

Comparative study for connecting new flare capacity to existing flare Systems

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ABSTRACT

Process facility operations are equipped with flare system to dispose flammable, toxic, or corrosive vapors to an environmentally acceptable gas for release to the atmosphere from both normal operational venting and relief during abnormal conditions. For safe incineration and radiation considerations flares are located at a remote point from the plant. Flare system when designed is to be limited for a certain capacity for a relieved gas; in addition, it may be designed in excess for future process facilities which may be further added to an existing one.

KHALDA Petroleum Company is an owner company of oil and gas plants in Egypt. The company started a remote facility in 2005 named as "QASR start of line" which equipped with a limited flaring system capacity of 416,800 kg/hr for each flare related to phases PH-1 and PH-2. After 10 years of operation the wells depletion occurred which affected the production capacity and hence the company decided to maintain the productivity. A new compression project is designed to improve recovery as the reservoir production rate and pressure decline. The new compression project facilities vent and disposal need a flare system in case of the emergency. This paper discusses two different scenarios available for connecting the new compression project facilities vent and disposal system either to the existing flare systems or to another destination, which better, safer and more economic

Keywords

Flaring system; depressurization; emergency shutdown; conventional blowdown; sequential blowdown; maximizing relieving capacity.

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Introduction

In most process facility operations gas and vapor have to be disposed of safely, quickly, and without environmental impact [1]. When the venting gas or vapor cannot be converted to useful energy it is routed to a remote point for safe incineration, which is called flaring. Flares are the most economical and customary means of disposing of excess light combustible gases in the process industries. The primary function of a flare is to convert flammable, toxic, or corrosive vapors to an environmentally acceptable gas. These acceptable gases are released to the atmosphere from both normal operational venting and relief during abnormal conditions [1, 2].

Flare is the last line of defense in the safe emergency release system in the petroleum and chemical plants. The flare provides a means of safe disposal of the vapor streams from its facilities, by burning them under controlled conditions. Such that adjacent equipment or personnel are not exposed to hazards, and at the same time obeying the environmental regulation of pollution control and public relations requirements. The chemical process used for flaring is a high temperature oxidation reaction to burn combustible components, mostly hydrocarbons, or waste gases from industrial operations [3].

In combustion, the gaseous hydrocarbon (natural gas, propane, ethylene, propylene, butadiene,

butane and etc.) reacts with atmospheric oxygen to form carbon dioxide (CO₂) and water. Several byproducts formed will be carbon monoxide, hydrogen and others dependent upon what is being burned. Efficiency of hydrocarbon conversion is generally over 98% [4-8].

The flare system must be correctly sized to handle the material vented during depressuring, especially peak flow. During the blowdown operation, a large amount of material must be disposed of simultaneously. It is necessary to ensure that there is sufficient flare discharge capacity to do this without violating hydraulic constraints in the flare piping. This causes overpressures or excessive vibrations or exceeding radiation limits from the flare tip. It is also necessary to accurately determine what size of restriction orifices or other flow-controlling devices and flare connections are required for depressuring each section of the plant [9-11].

Calculations of depressurization system reveal whether high volumes of gases will be flowing through the pipe header to the flare. In some cases, simultaneously depressurizing all the process and equipment, vessels, and piping in a plant will be difficult to accomplish (due to pipe sizing and economic impacts). In these cases, sequential or segmented depressurization of vessels should be considered. Providing for the worst vessels first or controlling the system to depressurize the area most affected first are possible scenarios that can be employed [11-14].

Case study

Qasr is a large, normally pressured gas-condensate reservoir located in the Western Desert of Egypt approximately 525 km west of Cairo. The field is operated by Khalda Petroleum Company (KPC), a joint venture between Apache Corporation and Egyptian General Petroleum Company (EGPC).

Field production is initially handled at the Start of

line (SOL) Qasr Plant. The Qasr gas and condensate free flows from the wellheads through the Qasr Phase I and Phase II facilities and export pipelines to the SHAMS manifold and Salam gas plant under reservoir pressure until year 2015. As the reservoir pressure declines the peak gas rate of 800 mmscfd are no longer be achievable. The Qasr Compression Project is designed to improve recovery as the reservoir production rate and pressure decline.

There are two existing independent HP flare systems, one for Phase I facilities and the other for Phase II facilities. Phase I HP flare system, comprising a duplex stainless steel collection system, carbon steel KO drum, carbon steel riser and stack on which is mounted a sonic flare tip with design capacity of 416,800 kg/h. Phase II HP flare system, comprising a duplex stainless steel Pipe collection system, carbon steel KO drum, carbon steel riser and stack on which is mounted a sonic flare tip with design capacity of 416,800 kg/h.

This paper discusses two options suggested when connecting a new facility to an existing process plant considering tie-in both flares systems into the existing.

The available options for Flare tie-in are sequenced flare to PH-1 or PH-2 existing, flare combination to both PH-1 and/ or PH-2 and independent new compression flare utility. These options are competitive to find the feasible method for atmospheric disposal of the compression area (gas compressors and condensate suction drum) to HP flare blowdown loads to achieve the following objectives: -

- Overpressure protection for process and utility systems
- Means of automatic depressurizing of the Compression Project process facilities during emergency or upset conditions.

- Safe disposal of hydrocarbons which may - from time to time - be vented from the compression plant during abnormal operations and plant maintenance, start-up or shutdown.
- Allow controlled manual depressurization of equipment items for maintenance, inspection and testing.
- Minimize the potential pollution of the environment.

These tie-in options will be compatible with one of the following blowdown scenarios:

Conventional blowdown “Total plant blowdown starting from max. operating pressure reaching to 7 barg within 15 min”.

Sequential blowdown starting from max. operating pressure reaching to 7 barg within 15 min., applying the sequential blowdown philosophy between Phase 1, Phase 2 and

Compression areas.

The plant layout is arranged into individual sections can be considered as separate fire zones. A credit will be taken for the area where the highest risk is occurred to be depressurized firstly then after the area under lower risk. This allows one section to be affected by a fire, without their necessarily being an impact on other sections.

Phase-1 process facility consists of 12 BDVs used in between the emergency shutdown valves dedicated to be used in emergency shutdown to release the process plant facility hazardous hydrocarbon.

Phase-2 process facility consists of 7 BDVs used in between the emergency shutdown valves dedicated to be used in emergency shutdown to release the process plant facility hazardous hydrocarbon.

The process facility emergency shutdown valves and blowdown valves is described in Figure 1 for Phase-1 and Figure 2 for Phase-2.

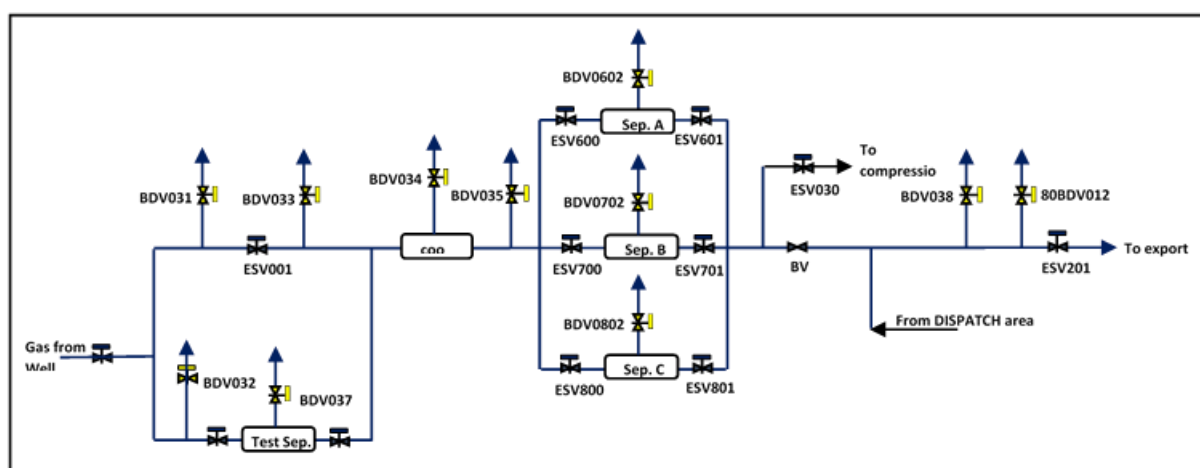


Figure 1: process flow diagram for Phase-1

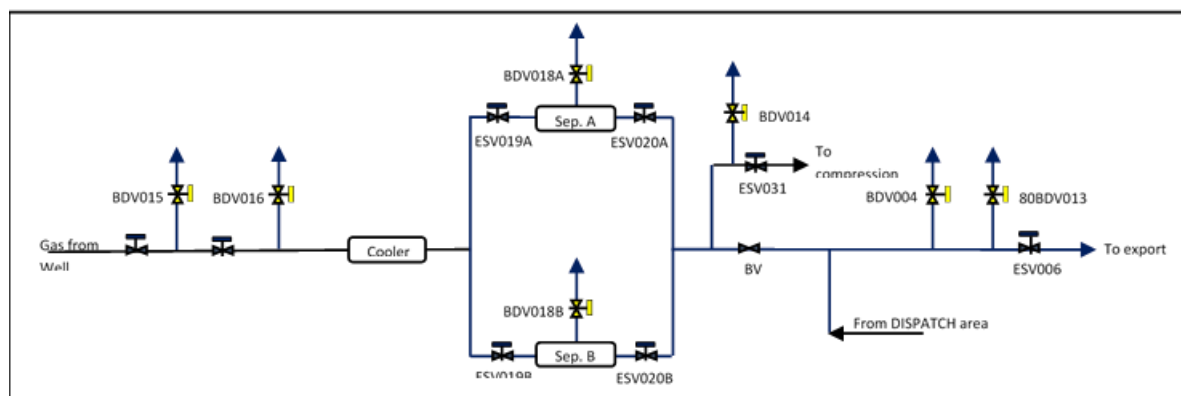


Figure 2: Process flow diagram for Phase-2

Compression facilities are new facilities added to the existing process facilities (Phase-1 and Phase-2 facilities) to increase the system pressure. These facilities are collected in a compression unit (Figure 4, a), a condensate handling system (Figure 4, b) and fuel system (Figure 4, c). The condensate system consists of two identical suction drums A (cond. Drum A) and B (cond. Drum B) units, each in equal capacities and used in 100% redundancy as one in service and the second one is standby which is assumed to be depressurized and under positive nitrogen pressure to be preserved free of

hydrocarbon liquid and gases. The fuel system contains a scrubber to free the gas from any entrained liquids associated with the gas. Also, there are preheaters to raise the gas stream temperature in a preparation step for conditioning the gas to be subjected to pressure reduction without hydrate formation.

The new compression unit facility consists of 12 BDVs. These valves are used in between the emergency shutdown valves to release the process plant facility hazardous hydrocarbon.

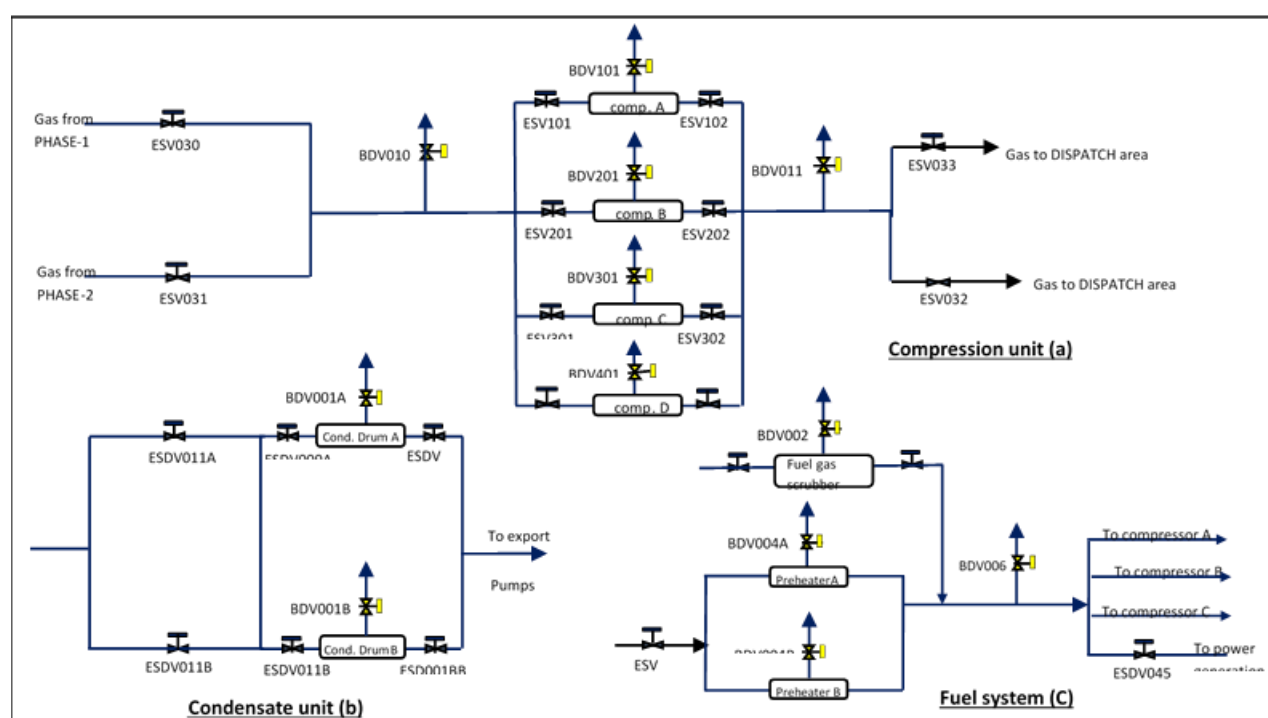


Figure 3: Compression unit facilities

Methodology

Scenario-1: Implementation an independent new Compression Flare system

The blowdown philosophy complies with the API 521 standards to release the hazardous hydrocarbon gas from the maximum pressure at 131 barg during the emergency to be reduced in 15 minutes to reach 7 barg. In such case the process facility can be maintained safe in case of emergency fire or even in the preliminary gas release.

In this suggested scenario, a new independent compression flare system will be constructed. The compression initial pressure assumed to be the maximum operating pressure for all equipment. As a result of pressure reduction at the compression suction header, the depressuring pressure will vary according to the operating condition. The blowdown philosophy applied to phase-1 and phase-2 is also applied to the new compression flare system.

Scenario-2: Sequenced Flare to Phase-1 and Phase-2 existing

This scenario is based on arranging the plant flare systems into individual sections. These sections can be considered as separate fire zones. This allows one section to be affected by a fire, without an impact on the other sections. This design limits the requirement of full plant blowdown, which is desirable because an emergency blowdown results in the loss of a significant mass of hydrocarbons to the atmosphere (more conservative for HC gas). This sequenced scenario depends on relieving the compression facilities to phase-1 or phase-2 flare system after the piping and equipment of phase-1

or phase-2 have reached to 7 barg at 15 minutes. Connection of compression facilities to phase-1 or phase-2 flare system depends on the design capacity of the flaring system (416,800 kg/h).

Results and discussion

The simulation is built using Aspen HYSYS program to perform the process plant facility blowdown scenarios in case of fire. The process plant facilities are simulated using Aspen Tech process modeling HYSYS V.10 and corresponding Aspen Flare System Analyzer V 10 for simulating the relieved gas different scenarios. The fire scenario is based on API-521 standard fire case. Each individual process equipment is to be sized according to the mechanical data sheet. Each pipe is to be specified according to the metal type, schedule and the nominal diameter and hence to state the pipeline length to determine the proposed volume of that pipe.

Scenario-1: Implementation an independent new Compression Flare system

The simulation is built using Aspen HYSYS v. 10 to perform the process plant facility blowdown scenario in case of fire through phase-1 and phase-2 facilities. The fire scenario is based on API-521 standard fire case. Total flared gas during blowdown equals the sum of all BDVs Blowdown valves individually in each phase. All system depressuring in the moment of emergency case activation are taken into consideration to achieve the depressuring through 15 minutes. The total peak flow calculated for phase-1 is illustrated in Table 1 and for phase-2 is illustrated in Table-2:

Table 1: Total flared gas during blowdown for phase 1 (scenario-1)

EBDV TAG	SERVICE	TOTAL VOLUME;		Initial Pressure	Initial Temp	Final Pressure	Orifice Area/Diameter	Blowdown Rate
		Gas	Liq.	Barg	C	Barg	mm ² /mm	Kg/hr.
30-BDV-031	FROM FLOW LINES THROUGH PRODUCTION HEADER TO AIR COOLERS INLET	33.5851		131	110	7	762.2 / 31.15	43300
		26.816	6.7691					
30-BDV-032	FROM FLOW LINES THROUGH TEST HEADER TO TEST	2.2784		131	90	7	60 / 8.73	3581
		2.21	0.0684					
30-BDV-033	AIR COOLERS WITH INLET /OUTLET AND BYPASS LINE	11.7		131	92.3	7	279.3 / 10.88	16574
		11	0.7					
30-BDV-034	AIR COOLERS WITH INLET /OUTLET AND BYPASS LINE	8.1		131	58	7	208.5 / 8.28	13750
		7.6	0.5					
30-BDV-035	INTERCONNECTING PIPING BETWEEN AIR COOLERS & PRODUCTION SEPARATORS	17.63		131	57.8	7	441.7/ 23.71	29234
		16.51	1.12					
30-BDV-602	Production Separator A	36.82		131	57.8	7	883.9/ 33.55	56846
		29.456	7.364					
30-BDV-702	Production Separator B	36.82		131	57.8	7	883.9 /	56846
		29.456	7.364					
30-BDV-802	Production Separator C	36.82		131	57.8	7	883.9 /	56846
		29.456	7.364					
30-BDV-505	Test Separator	9.1		131	57.8	7	226.5 /	14553
		7.8	1.3					
30-BDV-038	Process gas outlet piping	18.23		131	57.8	7	448.2 /	28825
		18.23	0					
		26		131	57.8	7	632.1 /	40653

EBDV TAG	SERVICE	TOTAL VOLUME;		Initial Pressure	Initial Temp	Final Pressure	Orifice Area/Diameter	Blowdown Rate
		Gas	Liq.	Barg	C	Barg	mm²/mm	Kg/hr.
30-BDV-037	Process gas outlet piping	25.995	0.005					
80-BDV-012	Inter-piping between Comp. Discharge & tie-in	36.304		131	57.8	7	873/33.34	56142
		36.304	0					
TOTAL FLARED GAS DURING BLOWDOWN, Kg/hr.								417150
Flare Designed Flow Rate, Kg/hr.								416800
Excess of Design %								0%
Shortage of Design %								-0.08%

Table 2: Total flared gas during blowdown for phase 2 (scenario-1)

EBDV TAG	SERVICE	TOTAL VOLUME		Initial Pressure	Initial Temp	Final Pressure	Orifice Area/Diameter	Blowdown Rate
		Gas M ³	Liq. M ³	Barg	°C	Barg	mm ² /mm	Kg/hr.
40-BDV-015	FROM FLOW LINE RECEIVER PACKAGE,	33.5851		131	90	7	776.4 /	46377
		26.8166	6.7691					
40-BDV-016	FROM INLET TO AIR COOLERS, TEST SEPARATOR, TO INLET OF	61.38		131	90	7	1403 / 42.26	83798
		49.02	12.36					
40-BDV-018A	PRODUCTION SEPARATOR	30.69		131	57.8	7	742.1 / 30.74	47725
		15.34	15.35					
40-BDV-018B	PRODUCTION SEPARATOR	30.69		131	57.8	7	742.1 / 30.74	47725
		15.34	15.35					
40-BDV-004	From outlet of Production Separators to Phase -2 battery limit ESV at Salem Pipeline	14.613		131	57.8	7	371.3 / 21.74	24600
		14.61	0.003					
80-BDV-013 (new valve)	INTERPIPING BETWEEN COMP. DISCHARGE & TIE-IN	47.6795		131	57.8	7	1137 / 38	73139
		47.67	0.0095					

80-BDV-014 (new valve)	INTERPIPING BETWEEN phase-2 -2 & TIE-IN	15.122		131	57.8	7	375.6/ 21.87	24154
		15	0.122					
TOTAL FLARED GAS DURING BLOWDOWN, Kg/hr.								34751
Flare Designed Flow Rate, Kg/hr.								416800
Excess of Design %								17%
Shortage of Design %								0.00%

The compression initial pressure assumed to be the maximum operating pressure for all equipment, as a result of pressure reduction at the compression

suction header, the depressuring pressure will vary according to the operating condition. The total peak flow calculated as described in Table 3:

Table 3: Total flared gas during blowdown for the new compression unit

EBDV TAG	SERVICE	TOTAL		Initial Press.	Initial Temp.	Final Pressure	Orifice Area / Diam.	Blowdo wn Rate
		Gas M ³	Liq. M ³					
				Bara	°C	Bara	mm ² /mm	Kg/hr
80-BDV-010	SEPARATORS OUTLET TO COMPRESSION	123.865		85	47.58	7	2457/ 55.9	101223
		123.86	0					
80-BDV-101	COMPRESSION MACHINE TRAIN A	62.3		95	72.76	7	1229/ 39.56	52350
		57.8	4.4747					
80-BDV-201	COMPRESSION MACHINE TRAIN B	47.3951		100.23	76.71	7	956.4 / 34.89	42646
		44.55	2.8451					
80-BDV-301	COMPRESSION MACHINE TRAIN C	62.2747		95	72.76	7	1229/ 39.56	52350
		57.8	4.4747					
80-BDV-401	COMPRESSION MACHINE TRAIN D	47.3951		100.23	76.71	7	956.4 / 34.89	42646
		44.55	2.8451					
80-BDV-011	COMPRESSION DISCHARGE TO EXISTING EXPORT FACILITIES	58		130	57.8	7	1370 / 41.76	87377
		58	0					
80-BDV-001A	CONDENSATE SUCTION DRUM A	28.165		70	57.8	7	511.8 / 25.53	8196.5
		19.595	8.57					
80-BDV-001B	CONDENSATE SUCTION DRUM B	28.194		70	57.8	7	511.8 / 25.53	8196.5
		19.624	8.57					

EBDV TAG	SERVICE	TOTAL		Initial Press.	Initial Temp.	Final Pressure	Orifice Area / Diam.	Blowdown Rate
		Gas M ³	Liq. M ³					
				Barg	°C	Barg	mm ² /mm	Kg/hr
80-BDV-002	FLASH GAS PREHEATER	0.068		70	57.8	7	1.264 / 1.269	40.49
		0.068	0					
80-BDV-004A	HP FUEL GAS PREHEATER	2.304		130	57.44	7	59.15 / 8.67	1889
		2.304	0					
80-BDV-004B	HP FUEL GAS PREHEATER	2.258		130	57.44	7	59.15 / 8.67	1889
		2.258	0					
80-BDV-006	HP FUEL GAS KO DRUM	7.291		42	50	7	103.3 / 11.47	1935
		7.291	0					
TOTAL FLARED GAS DURING BLOWDOWN, Kg/hr								400738.49
Flare Designed Flow Rate, Kg/hr								416800
Excess of Design %								4%
Shortage of Design %								0.00%

The results above show that the total flared gas directed to phase-1 flare will be 417150 Kg/hr. (it exceeds the design flare capacity by 0.08% of design capacity 416800 Kg/hr.) which is accepted considering the flare design margin. The total flared gas directed to phase-2 flare will be 347518 Kg/hr. (which is lesser than the design flare

capacity by 17% of design capacity 416800 Kg/hr.). The total flared gas directed to an identical new flare will be 400738 Kg/hr. (which is lesser than the design flare capacity by 4%). The new identical flare system estimated cost with +/- 10% accuracy is illustrated in Table 4.

Table 4: New Identical Flare System Cost Estimation

Equipment	Cost (\$)
200 m Piping (16" Duplex): Headers, sub headers and supports	400,000
Carbon Steel HP Flare Knock Out Drum	1,000,000
Carbon Steel HP Flare Stack	1,000,000
Total	2,400,000

Adding a new independent compression flare utility will positively help relieving the new compression surge volume in a minimum time as per API521 standard (15 minutes or less). Independent flare will not affect existing facilities depressuring time and in addition the project will

not be affected when one of the existing flares is under maintenance. But on the other hand, will negatively affect the project budget as this requires a high capital cost of the new flare system.

Scenario-2: Sequenced Flare to Phase-1 and Phase-2 existing

Simultaneously depressurizing all the process and equipment, vessels, and piping in a plant will be difficult to accomplish (due to pipe sizing and economic impacts). In these cases, sequential or segmented depressurization of vessels should be considered. Providing for the worst vessels first or controlling the system to depressurize the area most affected first are possible scenarios that can be employed. Sequential blowdown starts from equipment maximum operating pressure to 7 Barg within 15 minutes. This scenario is performed in order to estimate the peak blowdown rate for each zone based on external fire depressuring criteria and to depressurize to 7 Barg in 15 minutes:

The results of scenario 2 show that:

- 1- Once the compression facility starts to relief to phase-1 flare after phase-1 piping and equipment have reached to 7 barg at 15 min, the total flared gas will be handled by phase-1 flare for the following 15 minutes is 418812.49 Kg/hr (Table 5). (which exceeds with accepted limits the design flare capacity of PH-1 by 0.5% of flare design capacity 416800 Kg/hr.). That means that the sequential blowdown solution will not meet

the phase-1 flare design requirements.

- 2- Once the compression facility starts to relief to phase-2 flare, after Phase-2 piping and equipment have reached to 7 barg at 15 min, the total flared gas will be handled by phase-2 flare for the following 15 min. is 415604.49 Kg/hr (Table 6). (which is lesser than the design flare capacity by 0.3% of flare design capacity 416800 Kg/hr.). That means that the sequential blowdown solution will meet the phase-2 flare design requirements and also the blowdown criteria.
- 3- Adding the new compression facility considering the sequenced flaring technique will cost a new system of uninterrupted power supply (UPS) with logic solver to resume efficient in case of total plant power failure. Use of UPS or emergency diesel generator may be considered so that when the normal power supply is interrupted, a standby power supply would automatically start, in a fraction of a second, to support critical equipment or units. Estimated cost with +/- 10% accuracy for new redundant UPS system to avoid any failure causing direct flaring at the same time is approximately 10000 \$.

Table 5: Total Flared Gas during Blowdown for phase-1 (scenario- 2)

EBDV TAG	SERVICE	TOTAL		Initial Press. Barg	Initial Temp C	Final Pressure Barg	Orifice Area/Diam mm2/mm	Blowdown Rate Kg/hr	Balance Flow Kg/hr
		GAS M ³	LIQ. M ³						
30-BDV-031	FROM FLOW LINES THROUGH PRODUCTION HEADER TO AIR COOLERS INLET	33.5851		131	110	7	762.2 / 31.15	43300	1895
		26.816	6.7691						
30-BDV-032	FROM FLOW LINES THROUGH TEST HEADER TO TEST SEPARATOR INLET	2.2784		131	90	7	60 / 8.73	3581	144.6
		2.21	0.0684						
		11.7		131	92.3	7		16574	662.4

EBDV TAG	SERVICE	TOTAL		Initial Press.	Initial Temp	Final Pressure	Orifice Area/Diam	Blowdown Rate	Balance Flow Rate
		GAS M ³	LIQ. M ³						
		Barg	C	Bar g	mm2/mm	Kg/hr			
30-BDV-033	AIR COOLERS WITH INLET /OUTLET AND BYPASS LINE	11	0.7				279.3 / 18.86		
30-BDV-034	AIR COOLERS WITH INLET /OUTLET AND BYPASS LINE	8.1		131	58	7	208.5 / 16.29	13750	531.8
		7.6	0.5						
30-BDV-035	INTERCONNECTING PIPING BETWEEN AIR COOLERS & PRODUCTION SEPARATORS	17.63		131	57.8	7	441.7 / 23.71	29234	1145
		16.51	1.12						
30-BDV-602	Production Separator A	36.82		131	57.8	7	883.9 / 33.55	56846	2512
		29.45	7.364						
30-BDV-702	Production Separator B	36.82		131	57.8	7	883.9 / 33.55	56846	2512
		29.45	7.364						
30-BDV-802	Production Separator C	36.82		131	57.8	7	883.9 / 33.55	56846	2512
		29.45	7.364						
30-BDV-505	Test Separator	9.1		131	57.8	7	226.5 / 16.9	14553	680.2
		7.8	1.3						
30-BDV-038	Process gas outlet piping	18.23		131	57.8	7	448.2 / 23.89	28825	1245
		18.23	0						
30-BDV-037	Process gas outlet piping	26		131	57.8	7	632.1 / 28.37	40653	1769
		25.99	0.005						
80-BDV-012	Inter-piping between Comp. Discharge & tie-in	36.304		131	57.8	7	873 / 33.34	56142	2465
		36.30	0						
TOTAL FLARED GAS DURING BLOWDOWN, Kg/hr								417150	18074
Flare Designed Flow Rate, Kg/hr								416800	416800
Excess of Design %								0%	
Shortage of Design %								-0.08%	
Required Compression Flared Gas									400738
In Case of Sequential Blowdown, Total Compression Flared Gas									418812
In Case of Sequential Blowdown, Excess of Design %									0.0%
In Case of Sequential Blowdown, Shortage of Design %									-0.5%

Table 6: Total Flared Gas during Blowdown for Phase-2 (scenario-2)

EBDV TAG	SERVICE	TOTAL VOLUME;		Initial Press .	Initial Temp .	Final Press .	Orifice Area/ Diameter	Blow down Rate	Balance Flow After 15 min
		Gas m ³	Liq. m ³	Barg	C	Barg	mm ² /m	Kg/hr .	Kg/hr.
40-BDV-015	FROM FLOW LINE RECEIVER PACKAGE, PRODUCTION HEADER PACKAGE, TO AIR COOLERS	33.56		131	90	7	776.4/31.44	46377	1967
		26.8	6.76						
40-BDV-016	FROM INLET TO AIR COOLERS, TEST SEPARATOR, TO INLET OF PRODUCTION SEPARATORS	61.38		131	90	7	1403/42.26	83798	3523
		49.02	12.36						
40-BDV-018A	PRODUCTION SEPARATOR	30.6		131	57.8	7	742.1 / 30.74	47725	2086
		15.3	15.3						
40-BDV-018B	PRODUCTION SEPARATOR	30.6		131	57.8	7	742.1 / 30.74	47725	2086
		15.3	15.3						
40-BDV-004	From outlet of Production Separators to Phase-2 battery limit ESV at Salam Pipeline	14.603		131	57.8	7	371.3 / 21.74	24600	968
		14.6	0.003						
80-BDV-013 (NEW VALVE)	INTERPIPING BETWEEN COMP. DISCHARGE & TIE-IN	47.609		131	57.8	7	1137 / 38	73139	3221
		47.6	0.009						
80-BDV-014 (NEW VALVE)	INTERPIPING BETWEEN PH II & TIE-IN	15.12		131	57.8	7	375.6 / 21.87	24154	1015
		15	0.12						
TOTAL FLARED GAS DURING BLOWDOWN, Kg/hr								3475	1486
Flare Designed Flow Rate, Kg/hr								4168	4168
Excess of Design %								17%	
Shortage of Design %								0.00	
Required Compression Flared Gas									4007

EBDV TAG	SERVICE	TOTAL VOLUME;		Initial Press	Initial Temp	Final Press	Orifice Area/ Diameter	Blow down Rate	Balance Flow After 15 min
		Gas m ³	Liq. m ³	Barg	C	Barg	mm ² /m	Kg/hr	Kg/hr.
Total Compression Flared Gas									4156
In Case of Sequential Blowdown, Excess of Design %									0.3%
In Case of Sequential Blowdown, Shortage of Design %									0.0%

Conclusion

The two scenarios for connecting a new flare system of the new compression unit to the two existing flare systems are considered. The two scenarios are implementing a new flare system for the new compression unit and sequential blowdown,. Simulation and calculations revealed that:

For scenario 1, if a new flare system is used (Final Pressure 7 barg within 15 min) the total flared gas will be directed to Phase-1 flare will be 417150 Kg/hr. (it exceeds the design flare capacity by 0.08% of design capacity 416800 Kg/hr.) which is accepted considering the flare design margin, and the total flared gas will be directed to Phase-2 flare will be 347518 Kg/hr. (which is lesser than the design flare capacity by 17% of design capacity 416800 Kg/hr.). For compression depressurization, the total flared gas will be directed to an identical new flare will be 400738 Kg/hr (which is lesser than the design flare capacity by 4%). A new flare for the peak load of 400738 Kg/hr will require a large capital cost which is approximately 2,400,000 \$.

For scenario 2, if sequential blowdown (final Pressure 7 Barg in 15 min.) is used, Once the compression facility starts to relief to Phase-1 flare after Phase-1 piping and equipment have reached to 7 barg at 15 min, the total flared gas will be handled by Phase-1 flare for the following 15 min. is 418812.49 Kg/hr. (which exceeds the design flare capacity by 0.5% of flare design capacity 416800 Kg/hr. which is accepted considering the

flare design margin). Once the compression facility starts to relief to Phase-2 flare, after Phase-2 piping and equipment have reached to 7 barg at 15 min, the total flared gas will be handled by Phase-2 flare for the following 15 min. is 415604.49 Kg/hr. (which is lesser than the design flare capacity by 0.3% of flare design capacity 416800 Kg/hr. Adding the new compression facility considering the sequenced flaring technique will cost a new system of UPS with logic solver to resume efficient in case of total plant power failure, it approximately costs 10000 \$.

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