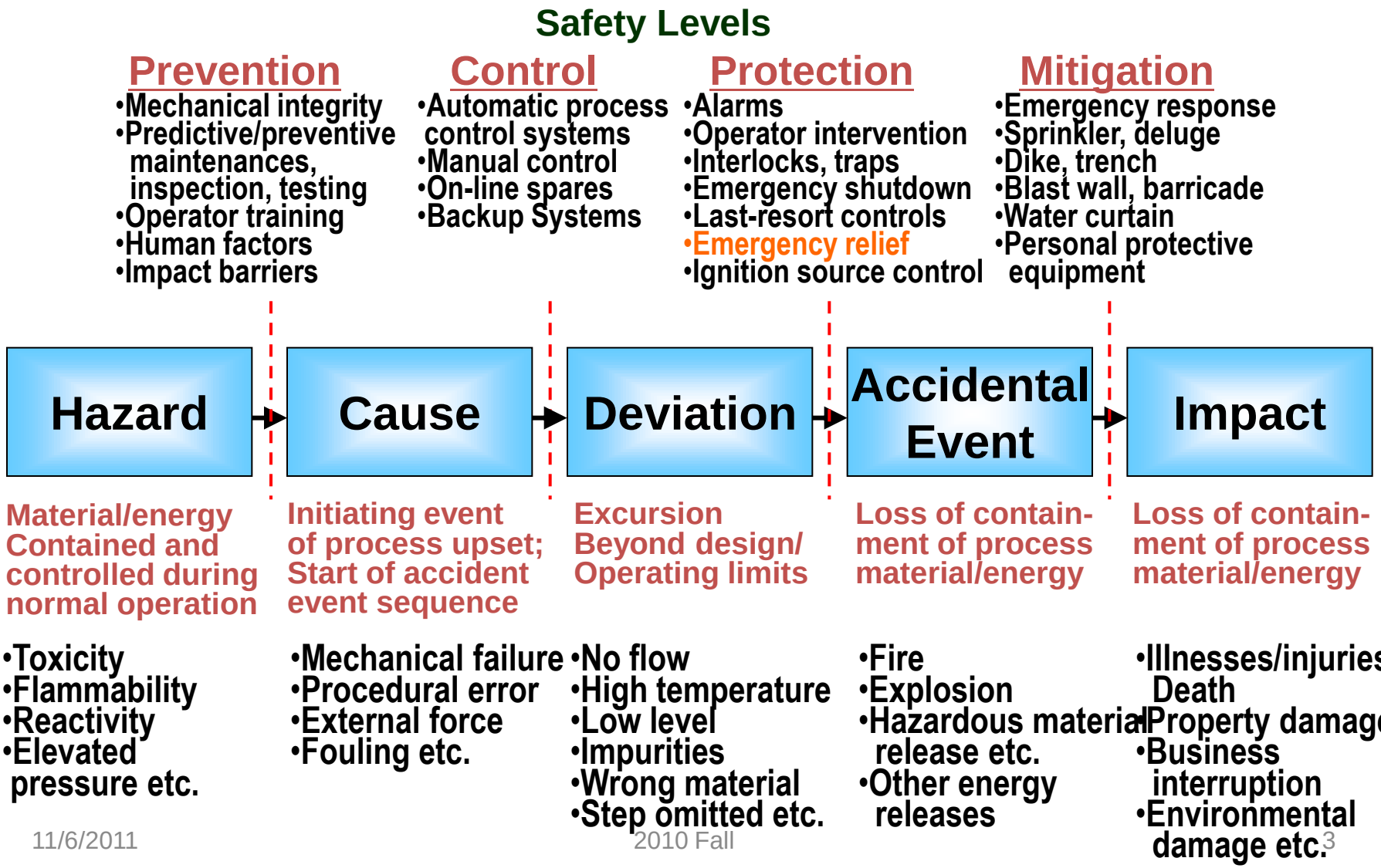
Relief Systems

Korean lizard protect itself by cutting off its tail when attacked

Accidental Flow



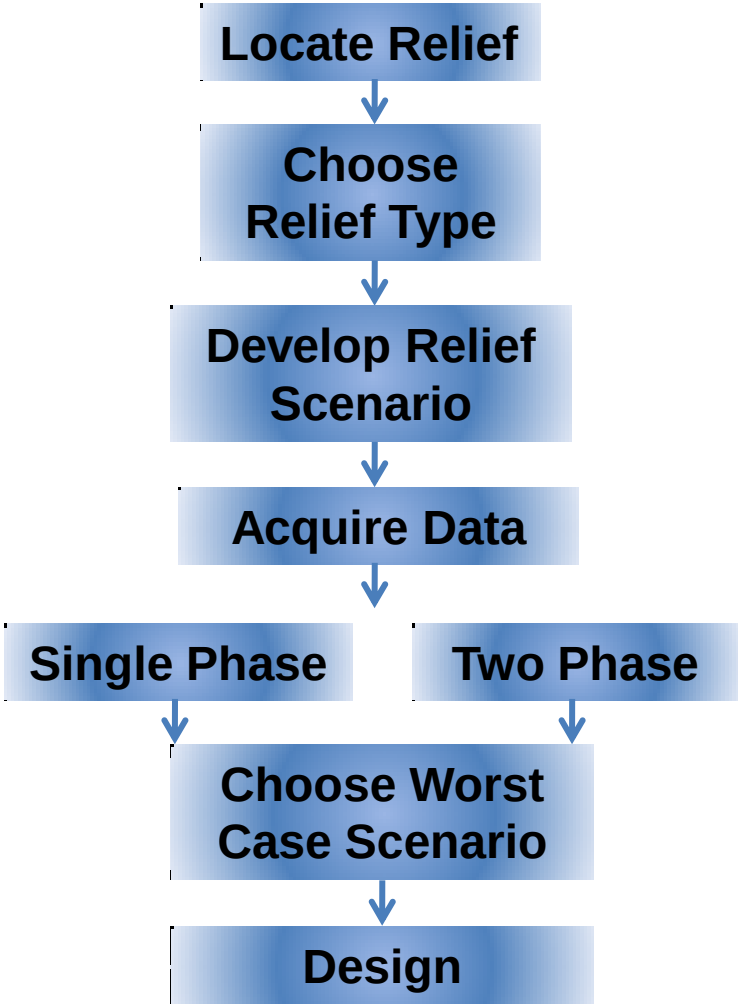
Relief System Protection

- Tiered safety systems, Tab. 5-10, p. 214
  - Last layer of preventive protection
  - Prevent costly incident at price of lost material
  - Material released into containment system, a plant-wide system within a process plant

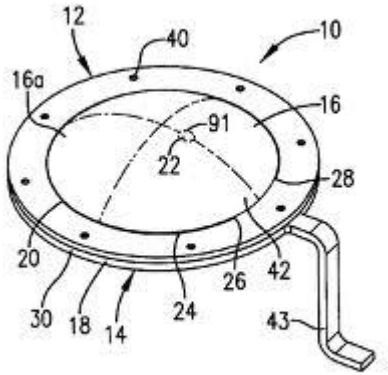
Major area	Examples
Inherent safety	
Engineering design	Plant physical integrity, Process integrity, Process design features for emergency control: Emergency relief systems, Spill containment
Management	
Early vapor detection and warning	
Countermeasures	
Emergency response	

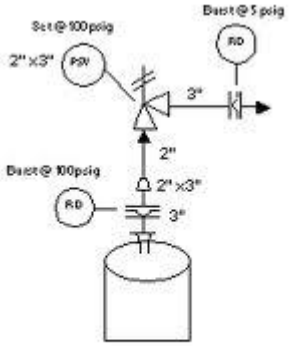
Relief System Issues

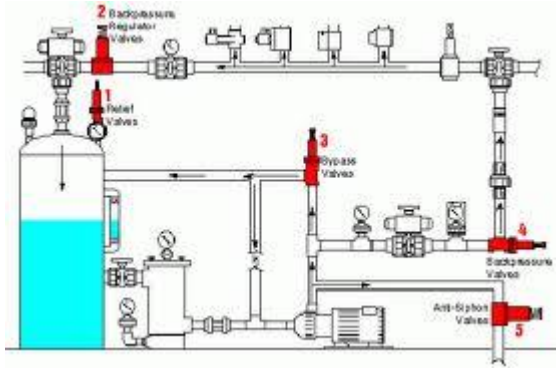
- Relief capacities: not too small or too large
- Properties of materials for treatment
- Containment system capacity, compatibility
- Locations and types of relief devices
- Relief method: Fig 8-1, p. 354
- Nomenclature, pp. 356, 357



- **Relief Concepts**
  - **to protect personnel from the dangers of overpressurizing equipment,**
  - **to minimize chemical losses during pressure upsets,**
  - **to prevent damage to equipment**
  - **to prevent damage to adjoining property,**
  - **to reduce insurance premiums, and**
  - **to comply with governmental regulations.**
- **Relief system: The network of components around a relief device, including the pipe to the relief, the relief device, discharge pipelines, knockout drum, scrubber, flare, or other types of equipment that assist in the safe relief process.**







Process Vessel

Relief System

Relief valve

Rupture disc

Balanced bellows

Vent

Knockout Drum

Scrubber

Condenser

Flare

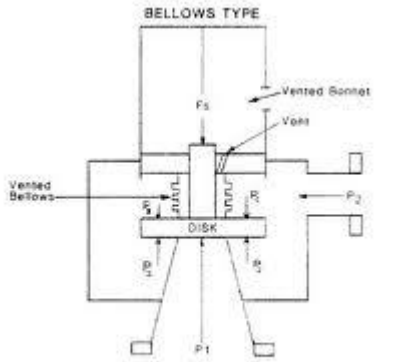
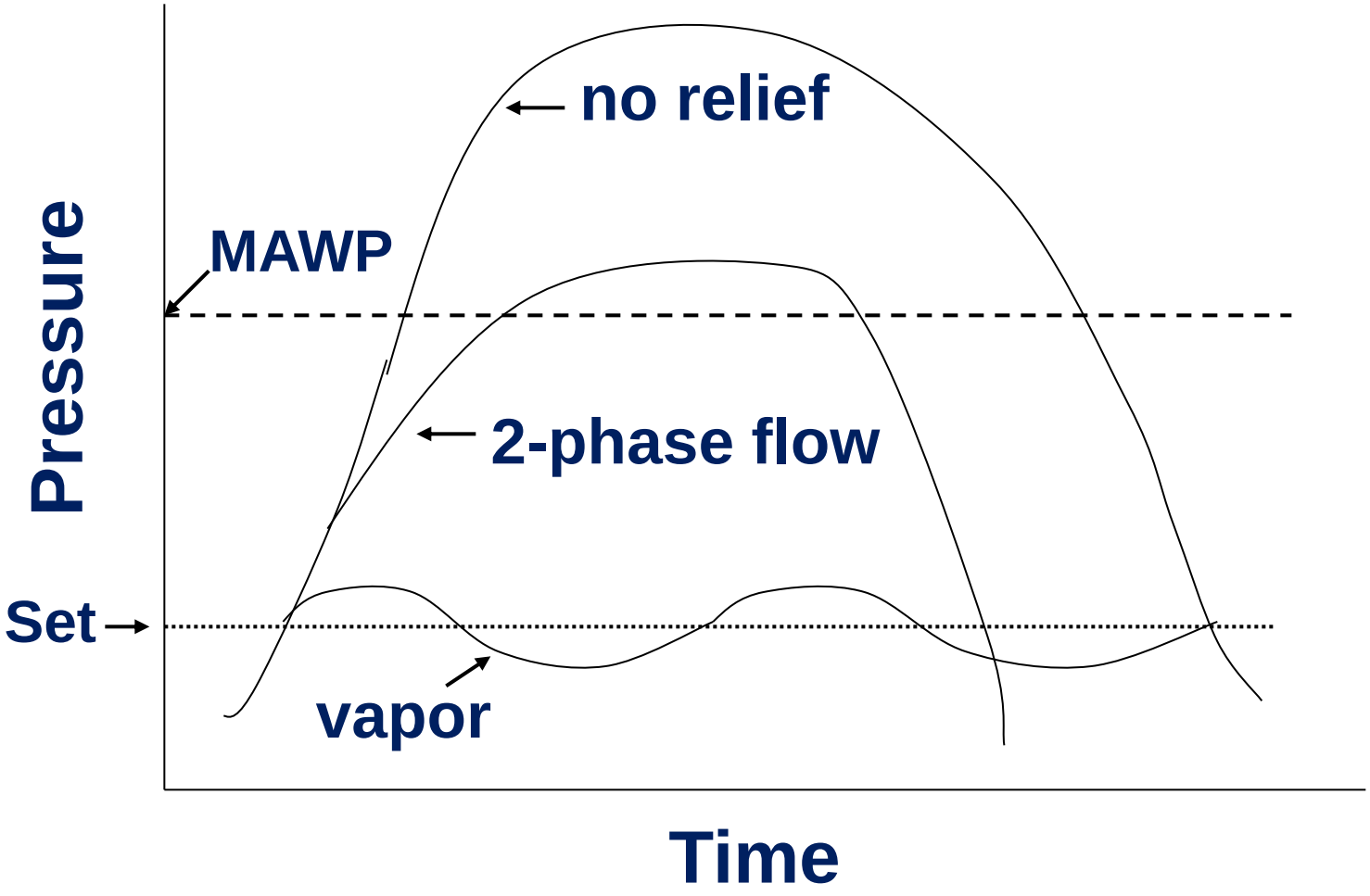


Figure 13-5. Operation of balanced-bellows safety-relief valve. (Reprinted with permission from API 520.)

Release Behavior



- **Set pressure: The pressure at which the relief device begins to activate.**
- **Maximum allowable working pressure (MAWP): The maximum gauge pressure permissible at the top of a vessel for a designated T ☞ design pressure.**

- Operating T ↑, the MAWP ↓

☞ the vessel metal loses its strength

- Operating T↓, the MAWP ↓

☞ metal embrittlement at lower T

- Vessel failure typically occurs at 4 or 5 times the MAWP

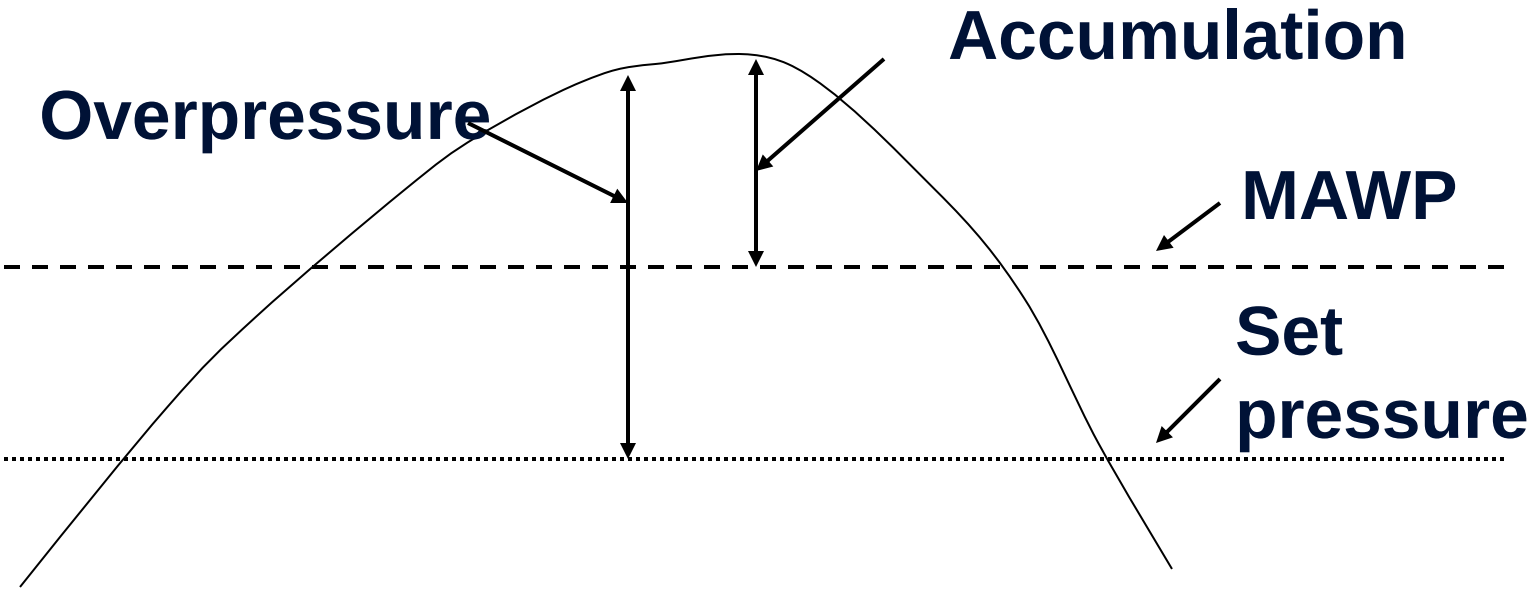
- Vessel deformation may occur at as low as twice the MAWP.

- **Operating pressure: The gauge pressure during normal service, usually 10% below the MAWP.**
- **Accumulation: The pressure increase over the MAWP of a vessel during the relief process. ☜ % of the MAWP**
- **Overpressure: The pressure increase in the vessel over the set pressure during the relieving process.**

  - Equivalent to the accumulation when the set pressure is at the MAWP ☜ % of the set pressure
- **Backpressure: The pressure at the outlet of the relief device during the relief process**
- **Blowdown: The P difference between the relief set P and the relief reseating P ☜ % of the set P**
- **Maximum allowable accumulated pressure: The sum of the MAWP and the allowable accumulation.**

Relief Device Locations

- Process unit operations
- Hazardous pressures: exceed allowable accumulation > MAWP
- Identify hazardous pressures (HAZOP)



Guideline for Relief Pressure

Fig. 8-4, p. 358

Causes of Increased Pressure

- Heating, loss of cooling, inadequate agitation
- Incorrect concentration, contaminants
- Catalysts, contaminants
- Operator error
- Enclosed liquids, thermal expansion
- Valve failure
- External fire

Relief Type Selection

- **Select type and size**
  - **Material: gases, liquids, gases & liquids, solids**
  - **Properties, e.g., corrosive, flammable, inert**
  - **Process conditions**
- **Vent: atmosphere, treatment systems (scrubber, flare, condenser, incinerator)**

Standard Relief Valve

- **Operation: pressure drop across valve seat**
- **Flow rate proportional to pressure drop**
- **Set pressure: spring tension adjusted for 10 % above normal operating pressure**
- **Set pressure and flow rate through valve are dependent on downstream pressure or *backpressure***

Standard, Bellows, and Rupture Relief Devices

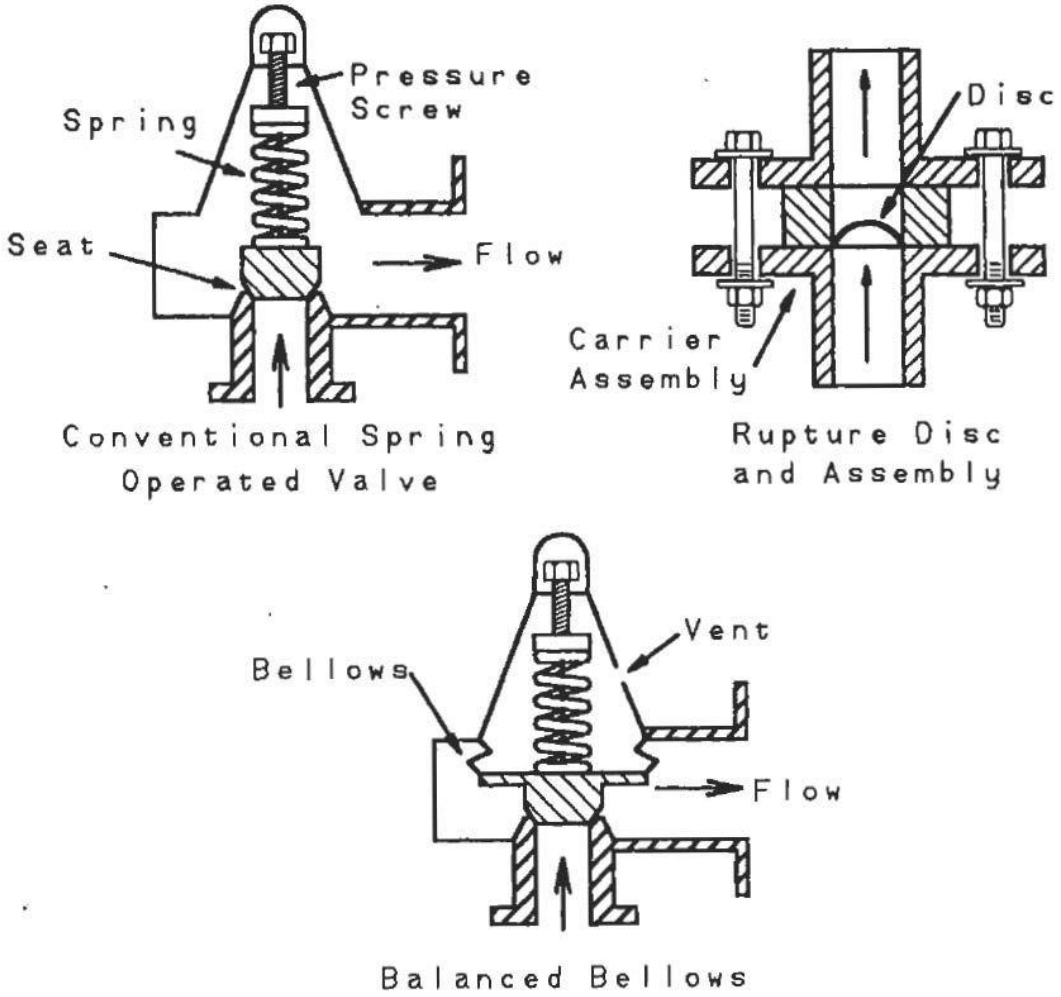


Figure 8-7 Major types of relief devices.

Balanced-Bellows Valve I

- Spring and back of valve seat is separated from fluid by a bellows
- Back of valve is vented to atmosphere
- Valve opens at the set pressure regardless of backpressure
- Flow rate through valve is dependent on backpressure

Balanced-Bellows Valve II

- **Advantages: more accurate set pressure, better protected from fluids**
- **Disadvantage: expensive**
- **When to use: for a constant relief flow rate if large variations in back pressure can occur**

Spring Relief Valve Types

- **“Relief” valve for liquids**
  - **Begins to open at set pressure**
  - **Max flow at 25% overpressure**
- **“Safety” valve for gases**
  - **Pops open above set pressure**
  - **Flow keeps valve open**
  - **Reseats at 4 % below set pressure (*blowdown*)**
- **“Safety relief” valve for liquids and gases**
  - **Begins to open at set pressure**
  - **Max flow at 25% overpressure**

Advantages of Rupture Disks

- Simple, inexpensive
- Single reliable sealing
- Available in wide range of sizes, including larger than standard valves
- Venting rates can be much larger than with spring-operated valves
- Often used in series with a standard relief valve

Disadvantages of Rupture Disks

- Does not close after opening
- Excessive material can be vented
- Air can leak in after opening
- Corrosion can result in disk holes and leaking
- Flexing of disk due to cycling can lead to failure at lower than nominal Pressure