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Revision Memo

03/04	Page 2	Updated references to Global Practices
	Page 4	Revised closed drain header connection details.
	Page 7	Added sizing basis for branches serving individual PR valve services and for branches serving multiple PR valve services.
	Page 9	Corrected Equation 1a. Added Equation 1b
	Page 11	Added maximum velocity limitation for short cumulative duration releases such as PR valves.
	Figure 4	Deleted level "C" Added LHA at level "D"



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SCOPE

This section covers the design of: (a) facilities to handle equipment drainage and contaminated aqueous effluents and send them to appropriate disposal, (b) closed release systems to receive pressure relief device discharges, emergency vapor blowdowns, etc., and (c) facilities for process stream diversion and slop storage. Also covered are criteria for selecting the appropriate method of disposal. Design of flares is covered in [Section XV-E](#).

REFERENCES

DESIGN PRACTICES

Section II	Design Temperature, Design Pressure and Flange Rating
Section III	Fractionating Towers
Section V	Drums
Section X	Pumps
Section XIV	Fluid Flow
Other sections of Section XV	

OFFSITE DESIGN PRACTICE

Section XXII	Storage Facilities
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GLOBAL PRACTICES

GP 03-02-01,	Sewer Systems
GP 03-02-04,	Pressure Relieving Systems
GP 03-03-02,	Suction and Discharge Piping for Centrifugal Pumps
GP 03-06-04,	Vents and Drains, Flushing and Cleaning Connections
GP 03-09-01,	Winterizing and Protection Against Ambient Temperatures
GP 03-12-01,	Valve Selection
GP 05-02-01,	Internals for Towers, Drums, and Fixed Bed Reactors
GP 08-01-01,	Cooling Towers
GP 09-02-01,	Additional Requirements for Pressure Storage Spheres
GP 09-07-01,	Accessories for Atmospheric Storage Tanks
GP 18-10-01,	Additional Requirements for Materials

OTHER LITERATURE

API Standard 650 - *Welded Steel Tanks for Oil Storage*
Frangible Roofs - Are They Needed?, EE.36E.84
Piping Vibration Evaluation Guide, EE.21E.89
Hot Oil and Slop Tankage Safety Guidelines, 87ECS3R10

BACKGROUND

The purpose of the facilities described in this section is to provide for safe handling of various drainage and emergency streams, so that they may be safely routed to sewer, tankage, flare, or other appropriate destination. Drainage systems specified herein ensure that flammable or toxic materials may be disposed of without hazard of fire or injury when equipment is taken out of service. Also described are systems to handle process water drawoffs, cooling water, and other aqueous effluent streams which may be contaminated with hydrocarbons, and which could otherwise create hazardous conditions if they were discharged directly to the sewer.

Pressure relief device releases are routed to the flare via the closed release system comprising laterals, headers, and blowdown drums when the presence of liquid, toxic properties, or other factors would make direct discharge to the atmosphere hazardous. These criteria are detailed in [Section XV-C](#). Emergency vapor blowdown facilities for process units are described in [Section XV-F](#).

Product and intermediate process streams may need to be diverted to alternative disposal if they are off-specification (e.g., during startup) or in the event of emergency shutdown of downstream equipment.



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DESIGN PROCEDURE

EQUIPMENT DRAINAGE

General requirements for valving and discharge of all vent and drain connections on process equipment are detailed in **GP 3-6-4**. This GP covers low point drains and high point vents, as well as connections specifically provided for equipment drainage and venting at shutdown or when taken out of service. Also covered are vents and drains for instruments, gage glasses, sample points, etc. As an additional requirement not covered by **GP 3-6-4**, regularly used drain connections and sample points in light ends service must be double valved.

The requirements of **GP 3-6-4** for discharge of dangerous materials to closed drain systems are supplemented by the following paragraphs.

Disposal of Drainage of Process Equipment Contents - When items of onsite process equipment are taken out of service, either individually during plant operation or for general turn-around, means of draining and safe disposal of the residual liquid hydrocarbon contents must be provided, in accordance with the following:

PROCESS EQUIPMENT CONTENTS	LIGHT ENDS (RVP > 15 psia) (103 kPa abs)	HEAVIER THAN LIGHT ENDS, AT TEMPERATURE ABOVE FLASH POINT	HEAVIER THAN LIGHT ENDS, AT TEMPERATURE BELOW FLASH POINT
Vessels with liquid inventory >25 gallons (0.1 m ³)(1)(2)(4)(5)	Closed Drain Header	Closed Drain Header	Vacuum Truck(3)(6)
Vessels with liquid inventory ≤ 25 gallons (0.1 m ³)(1)(2)(4)(5)	Closed Drain Header	Vacuum Truck(3)(6)	Vacuum Truck(3)(6)
Pumps (see also Section X-H)	Closed Drain Header	Vacuum Truck(3)(6)	Vacuum Truck(3)(6)
Compressor casing, cylinder and knockout bottle drains	Closed Drain Header	—	—

Notes:

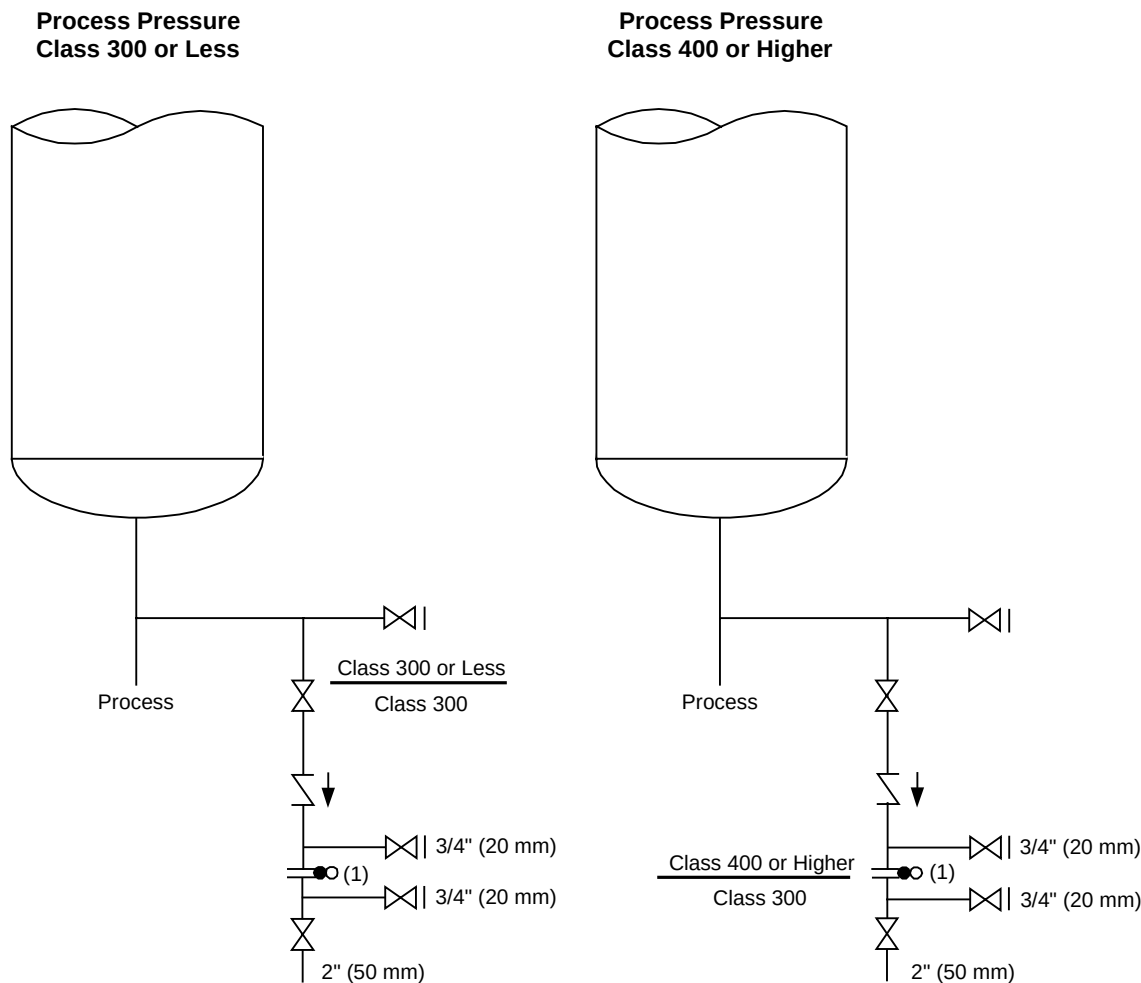
- (1) "Vessels" include towers, drums, and miscellaneous onsite equipment such as filters, strainers, separators, etc. Heat exchangers are treated separately below (see Note 4).
- (2) "Inventory" refers to liquid hydrocarbon contents at the top of the working level range. Tray holdup is included, but piping contents are disregarded.
- (3) Refinery preference may exceed these requirements. In such cases, additional 1 in. (25 mm) connections from equipment to the closed drain header may be installed [3/4 in. (20 mm) connections are adequate for pumps].
- (4) Heat exchangers, which are valved for on-stream maintenance, should be considered as "vessels" in the table above, according to inventory and contents. Shell sides and tube sides should be treated separately. However, if the liquid contents of an exchanger can be gravitated into connected equipment through the process piping before closing all the isolating valves, then the requirement for drainage (called for by the table) may be deleted.
- (5) Heat exchangers, which are not valved for onstream maintenance, require only a means of drainage for a unit shutdown situation. If the liquid contents of a heat exchanger cannot be gravitated or displaced (as part of the shutdown procedure) into a connected vessel which is provided with appropriate means of drainage, then the exchanger should be considered as a "vessel" and provided with drainage facilities according to inventory and contents in the table.
- (6) The methods of equipment drainage described above are considered to provide safe disposal of liquid hydrocarbon contents of most process unit designs. Other methods may also be safe, such as draining to closed system or oily water sewer when permitted by environmental regulations. High pour point materials, which could solidify, should not be drained to the sewer. If using open connections to sewers:
 - Consideration must be given to prevailing conditions (wind, adjacent ignition sources, need for protective clothing, etc.).
 - The connection must be at least 50 ft (15 m) from any continuous ignition source.
 - The release must be controlled.

Closed Drain Header Systems for Flammable Liquids - Closed liquid drain headers are provided, according to the criteria described in the preceding paragraphs, for the safe drainage of light ends and light stocks which would otherwise cause hazardous releases of hydrocarbon to the atmosphere or to the sewer. The connections are relatively small, and are intended for preparation of equipment for maintenance. Design of closed drain header systems should be as follows:

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- Connections to equipment are typically 2 in. (50 mm) and 3 in. (80 mm) for process vessels and exchangers, according to the size of the equipment. Each connection includes an accessible block valve. A check valve should be included if overpressure or other hazard could result from reverse flow during simultaneous drainage from more than one vessel. Individual connections from the equipment are made into the top of the drain header.
- The header is normally a 3 in. pipe (80 mm) [2 in. (50 mm) may be adequate for small units]. The individual vessel drain lines should connect to the top of the elevated CDH line and the CDH should be sloped downward to a non-condensable blowdown drum.

TYPICAL CLOSED DRAIN CONNECTIONS



Note:

(1) In lieu of a blind, a breakaway connection may be used.

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3. The header is rated the same as the highest pressure rated equipment connected to it, is fitted with a safety valve if designed for a lower pressure rating, or is blinded or provided with a breakaway from the high pressure equipment and only used when the high pressure equipment is out of service. Consideration must also be given to special cleaning operations (e.g., steam-out). Sections of the header, separated by check valves, may be designed for different pressure ratings, but safety valve protection is still required for the lower-rated sections, unless the header cannot be over-pressured to more than 1.5 times the design pressure. Conversely, in some situations, it may be appropriate to provide PRV for the lower rated equipment connected to the closed drain header.
4. The header must be designed for the extremes of high and low temperatures and corrosive conditions, which can arise from the discharge of process streams into it. The flashing and auto-refrigeration of light ends liquids may require special materials. Specify a Critical Exposure Temperature (CET) for the system and/or the temperature to which the metal may be exposed by shock chilling. The actual metallurgical requirements covered by **GP 18-10-1** should then be followed. It is usually economical to minimize the use of special materials by segregating such streams into separate sub-headers of the closed drain system. These sub-headers may be routed separately to the blowdown drum with a high level cut-off valve in each, or may be combined into a single line with high level cut-off valve. Where sub-headers of different piping materials are combined, the material of the lower temperature header is continued for the rest of the combined line, and is also extended back into the other header for 20 ft (6 m), preceded by a low temperature check valve.
5. The header and laterals should be heat traced and insulated in accordance with **GP 3-9-1**, where ambient temperatures or stream temperatures could result in solidification of heavy process streams, or in freezing of water or moisture that may be present.
6. Several 1 in. (25 mm) valved stubs should be provided at appropriate points in the header, to which temporary drain connections can be made from equipment where permanent connections would not be justified because of infrequent usage or small inventory. The stubs should be located at grade, within 100 ft (30 m) of such equipment.

Closed Drain Headers for Special Materials - Closed drain headers are normally provided for safe drainage of equipment containing severely toxic, corrosive, pollutant or high-cost chemicals [e.g., phenol, n-methyl-pyrrolidone (NMP), sulfuric acid, mono-ethanolamine (MEA), sulfur dioxide, Flexsorb solutions, etc.] where there is an appreciable inventory in a number of processing vessels in a plant. The header should be at least 2 in. (50 mm) in diameter, and should be tied into the major vessels and equipment with 1 in. (25 mm) minimum size connections [3/4 in. (20 mm) is adequate for pumps]. The header may be routed to a gravity drain drum (with recovery to the process by pump or gas pressurization), sump, or to a pump-out pump returning to the process, or in the case of sulfuric acid, to the acid blowdown drum.

If the drain drum requires a vent, the vent should be piped to a closed system, or to a safe location, depending upon the toxicity and vapor pressure of the materials drained.

DISPOSAL OF HYDROCARBON-CONTAMINATED AQUEOUS PLANT EFFLUENTS

Aqueous Drawoffs from Hydrocarbon Vessels - Water or aqueous materials that are withdrawn continuously or intermittently from vessels where they directly contact hydrocarbons (for example, process water from distillate drums, and spent wash water or spent caustic solution from settlers) must be disposed of in such a way that entrainment or inadvertent withdrawal of hydrocarbon will not create a hazard. Disposal is therefore a function of hydrocarbon category, as follows:

1. **Vessels Containing Light Ends** - Shall discharge to water disengaging drum, sour water disengaging drum or spent caustic disengaging drum according to subsequent treatment methods. These drums must be designed in accordance with this section.
2. **Vessels Containing Hydrocarbons Heavier than Light Ends, at Temperatures Above their Flash Points**, with their True Vapor Pressure less than 15 psia (103 kPa abs), and which have:
 - a. Continuous automatic level controlled drawoff shall discharge as in **Par. 1** above, or into a vented section of the oily water sewer through a closed connection. If the drawoff is sour water or spent caustic, see **Par. 2c** below. If the drawoff contains toxics (e.g., Benzene) alternative wastewater treatment may be required.
 - b. Intermittent manually controlled drawoff shall discharge through open connection to oily water sewer catch basin. If the drawoff is sour water or spent caustic, see **Par. 2c** below. If the drawoff contains toxics (e.g., Benzene) alternative wastewater treatment may be required.
 - c. Sour water or spent caustic shall be discharged as in **Par. 1** above, or to an atmospheric collection tank for subsequent disposal, provided the tank has adequate venting capacity for the contingency of receiving hydrocarbon and has means of skimming liquid hydrocarbon.

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3. **Vessels Containing Hydrocarbons Heavier than Light Ends at Temperatures Below their Flash Points:**
 - a. Discharge to an oily water sewer catch basin through an open connection, except when the drawoff is sour water or spent caustic, see **Par. 3b** below. If the drawoff contains toxics (e.g., Benzene) alternative wastewater treatment may be required.
 - b. Sour water or spent caustic must be discharged as in **Par. 1** above, or to an atmospheric collection tank for subsequent disposal, provided that it has means of skimming liquid hydrocarbons.
4. **Vessels Containing Hydrocarbon Liquids Heavier than Light Ends at elevated temperatures such that their true vapor pressure is 15 psia (103 kPa abs) or higher**, must be considered as light ends. Aqueous drawoffs from vessels containing such materials (for example, crude desalters) shall be discharged in accordance with **Par. 1** above.
5. **Water from Tankage** - Special disengaging facilities are not provided for water withdrawn from offsite tankage and pressure storage. Details of water drawoffs from these installations are covered by appropriate International Practices **GP 9-2-1** and **GP 9-7-1**. Refer also to [Sections XV-B](#) and [XV-J](#).

Aqueous Effluents from Heat Exchangers - Tube failure in a water-cooled or steam-heated exchanger in hydrocarbon service will result in contamination of the effluent cooling water or condensate by the process stream if the latter is at a higher pressure. These effluents must therefore be disposed of such that hydrocarbon contaminations can be safely contained. Design requirements are as follows:

1. Special disengaging facilities are required in the following cases:
 - a. Coolers and condensers in light ends service with the hydrocarbon inlet pressure greater than the cooling water outlet pressure under normal operating conditions.
 - b. Steam heaters and reboilers with the hydrocarbon inlet pressure greater than the condensate outlet pressure under normal operating conditions, and where the hydrocarbon at steam condensate temperature has a true vapor pressure of 15 psia (103 kPa abs) or greater.
2. The special disengaging facilities may consist of one of the following:
 - a. A water-disengaging drum designed in accordance with this section.
 - b. A cooling tower, in the case of a recirculating cooling water system, provided that the safety features described in this section (see EFFLUENT DISENGAGING SYSTEMS) are incorporated.
 - c. A condensate disengaging drum, in the case of steam condensate where recovery and reuse is required, designed in accordance with this section (see EFFLUENT DISENGAGING SYSTEMS).
3. For coolers, condensers, steam heaters and reboilers that are not covered by cases **a.** or **b.** in **Par. 1** above, effluent cooling water and condensate are discharged as follows:
 - a. To clean water or oily water sewer in accordance with Section XV-B, which limits the discharge temperature to a maximum of 120°F (49°C), or
 - b. To an atmospheric collection tank, in the case of steam condensate where recovery and re-use are required. If the hydrocarbon pressure at the exchanger inlet is greater than the condensate outlet pressure, then the tank must have means of skimming liquid hydrocarbon and the tank vent should be large enough to safely relieve the pressure generated. The vent must release to a safe location.

CLOSED RELEASE SYSTEM

Closed Release systems are designed to handle Pressure Relief device releases, and may also be used to handle certain other emergency and non-continuous releases. These include drainage from fuel gas, compressor and absorber knockout drums, vessel/unit depressuring, water disengaging drum vents and feed diversion streams. The requirements to use a closed release system for PR devices can be found in [Section XV-C](#) under "Selection of Atmospheric or Closed Discharge for PR Valves."

Types of Closed Release Systems

1. **Conventional Flare System** - The majority of pressure relief devices discharges must be routed to the flare through a closed system consisting of laterals, headers, and a blowdown drum.
2. **Condensable Blowdown Drum with Atmospheric Vent** - Releases which can be totally condensed may be routed through a closed release system consisting of laterals, headers and a condensable blowdown drum, which may be vented to the atmosphere provided that the criteria defined in this section (under BLOWDOWN DRUMS) are met.

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3. **Segregated H₂S Flaring System** - Continuous releases (greater than 30 minutes) of hydrogen sulfide are normally routed to a segregated H₂S flare system described in [Section XV-E](#), to remove a potential source of plugging from the regular flare system. PR devices in concentrated H₂S service are not considered "continuous releases." They should be routed to the regular flare system, and not to the segregated H₂S flaring system which has a higher probability of plugging.

H₂S flare headers should be constructed for ease of isolation, washing out and dismantling for cleaning. The need for periodic cleaning of the H₂S flare header must be recognized, and alternative routing for H₂S releases must be provided for such occasions if a shutdown of the H₂S sources cannot be tolerated.

4. **Other Segregated Closed Systems for Special Services** - Special closed systems are also provided for PR device releases in certain services where operating problems or hazards would result from discharge into the regular flare header. Such services include severely toxic, corrosive, polluting, or high-cost materials; and the following are examples of the special facilities required:
- Segregated header and condensable blowdown tank for PR devices discharging solvents [i.e., phenol, methyl ethyl ketone (MEK), dimethyl formamide (DMF), n-methyl-pyrrolidone (NMP), etc.].
 - Segregated header and blowdown drum system (which vents into a regular flare header) for PR devices discharging corrosive material such as acid or acid extract in processes such as alkylation or isobutylene extraction.
 - Segregated sections of flare header to prevent the mixing of vapors which would react chemically causing the deposition of solids. For example, ammonia must be segregated from H₂S or CO₂ to avoid header plugging by ammonium sulfide or ammonium carbonate. In some situations, heating of the flare line may prevent reaction and formation of solid deposits. Refer to [Section XV-E](#), **Figures 13 and 14** to establish if this is a concern and aid in design if it is.

Sizing Closed Release Systems Laterals and Headers (Flare Header) - The laterals and headers must be sized to limit the built-up back pressure to a level consistent with the PR valve being used at the design relief rate. See [Section XV-C](#) for allowable backpressure for pressure relief valves. Note that the contingency that sets the PR valve size is not always that which results in the maximum discharge line pressure drop. This is particularly true if different contingencies result in the relief of different phases or greatly different molecular weight or specific gravity fluids. Therefore, all valid contingencies should be checked. In addition, when considering a remote contingency, the built-up back pressure limitation is relaxed to the extent possible without violating the "1.5 Times Design Pressure Rule," (for example, this is equivalent to allowing the built-up back pressure limit for a conventional PR valve to increase to 25% of set pressure, assuming the equipment has been hydrotested to 150% of the design pressure).

- Releases into the System** - All releases tied into the closed system must be considered for sizing; this includes PR device discharges, fuel gas compressor and absorber knockout drum drainage, vapors vented from water disengaging drums, feed diversion streams, and vapor blowdowns.
- Maximum Flow to be Handled** - The system must be sized to handle the largest total flow from all of the sources connected to it resulting from any single contingency. The capacity of the system must also be checked for any remote contingency (within the "1.5 Times Design Pressure Rule").

Each part of the system, headers, laterals, blowdown and disengaging drums, etc., must be capable of handling the maximum contingency flow which can occur in that section of the header. Any continuous load, such as excess gas flaring or gas purge for flash back protection, is additive to the largest contingency.

Each branch of the system that serves a single PR valve service (which may include multiple PR valves) should be sized based on the combined **rated capacity** of all the PR valves installed for that service (excluding installed spares, if any). Branches of the system that serve two or more PR valve services may be sized based on the combined **design capacity** of all the services that discharge simultaneously. A PR valve service, in this context, refers to one (or more) PR valves installed on a specific equipment item or piping section.

The contingency design bases for evaluating release rates into the closed release system are defined in Sections of [Section XV](#), as follows:

- Pressure relief device discharge rates: [Section XV-C](#) (Part 1).
- Vapor blowdown release rates: [Section XV-F](#).
- Vapor releases from water disengaging drums: this section.
- Feed diversion streams: this section.



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3. Pressure Drops through the Closed Release System

- a. Pressure drops through the closed release system are made up of individual component pressure drops of the laterals, headers, and blowdown drum. These pressure drops must be determined in conjunction with the following:
 - (1) Pressure Relief Valves including their inlet and outlet piping: [Section XV-C](#).
 - (2) Flare including headers, flare seal (determined by dipleg submergence), flare stack, and flare tip: [Section XV-E](#).
- b. With the flare tip and seal pressure drop and flare elevation fixed (in accordance with the Design Procedures in [Section XV-E](#)), the flare stack, headers and laterals are sized for the largest release, while not exceeding the maximum allowable operating pressure in the associated blowdown drums and water disengaging drums. These maximum allowable operating pressures, as described in this section, are in turn determined by:
 - (1) Maximum allowable backpressure on PR valves, which is a function of set pressure, type of valve, and largest contingency. Back pressure limitations are discussed in [Section XV-C](#), **Part II, Effect of Backpressure**, and **Part IV, PRV Outlet Piping**.
 - (2) Maximum allowable backpressure on vapor diversion (or blowdown) streams which will permit the desired design rate to be released from equipment.
 - (3) Maximum allowable backpressure on water streams from equipment, which will permit the design flow to be released to the water-disengaging drum.
- c. Overall capacity design of the flare system consists of appropriate sizing of the laterals, headers, and flare stack to meet the above criteria, using the fluid flow calculation procedures described in [Section XIV](#).

4. Method of Sizing Laterals and Headers

- a. Divide the closed release system into segments usually beginning and ending with piping connections, i.e., a segment of the main header starts where one lateral joins the header and ends where the next lateral joins the header. Laterals can be considered as a segment or broken into several segments in the same manner.
- b. Determine the size of each segment separately by evaluating all valid contingencies, single and remote, which would result in material being released into that segment.
- c. Add in any continuous loads to reach the total for each segment.

5. Routing of Closed Release System Header through Process Areas - Closed release system headers (flare header) in process areas should be routed to avoid locations of particularly high fire risk, such as over pumps, near furnaces, etc. The headers and laterals should also be laid out and provided with isolating CSO valves and spectacle blinds, unless prohibited by local codes, such that it is not necessary for flare lines to remain in service in units which are shut down separately.

6. **Liquid Drainage from Closed Relief System** - Accumulation of liquid in closed relief systems can impose appreciable backpressure and reduce relieving capacity. The following design features must be included to avoid these problems:
 - a. PR devices should be mounted above the header, so that the outlet piping drains into the header. In exceptional cases, location below the header is permitted, with special drainage for the outlet piping, as described in **GP 3-2-4**.
 - b. The closed release header system should slope continuously down to the blowdown drum from all points where discharge piping from PR devices or other releases enter it. The required slope must be greater than 0.2%.
 - c. There must be no low points or other liquid traps where liquid can accumulate in closed release systems.
 - d. Heat tracing of laterals and headers should be provided where plugging by deposition of wax, ice or congealing of viscous liquids may occur. (Refer also to **GP 3-2-4**.)
 - e. Some pressure relief devices can discharge two-phases into the Closed Relief System, thus, the header design and support must be good for slug forces. Two phase flow curves have been developed (see **Figures 1 & 2** in [Section XIV-D](#)) by which the existence of slug flow can be predicted if the fluid properties and process conditions are known. The properties of the mixture are then used in [Equation \(1a\)](#) to determine the magnitude of the reaction force. See Report EE.21E.89 for further details.



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$$F = 2 \left(\frac{W}{g} \right) V \cos \left(\frac{1}{2} \theta \right) \quad \text{Eq. (1a)}$$

where: F = Force, lb (kg)
W = Flowrate, lb/sec (kg/sec)
g = 32.2 ft/sec² (9.81 m/sec²)
V = Fluid velocity, ft/sec (m/sec)
θ = Included angle of the direction change

To determine the direction of the reaction force relative to the direction of flow upstream of the bend, use the following equation:

$$\phi = \arctan \frac{\sin \theta}{1 + \cos \theta}$$

where: φ = Angle between the reactive force vector and the direction of flow upstream of the bend
θ = Included angle of the direction change

Design Temperatures of Closed Release System - The design temperatures of a header or lateral in the closed release system are set by the extremes of the emergency operating temperatures which can result from any of the streams tied into it. If materials are handled at temperatures below 60°F (15°C) or if they can auto-refrigerate to below 60°F (15°C), a minimum design temperature must also be specified.

The extremes of discharge temperature used for relief systems design are based upon operating failure contingencies. Thus, the design temperature for the purpose of materials selection for laterals and headers is taken as the design temperature of the protected vessel, with credit for temperature drop as described below. However, in external fire exposure contingencies, the design temperature selected may be exceeded by the process fluid temperature (e.g., in the case of high-boiling liquids) or by equipment surface temperature (as a result of flame exposure). While these fire contingency temperatures are not used to set the design temperature of the closed relief system, they shall be tabulated in the specification for use by the piping designer.

Establish design temperatures by:

1. Dividing the closed release system, including the main header and all laterals, into segments usually beginning and ending with piping connections (i.e., a segment of the main starts where one lateral joins the main and ends where the next lateral joins the main). Each lateral can be considered as one or more segments depending on complexity.
2. Determine the design temperature for each segment from the material with the highest temperature entering that segment resulting from a single contingency. It is best to start with the segments furthest from the blowdown drum and work towards the drum. Credit may be taken for expansion cooling as a result of a release and ambient convective cooling of the upstream segments with zero wind on the hottest day during a 30-minute release.
3. The minimum design temperature is determined for each segment in the same manner as 1 and 2 above except the lowest temperature material entering each segment is identified. Also, the lowest ambient temperature will have to be considered if this is lower than any materials entering a segment. Shock chilling should be considered if a segment can be exposed to cold liquids released into it. See **GP 18-10-1** when applying low temperature requirements.

Where laterals of different piping materials are combined, the material of the lower-temperature header is continued for the rest of the combined line, and is also extended back into the other lines for 20 ft (6 m).

Thermal Expansion or Contraction Temperatures - The maximum thermal expansion or contraction of the header and laterals are set by the hottest and coldest relieving temperatures, ambient conditions (solar radiation and lowest one day mean temperature), operational failure, or external fire exposure contingencies. If fire exposure contingency temperatures are higher than the system design temperature, the allowable thermal expansion stress for piping flexibility calculations may be up to twice the normal ASME B31.3 allowable stress.

1. Design for thermal expansion/contraction shall be as follows:
 - a. Divide the closed release system into segments as in **Par. 4a** above.
 - b. Determine the thermal expansion temperature individually for every segment by evaluating all single contingencies, which would result in material flowing through the specific segment. Use the single contingency, which results in the highest pipe wall temperature. If the pipe wall temperature is hotter, credit can be taken for convective cooling on the hottest day with no wind. Credit can also be taken for expansion temperature drop of the related material.
 - c. All pipe support shoes, beams, etc., for the entire piping system must be designed such that the lines remain adequately supported after thermal expansion to the emergency operating temperatures of a fire contingency.