
	<p>نگهداشت و افزایش تولید میدان نفتی بینک سطح الارض</p> <p>احداث ردیف تراکم گاز در ایستگاه جمع آوری بینک</p>								
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## طرح نگهداشت و افزایش تولید 27 مخزن

### FLARE, BLOW DOWN AND RELIEF PHILOSOPHY

#### نگهداشت و افزایش تولید میدان نفتی بینک





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IDC: Inter-Discipline Check  
 IFC: Issued For Comment  
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 AFD: Approved For Design  
 AFC: Approved For Construction  
 AFP: Approved For Purchase  
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 AB-R: As-Built for CLIENT Review  
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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 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.

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## 2.0 SCOPE

The purpose of this document is to implement the methods employed for protecting the facilities against over pressuring, pressure relief systems, blow down and flaring system for Binak New Gas Compressor.

## 3.0 NORMATIVE REFERENCES

### 3.1 LOCAL CODES AND STANDARDS

- IPS (NIOC) E-PR-460 Engineering Standard for Process Design of Flare and Blowdown Systems

### 3.2 TERNATIONAL CODES AND STANDARDS



- API STD 521 Pressure-relieving and Depressuring Systems, 6th Edition
- API STD 520, Part 1 Sizing, Selection, and Installation of Pressure-relieving Devices, Part I - Sizing and Selection, 9th Edition
- API STD 520, Part 2 Sizing, Selection, and Installation of Pressure-relieving Devices-Part II, Installation, 6th Edition
- API RP 553 Refinery Valves and Accessories for Control and Safety Instrumented Systems, 2nd Edition
- API STD 2000 Venting Atmospheric and Low-pressure Storage Tanks, 7th Edition
- IEC 61511 (all parts) Functional Safety-Safety instrumented systems for the process industry sector

### 3.3 THE PROJECT DOCUMENTS

For each plant defined by NISOC within project scope of work, corresponding documents (PFD, H&M Balance, Hazard Source List, P&IDs, Design Basis, Process design criteria) shall be used as reference for using this document.



### 3.4 ENVIRONMENTAL DATA

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



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### 3.5 ABBREVIATIONS

API	American Petroleum Institute
BDV	Blowdown Valve
BTU	British Thermal Units
CSC	Car Seal Closed
DCS	Distributed Control System
FC	Fails Closed
FO	Fails Open
F&G	Fire and Gas
EDP	Emergency Depressurization
EIS	Electrical Isolation System
ESD	Emergency Shutdown
ESDV's	Emergency Shutdown Valves
HAZOP	Hazard and Operability Study
MMSCFD	Million standard cubic feet per day
NISOC	National Iranian South Oil Company
NLL	Normal Liquid Level
OCS	Operator Control Station
OPPS	Over-Pressure Protection Systems
PCS	Process Control System
P&ID	Piping & Instrumentation Diagram
PLC	Programmable Logic Control
PSHH	Pressure Switch High-High

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PSLL	Pressure Switch Low-Low
PSS	Process Safety System
SDV	Shutdown Valve
TSHH	Temperature Switch High High
TSO	Tight Shut Off
TSV	Temperature Safety Valve
UCP	Unit Control Panel
UPS	Uninterrupted Power Supply

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## 4.0 PRESSURE PROTECTION AND RELIEF

### 4.1 CAUSES OF OVER-PRESSURIZATION

The faults listed below can lead to an over-pressurization; they shall be taken into account for the design of the pressure protection and relief systems.

- Blocked outlet, blow-by, inadvertent inlet valve opening from high-pressure source, check-valve malfunction
- Loss of power, mechanical failure of fans, reflux failure, etc.
- Loss of heat (some particular cases of fractionation systems in series)
- Fire, excessive heat input, unsteady process (exothermic reactions, etc.)
- Utility failure and/or loss of control (air instrument, power, etc.)
- Heat exchanger tube failure, transient pressure surges, quick-closing valves
- Severe slugging regime (multiphase flow)

### 4.2 PRESSURE PROTECTION SYSTEMS

Two main approaches are possible for over-pressure protection systems:

#### 4.2.1 Full Pressure-Rated Mechanical Design

The system design pressure exceeds the maximum possible pressure at design temperature, reached in the event of a process upset, and with due allowance for corrosion being made.



#### 4.2.2 Relief Systems

The system design pressure includes a safety margin above the system maximum operating pressure but, in case of a process upset, the pressure prevailing in the system can exceed the design pressure. It is therefore fitted with devices actuated by the system static pressure and designed to open in case of upset conditions. The pressure systems in the plant shall normally be protected following API STD 520 & API STD 521 recommendations except for atmospheric and low pressure storage tanks which shall meet the venting requirements as per API STD 2000.

### 4.3 CRITERIA FOR INSTALLATION OF RELIEF DEVICES

Any vessel shall be equipped with a protection device sized for fire or other contingencies. Pressure relief may consist of one or a combination of PSV, TSV and rupture disc. The criteria for installation of PSV's and TSV's are as follows:



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	PSV (Process)	PSV (Fire case)	TSV
Piping that <b>cannot</b> be isolated (5): - All fluids	No	No	No
Piping that can be isolated (5) <b>but cannot</b> be exposed to fire: - Flammable gas - Liquefied HC - Liquid HC	No (1) No (1) No (1)	No No No	No Yes (7) (6) Yes (7) (6)
PIPING that can be isolated (5) <b>and can</b> be exposed to fire (8): - Flammable gas - Liquefied HC - Liquid HC	No (1) No (1) No (1)	if > 3 tonnes if > 2 tonnes if > 2 tonnes	No Yes (6) Yes (2) (6)
Vessels that <b>cannot</b> be isolated (5): - All fluids	Yes (3)	No	No
Vessels that can be isolated (5) <b>but cannot</b> be exposed to fire: - All fluids	Yes (3)	No	No
Vessels that can be isolated (5) <b>and can</b> be exposed to fire (8): - All fluids	Yes (3)	Yes	No



#### Notes:

- (1). Assuming piping is protected against the maximum possible pressure under upset conditions (full pressure rated design or PSV installed upstream of it). Otherwise a process PSV is required.
- (2). The installation of TSV's on piping handling liquid hydrocarbon shall be assessed case by case, based on service criticality and risk assessment.
- (3). As per ASME SEC VII.
- (4). Includes pressurized hydrocarbon at ambient temperature, refrigerated hydrocarbons at atmospheric pressure or partially refrigerated pressurized hydrocarbon.
- (5). Any type of isolation, automatic or manual valves.
- (6). A TSV is not required if a PSV (process or fire case) is already installed.
- (7). A TSV is required if ambient temperature conditions and/or sun radiation may lead to a prevailing pressure exceeding piping design pressure.
- (8). Piping or vessels shall be considered as being possibly exposed to fire if more than 10 % of their external surface can be engulfed in a pool fire likely to last more than 3 minutes.

In case of toxic substances, the threshold criteria for the installation of PSV fire case and/or TSV may be made more stringent. This issue shall be assessed on a case by case basis

#### 4.4 RELIEF DEVICE SETTING

The set point and other characteristics of the relief devices shall be as per API STD 520 for process equipment, utilities and pressure vessels for storage of liquefied hydrocarbon. API STD 2000 recommendations shall apply for liquid petroleum product tanks.

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#### 4.5 RELIEF SYSTEM SIZING

Individual relief valves shall be sized to relieve the pressure resulting from the combination of any single safety system failure (double jeopardy not considered) with any possible process or utility failure. For the sizing of the relief systems, the following scenario shall be considered (non-exhaustive list):

##### 4.5.1 Flow

- Blocked outlet
- Blow by, (control valve and bypass shall be considered as fully opened)
- Inadvertent valve opening from high pressure source
- Check valve malfunction
- Heat exchanger tube rupture

##### 4.5.2 Heat

- Fire
- Excessive heat input
- Loss of cooling
- Loss of power
- Loss of cooling agent
- Mechanical failure of fans
- Reflux failure
- Loss of heat (particular case of fractionating systems in series)



##### 4.5.3 Utility failure and/or loss of control

- Power
- Instrument air
- Transient pressure surge
- Quick closing valves
- Two phase slugs

#### 4.6 RELIEF SYSTEM CONFIGURATION

The following rules shall apply for determining the number of relief valves which need to be fitted onto equipment for pressure protection:

- For process pressure safety valves, if n is the number of PSVs (or set of PSV) necessary to ensure 100 % relief capacity, then n + 1 PSV (or set of) shall be installed.
- A single PSV (fire case) is provided for equipment that can be momentarily isolated for maintenance, providing the PSV does not also have a process function.
- Where, for capacity reasons, several pressure relief valves must be provided in parallel, the

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set pressures should be staggered to avoid chattering during relief. The difference between set points shall be less than 5 % of the design pressure in accordance with the recommendations in API STD 520 and API STD 521.

- A single TSV shall be provided for pipe work thermal relief.
- One PSV in P&ID (with one spare provided and located in warehouse) means that the PSV will be designed for fire case only. Two or more PSV's (n+1 spare) shown on P&ID means that safety valves are designed for a relieving case other than the fire case

#### 4.7 PSV INSTALLATION

The following rules shall apply for isolation of PSV (Refer to API STD 520, Part2 for more detail guideline and instruction):



- Gate valve to be provided upstream of the PSV for a pipe class rating of up to 150 # and for diameter lower than or equal to 8" and for non-sour service or non-toxic.
- Valve located downstream of PSV to be gate valve type for non-sour service and ball valve type for sour service or toxic service.
- If feasible, and assuming this does not create interference with other process systems, the relief discharge lines from a process unit and/or fire zone shall be routed to a common sub-header. In such a case no isolation valve shall be provided on each individual relief discharge line and a single isolation valve shall be fitted on the sub-header, upstream of its connection with the main header.
- Where sub-header downstream isolation valves are unavoidable, they shall locked- open in normal operating conditions. A single valve without positive isolation is considered as acceptable even for toxic gas services.
- Full bore ball valves shall be used for service where design temperature  $\leq 200^{\circ}\text{C}$

#### 4.8 LOCATION

- PSV should be installed directly on the vessel. However, client criteria is to minimize the number of nozzles on vessel and therefore relocating the PSV on overhead vapor line should be considered by EPC CONTRACTOR, provided there is no demister installed and within API constraints.
- A spool piece will be installed upstream of the PSV. However, the advantage of using the spacer at vessel nozzle can be considered.
- PSV bypass line to be in 2" regardless of the vessel capacity.

#### 4.9 RELIEF SYSTEM PIPING

- Block valves shall be avoided on flare header and sub header. However, full bore ball valves with position indicator are required for maintenance at each battery limit.
- Flare header shall be self-draining towards the flare drum.
- All connections shall be done with no low point and preferably on the top of the header.

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Connection to the header should be at an angle of 45°. Relief lines with diameters below 4" NB may enter the header at an angle of 90°.

- Flow orifice or flow meter (except annubar type or equivalent) which can be blocked by foreign matters shall not be installed in flare header and sub-header.
- The fitting of check valves downstream of relief devices is prohibited.
- Adequate systems shall be installed to separate liquids before the vent or flare tip. Where a significant quantity of liquid is expected, a K.O. drum shall be provided with its own liquid evacuation devices. The design of the network and, in particular, of the drain points, shall be such that the ingress of air under vacuum conditions is avoided.
- The relief piping shall be selected from material suitable for lowest expected discharge temperature. If water may be present, the risk of ice or hydrate formation shall be assessed, and methanol injection (or any other suitable mitigation measure), such as segregated headers to the flare K.O. drum, should be considered to avoid blockage.
- Adequate supports shall be provided upstream and downstream of relief devices.

## 5.0 EMERGENCY DEPRESSURIZATION

### 5.1 GENERAL CONSIDERATION

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.

Blowdown Valve Specification is as follow:

- TSO, Full Bore
- FO, de-energized to open (except for slug catcher, XV energized to open)
- No fire proofing required

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- Minimum diameter greater than or equal to 2".



## 5.2 CRITERIA USED 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):	
	<ul style="list-style-type: none"> <li>Flammable gas</li> <li>Liquefied HC (4)</li> <li>Liquid HC</li> <li>Two-phase</li> <li>Toxic gases</li> </ul>	<ul style="list-style-type: none"> <li><math>P &gt; 17 \text{ barg}</math> and <math>PV_{\text{gas}} &gt; 100 \text{ bar. m}^3</math> (6)</li> <li><math>M_{\text{gas}}</math> or <math>M_{\text{liq}} &gt; 2 \text{ tons of C}_4</math> and more volatile (6)</li> <li>No (3)</li> <li><math>P &gt; 17 \text{ barg}</math> and <math>PV_{\text{gas}} &gt; 100 \text{ bar. m}^3</math></li> <li>As required for protection of personnel</li> </ul>
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):	
	<ul style="list-style-type: none"> <li>Flammable gas</li> <li>Liquefied HC (4)</li> <li>Liquid HC</li> <li>Two-phase</li> <li>Toxic gases</li> </ul>	<ul style="list-style-type: none"> <li><math>P &gt; 17 \text{ barg}</math> and <math>PV_{\text{gas}} &gt; 100 \text{ bar. m}^3</math> (6)</li> <li><math>M_{\text{gas}}</math> or <math>M_{\text{liq}} &gt; 2 \text{ tons of C}_4</math> and more volatile (6)</li> <li>No (3)</li> <li><math>P &gt; 17 \text{ barg}</math> and <math>PV_{\text{gas}} &gt; 100 \text{ bar. m}^3</math></li> <li>As required for protection of personnel</li> </ul>

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.

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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 SYSTEM VOLUME DETERMINATION

Volume of the system to be depressurized shall be determined by the isolation block valves 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. Purge and drain lines are neglected in the total volume.

### 5.4 INDIVIDUAL BLOWDOWN CALCULATIONS

Three different depressurization procedures are considered within the PROJECT:

- Depressurization in case of external pool fire ("Hot fluid depressurization")
- Depressurization after prolonged shutdown ("Cold fluid depressurization")
- Spurious Depressurization

#### Depressurization in case of external pool fire

The flow is assumed to be critical through the Restriction Orifice and designed according to the followed considerations:

a) 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

b) Final Conditions:

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

c) 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;

d) 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.ft<sup>2</sup> 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 ft<sup>2</sup> (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/m<sup>2</sup>°C
- For restriction orifice, atmospheric conditions shall be considered downstream the orifice.

### Depressurization after prolonged shutdown

In the cold depressurization procedure, the target is to check the final temperature after the



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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/m<sup>2</sup>°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.

### **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



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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 : 17°C
- Heat transfer coefficient : 5 W/m<sup>2</sup>°C

## 5.5 FIRE ZONE DEPRESSURIZATION

Inside one fire zone, the system exposed to fire will be defined within a cylindrical volume (dimensions: about 18 m diameter x 8 m height). This zone will be determined as the area generating the largest blowdown flow (in general this area presents the largest liquid inventory). Therefore, the flow rate generated by the blowdown of one fire zone will be calculated by adding flow rate through BDV's and included in the cylindrical volume exposed to fire with the flow rate calculated on the basis of a spurious blowdown for other BDV's. Phased EDP system within one fire zone, using sectionalizing of process systems within the fire zone using sectionalization valves to mitigate Depressuring rate, will be foreseen if instantaneous flow rate generated by the depressurization is higher than the design flow rate of the flare.

## 5.6 SIMULATION SOFTWARE FOR EDP CALCULATION

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

## 6.0 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. bed below.