Il dimensionamento delle valvole di sicurezza da parte di un EPC Contractor

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- Introduction
- PSV workflow
- Sizing activities
- Considerations

Safety-Relief Devices adopted in a plant:

- Pressure Safety Valves (PSV)
- Rupture Disks (RD)
- PIN Devices
- Breathing Valves (for low pressure tanks and vessels)

PSV are fundamental devices present in every new or existing plant. EPC Contractor is responsible to size, select and properly mount these devices with the help of PSV manufacturers.

Today we want to highlight the main steps of PSV sizing from the point of view of the EPC contractor.

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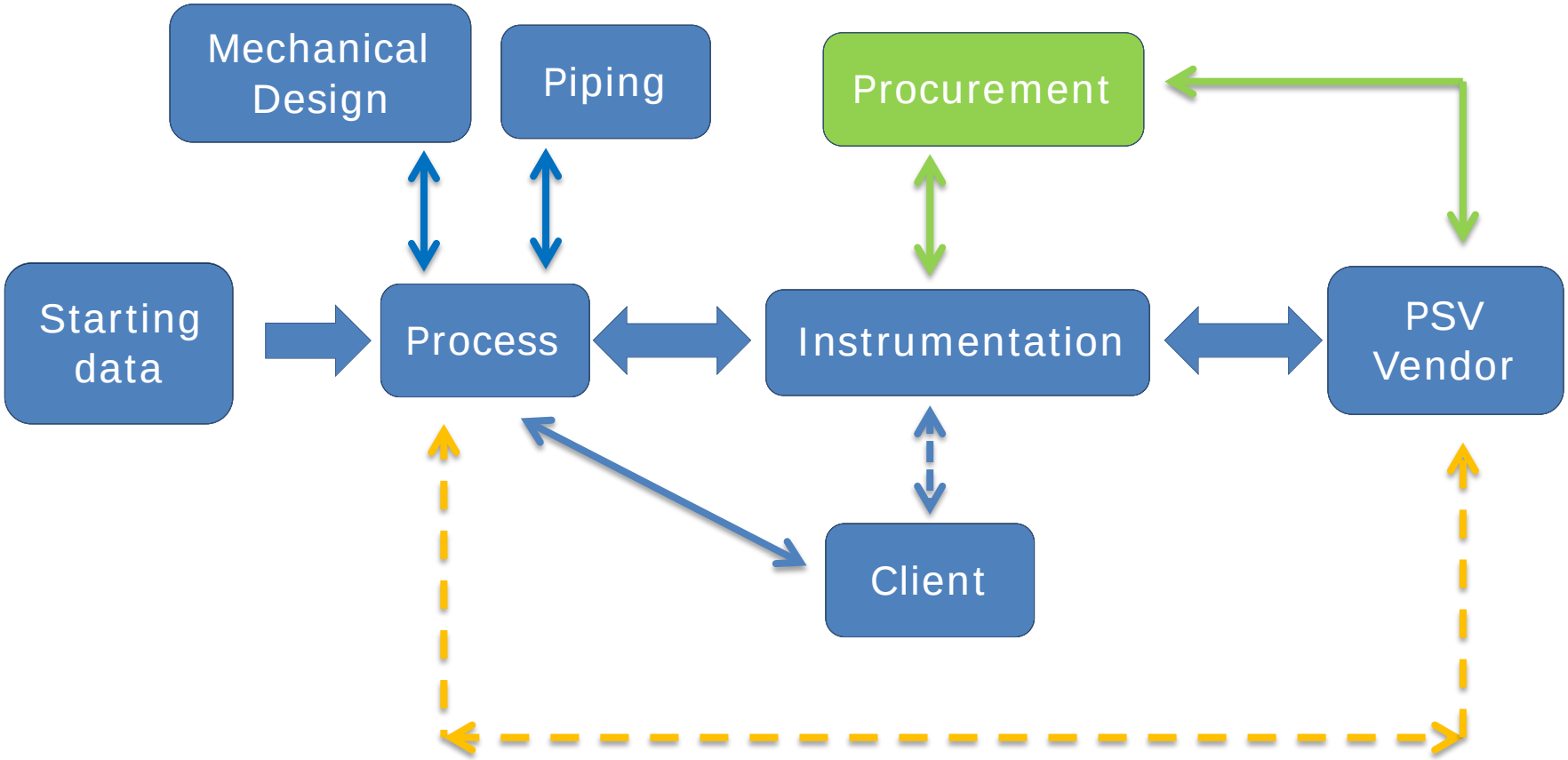
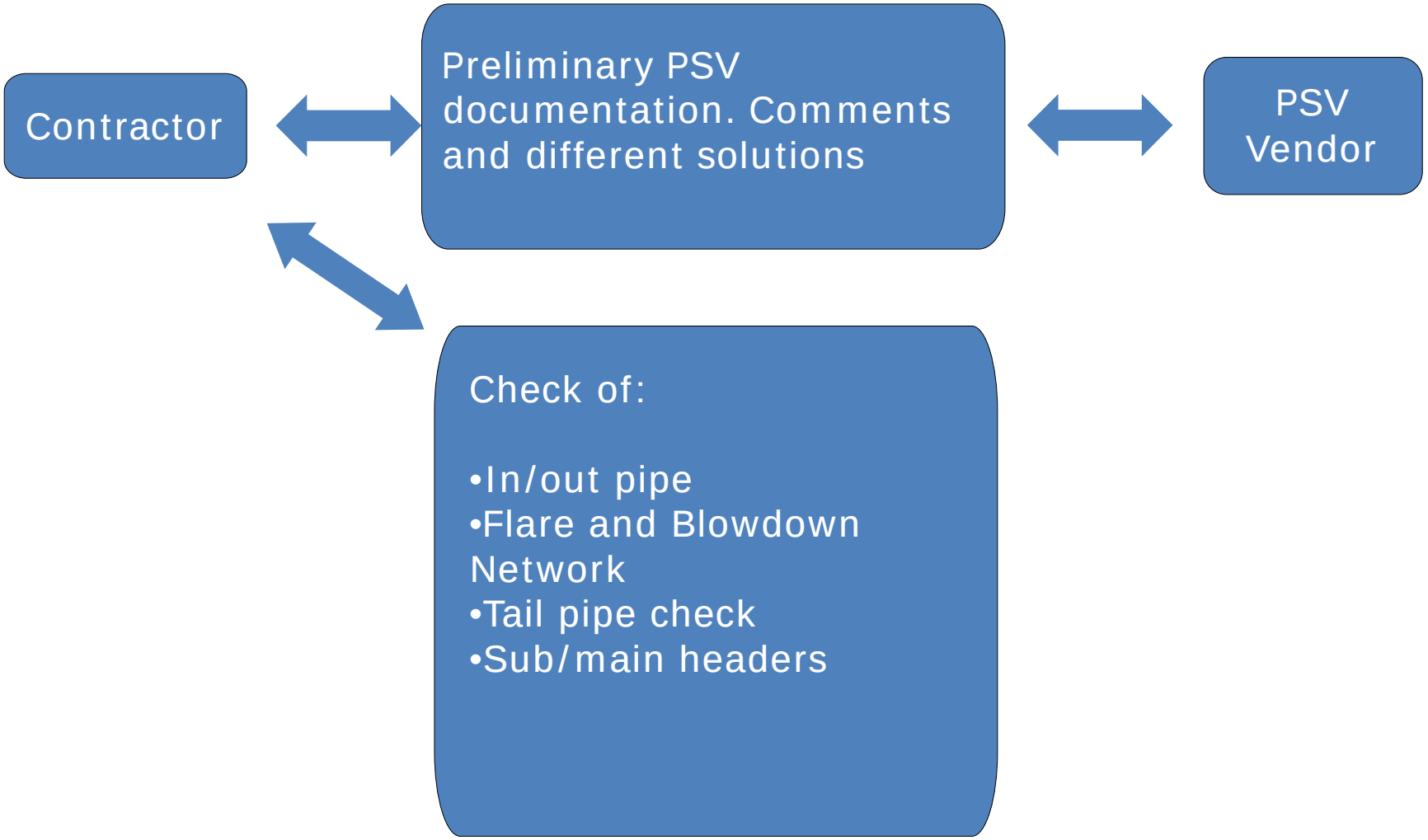

Mechanical Design
Piping
Procurement
Starting data
Process
Instrumentation
PSV Vendor
Client

PSV workflow



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Licensor / PDP: provide the basic information:

- Fluid data
- Safety design criteria
- Critical PSV size (if any, critical by process point of view)

BASIC / FEED: PSV, pipes and Blowdown Network are defined (not / preliminary sized)

- PSV preliminary datasheet
- Blowdown Headers/Sub-headers preliminary size

EPC: PSV selection and sizing, pipe sizing, Flare and Blowdown Network check /sizing

- PSV datasheet, PSV material requisition
- In/out pipe size (tail pipe, sub-headers, main header)
- KO drums datasheet
- Flare datasheet
- Blowdown network system size

PSV standards:

- Contractual requirements
- PMC / Client guidelines
- Local Authority

Verify which are the design rules and the installation rules to be followed.
API / ASME are the most used standards but sometimes local regulation should be applied.

Existing plants:

- New blow down network connected to existing Flare
- Expansion of an existing network

Revamping of existing blow down network with potential overload of existing flares needs a specific study with the aid of dynamic simulations.

PSV sizing – Fluid data:

- Licensor data
- Heat and Material Balance
- Preliminary datasheets
- Commercial process simulation software (e.g. Aspen HYSYS, Honeywell UNISIM, SIMSCI PROII)

During FEED phase, PSVs are in general not or preliminary sized.
The Contractor should evaluate all the starting hypothesis in order to the define which are the critical equipment and if some PSVs should be installed.

PSV sizing – Typical Overpressure Scenarios:

- General
  - Fire
  - Thermal expansion
  - Overfilling
- Control Valve Related
  - Blocked Outlet
  - Control Valve Failure
  - Abnormal Flow through Valve
  - Failure of Automatic Controls
- Heaters and Coolers
  - Exch. Tube Rupture
  - Cold Side of Exchanger Blocked In
  - Blocked-In Fired Heater
  - Loss of Heat
- Flare
  - General Power Failure
  - Local Power Failure
  - Cooling Water Failure
  - Coolant Failure (other than CW)
  - Loss of Heat
- Reaction/Mixing
  - Chemical Reaction
  - Accidental Mixing
  - Inadvertent Loss of Segregation
  - Pressure Surge or Internal Explosion
- Distillation Column
  - Reflux Failure
  - Abnormal Heat or Vapor Input
  - Accumulation of Non-Condensables
  - Loss of Absorbent

Overpressure scenarios are checked using also commercial simulation software (steady-state and dynamic) when needed.
Some scenarios are highlighted / evaluated after HAZOP study

API std 521 gives specific guidelines to define the scenarios.

PSV sizing – PSV preliminary calculation:

- Flow rate estimation
- Discharge conditions
- PSV size
- PSV selection

Particular cases:

- Two-phase fluids
- Supercritical conditions
- Wide boiling range hydrocarbon mixtures

Pipe sizing:

- Inlet pipe loss (e.g. 3% rule)
- Backpressure check (outlet pipe losses)
- Thrust evaluation (reaction forces during discharge)
- Tail pipe check sizing (in/out)
- Sub-headers check / sizing
- Main header check / sizing
- Vibration analysis (AIV check)

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Device type choice (Standard, Balanced, Pilot)

It is “usually” a function of backpressure. But can be influenced by other conditions (e.g. freezing fluids, dirty fluids, blow down network etc..).

Potential overdesign problems

A bigger valve is not always the best solution !

Attention to:

- excessive pressure drop in inlet
- excessive load in flare system
- acoustic induced vibrations . AIV analysis could be necessary.

Rated flow rate versus **Calculated flow rate**

- API versus ASME orifice areas
- Flare and Blow down network potential overload
- Excessive discharge reaction forces and vibration risk

Chattering and Instability risk:

- Pipe Inlet length (3% rule of inlet loss)
- Three-way changeover valves

Checking of Sub vendors / package:

- Different calculation codes adopted
- Excessive Flow rate discharged to flare

It is fundamental a Continuous Feedback among:

- PSV vendor
- Licensor/Client
- Contractor

Use a Common Calculation Approach:

- Calculation tool (e.g. TCM SAFETY software)
- Calculation procedures for specific problems (e.g. TCM Work Instructions)

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