the thicknesses of the different parts of the isolated system.

The fluid compositions and conditions and the dimensions of piping used in the depressurization calculations are based on the latest simulations, PFD’s and P&ID’s.

The system initial pressure is taken as the system design pressure.

The blow-down valves (BDV) sizes are determined by the fire case depressurization and Minimum design metal temperature will be determined by the cold case depressurization.

5.4 DEPRESSURIZATION IN CASE OF EXTERNAL POOL FIRE

The following conditions are considered:

Initial Conditions:

Pressure = Initial pressure is in any case the network design pressure (unless it differs more than 15% from operating pressure) or PSHH (taken as 90% of design pressure)

Temperature = Maximum operating (it is assumed that heat exchanges are stopped) Liquid Level = NLL for vessel with auto level control

LSH for vessel with ON/OFF control

Liquid Level corresponding to piping hold up for piping

LSH for relief K.O. drum or flare vessel

Final Conditions:

7 bar g or 50 % of PSHH (or design pressure) whichever is lower.

Depressurization time

As a general rule, for vessels whose smallest wall thickness is equal to or greater than 25 mm, time to achieve the final pressure level after an EDP has been initiated shall be, by default: within 15 minutes or less for piping and vessels containing hydrocarbon, both gas or liquid; within 8 minutes or less for storage vessels containing LPG's or light condensate to avoid the risk of BLEVE; For wall thickness smaller than 25 mm, the following rule shall be applied:

- Wall thickness < 25 mm: 15 minutes minus 3 minutes for each 5 mm decrease in thickness;
- Vessel Thickness ≥ 25 mm = 15 minutes or less for piping and vessels containing HC (both gas/ liquid)

in this calculation wall thickness is considered ≥ 25 mm. this item is finalized after received vendor data.

Heat input

Pool Fire: This shall be considered only in the fire zone corresponding to a cylindrical volume of about 18 m diameter/8 m height. In the case of equipment and/or piping elevated at 8 meters or higher, heat input will only be considered if a retention structure appears. The heat input will be specified as per API:

$q = 21000\ F\ A^{-0.18}$

$Q = 21000\ F\ A^{0.82}$

Where:

q = average unit heat absorption, in BTU/h.ft² of wetted surface

Q = total heat absorption (input) to the wetted surface, in BTU/h

F = environment factor to be taken equal to 1 for EDP - insulation shall be considered as non-fire resistant

A = total wetted surface, in ft² (The expression $A^{-0.18}$ is the area exposure factor or ratio. This ratio recognizes the fact that large vessels are less likely than small ones to be completely exposed to the flame of an open fire)

Heat exchanges by natural convection with the ambient shall be based on:

- ambient temperature: 33.03 °C
- Heat transfer coefficient : 5 W/m2°C
- For restriction orifice, atmospheric conditions shall be considered downstream the orifice.

Flow Through Restriction Orifice:

The flow is normally assumed to be critical through the orifice. This shall be checked when flare header is sized.

5.5 DEPRESSURIZATION AFTER PROLONGED SHUTDOWN

In the cold depressurization procedure, the target is to check the final temperature after the system has reached the final network pressure (around 0 barg), in order to assure the material resistance at the lowest temperature reached in the system. Besides, this calculation allows calculating the time necessary to reach this pressure: in fact, the restriction orifice will be sized for the depressurization in case of pool fire, which usually gives the highest peak flow.

The same initial pressure for the fire case is assumed as starting point for the depressurization, while the initial temperature is the operating temperature or 21°C, whichever the lowest. Total

volume of the circuit to be depressurized (same as calculated for depressurization for fire). Total volume of the circuit to be depressurised (same as calculated for depressurisation for fire). Heat exchanges by natural convection with the ambient shall be based on:

- Ambient temperature: 18.75°C
- heat transfer coefficient : 5 W/m2°C

In case of conflict between this calculated minimum temperature and the material resistance low limit temperature, API RP 579 and ASME BPVC Section VIII Division 1 can be followed using critical exposure temperature (CET). In particular, the maximum operating pressure, instead of the design pressure, will be selected as starting point and the calculation procedure will also consider the effect of metal weight on heat capacity.

5.6 SPURIOUS BLOWDOWN

Spurious blowdown will be applied for all systems and defined as follows:

a) Initial conditions :

Pressure = Network design pressure or PSHH.

Temperature = Minimum operating (it is assumed that heat exchanges are stopped)

Liquid Level = NLL for vessel with auto level control, LSH for vessel with ON/OFF control Liquid Level corresponding to piping hold up for piping, LSL for relief K.O. drum or flare vessel

b) Final Conditions:

The calculation shall be carried up to ATM pressure to find the minimum achieved temperature.

c) Depressurization time

No time is taken into account here because the blowdown rate depends on the orifice sized on fire case blowdown basis.

d) Heat input

None in this case. However, insulation, if any, will be considered.

Heat exchanges by natural convection with the ambient shall be based on:

- Ambient temperature : 18.75°C
- Heat transfer coefficient : 5 W/m2°C

6.0 SIMULATION SOFTWARE FOR EDP CALCULATION

Depressurizing Utility in Aspen HYSYS V.11 is used as default software tool to perform corresponding calculation procedure in previous section.

7.0 IMPACT OF EDP ON MATERIAL SELECTION

The piping material will be selected taking into account the temperatures occurring during depressurisation. Piping repressurization shall be considered to be performed with the minimum depressurisation temperature. As a base case, the above consideration shall be applied also for vessels: the minimum temperature due to blowdown conditions shall be associated with design pressure.

8.0 VOLUME OF DEPRESSURIZED SYSTEM

The ESDVs divide the compressor station into 9 main sections in case of a general emergency shutdown which are detailed in here below table 1.

Table1: Blow Down Sections in BINAK New Compressor Station

SECTION No.	Valve Tag No.	Main Equipment/Lines within the section	Blow Down Volume (m^3)
1	**BDV-2134A**	GAS-111-0026A-AN07-8"-PT V-2101A GAS-111-0031A-AN05-8"-ET C-2101A GAS-111-0036A-CN05-6"-PT AE-2101A GAS-111-0037A-CS00-6"-NP V-2102A GAS-111-0044A-CN05-6"-ET (TRAIN A)	8.4
2	**BDV-2134B**	GAS-111-0026B-AN07-8"-PT V-2101B GAS-111-0031B-AN05-8"-ET C-2101B GAS-111-0036B-CN05-6"-PT AE-2101B GAS-111-0037B-CS00-6"-NP V-2102B GAS-111-0044B-CN05-6"-ET (TRAIN B)	8.4
3	**BDV-2134C**	GAS-111-0026C-AN07-8"-PT V-2101C GAS-111-0031C-AN05-8"-ET C-2101C GAS-111-0036C-CN05-6"-PT	8.4

		AE-2101C GAS-111-0037C-CS00-6"-NP V-2102C GAS-111-0044C-CN05-6"-ET (TRAIN C)	
4	**BDV-2132A**	GAS-111-0044A-CN05-6"-ET C-2102A GAS-111-0051A-FN05-6"-IS AE-2102A GAS-111-0054A-FS00-6"-NP (TRAIN A)	2.5
5	**BDV-2132B**	GAS-111-0044B-CN05-6"-ET C-2102B GAS-111-0051A-FN05-6"-IS AE-2102B GAS-111-0054B-FS00-6"-NP (TRAIN B)	2.5
6	**BDV-2132C**	GAS-111-0044C-CN05-6"-ET C-2102C GAS-111-0051C-FN05-6"-IS AE-2102C GAS-111-0054C-FS00-6"-NP (TRAIN C)	2.5
7	**BDV-2141**	GAS-111-0058A-FS00-6"-NP GAS-111-0058B-FS00-6"-NP GAS-111-0058C-FS00-6"-NP V-2103	3.1
8	**BDV-2151**	GAS-111-0066-FN05-6"-PT DEHYDRATION PACKAGE GAS-111-0179-FN05-6"-PT	7.5
9	**BDV-2110**	GAS-111-0101-AN07-6"-PT GAS-111-0012-AN07-14"-PT V-2104 GAS-111-0019-AN07-8"-PT V-2105 FL-112-0017-AN07-2"-PT	184.9

The total volume of each section is the sum of volumes of all lines and equipment in the section.

9.0 RESULTS AND CONCLUSION

Considering all above assumptions, depressurizing calculation for BINAK NEW gas compressor station has been implemented and results are given in below table.

As per below results, at cold case depressurizing through blowdown valves, fluid temperature does not reduction to lower values than -29ºC.

Valve Tag No.	Protected Equipment	Case	Initial Pres. (barg)	Initial Temp. (ºC)	Time (Sec)	Final Pressure (barg)	Vessel Fluid Min. Temp (ºC)	Valve Outlet Min. Temp (ºC)	Peak Flow (kg/hr)	RO Area (mm2)
BDV-2134A	V-2101A, C-2101A, AE-2101A, V-2102A, C-2102A, AE-2102A TRAIN A	Fire case	22	60.0	900	7	37.88	32.17	**778.4**	**56.93**
		Cold shutdown case	22	21.0	2520	0	14.35	4.91	**796.4**	
		Spurious blowdown case	22	60.0	3600	0	35.27	29.52	**725.6**	
BDV-2134B	V-2101B, C-2101B, AE-2101B, V-2102B, C-2102B, AE-2102B TRAIN B	Fire case	22	60.0	900	7	37.88	32.17	**778.4**	**56.93**
		Cold shutdown case	22	21.0	2520	0	14.35	4.91	**796.4**	
		Spurious blowdown case	22	60.0	3600	0	35.27	29.52	**725.6**	
BDV-2134C	V-2101C, C-2101C, AE-2101C, V-2102C, C-2102C, AE-2102C TRAIN C	Fire case	22	60.0	900	7	37.88	32.17	**778.4**	**56.93**
		Cold shutdown case	22	21.0	2520	0	14.35	4.91	**796.4**	
		Spurious blowdown case	22	60.0	3600	0	35.27	29.52	**725.6**	

Valve Tag No.	Protected Equipment	Case	Initial Pres. (barg)	Initial Temp. (ºC)	Time (Sec)	Final Pressure (barg)	Vessel Fluid Min. Temp (ºC)	Valve Outlet Min. Temp (ºC)	Peak Flow (kg/hr)	RO Area (mm2)
BDV-2132A	**C-2102A AE-2102A (TRAIN A)**	Fire case	62	60.0	900	7	59.9	17.5	**1333**	**31.39**
		Cold shutdown case	62	21.0	1860	0.0	14.21	-28.61	**1414**	
		Spurious blowdown case	62	60.0	1920	0.0	24.87	8.44	**1199**	
BDV-2132B	**C-2102B AE-2102B (TRAIN B)**	Fire case	62	60.0	900	7	59.9	17.5	**1333**	**31.39**
		Cold shutdown case	62	21.0	1860	0.0	14.21	-28.61	**1414**	
		Spurious blowdown case	62	60.0	1920	0.0	24.87	8.44	**1199**	
BDV-2132C	**C-2102C AE-2102C (TRAIN C)**	Fire case	62	60.0	900	7	59.9	17.5	**1333**	**31.39**
		Cold shutdown case	62	21.0	1860	0.0	14.21	-28.61	**1414**	
		Spurious blowdown case	62	60.0	1920	0.0	24.87	8.44	**1199**	

Valve Tag No.	Protected Equipment	Case	Initial Pres. (barg)	Initial Temp. (ºC)	Time (Sec)	Final Pressure (barg)	Vessel Fluid Min. Temp (ºC)	Valve Outlet Min. Temp (ºC)	Peak Flow (kg/hr)	RO Area (mm2)
BDV-2141	V-2103	Fire case	62	60.0	900	7	59.9	17.36	**1722**	**40.51**
		Cold shutdown case	62	21.0	1800	0.0	12.49	-28.61	**1825**	
		Spurious blowdown case	62	60.0	1800	0.0	22.81	7.155	**1548**	
BDV-2151	DEHYDRATION PACKAGE PK-2101	Fire case	62	60.0	900	7	16.57	5.14	**4578**	**107.5**
		Cold shutdown case	62	21.0	1800	0.0	2.89	-28.61	**4843**	
		Spurious blowdown case	62	60.0	1800	0.0	16.23	1.62	**4112**	
BDV-2110	V-2104, V-2105	Fire case	9	36.87	900	4.5	36.86	30.43	**5665.4**	**943.5**
		Cold shutdown case	9	19.0	18000	0.0	6.96	4.95	**5517.1**	
		Spurious blowdown case	9	19.0	18000	0.0	6.96	4.96	**5517.1**	