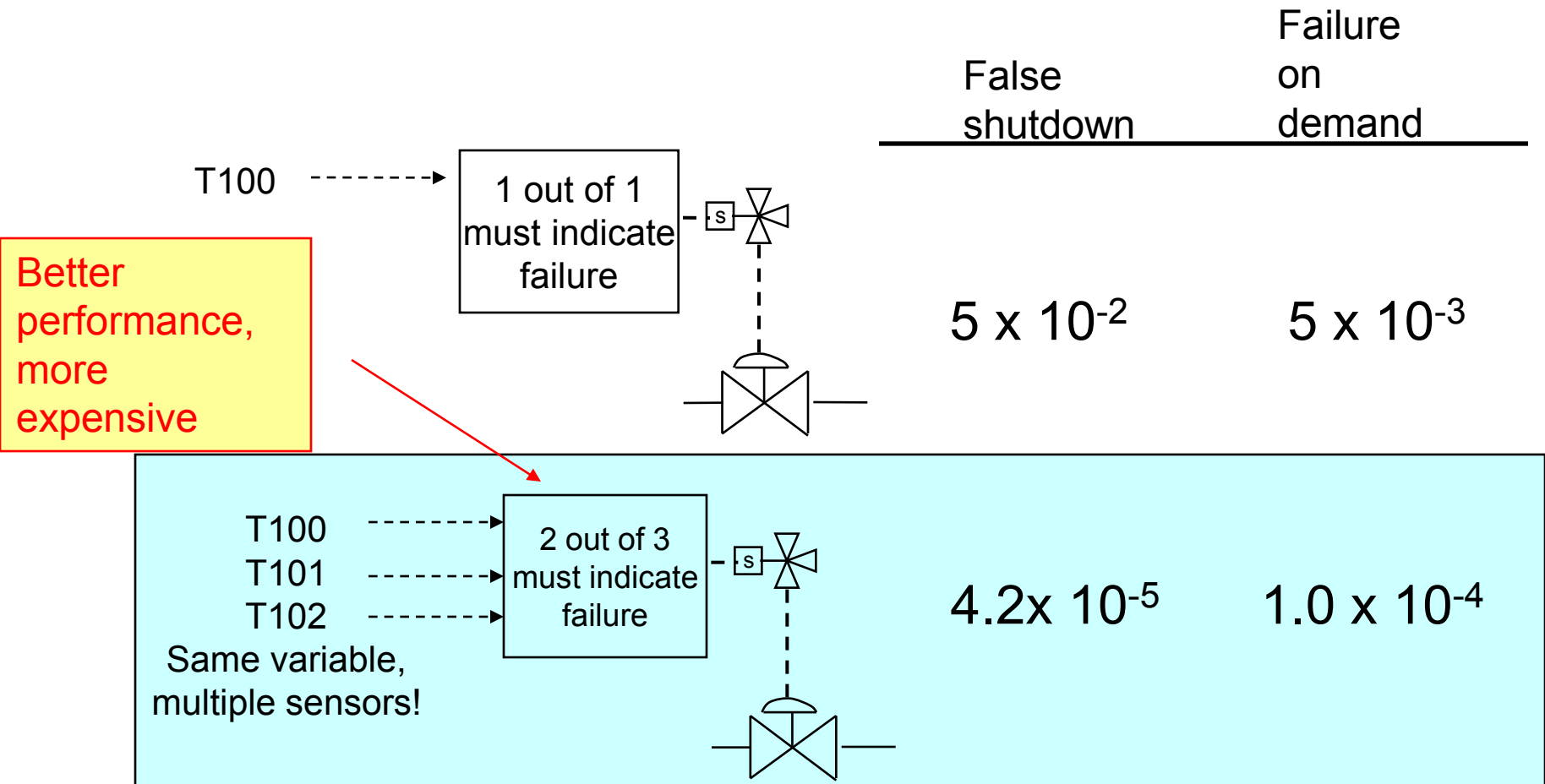


3. Safety instrumented (interlock) system (SIS)

The SIS saves us from hazards, but can shutdown the plant for false reasons, e.g., instrument failure.



Risk matrix for selecting SIS design

Event severity	extensive	Medium 2	Major 3	Major 3
	serious	Minimal 1	Medium 2	Major 3
	minor	Minimal 1	Minimal 1	Medium 2
		low	moderate	high
		Event likelihood		

Table entries

word = qualitative risk description
 number = required safety integrity level (SIL) →

Safety Integrity Levels

(Prob. of failure on demand)

1 = .01 to .1

2 = .001 to .01

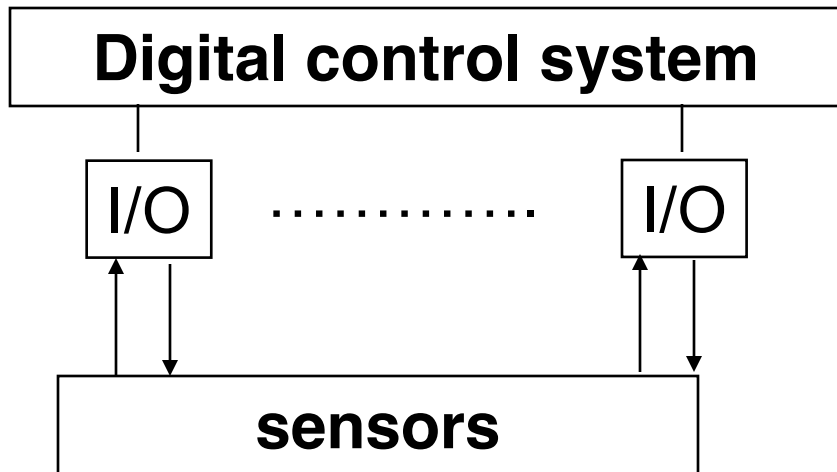
3 = .0001 to .001

Selection documented for legal requirements

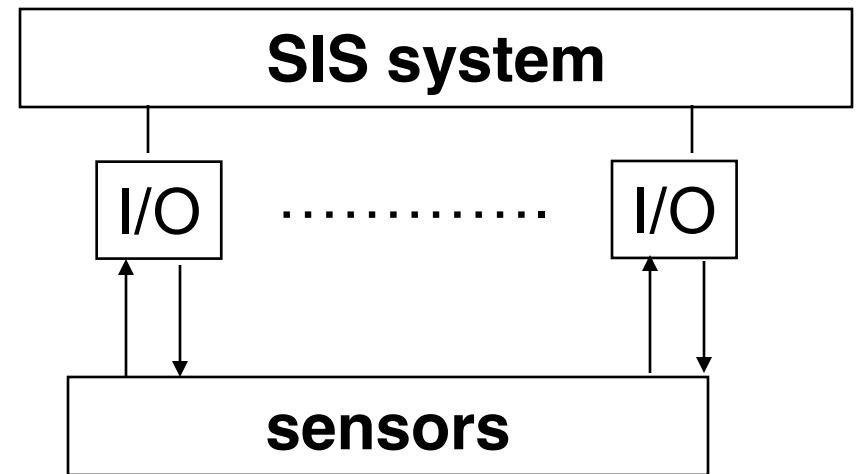
3. Safety instrumented (interlock) system (SIS)

We desire independent protection layers, without common-cause failures - Separate systems

BPCS and Alarms



SIS and Alarms associated with SIS

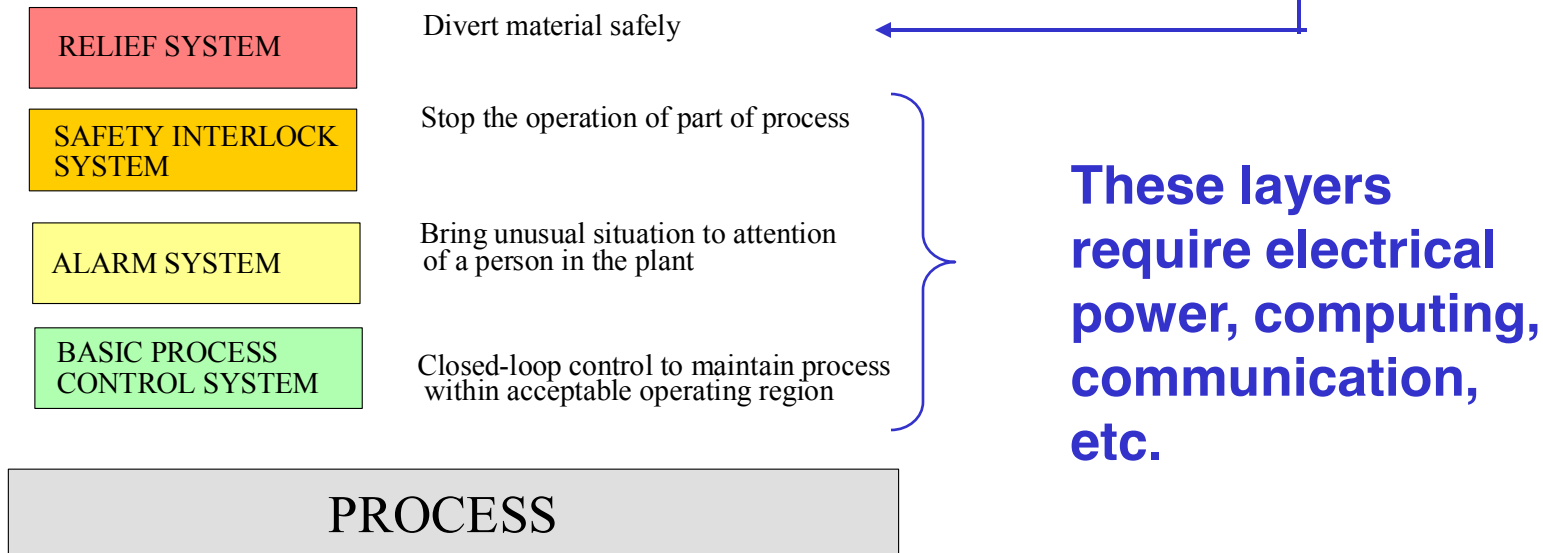


Key concept in process safety - redundancy!

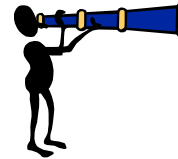
What do we do if a major incident occurs that causes

- loss of power or communication
- a computer failure (hardware or software)

SAFETY STRENGTH IN DEPTH !



4. Safety relief system



What's in
this topic?

RELIEF SYSTEM

**SAFETY INTERLOCK
SYSTEM**

ALARM SYSTEM

**BASIC PROCESS
CONTROL SYSTEM**

- Location
- Equipment selection
- Documenting on drawings
- Maximum capacity

Relief systems in process plants

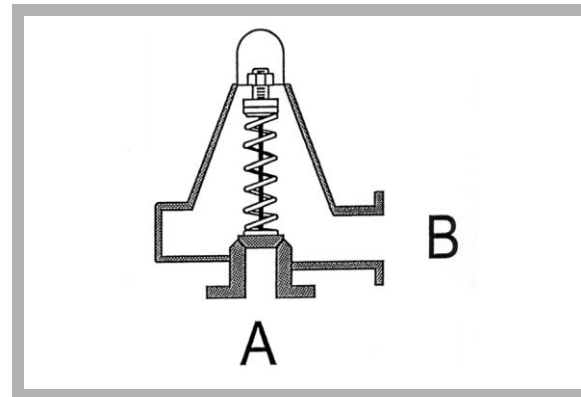
- Increase in pressure can lead to rupture of vessel or pipe and release of toxic or flammable material
 - Also, we must protect against unexpected vacuum!
- Naturally, best to prevent the pressure increase
 - large disturbances, equipment failure, human error, power failure, ...
- Relief systems provide an exit path for fluid
- Benefits: safety, environmental protection, equipment protection, reduced insurance, compliance with governmental code

Location of relief systems

- Identify potential for damage due to high (or low) pressure (HAZOP Study)
- In general, **closed volume** with ANY potential for pressure increase
 - may have exit path that should not be closed but could be
 - hand valve, control valve (even fail open), blockage of line
- Remember, this is the **last resort**, when all other safety systems have not been adequate and a fast response is required!

Standard relief methods

- Basic principle: No external power required - **self actuating** - pressure of process provides needed force!
- **Valves** - close when pressure returns to acceptable value
 - Relief valve - liquid systems
 - Safety valve - gas and vapour systems including steam
 - Safety relief valve - liquid and/or vapour systems
- Pressure of protected system can exceed the set pressure.



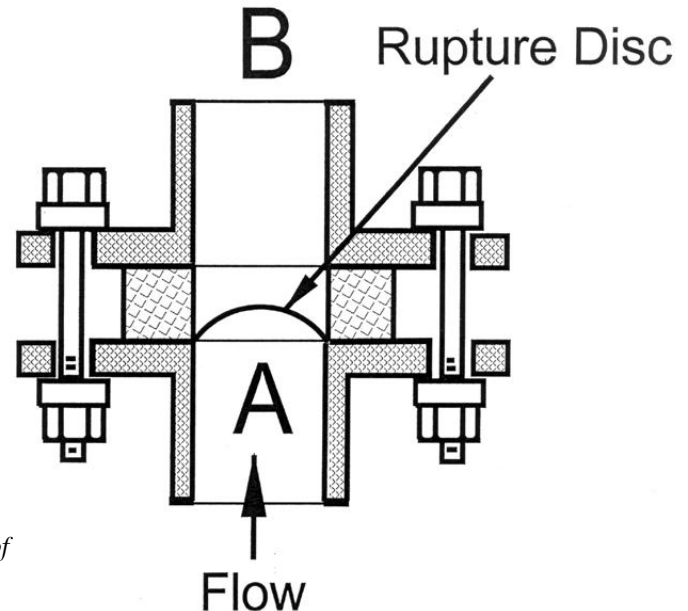
Safety relief control valve



<http://www.yongyivalves.com/High-Pressure-and-High-Temperature-Safety-Relief-Valve-59.html>

Standard relief methods

- Basic principle: No external power required - **self acting**
- **Rupture disks or burst diaphragms** - must be replaced after opening



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Rupture disks or burst diaphragms



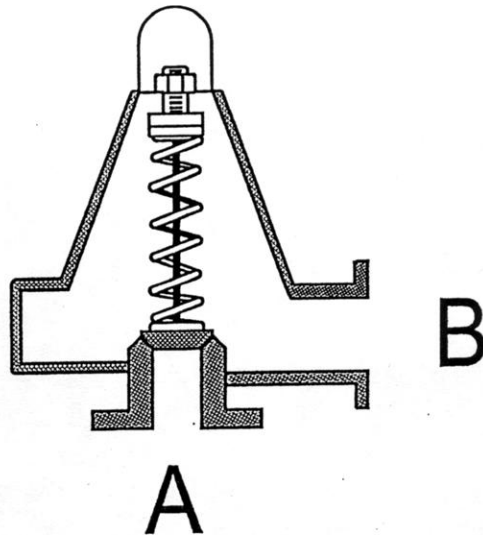
<http://www.valvecenter.co.uk/products.html>

Some information on relief valves

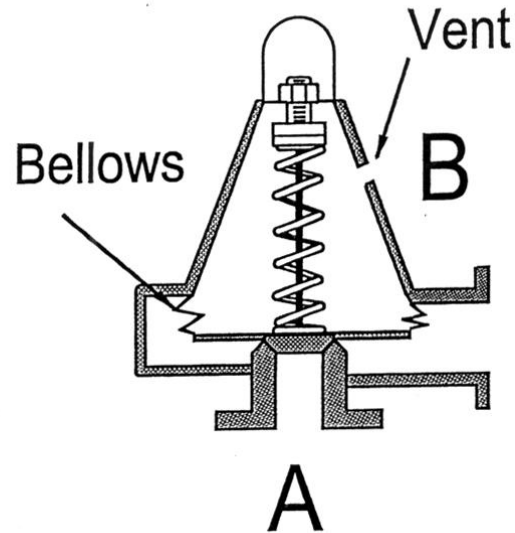
Two types of designs determine influence of pressure immediately after the valve

- **Conventional valve** - pressure after the valve affects the valve lift and opening
- **Balanced valve** - pressure after the valve does not affect the valve lift and opening

Conventional



Balanced



Some information on relief valves

Advantages

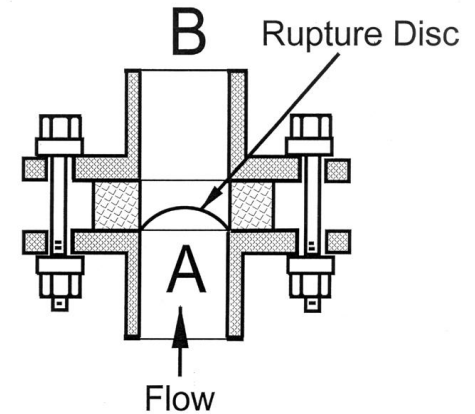
- simple, low cost and many commercial designs available
- regain normal process operation rapidly because the valve closes when pressure decreases below set value

Disadvantages

- can leak after once being open (O-ring reduces)
- not for very high pressures (20,000 psi)
- if oversized, can “chatter”, leading to damage and failure (do not be too conservative; the very large valve is not the safest!)

Some information on rupture disks/ burst diaphragms

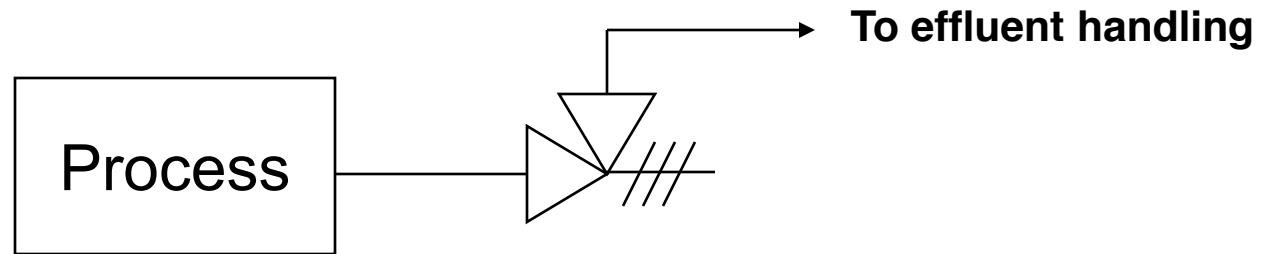
- A wide range of materials and designs are available
- **Advantages**
 - no leakage until the burst
 - rapid release of potentially large volumes
 - high pressure applications
 - corrosion leads to failure, which is safe
 - materials can be slurries, viscous, and sticky
- **Disadvantages**
 - must shutdown the process to replace
 - greater loss of material through relief
 - poorer accuracy of relief pressure



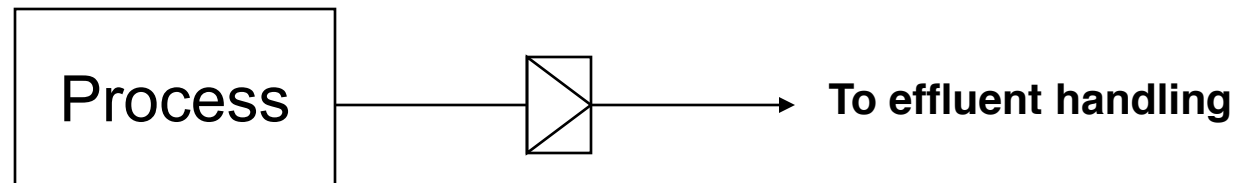
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Showing relief systems on process & instrumentation (P&I) drawings

Spring-loaded safety relief valve



Rupture disc



Add relief system to the following process drawing

