PRESSURE RELIEF & DISPOSAL SYSTEM

OISD - STANDARD - 106
Amended edition, August, 1999
Revised Edition October 2010

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PRESSURE RELIEF & DISPOSAL SYSTEM

Prepared By:

FUNCTIONAL COMMITTEE ON PRESSURE RELIEF & DISPOSAL SYSTEM

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NOIDA – 201301 (U.P.)
Preamble

Indian petroleum industry is the energy lifeline of the nation and its continuous performance is essential for sovereignty and prosperity of the country. As the industry essentially deals with inherently inflammable substances throughout its value chain – upstream, midstream and downstream – Safety is of paramount importance to this industry as only safe performance at all times can ensure optimum ROI of these national assets and resources including sustainability.

While statutory organizations were in place all along to oversee safety aspects of Indian petroleum industry, Oil Industry Safety Directorate (OISD) was set up in 1986 Ministry of Petroleum and Natural Gas, Government of India as a knowledge centre for formulation of constantly updated world-scale standards for design, layout and operation of various equipment, facility and activities involved in this industry. Moreover, OISD was also given responsibility of monitoring implementation status of these standards through safety audits.

In more than 25 years of its existence, OISD has developed a rigorous, multi-layer, iterative and participative process of development of standards – starting with research by in-house experts and iterating through seeking & validating inputs from all stake-holders – operators, designers, national level knowledge authorities and public at large – with a feedback loop of constant updation based on ground level experience obtained through audits, incident analysis and environment scanning.

The participative process followed in standard formulation has resulted in excellent level of compliance by the industry culminating in a safer environment in the industry. OISD – except in the Upstream Petroleum Sector – is still a regulatory (and not a statutory) body but that has not affected implementation of the OISD standards. It also goes to prove the old adage that self-regulation is the best regulation. The quality and relevance of OISD standards had been further endorsed by their adoption in various statutory rules of the land.

Petroleum industry in India is significantly globalized at present in terms of technology content requiring its operation to keep pace with the relevant world scale standards & practices. This matches the OISD philosophy of continuous improvement keeping pace with the global developments in its target environment. To this end, OISD keeps track of changes through participation as member in large number of International and national level Knowledge Organizations – both in the field of standard development and implementation & monitoring in addition to updation of internal knowledge base through continuous research and application surveillance, thereby ensuring that this OISD Standard, along with all other extant ones, remains relevant, updated and effective on a real time basis in the applicable areas.

Together we strive to achieve NIL incidents in the entire Hydrocarbon Value Chain. This, besides other issues, calls for total engagement from all levels of the stake holder organizations, which we, at OISD, fervently look forward to.

Jai Hind!!!

Executive Director
Oil Industry Safety Directorate
FOREWORD

The oil industry in India is nearly 100 years old. As such a variety of practices have been in vogue because of collaboration/association with different foreign companies and governments. Standardisation in design philosophies, operating and maintenance practices at national level was hardly in existence. This coupled with feedback from some serious accidents that occurred in the recent past in India and abroad, emphasised the need for the industry to review the existing state of art in designing, operating and maintaining oil and gas installations.

With this in view, the Ministry of Petroleum and Natural Gas in 1986 constituted a Safety Council in 1986, assisted by the Oil Industry Safety Directorate (OISD), staffed from within the industry in formulating and implementing a series of self-regulatory measures aimed at removing obsolescence, standardising and upgrading the existing standards to ensure safer operations. Accordingly OISD constituted a number of functional committees comprising of experts nominated from the industry to draw up standards and guidelines on various subjects.

The present document was prepared, by the Functional Committee on ‘Process Design and Operating Philosophies’. This document is based on the accumulated knowledge and experience of industry members and the various national and international codes and practices. It is hoped that the provision of this document, if implemented objectively shall go a long way to improve the safety and reduce accidents in the oil and gas industry. Suggestions are invited from the users for further improvement in the standard after it is put into practice. Suggestions for amendments to this document shall be addressed to:

The Co-ordinator,
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These documents are intended to supplement rather than replace the prevailing statutory requirements.
# Functional Committee

## (Second Edition, April 2009)

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Name</th>
<th>Organisation</th>
<th>Position in Committee</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Shri S.S. Sunderajan</td>
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<td>Leader</td>
</tr>
<tr>
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</tr>
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<td>Member</td>
</tr>
<tr>
<td>4</td>
<td>Shri Gangadin Gautam,</td>
<td>EIL</td>
<td>Member</td>
</tr>
<tr>
<td>5</td>
<td>Shri A.G. Gupta</td>
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<td>Member</td>
</tr>
<tr>
<td>6</td>
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<td>Member</td>
</tr>
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<td>Member</td>
</tr>
<tr>
<td>8</td>
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</tr>
<tr>
<td>9</td>
<td>Shri S.K. Malhotra,</td>
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</tr>
<tr>
<td>10</td>
<td>Shri B.K. Das,</td>
<td>BRPL</td>
<td>Member</td>
</tr>
<tr>
<td>11</td>
<td>Shri P.K. Das</td>
<td>NRL</td>
<td>Member</td>
</tr>
<tr>
<td>12</td>
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<td>Member</td>
</tr>
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</tr>
</tbody>
</table>

In addition to the above, several other experts from industry contributed in the preparation, review and finalisation of this document.
FUNCTIONAL COMMITTEE  
(FIRST EDITION, AUGUST 1999)

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Name</th>
<th>Designation &amp; Organisation</th>
<th>Position in Committee</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Shri W.D. Lande</td>
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<td>Member</td>
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</tr>
</tbody>
</table>

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# PRESSURE RELIEF & DISPOSAL SYSTEM

## CONTENTS

<table>
<thead>
<tr>
<th>Serial No.</th>
<th>Item</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>2.0</td>
<td>Scope</td>
<td>1</td>
</tr>
<tr>
<td>3.0</td>
<td>Definitions</td>
<td>1</td>
</tr>
<tr>
<td>4.0</td>
<td>Need For Relieving Systems</td>
<td>4</td>
</tr>
<tr>
<td>5.0</td>
<td>Pressure Relieving/Safety Devices</td>
<td>4</td>
</tr>
<tr>
<td>6.0</td>
<td>Installation Of Safety Devices</td>
<td>5</td>
</tr>
<tr>
<td>6.1</td>
<td>General</td>
<td>5</td>
</tr>
<tr>
<td>6.2</td>
<td>Multiple Valves</td>
<td>6</td>
</tr>
<tr>
<td>6.3</td>
<td>Spare Safety Valves</td>
<td>6</td>
</tr>
<tr>
<td>7.0</td>
<td>Calculation of Relieving Loads</td>
<td>7</td>
</tr>
<tr>
<td>7.1</td>
<td>Individual Loads</td>
<td>7</td>
</tr>
<tr>
<td>7.2</td>
<td>Grouping of Relieving Loads</td>
<td>7</td>
</tr>
<tr>
<td>7.2.1</td>
<td>Plant-Wise</td>
<td>7</td>
</tr>
<tr>
<td>7.2.2</td>
<td>Complex-Wise</td>
<td>7</td>
</tr>
<tr>
<td>7.3</td>
<td>Reduction of Flare Load</td>
<td>8</td>
</tr>
<tr>
<td>8.0</td>
<td>Disposal System</td>
<td>8</td>
</tr>
<tr>
<td>8.1</td>
<td>Atmospheric Discharge</td>
<td>8</td>
</tr>
<tr>
<td>8.2</td>
<td>Closed Disposal System</td>
<td>9</td>
</tr>
<tr>
<td>8.3</td>
<td>Design of Closed Disposal System</td>
<td>9</td>
</tr>
<tr>
<td>8.3.1</td>
<td>Gathering Network</td>
<td>9</td>
</tr>
<tr>
<td>8.3.2</td>
<td>Unit Isolation Valves</td>
<td>10</td>
</tr>
<tr>
<td>8.3.3</td>
<td>Unit Knock-Out Drum</td>
<td>10</td>
</tr>
<tr>
<td>8.3.4</td>
<td>Cryogenic Discharges</td>
<td>10</td>
</tr>
<tr>
<td>8.3.5</td>
<td>Main Flare Header</td>
<td>11</td>
</tr>
<tr>
<td>8.3.6</td>
<td>Main Flare Knock-Out Drum</td>
<td>11</td>
</tr>
<tr>
<td>8.3.7</td>
<td>Seal Drums</td>
<td>12</td>
</tr>
<tr>
<td>8.3.8</td>
<td>Flare Stack</td>
<td>12</td>
</tr>
<tr>
<td>8.3.9</td>
<td>Flaring of H₂S Streams</td>
<td>12</td>
</tr>
<tr>
<td>8.3.10</td>
<td>Pilot Igniters</td>
<td>13</td>
</tr>
<tr>
<td>8.3.11</td>
<td>Standby Flare</td>
<td>14</td>
</tr>
<tr>
<td>8.3.12</td>
<td>Flare Gas Recovery Systems</td>
<td>14</td>
</tr>
<tr>
<td>8.4</td>
<td>Disposal Of Heavy Liquids And Non-Condensible Vapours</td>
<td>15</td>
</tr>
<tr>
<td>8.4.1</td>
<td>General</td>
<td>15</td>
</tr>
<tr>
<td>8.4.2</td>
<td>Cold And Heavy Hydrocarbon Discharge</td>
<td>15</td>
</tr>
<tr>
<td>8.4.3</td>
<td>Hot And Heavy Hydrocarbons Discharges</td>
<td>15</td>
</tr>
<tr>
<td>8.4.4</td>
<td>Thermal Relief Discharges</td>
<td>15</td>
</tr>
<tr>
<td>8.4.5</td>
<td>Discharge From Relief Valves Of Pumps</td>
<td>16</td>
</tr>
<tr>
<td>8.5</td>
<td>Disposal Of Toxic/ Corrosive Fluids</td>
<td>16</td>
</tr>
<tr>
<td>8.5.1</td>
<td>General</td>
<td>16</td>
</tr>
<tr>
<td>8.5.2</td>
<td>Design Considerations</td>
<td>16</td>
</tr>
<tr>
<td>9.0</td>
<td>Vapour Depressurising</td>
<td>17</td>
</tr>
<tr>
<td>9.1</td>
<td>Runaway Reactions</td>
<td>17</td>
</tr>
<tr>
<td>9.2</td>
<td>Exposure To Fire</td>
<td>17</td>
</tr>
<tr>
<td>9.3</td>
<td>Disposal Of Depressurised Material</td>
<td>17</td>
</tr>
<tr>
<td>10.0</td>
<td>Safety/Relief Valve Data Sheet</td>
<td>17</td>
</tr>
<tr>
<td>------</td>
<td>-------------------------------</td>
<td>----</td>
</tr>
<tr>
<td>11.0</td>
<td>Relief System Record</td>
<td>17</td>
</tr>
<tr>
<td>12.0</td>
<td>References</td>
<td>19</td>
</tr>
<tr>
<td>13.0</td>
<td><strong>Attachments:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Table -1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Toxic/Corrosive Chemicals</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Annexure -I</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pressure Relief Valves Data Sheet</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Annexure -II</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Safety Relief Valve Record</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Annexure -III</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High Integrity Pressure Protection System</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Annexure-IV</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Types Of Pressure Relieving / Safety Devices</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Figure- 1</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Water Seal Drum</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Figure- 2</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Blowdown Drum Combined With Close Drain System</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Figure- 3</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Quench Drum</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Figure- 4</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Scrubbing Unit</td>
<td></td>
</tr>
</tbody>
</table>
1.0 INTRODUCTION

The Pressure Relief and Disposal System is a key safety area in the hydrocarbon processing industries. Latest editions of API-520 on “Design and Installation of Pressure Relieving System in Refineries” and API-521 on “Guideline for Pressure - Relieving and Depressurising Systems” are well recognised documents and widely used in the petroleum industry all over the world and these guidelines are also applicable to petroleum installations in India. However, certain provisions of these guidelines are modified to conform to Indian climatic conditions, local practices and statutory requirements, and supplement with the provisions which are not addressed specifically in these guidelines and are in practice through other statutory rules and regulations such as Static & Mobile Pressure Vessels (unfired) Rules (SMPV), 1981.

2.0 SCOPE

The standard covers relieving devices and their discharge systems of vessels and equipment in the exploration & production installations and related oil & gas processing plants, refineries, petrochemical plants and storage & handling locations, which are designed for a maximum allowable working pressure of more than 1 Kg/CM²g. This standard does not cover pressure vessels used for transportation of petroleum products. The intent of the present standard is to highlight the areas of concern specific to Indian environment and requirements. This document does not dilute the safety requirements of prevailing Offshore Safety Standard such as API-14C, 521, IEC 61508 etc.

3.0 DEFINITIONS

For the purpose of this standard the following definitions shall apply:

1. Accumulation:

Accumulation is the pressure increase over the maximum allowable working pressure (MAWP) of the vessel allowed during discharge through a pressure relief device.

Accumulation can be expressed in pressure units or as a percentage of MAWP or design pressure.

2. Back pressure:

Back pressure is the increase in pressure at the outlet of a pressure relief valve as a result of the pressure in the discharge system. This is the sum of superimposed and built-up back pressures.

3. Blow down:

Blow down is the difference between set pressure and closing pressure of a pressure relief valve, expressed as a percentage of set pressure or in pressure units.

4. Built-up back pressure:

Built-up back pressure is the increase in pressure at the outlet of a pressure relief valve that develops as a result of flow after the pressure relief valve opens.

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5. **Burst pressure of a rupture disk:**

   The burst pressure of a rupture disk at the specified temperature is the value of the upstream static pressure minus the value of the downstream static pressure just prior to when the disk bursts.

6. **Cold differential test pressure (CDTP):**

   The cold differential test pressure is the pressure at which a pressure relief valve is adjusted to open at the test stand.

7. **Design pressure:**

   The design pressure of the vessel along with the design temperature is used to determine the minimum required thickness or physical characteristic of each vessel component as determined by the vessel design rules. It can be used in place of Maximum allowable working pressure (MAWP) in all cases where MAWP has not been established. The design pressure is equal to or less than the MAWP.

8. **Flare**

   Flare is a mean of safely disposing off gases through the use of combustion. With elevated flare, the combustion is carried out at the top of a pipe or stack where the burner and igniter are located. A Ground flare is similarly equipped except that combustion is carried out at/near ground level.

9. **High Integrity Pressure Protection System (HIPPS)**

   High Integrity Pressure protection System (HIPPS) is a Safety Instrumented System (SIS) that is designed to provide overpressure protection that is at least equivalent in reliability to a mechanical relief device.

10. **Maximum allowable working pressure (MAWP):**

    The maximum operating working pressure is the maximum gauge pressure permissible at the top of the completed vessel in its operating position for a designated temperature. The MAWP is based on the calculations for each element in a vessel using normal thickness, exclusive of additional metal thickness allowed for corrosion and loadings other than pressure. Normally the MAWP is the basis for pressure setting of the pressure relief devices that protect the vessel.

11. **Non-Reclosing type Relief Valve:**

    A pressure relief valve, which once activated to discharge pressure in a system, do not automatically close.

12. **Operating pressure:**

    The maximum operating pressure is the maximum pressure expected during normal system operation.

13. **Overpressure:**

    Overpressure is the pressure increase over the set pressure of the relieving device allowed to achieve rated flow. Overpressure is expressed in pressure units or as a percentage of set pressure.
14. Pressure Relief Valve:

It is a generic term applied to relief valves, safety valves and safety relief valves. A pressure relief valve is designed to automatically open during emergency or abnormal conditions to prevent a rise of internal fluid pressure in excess of specified design value and automatically reclose and prevent the flow of fluid.

15. Reclosing type Relief Valve:

A pressure relief valve; which monitors pressure in a system and automatically recloses after opening and discharging an initial volume of high pressure fluid.

16. Relief valve:

Relief Valve is a spring loaded pressure relief valve actuated by the static pressure upstream of the valve. The relief valve opens in proportion to the pressure increase over the set pressure. A relief valve is used primarily with incompressible fluids.

17. Safety valve:

Safety valve is a spring loaded pressure relief valve actuated by the static pressure upstream of the valve and characterized by rapid opening or pop action. A safety valve is used primarily with compressible fluids.

18. Safety relief valve:

Safety relief valve is a spring loaded pressure relief valve that is used either as a safety or relief depending on the application.

19. Set pressure:

The set pressure is the inlet gauge pressure at which the relief device is set to open under service conditions.

20. Shall

Indicates provisions that are mandatory in nature.

21. Should

Indicates that the provisions are recommendatory as per good engineering practices.

22. Superimposed back pressure:

Superimposed back pressure is the static pressure that exists at the outlet of a pressure relief device at the time the device is required to operate.

23. Surge Relief Valve:

It is the quick responding pressure relief valve provided to maintain the pressure so as not to exceed the pre-set value (because of overpressure in pipeline due to surge effect) by providing immediate relief of the excess pressures from the line to the relieving system.
4.0 NEED FOR RELIEVING SYSTEM
The relieving of pressure from a process system arises from a number of reasons as below:

i) To ensure a system is not allowed to pressurise beyond its maximum allowable working pressure, in order to avoid possible failure of the weakest part of the system.

ii) For precautionary relieving of pressure from the system called as depressurisation. This is applicable for high pressure and or high inventory systems which need to be depressurised during an emergency.

iii) In the case of a fire, the maximum allowable yield stress of the metal reduces significantly due to increased temperature. Relieving pressure under these situations allows the actual stresses to be reduced below the lowered maximum allowable stresses thereby preventing failure.

iv) To take care of thermal expansions when a pipeline or equipment containing a liquid is blocked in and subsequently heated.

v) To protect the pipeline against surge pressure, a surge relief valve is provided.

5.0 PRESSURE RELIEVING / SAFETY DEVICES

5.1 There are basically four type of safety devices used for relieving pressure in a system. These are:

i) Reclosing type Safety/Pressure Relief valves
   a. Conventional
   b. Balanced Pressure relief valves
   c. Pilot-operated relief valves

ii) Non Reclosing type Safety/Pressure Relief Valves,
   a. Rupture disk Device
   b. Pin-actuated device

iii) Surge Relief Valves and

iv) Emergency depressurisation Valves.

Details for different type of pressure relieving devices are given in Annexure IV.

5.2 SET PRESSURE OF RELIEF VALVES:
Relief valves shall be set at 110% of the normal operating pressure to allow a reasonable margin so that the valves do not open frequently with minor process upsets. The difference between the set pressure and the normal operating pressure should not be less than 2 Kg/CM2. This aspect shall be considered for selecting the design pressure of the equipment. The set pressure of various Relief Valves shall be fixed based on criteria given below:

5.1.1 Pilot Operated Valves :

Pilot operated valves shall be used:

i) Where the margin between set pressure and maximum operating pressure is less than 10% of the maximum operating pressure (as low as 5% is judged to be acceptable).

ii) When the built-up backpressure is expected to exceed 50 per cent of the set pressure.
5.1.2 Surge Relief Valve:

i) Liquid Pipelines

The set pressure of the surge relief valve in Liquid Pipelines and the required capacity needed to be relieved through surge relief valve shall be determined by carrying out a surge analysis for different probable scenarios under which a surge shall occur in the pipeline as given in OISD STD 141. The set pressure shall be decided in such a way that the relieving pressure of the surge relief valve does not exceed 110% of maximum operating pressure of the pipeline.

ii) Gas Pipelines

The set pressure of the surge relief valve in Gas Pipelines to protect it from over pressure shall be decided in order not to exceed the following limits:

a. Set pressure shall be equal to 104% of maximum allowable operating pressure for a system with pipe/pipeline components operating over 72% of the Specified Minimum Yield Strength (SMYS).

b. Set pressure shall be 110% of maximum allowable operating pressure for a system with pipe/pipeline components operating at or below 72% of the Specified Minimum Yield Strength (SMYS) other than in low pressure distribution systems:

c. For low pressure distribution systems, the set pressure shall be a pressure that would otherwise cause unsafe operation of any connected piping, equipment and discharge system.

5.3 RUPTURE DISC

When rupture disc is used, the bursting pressure of the rupture disc and safety valve set pressure shall be kept at same nominal value. A pressure gauge/bleeder between rupture disc and relief valve helps to indicate the health of the rupture disc.

5.4 EMERGENCY DEPRESSURISING VALVES:

For sizing of Emergency Depressurising Valves, generally involves reducing the equipment pressure from initial conditions to a level equivalent to 50% of vessel design pressure within approximately 15 minutes. This criterion is based on the vessel wall temperature versus stress to rupture and applied generally to vessels with wall thickness of approximately 1 inch or more. Vessels with thinner walls generally require a higher depressurising rate.

6.0 INSTALLATION OF SAFETY DEVICES

6.1 GENERAL

Relieving devices shall be installed directly on the equipment they are protecting or on the connected pipeline. However there shall not be any valve in the piping between vessel and point where safety valve is installed on the pipeline. These devices are best installed on the top of vessels or at high points so as to minimise and simplify the inlet piping. Following guidelines shall apply:

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(a) Inlet piping shall be adequately sized so as to limit pressure drop between vessel and safety valve to 3% of the set pressure on the inlet side.

(b) The discharge side including the header shall be sized so as to contain total back pressure within permissible limits depending upon the type of safety valve.

(c) Inlet and outlet of a safety valve shall not be less than the nominal sizes of inlet/outlet flanges respectively of the safety valve.

(d) Inlet and outlet (if pressure relieving device is discharging to a closed system) piping shall be free draining away from the safety valve.

(e) The discharge line shall join the header from top and preferably at an angle of 45° to avoid high pressure drop.

(f) In vessels where there are chances of liquid carryover along with vapour in the form of froth, mist, etc., the inlet line to safety valve and the outlet line from safety valve to the unit knock-out/Blowdown drum shall be sized based on two-phase flow.

6.2 MULTIPLE RELIEF VALVES

Multiple relief valves are required for hydro-carbon processing services, if the total relieving capacity required cannot be provided in a single valve. Installation of multiple relief valves allows staggered set points for each valve as recommended by API & ASME. When the required relieving capacity is provided in more than one pressure-relieving device, only one device shall be set at the maximum allowable working pressure, and the additional safety valve shall be set at higher pressures. In no case set pressure shall be higher than 105% of the maximum allowable operating pressure. If, however, the pressure relieving devices are used for protection against fire or other sources of external heat, the additional devices can be set at a pressure not exceeding 121% of the maximum allowable operating pressure.

Multiple relief valves with staggered set pressures are as such recommended to increase life of the valves and minimise leakage through the valves. A small leak due to operating pressure reaching above the set pressure will cause greater leakage in large valves. This, apart from leakage, also leads to chatter and reduced life of valves.

6.3 SPARE SAFETY VALVES

Spare safety valves are often installed to facilitate testing and maintenance of one safety valve while the other is on line. As per Static and Mobile Pressure Vessels (unfired) Rules, 1981, every pressure vessel used for storage of compressed gases including liquefied petroleum gases shall be provided with two or more pressure relieving devices. These are also used for continuity of operation in case of safety valve does not reseat after popping. Isolation valves for a single safety valve are provided to facilitate maintenance if safety valve is designed for fire case, heat exchanger tube rupture case or thermal expansion case. The spare safety valve should be kept isolated by closing the inlet valve.

A detailed examination of the service conditions of the system shall be done and if the conditions are very critical, only then spare safety valves shall be installed. Single isolation valve upstream and downstream of each safety valve shall be provided in such a case. Isolation valves on the inlet and outlet

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of each safety valve shall be installed with some provision for keeping the isolation valves in open position with appropriate locking device. These isolation valves shall be installed with their stem pointing downwards or horizontal to avoid the possibility of a valve remaining stuck closed in case the stem becomes free.

With the inclusion of isolation valves the number of flanges and total piping in the system increase and thus, increased possibility of leakages, inadvertent inclusion of blinds and inadvertent closing of isolation valves on both the safety valves. Chances of slip blinds remaining in position during construction and testing of the system are more when there is more number of flanges. Therefore, spare safety valves shall not be installed unless absolutely necessary or are required by a statutory authority. In case it is provided, there shall be a written down procedure of checking of such a system before start up.

7.0 CALCULATION OF RELIEVING LOADS
7.1 INDIVIDUAL LOADS

While determining individual relieving loads, following key points shall be considered:
(a) Every piece of equipment that can generate a vapour or liquid load under any contingency must be recognised after doing a detailed analysis. No load shall be left unconsidered as being small.
(b) A pressure relief valve handling a liquid at vapour equilibrium or a mixed-phase fluid will produce flashing with vapour generation as the fluid moves through the valve. This will reduce the effective mass flow capacity of the valve and must be taken into account. The latest edition of API-521, shall be referred to for estimating the loads of safety valves under such conditions.
(c) While calculating the load for a safety valve under fire condition, following key points shall be considered:
   (i) No credit shall be taken for the insulation provided on the vessel.
   (ii) No credit shall be taken for safety devices such as shutdown switches, solenoid valves, etc, as such devices shall be assumed to fail in the case of a fire. If, on the other hand, a positive action of safety device (e.g. emergency steam into heater coils) will add to the relief load, it would be assumed to function.

7.2 GROUPING OF RELIEVING LOADS

7.2.1 Plant-wise

The individual loads estimated as above shall be grouped together for various contingencies in order to design the relieving system components downstream of the safety valves. A table listing such loads shall be prepared for each plant or facility in the complex considering various contingencies. From this table the governing load for the plant is based on the contingency which gives the maximum load.

7.2.2 Complex-wise

In a big complex, where a number of individual plants and facilities are connected to a common relief system, the relieving load for the entire complex has to be estimated considering the relieving loads for individual plant or facilities as mentioned earlier. Grouping of the individual plant loads shall be done very judiciously based on the utility system design of the complex.
For example, if a common cooling water system serves a number of plants, the relieving loads from all such plants shall be added together in case of cooling water failure.

If, however, there are more than one cooling water system in the complex each fed by independent reliable power supply, the failure of one cooling water system shall call for grouping the relieving loads from only those plants which are served by this cooling water system.

It is important that a complete analysis of various contingencies that shall occur in the complex be done and their overall effect recognised very carefully while estimating the relieving loads for the entire complex.

7.3 REDUCTION OF FLARE LOAD:

High Integrity Pressure Protection System (HIPPS) shall be considered in design of pressure relieving system along with mechanical relief system for over pressure protection while going for De-bottlenecking of existing flare systems due to following:

➢ Additional load on existing flare system due to:
  • Expansion/ up gradation of the existing units
  • Connecting atmospheric relief valves to flare for existing units
  • Addition of new process units
  ➢ Excessive relief device back pressure
  ➢ Excessive vessel accumulation/ over pressure
  ➢ High flare thermal radiation levels
  ➢ High flare noise levels

HIPPS shall be applied for vessels that require external heat input (fractionation Columns), reactor vessels (Hydro-treaters) where crash cooling or isolation of feed is required to prevent runaway reaction, columns where rapid depressurisation is required in case of run away reactions (eg hydro-cracker and hydro-treaters) to simultaneously reduce pressure and remove heat, as safety valve will be ineffective.

While finalising the HIPPS, designer shall ensure that the MAWP of the vessel is greater than the highest pressure that can be reasonably expected to be achieved by the system. A detailed analysis of credible over pressure scenarios shall be conducted before deciding on use of HIPPS. Refer Annexure-III for brief write up on HIPPS.

8.0 DISPOSAL SYSTEM

The purpose of a disposal system is to channelize the relieved gas or liquid to a safe location where it does not pose any hazard to human life, property or to the environment. In some situations, the relieved vapours can safely be discharged to atmosphere directly. The choice of an appropriate disposal system will depend on the nature of relieved fluid and other local conditions.

8.1 ATMOSPHERIC DISCHARGE

The decision to discharge relieved vapours to atmosphere requires careful attention to ensure that disposal can be accomplished without creating a potential hazard or causing other problems, such as the formation of flammable mixture at grade level or on elevated structures, exposure of personnel to toxic vapours or corrosive chemicals, ignition of relieved stream at the point of emission, excessive noise levels and air pollution.

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No hydrocarbon and other toxic releases shall be discharged to atmosphere directly. However, in certain situation like marketing installations, LPG bottling plants and other remotely located installations where hydrocarbons are stored and handled and no flare or other closed disposal systems are feasible, the relieved vapours can be discharged to atmosphere. In such case following key points shall be considered while routing PSV discharge to atmosphere:

(a) The individual relief valve vent shall discharge to atmosphere in upward direction, so sized that minimum exit velocity of 150 meter/sec would be obtained. The maximum velocity shall not exceed 0.5 mach. If feasible, snuffing steam shall be connected to the vents. Under these conditions, the air entrainment rate is very high and the released gases will then be diluted to below their lower flammable limit.

(b) A single common vent shall not be used for several relief valves because this results in a discharge velocity much less than the designed discharge velocity when only one safety valve is operating.

(c) The vent of relief valve shall discharge at a minimum elevation of 3 meters above grade or the tallest structure, within a radius of 15 meters, whichever is higher.

(d) Individual vents shall have a drain hole of 1/2” at the low point in the vent line. The drain connection shall be piped to a safe location.

(e) If the relieved vapours produce excessive noise at the nearest operating structure, the vent line shall be provided with acoustic insulation. Silencers shall not be used as they are likely to block the outlet due to fouling, etc.

8.2 CLOSED DISPOSAL SYSTEM

All hydrocarbons, toxic vapour and liquid releases shall be discharged through a closed disposal system like flare, vent scrubber, incinerator or a blowdown drum as the case shall be. The primary function of a flare or incinerator is to convert flammable, toxic or corrosive vapours to less objectionable compounds by combustion.

Toxic vapours like SO2, phenol, chlorine, etc. which cannot be converted to less objectionable compounds by combustion shall be disposed off through a vent scrubber using caustic soda, water or other suitable agents as the case shall be. Refer Section 8.5 for details of scrubbers.

8.3 DESIGN OF CLOSED DISPOSAL SYSTEM

Once the various combinations of loads have been defined for all pertinent contingencies and the corresponding allowable back pressure has been determined for all relief valves, selection and design of various components of the disposal system can proceed as below:

8.3.1 Gathering Network

Individual relief valve discharges and other vents shall be combined and piped to a flare or a vent scrubber as the case shall be. All laterals and headers shall be free draining away from the safety valves towards a knock-out drum with a minimum slope of 1 in 500. All laterals shall join the header from top. Flare header shall be continuously purged from any convenient location to avoid air ingress in to the system. Fuel gas, inert gas and nitrogen are commonly used as purge material. Steam shall not be used as a purge material because it condenses in the system and create vacuum. Purge gas velocity shall be between 0.05 ft/sec to 0.1 ft/sec. as measured at the flare stack for flare systems having gas seals at the flare stack tip.
The network shall have adequate expansion loops to account for the temperature range of the released material. Where probability of viscous material carry over along with relief valve release exists, adequate design considerations shall be taken to avoid solidification in the downstream pipelines e.g. the lines shall be heat traced.

8.3.2 Unit Isolation Valves

Large complexes have many units feeding to a common flare system. Since units must be isolated from rest of the complex for maintenance, isolation valves with blinds at the battery limits of units shall be provided. These isolation valves shall be installed with their stems pointing downwards so as to minimise the chances of accidental closure.

Strict procedures should be in place that will prohibit inadvertent closing of isolation valves in relief piping. These procedures should require that the opening and closing of the valves be done by authorized person.

An updated list should be kept for all isolation valves located in relief piping system which could isolate relief valves. Documentation of the required position and reason for the lock or seal should be provided. Periodic inspection of isolation valves located in relief piping should be made which verify the position of the valves and the condition of locking or sealing device.

8.3.3 Unit Knock-out Drum

Wherever the discharge from a unit is expected to contain appreciable quantities of liquids, especially corrosive, fouling and congealing in nature, a Knock-out (K.O) drum of suitable size must be installed at the battery limit of each such unit with flare line sloping towards the K.O. drum. Unit K.O. drum is required if the layout of the units is such that it is not feasible to have a continuous sloping of the flare header(s) towards the main flare K.O drum. The liquid collected in these drums shall be drained/pumped to a suitable disposal system like a closed blowdown drum or slop system and not to open drains, while the vapours are led to the flare header.

These drums shall be sized to separate particles of 300 - 600 micron size and designed to hold the liquid discharge expected for 5 - 10 minutes from a single contingency. Gravity draining of liquid from these drums to the unit closed blowdown drum etc. shall be preferred. Alternatively, two pumps each sized to empty out the drum hold up in 20-30 minutes shall be provided. These pumps shall start/stop automatically at high/low level in the drum respectively and shall have provision for emergency power backup or alternate drive.

These drums shall also be provided with High and low level alarms and level indicator in the respective control rooms. If a congealing type of liquid is likely to be handled, these drums shall be heat traced or provided with steam coils.

8.3.4 Cryogenic Discharges

Cold liquid and vapour discharges pose additional problems of metallurgy. Such releases shall be handled separately before they join the main flare header. Liquid discharges at sub-zero temperature shall be piped to a separate drum provided with suitable vaporizing system. Care shall be taken that the heating medium, usually steam, does not get frozen by the extreme cold. If it is not feasible to vaporize/heat the cold

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discharged material, the entire flare piping design shall be of suitable material compatible with the service conditions. Under such situations it is more economical to segregate cryogenic discharges from the main flare header.

8.3.5 Main Flare Header

The main flare header collects the material relieved through safety valves for safe discharge to the flare stack for combustion. If unit K.O. drums are provided the flare headers downstream need be sized only for vapour flow. If there is substantial difference between the allowable back pressures of different safety valves, separate flare headers shall be provided for high pressure and low pressure streams. The flare header shall be so sized that the back pressure at the outlet of any safety valve does not exceed the maximum permissible value.

The flare header shall not have any pocket and shall be free draining towards the nearest K.O. drum. A slope of 1 in 500 is normally recommended. No check valves shall be permitted in the flare header system.

If the liquids to be handled include oil with a relatively high pour point, provision shall be made to avoid solidification in the system. Likewise, the introduction of high viscosity oils shall require protection against low ambient temperatures, particularly on instrument leads. Use of heat tracing is recommended under such situations. H2S is corrosive and if handled together with the main flare header, it will lead to corrosion of the header. It shall have a separate flare header of material suitable to handle acid gases.

Sizing of flare headers is usually done on pressure drop considerations. However, a check shall be made to ensure that the maximum velocity in the header is 0.5 mach i.e. below the sonic velocity. In many situations, the emergency discharge is at high temperatures, and flare header runs many hundred meters. This results in the loss of flare gas temperature due to heat loss to metal and surroundings. In order to estimate the total pressure drop in the flare header, the total header length shall be divided in to a number of small sections say 100 meters or so and pressure drop in each such section shall be estimated taking in to account the change in vapour density in each section.

8.3.6 Main Flare Knock-out Drum

In addition to the unit K.O drums, a main flare K.O. drum shall be installed close to the flare stack. This takes care of any liquids condensed due to atmospheric cooling of the headers.

Horizontal and vertical drums are both acceptable. Due to high vapour flow rates, split flow horizontal drums are usually economical. The drums shall be sized to separate out liquid droplets of 300-600 microns size. Heavy entrainment of liquid shall lead to fire balls from the flare stack falling on the grade which can lead to serious consequences. The K.O. drums should be sized to provide liquid hold up of 20-30 minutes. Two pumps, one running and one standby shall be provided to pump out the liquid collected in the K.O drum to a safe location. Pump capacity shall be such that the liquid hold up can be emptied out in 20-30 minutes. Provision of emergency drive (steam turbine or alternate source of power) shall be given so that these pumps can be operated during the failure of normal power supply. The pumps shall be designed to start automatically on high liquid level and stop on low level. It shall also be possible to start/stop these pumps from remote control room.

These drums also shall be provided with High and low level alarms and level indicator in the respective control rooms. Gas detectors (Hydrocarbon, H2S etc) shall be provided for detection of any leak near flare K.O. Drum and connected pumps.

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Selection of internals for the K.O. drum shall be given a careful consideration. Internals that shall clog or otherwise foul up shall not be used. Vortex breakers shall be used in the liquid outlet lines. Adequate arrangements shall be made to handle congealing liquids. Heating coils in the K.O. drum, tracing of liquid lines with steam or electric tracers shall be considered. Under these circumstances, K.O. drums shall be sized for a min. design pressure of 3.5 Kg/cm².

8.3.7 Seal drums

Seal Drums together with provision for purging and the installation of flare seals provide adequate protection against flash back from the flare tip. Seal drums integral with flare stack are commonly used. Otherwise these vertical drums shall be mounted as close to the flare stack as possible.

Refer fig.1 for details of a typical seal drum. Some use flame arrestors in the flare header close to the stack to guard against any flash back. Such devices are likely to get blocked or fouled up resulting in higher back pressures in the flare header. Sometimes they shall completely block the header. Also their inspection is very difficult. For these reason, flame arrestors shall not be used in the flare system.

The seal drum shall have a cross sectional area at least equal to 4 times the inlet pipe cross sectional area and be designed for 3.5 Kg/CM² as minimum. The inlet pipe shall drop vertically down for at least 3 meters above the water level to avoid ingress of air in to the system due to vacuum created when hot vapours cool off. In the event of a flash back, a 3 meter slug of water is pressed back in to the vertical inlet piping thus preventing an explosion from propagating further upstream. Enough water must be stored in the vessel so that seal does not break under such conditions. This might necessitate an increase of the drum dia. Maximum allowable back pressure in the header will decide the maximum submergence of inlet pipe under the seal. A minimum seal of 100 mm is recommended. As a standard design practice, maximum seal height shall not exceed 300 mm.

Water shall be continuously added to the seal drum and the overflow shall be automatic through a liquid seal leg. As a minimum, the leg height shall be equal to 1.75 times the maximum expected operating pressure (not design pressure). The vertical down flow section of the water outlet line from the drum is sized for maximum velocity of 0.12 m/s to allow entrained gases to disengage. The seal loop shall be sized for the normal water flow of 6.0 m³/hr. All lines connecting K.O. drums, seal drums and the flare stack shall be free of pockets. The seal leg shall be provided with a 1½” siphon breaker. Provision shall be made to skim off any oil that get accumulated in water seal drum.

Intermittent bubbling through the seal dip leg sometimes causes problems of flame pulsation or low frequency flare noise. The normal seal drum design includes a serrated edge at the base of the dip leg to allow progressively larger opening for gas flow as the pressure and flow increase.

In cold places where there is possibility of freezing of water in the water seal drum, a steam coil shall be provided in the drum to keep water warmed up. A level gauge and high and low level alarm also shall be provided on the seal Drum. Effluent water from water seals must be routed to ETP/safe means of disposal, considering possible hazards arising from liquid or vapour hydrocarbons or toxic materials that shall be entrained or dissolved in the water.

8.3.8 Flare Stack
Flare stack are usually elevated structures designed to burn out flammable vapours safely so as to cause minimal damage to environment, population and property. Such flare stacks are usually associated with a certain amount of smoke, noise and glare which are considered to be public nuisances.

Of late, ground, box or enclosed flares have become popular to minimise public nuisance problems. These flares are, however, complex pieces of heavily instrumented equipment. These shall be used to burn off completely only the normal flaring loads which are usually small. These shall not be used as means of disposal of emergency loads. The box flare load shall never exceed its rated capacity during emergency. These must always be backed up by elevated stacks which automatically take over the emergency loads. The switching of loads between the elevated and box flares shall be accomplished by means of appropriate water seals.

Smokeless flaring shall be achieved by proper selection of flare tips and use of steam or air. Smokeless flaring shall conform to measurement through Ringler charts (typically Ringler 1).

Flare stack diameter is usually based on maximum allowable velocity which shall be considered as 0.2 Mach for normal loads and 0.5 Mach for short time emergency loads. Flare stacks shall also be provided with gas seals to prevent flash back and cutdown the purge gas rates.

The stack height shall be based on the maximum allowable radiation level as per the latest available edition of API 521 at the nearest location which can be ground level or other elevated structures. For our country, where solar radiation is comparatively much higher (about 300 BTU/hr. ft²), the radiation level as given in latest edition of API-521, shall be considered inclusive of solar radiation. While calculating the height of the flare stack for ensuring ground level radiation, no credit for attenuation of radiation while passing through the atmosphere shall be taken and air shall be considered to be a transparent gas for this purpose.

In some situations (for example cold flaring), ground level concentrations of flare gas will govern the height of stack. All the applicable pollution standards shall be followed while finalising the height of flare stack.

The flare stack shall be located at a minimum distance of 90 meters from plant and storage area and also from public roads and property as stipulated in OISD STD-118 on “Layout for Oil & Gas Installations” for separation distances. When two or more flares are provided, the separation distance between them must be checked for allowable radiation consideration as mentioned above.

It is necessary to have sterile area around the flare stack, free of grass and other vegetation growth to avoid any fire hazard by falling of burning material from the stack. No permanent structure/ shelter shall be allowed in this area.

The flare area shall be adequately covered with Fire Water network in line with OISD STD 116 requirement.

8.3.9 Flaring of H₂S streams
Continuous releases of concentrated H₂S streams shall be segregated in a separate flare system to limit the extent of fouling and plugging problems. The H₂S flare system should consist of a segregated header routed up the side of a conventional elevated flare stack sharing the same structure, Flare elevations must be sufficient to meet atmospheric pollution and ground level concentration requirements for the sulphur dioxide produced. A flashback protection is required for H₂S flaring systems and usually a continuous gas purge is given. For H₂S flare K.O. drum shall be installed close to the flare stack and designed as per requirement given in 8.3.6 for main flare knock out drum. The flare stack shall be located at a safe distance from plant and

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storage area and also from public roads and property as stipulated in OISD STD-118 on “Layout for Oil & Gas Installations” for separation distances.

8.3.10 Pilot Igniters

To ensure ignition of flare gases, continuous pilots with a means of remote ignition are recommended for all flares. The most commonly used type of igniters is the flame-front propagation type, which use a spark from a remote location to ignite a flammable mixture. Igniters control panel shall be located away from the base of elevated flares. The igniter panel shall be sufficiently away from flare stack and shall be provided with a canopy to protect men and equipment from liquid spill or thermal radiation.

8.3.11 Standby Flare

Various units, storage and handling facilities of a complex shall be connected to a single flare. It must be recognised that flare stack and the associated auxiliaries do require some inspection and maintenance, for which these may not be available. If all the process units, storage, handling and other facilities which are connected to the flare system are not shutdown together and some facilities are operative, a standby flare with appropriate isolation devices shall be provided. Alternatively, the entire load from a complex shall be suitably distributed among two or more flares so that each one of them can be inspected/ repaired during partial shutdown of the complex.

8.3.12 Flare Gas Recovery Systems

Environmental and economic considerations have resulted in the use of flare gas recovery systems to capture and compress flare gases for other uses. Many times the recovered flare gas is treated and routed to the refinery fuel gas system. Depending upon flare gas composition, recovered gas can have other uses.

Considering the criticality of flare gas recovery system in the refinery operation, it shall be installed after careful review and design shall ensure the following:

1) The flare gas recovery system shall be designed as a side stream from the flare header and Main flare gas flow shall not be through any compressor knock out or suction piping. This is to ensure that flare gases have clear flow path available all the time.
2) Flare gas recovery systems shall be located on the Main-flare header downstream of all unit header tie-ins. The location of flare gas recovery system shall be such that header pressure does not vary substantially at this point with load.
3) Locations upstream of process unit tie-ins shall be carefully considered to rule out any potential of backflow and high-oxygen concentrations.
4) The tie-in line to the flare gas recovery system shall come off the top of the flare line to minimize the possibility of liquid entrance.
5) The protection for backflow of air from the flare into the compressors at low flare-gas loads shall be considered. Oxygen content of the flare gas stream shall be measured and interlock shall be provided to shut down the flare gas compressors if potentially dangerous conditions exist.
6) The gases which are not compatible with the flare gas-treating systems or ultimate destinations must be routed directly to flare stack bypassing the flare gas recovery system.
7) Protection against back flow of air from the flare into the flare-gas recovery system shall be provided. Provision to detect reverse flow and automatically shut down the flare gas recovery system shall be provided.
8) If a control valve must be used in the flare line to regulate flare-gas recovery system suction pressure, the control valve shall be of a fail-open design and be interlocked to go fully open upon a higher-than-normal header pressure, high-oxygen content, or when the compressors are unloaded or shutdown.

9) The flare gas recovery system shall not be installed within 90 m radius of flare stack.

10) The possibility of significant liquid in flare systems is usually quite high. Liquid-knockout vessels shall be provided for the compressors with automatic shut down of the compressors on high suction-drum levels.

11) Flare-gas-recovery systems operate over wide ranges, usually within very narrow suction pressure bands. The flare-gas-recovery compressors shall be equipped with several stages of un-loaders and a compressor-recycle valve. Suction pressure is maintained by pressure control of a recycle valve, with additional loading and unloading of the compressors when limits of valve opening or closing or suction pressure are reached. Usually, the controls are set up to sequentially load and unload the compressors.

8.4 DISPOSAL OF HEAVY LIQUIDS AND NON-CONDENSABLE VAPOURS

8.4.1 General
If a unit has a sizable amount of relieving load consisting of heavy and fouling type of liquids and non-condensable vapours, it is desirable to have separate disposal system dedicated to such safety valves which discharge liquids and/or non-condensable vapours. In addition to the provision of section 8.1 on “Atmospheric Discharge” or the provision of Section 8.3 on design of “Closed Disposal System”, as the case may be, the following guidelines shall apply for disposal under these situations:

8.4.2 Cold and Heavy Hydrocarbon Discharge
Heavy Hydrocarbons which are not expected to vaporize at atmospheric pressures and operating temperatures must be discharged through a closed system to a blowdown drum. If the hydrocarbons are highly viscous or would solidify at ambient temperatures, the piping, valves, etc. in the system shall be heat traced. The blowdown drum shall be sized to hold the largest liquid relief for 5-10 minutes. The liquid from the drum can be pumped to slop system. The design criteria for pumps and the instrument details shall be similar to that mentioned under 8.3.3 on “Unit Knock-out Drums”. The blowdown drum shall be connected to flare. A steam coil and temperature indicator shall be provided in the drum, if the liquid discharged is heavy and congealing type. This relief blowdown drum can be combined with the closed drain system of the units. Under these situations, the drum shall be located underground and vented to atmosphere with a steam purge. See fig.-2.

8.4.3 Hot and Heavy Hydrocarbons Discharges
Heavy hydrocarbons, which, because of high temperatures, might be expected to evolve a large amount of vapour, shall be discharged to a quench drum. Such a system with relevant details is depicted in figure-3. The quench drum is a vertical vessel fitted with baffles and is connected by means of a conical transition to flare header. The hot hydrocarbon material is fed in to the drum below the baffles. Suitable quenching medium like water or gas oil etc. is sprayed at the top of baffles under temperature control. The cooled hydrocarbon liquid along with the quench material is drawn from the bottom of the drum and disposed off to sewer.

The uncondensed vapours along with any steam formed, passes up the quench drum to flare header. The vapour line from the drum to the flare shall be sized properly to take care of any steam formed.

8.4.4 Thermal Relief Discharges
When piping, vessels and exchangers are isolated with cold liquids blocked within and are subsequently heated by heat tracing or other means of heat input, hydraulic expansion takes place which can cause serious
failures. In most systems, a thermal relief valve (TRV) usually of \( \frac{3}{4} \times 1'' \) nominal size shall be used to take care of this phenomenon, even though it is commonly oversized. Two general applications where TRVs are larger than \( \frac{3}{4} \times 1'' \) valves are long pipelines of large diameter in uninsulated, above ground installations and large vessels or exchangers operating liquid-full. For these cases, relief rate calculation and TRV size checking are recommended. TRV provided on cooling water return line from water coolers shall be \( \frac{1}{2}'' \times 1'' \) with its discharge open to atmosphere.

Usually any location on a pipe or equipment is suitable for installing a TRV limited by suitable discharge route. A TRV shall be located on a pipe rather than on the equipment if both belong to the same blocked in system and at the lowest elevation/platforms for ease of maintenance.

TRVs shall be relieved to closed blowdown vessel in process units and in closed/open blowdown system in offsite & lines used for water service. A TRV discharge can be connected to a vessel where the particular liquid is stored.

8.4.5 Discharge from Relief Valves of Pumps

Discharge of liquids from safety/relief valves on the discharges of pumps shall be returned to the suction line or suction vessel from which the pump takes suction.

8.5 DISPOSAL OF TOXIC/ CORROSIVE FLUIDS

8.5.1 General

If the relieved fluids which are to be discharged are of toxic or corrosive nature and does not burn effectively in a flare, such fluids shall be disposed off after scrubbing/ neutralising thoroughly.

Such disposal systems typically use a neutralising agent either as a large pool or spray in contact tower. The type of relieved material involved and the choice of scrubbing/ neutralising agent and disposal system shall be considered from case to case. Table-1 gives a list of some typical relieved materials along with the type of disposal system.

8.5.2 Design Considerations

From metallurgy considerations to handle corrosive materials and to reduce the load on scrubbing system, the discharge of toxic and corrosive chemicals shall be piped separately from other hydrocarbon discharges. The system capacity shall take care of the largest release of the toxic materials.

(a) Neutralisation in Pool

In a scrubbing system consisting of a pool of appropriate liquid, the discharged vapours will pass in to the liquid pool through a well designed sparger supported at the bottom of liquid pool. The liquid level in the pool containing neutralising agent shall always be maintained. Whenever the liquid strength gets exhausted after a release, the liquid shall be replaced.

(b) Neutralisation in a Spray Tower

The disposal system will consist of a spray tower instead of a pool. Such a tower is provided with baffles. The scrubbing/neutralising liquid is circulated from the bottom of the tower to the top by means of a pump. Any vapour released in to the spray tower will react with circulating liquid before getting

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released to flare/ atmosphere. See figure-4 for a typical spray tower. Design shall ensure its continuous operation in any contingency.

9.0 VAPOUR DEPRESSURISING

The vapours from hydrocarbon emergency depressurising system shall be routed to the closed disposal system as described in Section 8.0.

9.1 RUNAWAY REACTIONS

In some processes like hydro-cracking, reforming and oxidation process there is a likelihood of a runaway reaction leading to sudden rise in system pressure and/or temperature. In such situations emergency depressurising systems are recommended to be used in addition to relief valves. The depressurising system drops the system pressure rapidly through a pressure control valve. Such discharges shall be lead to the closed disposal system like flare etc. Design temperature of equipment in depressurisation loop shall be taken into account for proper metallurgy.

Off gases containing oxygen from vessels shall not be routed to flare. Instead it should be connected to nearby heater/ incinerator. Example bitumen blowing Unit.

9.2 EXPOSURE TO FIRE

When a vessel under pressure is exposed to fire, the metal temperature can reach a level at which stress rupture of the vessel could occur, even though the pressure does not go beyond the relief valve set pressure. Emergency depressurising systems are recommended for rapidly removing vapours from vessels exposed to a fire. A typical vapour-depressurising system shall reduce the pressure in the vessel to 50% of the design pressure in 15 minutes. Following three effects shall be considered while estimating the amount of vapours to be handled by the emergency depressurising system:

— Vapours generated from liquid by heat input from fire.
— A change in density of internal vapour due to reduction on pressure.
— Liquid flash due to pressure reduction, when the system contains liquids at its saturation temperature.

9.3 DISPOSAL OF DEPRESSURISED MATERIAL

The vapours from hydrocarbon emergency depressurising system shall be routed to the closed disposal system as described in Section 8.0.

10.0 SAFETY/RELIEF VALVE DATA SHEET

It is important that all the relevant process data for the pressure relieving devices be furnished in the form of a standard data sheet. A sample sheet of Safety/Relief valve data sheet is given as Annexure-I

11.0 RELIEF SYSTEM RECORD

A record of all the relief valves and the other components of the relief system e.g. headers, pump, vessels, etc. shall be kept. This record shall be reviewed before undertaking any modifications in the plant.
facilities which are likely to increase the relieving load from the plant. Such a review of the relief system is important when increasing the plant capacity, major changes in operating conditions or addition of some equipment for better energy recovery or other considerations are being planned. From safety considerations, it is imperative that sizing calculations for pressure relieving and disposal devices shall be made a part of permanent plant record. A sample sheet showing the record of a safety valve is given here as Annexure-II. Records for other components of the relief system shall also be made on similar lines.

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12.0 REFERENCES

1. API 520. Recommended Practice for the Design and Installation of Pressure-Relieving Systems in Refineries,
2. API 521. Guide for Pressure-Relieving and Depressuring System
3. Static and Mobile Pressure Vessels (unfired) Rules
5. Paper on High Integrity Pressure Protection Systems (HIPPS) Published in Chemical Engineering Progress, November 2000
6. Instrument Engineers Handbook Volume 3
7. ASME B31.4 (Pipeline transportation system for liquid hydrocarbon and other liquids)
8. ASME B31.8 (Gas transmission & distribution piping system)
<table>
<thead>
<tr>
<th>Relieved Material</th>
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<tr>
<td>1. Sulphur Oxides</td>
<td>Soln. of lime or soda ash</td>
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<td>2. Ammonia</td>
<td>Water</td>
<td>Absorption in pool of water</td>
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<tr>
<td>3. Chlorine</td>
<td>Soln. of soda ash or lime</td>
<td>Absorption in large pool of alkali.</td>
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<td>4. Phenols</td>
<td>Alkaline water (pH=8.5)</td>
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<td>5. Furfural</td>
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<td>6. Glycols</td>
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<td>7. Nitrogen Oxides</td>
<td>Soln. of caustic soda</td>
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<td>8. Sulpholane</td>
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<td>9. Amines</td>
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<tr>
<td>10. MEK</td>
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### SAFETY VALVE PROCESS DATA SHEET

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**Date**

**Purpose**

**Prepared By**

**Reviewed By**

**Approved By**

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ANNEXURE II

TAG NO. __________________________

SAFETY RELIEF VALVE RECORD

Vessels or Equipment Protected

CODE: ASME POWER BOILER/ASME UNFIRED PRESSURE VESSELS/API RP 520

Operating PR __________________ Relieving PR __________________ Accumulation __________________

Design PR: ___________________

Constant Back Pressure_________________ Variable Back Pressure_________________ (MAX)

Spring Set Pressure_________________ Valve Type: Conventional/Bellows

Fluid_________________ (Vapour/Liquid) sp.gr./Mol.Wt

Latent Heat_________________ Temp-Operating_________________ Relieving_________________

Special Requirements_________________ _____________________________

BASIS FOR SIZING

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<td>Tube Failure</td>
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<td>Reflux Loss</td>
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<tr>
<td>Control Failure</td>
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<td>Liquid Expansion</td>
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</table>

REQUIRED AREA

As Per API 520: ..................................................................................................................

Area of Valve Selected ........................................................................................................

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ANNEXURE III

High Integrity Pressure Protection System (HIPPS)

High Integrity Pressure Protection System (HIPPS) is a Safety Instrumented System (SIS) that is designed to provide overpressure protection that is at least equivalent in reliability to a mechanical relief device. HIPPS involve an arrangement of instruments, final control elements (eg Valves, Switches etc) and logic solvers configured in the manner designed to avoid over pressurising incidents by removing the source of overpressure or reducing the probability of an over pressure contingency to such a low level that it is no longer considered to be credible case. With appropriate levels of redundancy, HIPPS shall be designed to achieve a level of availability equal to or greater than a mechanical relief device.

HIPPS shall be considered in design of pressure relieving system along with mechanical relief system for over pressure protection to:

1) Eliminate a particular overpressure scenario from the flare design basis.
2) Eliminate the need for a particular relief device.
3) Provide system overpressure protection where a relief device is ineffective,
4) Reduce probability that several relief devices will have to operate simultaneously, thereby allowing for reduction in the size of the disposal system,
5) Reduce the demand rate on relief device consequently reducing the risk.
6) Reduce risk for high risk process units (eg those involving toxic materials).
7) To achieve high level of protection in some cases where it can be used in concert with relief device.

While finalising incorporation of HIPPS, following shall also be considered:

1) The cost of ownership and routine testing of HIPPS versus routine pressure relieving device maintenance.
2) Careful analysis shall also be made of the response of the process to the operation of the HIPPS.
3) The inadvertent operation of HIPPS can sometimes lead to major shut down and thus incur the hazards associated with the shutdown and subsequent start ups.

Once HIPPS design configuration is finalised, it shall be analysed to verify that the specified components and arrangements will meet the safety integrity level (SIL) requirement.

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ANNEXURE IV

TYPES OF PRESSURE RELIEVING / SAFETY DEVICES

1. RECLOSED TYPE SAFETY/PRESSURE RELIEF VALVES

1.1. Conventional

Conventional pressure relief valve is a spring loaded pressure relief valve whose operational characteristics are directly affected by changes in the back pressure. These safety/relief valves are susceptible to both superimposed and built-up back pressure and are not recommended when the total back pressure exceeds 10% of the set pressure.

1.2. Balanced Pressure relief valves

Balanced pressure relief valve is a spring loaded pressure relief valve that incorporates bellows or other means for minimizing the effect of back pressure on the operational characteristics of the valve. Balanced Bellow valves are not susceptible to back pressure and can be used for back pressure up to 50% of set pressure.

1.3. Pilot-operated relief valves

A pilot operated pressure relief valve is a pressure relief valve in which the major relieving device or main valve is combined with and controlled by a self actuated auxiliary pressure relief valve (pilot). In pilot-operated safety valves, the main safety valve opens through a pilot valve.

These relief valves essentially employ a self actuated auxiliary (pilot) pressure relief valve to control main pressure relieving device (main valve) which results in keeping system operating pressure within 5% of set pressure without the danger of increased seat leakage in the main valve. Pilots are generally designed with a separate control for set pressure and blow-down. Valves can be set to open fully at the set pressure and close with very short blow down. Modulating designs are available to take care of minor overpressure conditions without fully opening main valve to limit fluid loss and shock. Pilot operated valves result in lower valve sizes and reduced costs.

Pilot operated valves are provided with filters to protect against foreign matter and are used for relatively clean service (non-plugging, non-freezing).

2. NON-RECLOSED PRESSURE RELIEF VALVE:

2.1. Rupture disk Device:

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Rupture disk Valve is a non-reclosing pressure relief device actuated by static differential pressure between inlet and outlet of the device and designed to function by bursting of the disc. Ruptures Discs are thin metal diaphragms held between flanges and are designed to burst at the set pressure. Once burst, these are not reusable and have to be replaced. Their set pressure cannot be tested without destroying them. After the test, the rupture disc has to be replaced but there is no guarantee that the second rupture disc will burst at the same pressure. This is a major disadvantage of rupture disc, especially when the bursting pressure is low. For these reasons, rupture discs alone shall not be used. However, they shall be used between the vessel and a relief/safety valve for fluid of highly corrosive, congealing or fouling nature and also vacuum systems. Prolonged exposure of safety valve directly to such conditions can cause damage to valve components. Another area where rupture discs shall be installed at the safety valve on top of column/ vessels operating under vacuum where leakage across safety valve can lead to pressurization of column/ vessel. Suitable mechanism shall be provided to monitor the pressure across rupture disk to identify its bursting.

2.2. Pin-actuated Device:

A non-reclosing pressure relief device actuated by static pressure and designed to function by buckling or breaking of the pin, which holds a piston or a plug in place. Upon buckling or breaking of the pin, the piston or plug instantly moves to full open position.

3. EMERGENCY DEPRESSURISATION VALVES

When metal temperature is increased above the specific design temperature due to fire or exothermic or runaway reactions, the metal temperature can reach a level at which stress rupture can occur. This is possible even though the system pressure does not exceed the maximum allowable accumulation. Emergency depressurisation valves are provided in high pressure systems to quickly depressurise the system during operational emergencies. These valves do not have specific set point and are part of shut down logic. These valves can also be operated from control room/ local operating panel manually. (Examples: Dump Valves in Hydro cracker, DHDS etc).

4. SURGE RELIEF VALVES:

The liquid pipelines can be subjected to surge pressures, when there is a sudden change in the velocity of the moving fluid. This surge pressure can create a major disaster if the rate of change is too rapid.

Some of the eventualities which shall lead to creation of surge pressure in a liquid pipeline are:

- rapid closure of a manual or motor/ hydraulic/ pneumatic actuated valve
- closure of an emergency shut down valve
- stopping of a pump
- Combination of above

In order to protect the pipeline against surge pressure, a surge relief valve shall be provided which responds quickly at the time of pressure surge.
FIG. 1
WATER SEAL DRUM

NOTE-1: ELEVATION TO BE SAME AS OF OVERFLOW FUNNEL IN WATER SEAL

h1 = 3 METERS (MIN)
h2 = 1.75 X MAX. OPERATING PRESSURE
h3 = BACK PRESSURE IN THE HEADER
100 MM (MIN)
300 MM (MAX)

LEGEND
LI : LEVEL INDICATOR
LT : LEVEL TRANSMITTER
LG : LEVEL GAUGE
LC : LOCK CLOSED
LAL : LOW ALARM LOW
LALH : LEVEL ALARMS HIGH LEVEL
OWS : OILY WATER SEWER
ANEL : PANEL INSTRUMENT
LOCAL : LOCAL INSTRUMENT

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NOTES:

1. USE OF LEVEL SWITCH OR LEVEL TRANSMITTER IS OPTIONAL.

2. THE VALVE SHOULD BE PREPARED INSTALLED WITH ITS STEM POINTING DOWNWARDS TO AVOID THE POSSIBILITY OF VALVE REMAINING STUCK CLOSE IN CASE THE STEM BECOMES FREE.