

A background image of an industrial facility featuring a complex network of large, silver-colored pipes and structural steel. A worker in a blue uniform and hard hat is visible in the lower-left, working on the piping. The scene is brightly lit, likely by natural light from the right.

PIPING FUNDAMENTALS

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ACKNOWLEDGEMENT

- This report is a study of Fundamentals of piping as carried out by PIPING DEPT of EIL, New Delhi.
- I take this opportunity to thank all those who have contributed by giving their valuable and precious time towards its fulfillment.
- I would like to express my gratitude towards Mr. R.K. NANDA DGM of “PIPING ” Department, New Delhi who has given me extremely valuable project regarding the organization.
- I am also thankful and highly obliged to Mr. A.T. DHARMIK (HOD)) Piping Department for providing vital technical inputs and valuable suggestion and continuous guidance, which have gone a long way in providing impetus to our efforts in consummating this report.

SUBMITTED TO:

Mr. R.K.NANDA

COMPANY PROFILE

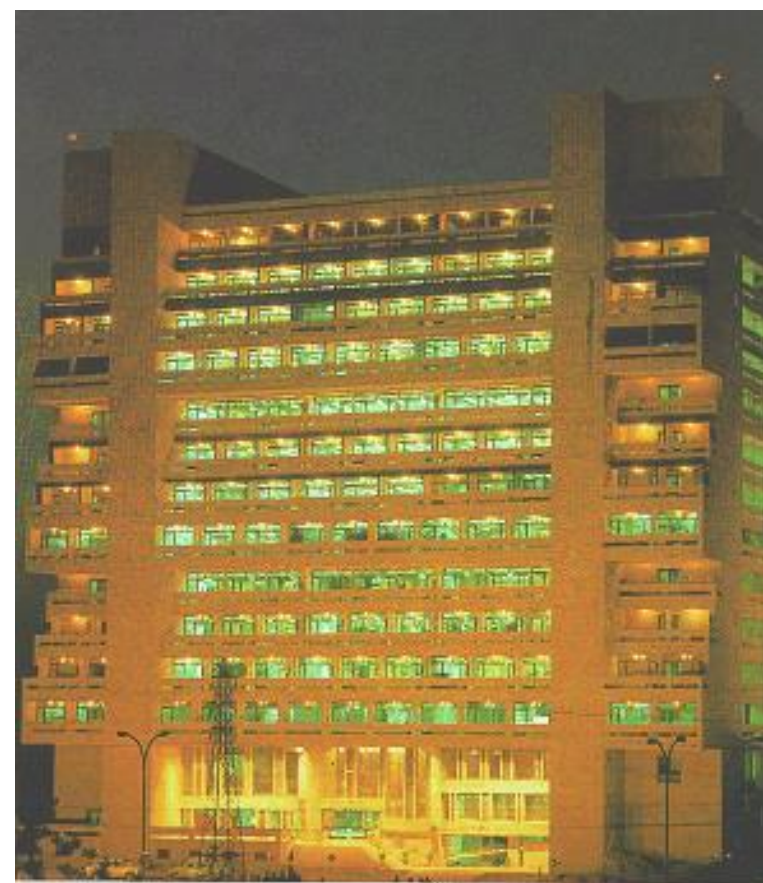
- **Engineers India Limited** was established in 1965 to provide engineering and related technical services for petroleum refineries and other industrial projects.
In addition to petroleum refineries, with which EIL started initially, it has diversified into and excelled in other fields such as pipelines, petrochemicals, oil and gas processing, offshore structures and platforms, fertilizers, metallurgy and power. EIL now provides a complete range of project services in these fields and has emerged as Asia's leading design and engineering Company.

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- **EIL's fields of activities include:**
- Petroleum Refineries
- Pipeline
- Oil and Gas Processing
- Petrochemicals
- Offshore Structures & Platforms
- Ports & Terminals
- Metallurgy
- Fertilizers

- Power
- Highways & Bridges
- Airports
- Non Conventional / Renewable Energy Sources
- Intelligent Buildings & Urban Development
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Piping Fundamentals

PIPE:

It is a Tubular item made of metal, plastic, glass etc. meant for conveying Liquid, Gas or any thing that flows.

It is a very important component for any industrial plant. And it's engineering plays a major part in overall engineering of a Plant.

PIPING

- . The term ***Piping*** means not only pipe but includes components like fittings, flanges, valves, bolts, gaskets, bellows etc.

Selection of Piping Materials

- Materials selection for achievement of metallurgical stability shall be made on the basis of design condition and to resist possible exposures against fire, corrosion, operating condition, service etc.
- The designer is confronted with the following concerns regarding the material of construction as he begins the design. These are:
 - a) Resistance to stress
 - b) Resistance to wear
 - Design Life, Resistance to corrosion etc.

ENGINEERING MATERIALS

- | | | |
|-----------------------|-------------------------|-----------------------|
| • (1) METALLIC | (2) NON-METALLIC | (3) COMPOSITES |
| (i) FERROUS | (i) ORGANIC | |
| (ii) NON-FERROUS | (ii) INORGANIC | |

- | <u>FERROUS</u> | <u>NON-FERROUS</u> | <u>ORGANIC</u> | <u>INORGANIC</u> |
|------------------|--------------------|-----------------|------------------|
| Carbon Steel | Nickel | Plastics | Ceramics |
| Low Alloy Steels | Monel | Thermo-Plastics | Graphite |
| Stainless Steels | Brasses | Thermo-Setting | Glass |

Most commonly used materials in refineries are

- **Carbon Steel**
- This is the most common and cheapest material used in process plants. Carbon steels are used in most general refinery applications. It is routinely used for most organic chemicals and neutral or basic aqueous solutions at moderate temperatures. Carbon steels are extensively used in temperature range of (-) 29 deg cent to 427 deg cent... Low Carbon steel (LTCS) can be used to a low temperature of (- 46) deg cent...
- **Alloy Steels**
- Low Alloy Steels contain one or more alloying elements to improve mechanical or corrosion resisting properties of carbon steel. Nickel increases toughness and improves low temperature properties & corrosion resistance. Chromium and silicon improve hardness, abrasion resistance, corrosion resistance and resistance to oxidation. Molybdenum provides strength at elevated temperatures. Some of the low alloy steels are listed below.

- **Stainless Steels**

- They are heat & corrosion resistant, noncontaminating and easily fabricated into complex shapes. There are three groups of Stainless steels, viz, Martensitic, Ferritic & Austenitic.
- Various codes, symbols in piping design are:
 - ASME - American society of mechanical engg.
 - API - American petroleum institute.
 - ANSI - American National Standards institute.

ASTM NUMBER	TYPE	MATERIAL
A-53	Gr. A,B	CARBON STEEL
A-106	Gr. A,B	CARBON STEEL
A-333	Gr. 1	CARBON STEEL
A-335	P1	CARBON MOLY
A-335	P11	CARBON MOLY
A-335	P5	CARBON MOLY
A-335	P9	CARBON MOLY
A-312	304	STAINLESS
A-312	316	STAINLESS
A-312	321	STAINLESS
A-312	347	STAINLESS
A-333	Gr. 3	NICKEL

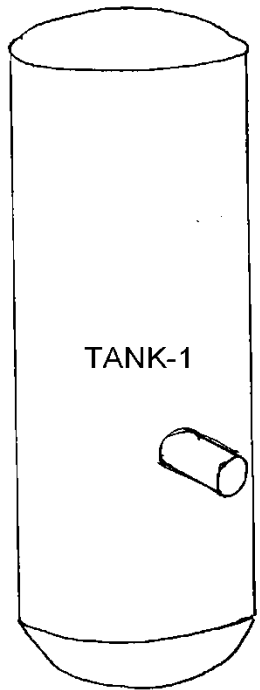
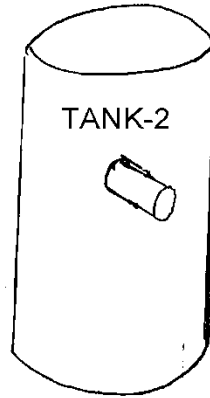
PREPARATION OF **STANDARD PMS/VMS**

- PMS is a Bible for a Piping Engineer. It consists all about material details, dimension details, type of ends, schedules/thicknesses, branch offs, NDT requirements, various codes/standards being followed etc for all Piping items. Main Piping items detailed out in PMS are listed below:
- Pipes
- Fitting
- Flanges
- Misc items (Steam traps/Strainers) etc
- Bolts
- Gaskets
- Valves

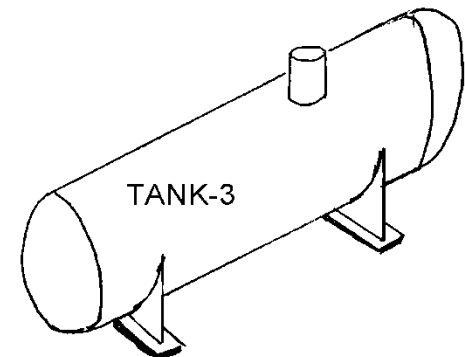
In any plant various fluids flow through pipes from one end to other.

We have to transfer the content of Tank no. 1 to the other two tanks.

We will need to connect pipes to transfer the fluids from Tank-1 to Tank-2 and Tank-3



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31st Aug. 2002*



To solve these problems we need the pipe components, which are called

PIPE FITTINGS

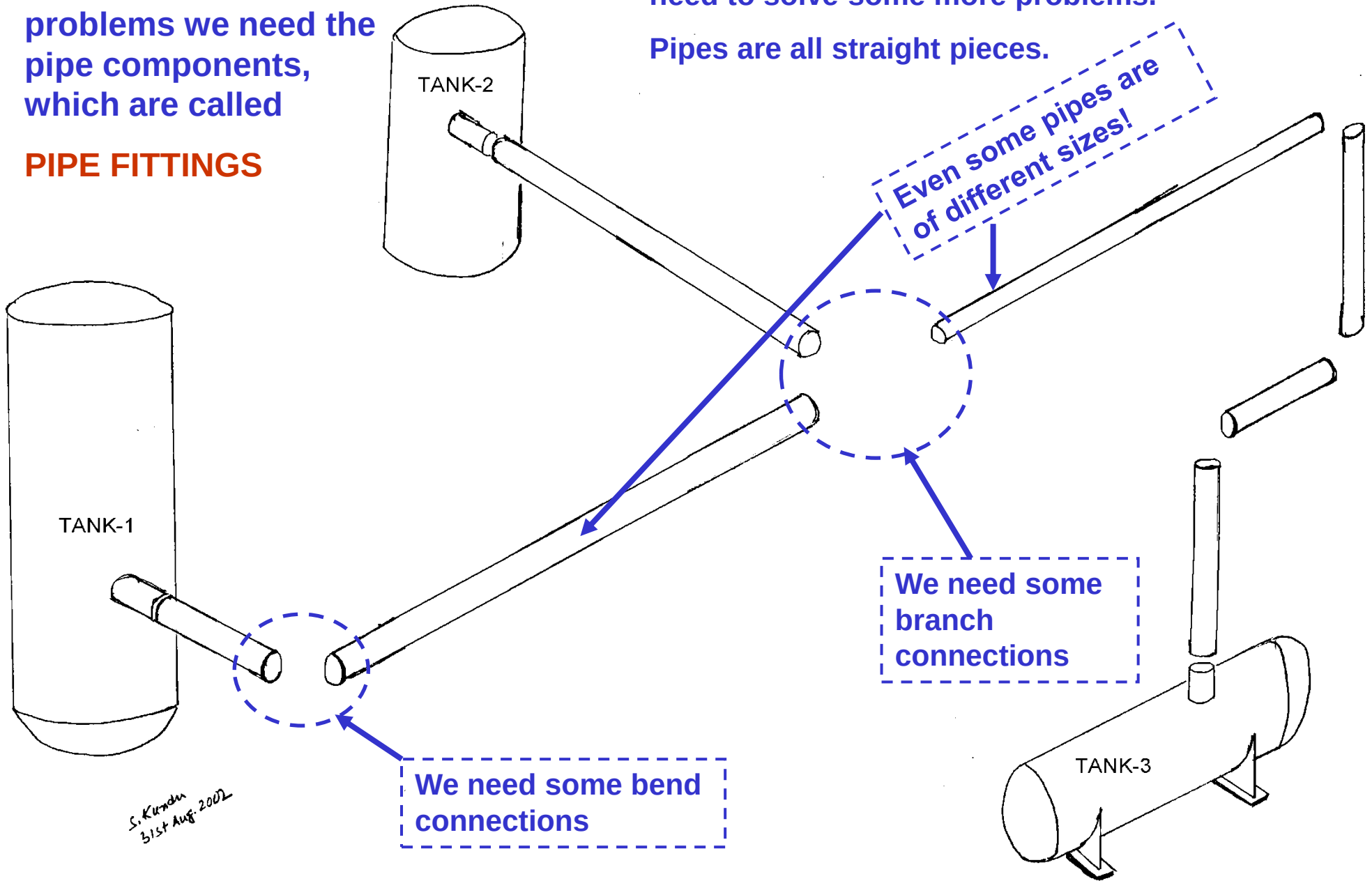
We have just brought the pipes, now we need to solve some more problems.

Pipes are all straight pieces.

Even some pipes are of different sizes!

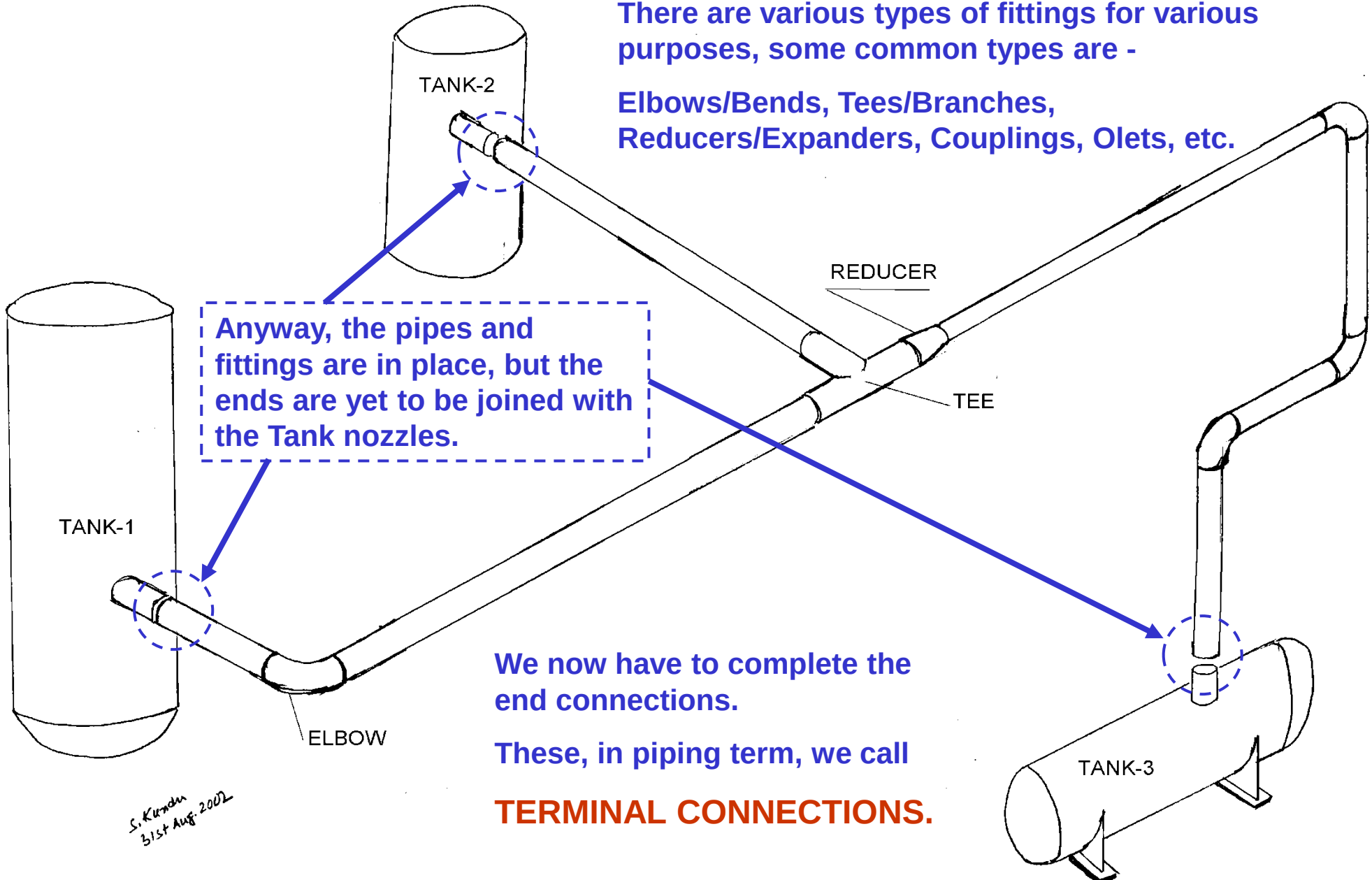
We need some branch connections

We need some bend connections



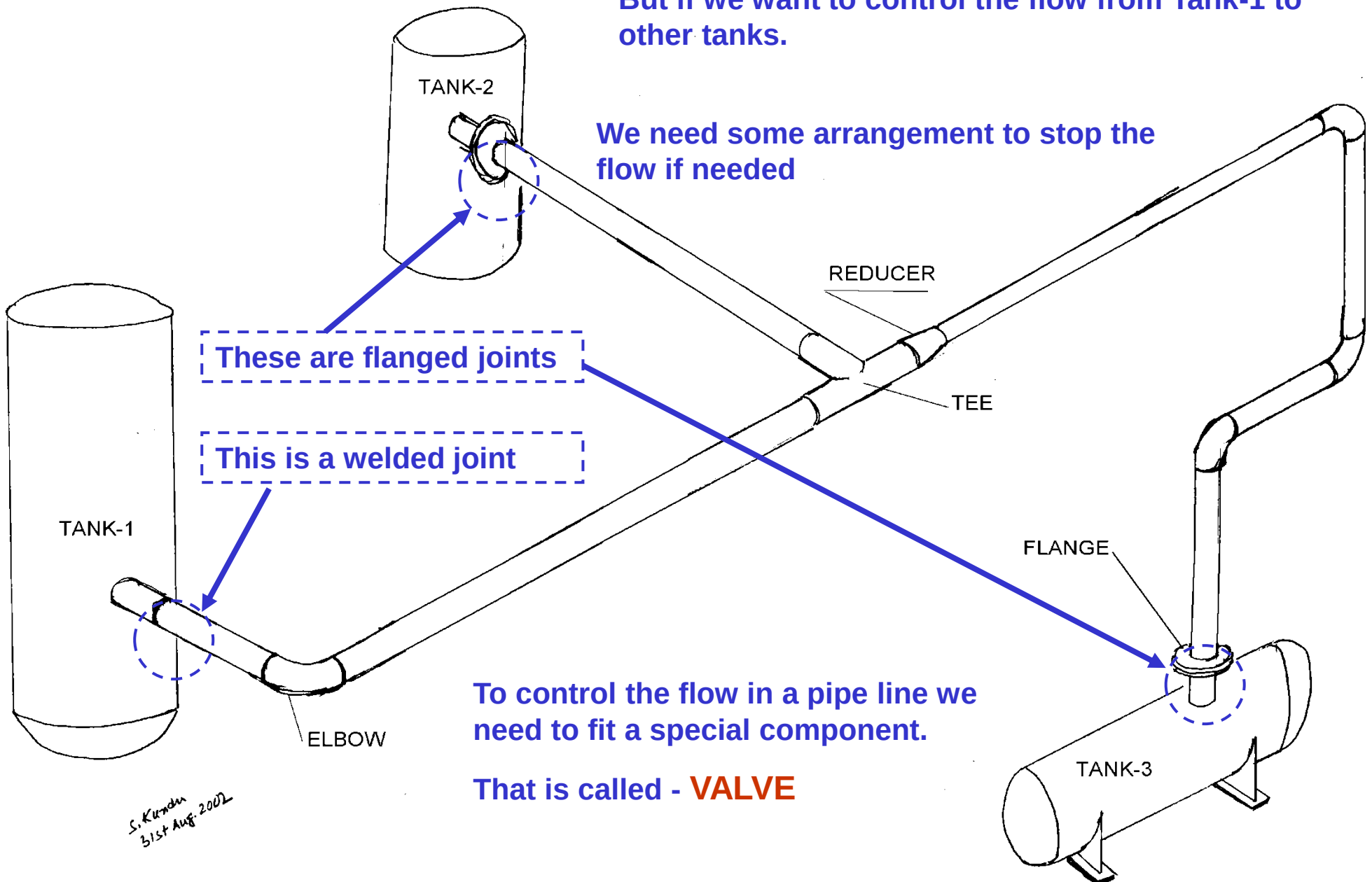
There are various types of fittings for various purposes, some common types are -

Elbows/Bends, Tees/Branches, Reducers/Expanders, Couplings, Olets, etc.



But if we want to control the flow from Tank-1 to other tanks.

We need some arrangement to stop the flow if needed



These are flanged joints

This is a welded joint

REDUCER

TEE

FLANGE

ELBOW

To control the flow in a pipe line we need to fit a special component.

That is called - **VALVE**

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FLANGES

- Flanges provide a bolted, separable joint in piping. The most of valves have flanged ends and must have a companion or matching flange attached. A gasket is then inserted between them, and the bolts are tightened to form a flanged joint.

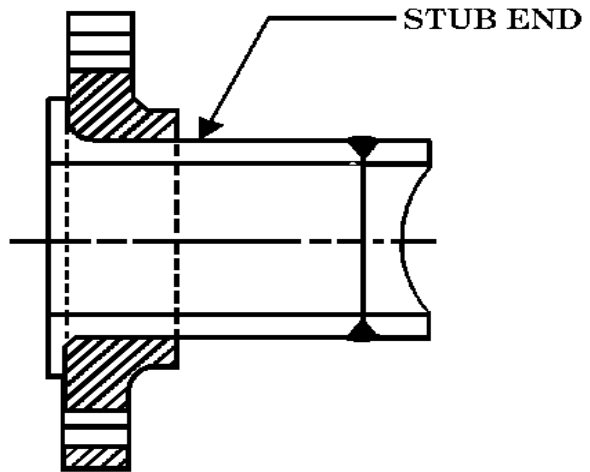
When to use Flanges?

- Where there is a clear need for removal of valves or equipment, for access of maintenance, or for blinding.
- Because all flanged connections are potential leak source, their use should be kept to the minimum needed for safe and reasonably convenient operation and maintenance.

TYPES OF FLANGES

- Weld Neck (WN):The welding neck flanges are attached by butt-welding to the pipes.
- Socket Weld (SW):The socket weld flanges are welded only on one side and are not recommended for severe services. These are used for small-bore lines only.
- Slip-on (SO):The slips on flanges are attached by welding inside as well as outside.
- Lap-Joint (LJ):The lap joint flanges are used with the stub ends when piping is of a costly material.

LAP-JOINT FLANGE (with Stub-end)



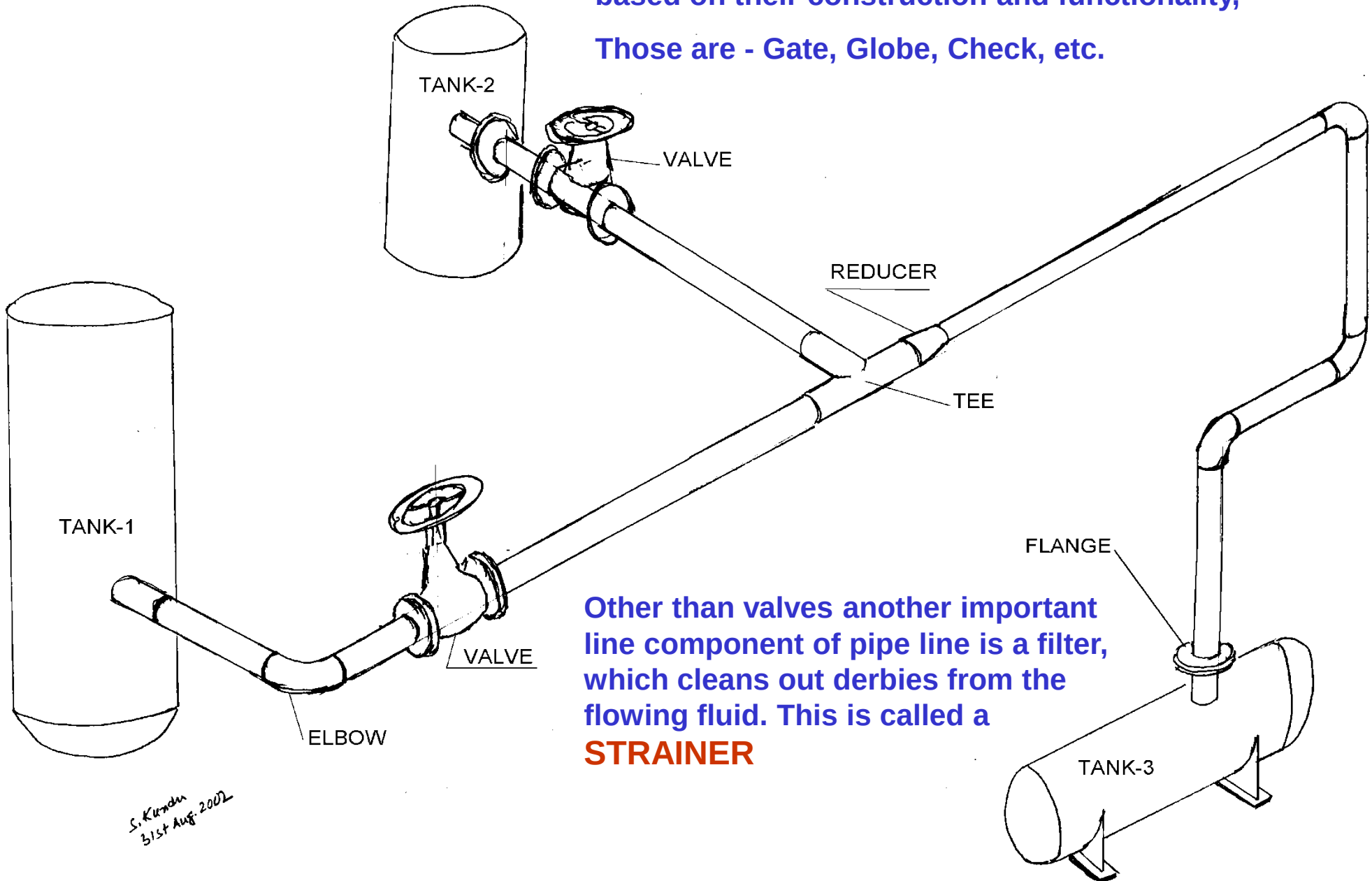
MATERIAL:

- Flanges are made of carbon steel forging having a highly refined grain structure and generally excellent physical properties well in excess of recognized minimum requirements. In addition to this, flanges in 300 pound and higher pressure classes can be made of Chrome-Molybdenum Forged steel (ASTM A182 GRADE F5A).

BOLTS & GASKETS

- Choice of bolting material is governed by service fluid and its temperature.
- The most commonly used bolts for flanges in refinery piping are the ASTM A193 Gr.B7 Stud bolts which fall into the high strength group. The temperature range is from -29°C to 454°C .
- A gasket is a thin circular disc, made up of soft compressive material. The most of valves have flanged ends and must have a companion or matching flange attached. A gasket is then inserted between them, and the bolts are tightened to form a flanged joint.

There are many types of valves, categorized based on their construction and functionality,
Those are - Gate, Globe, Check, etc.

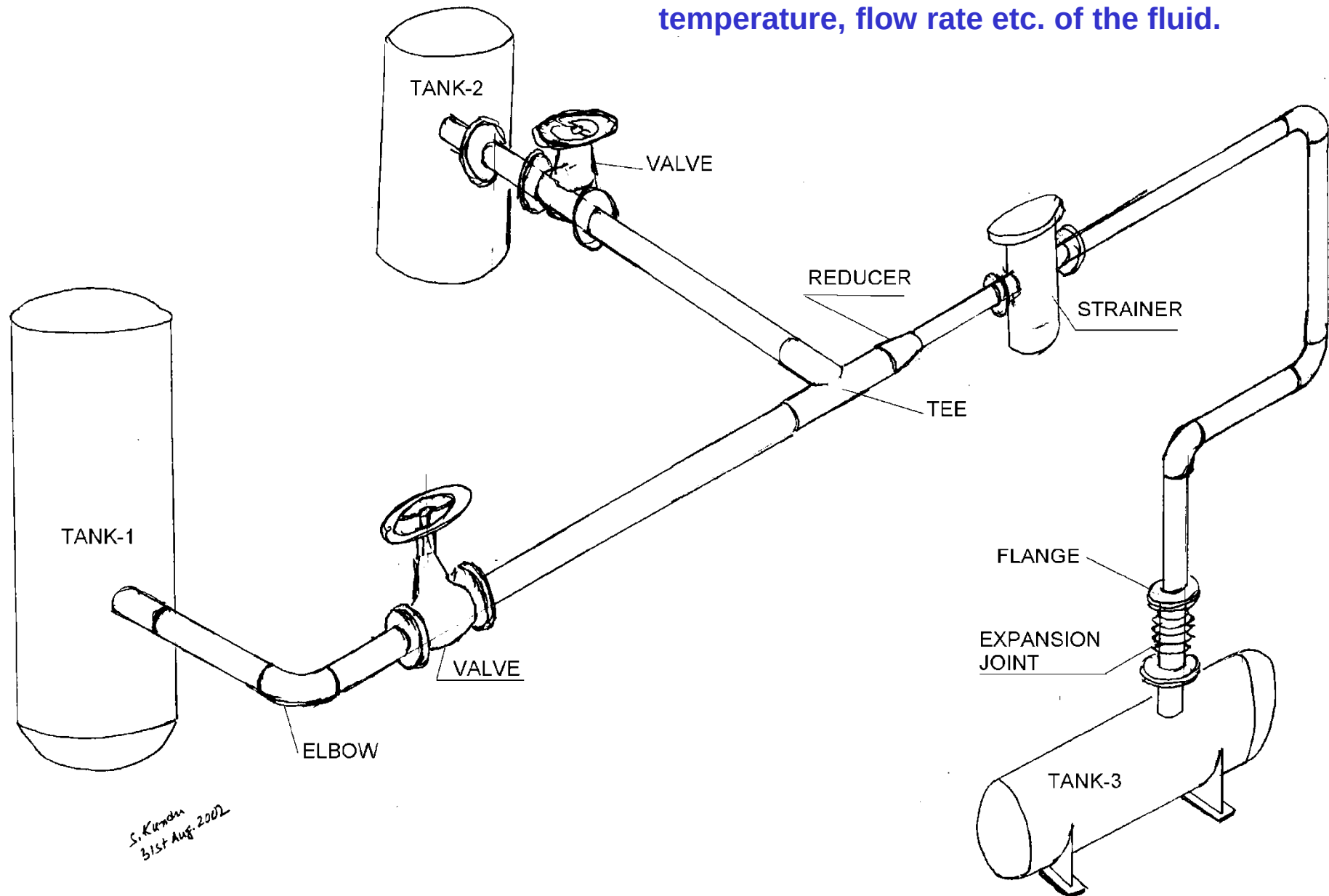


Other than valves another important line component of pipe line is a filter, which cleans out derbies from the flowing fluid. This is called a **STRAINER**

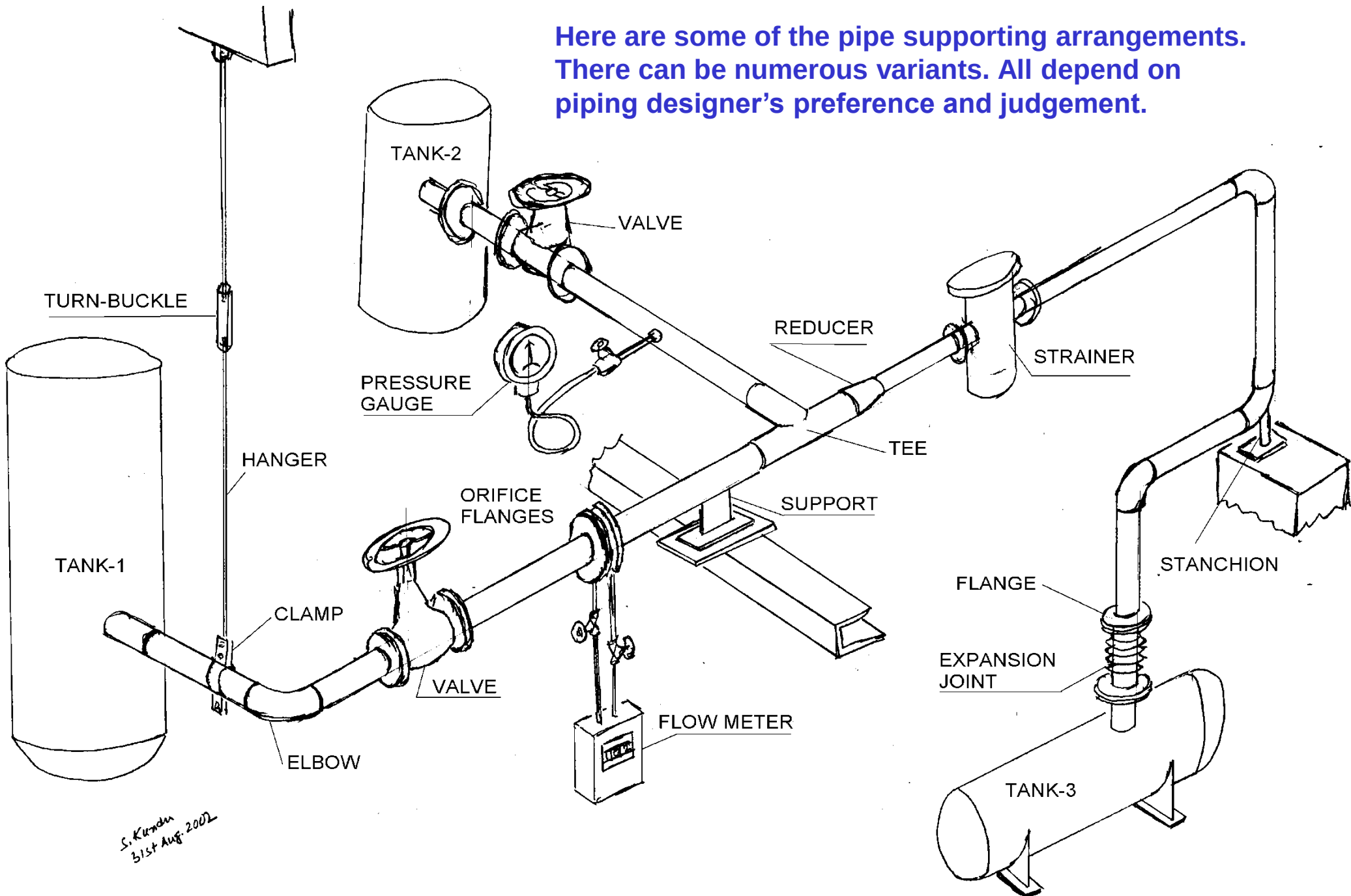
VALVES

- Valves stop or open and regulate flow. Some of the basic valve types are gate, globe, check, Ball, Plug, etc.
- **GATE VALVE:** It is usually manually operated and is designed for open or shut operation. Flow can enter either end of the gate body.
- **GLOBE VALVE:** is for throttling. Good examples of globe valves are the faucets on washbasin which throttle or adjust the flow to suit a person's needs. Flow must enter the valve and flow up, against the seat, and change the direction again to the outlet.
- **CHECK VALVE:** “checks” flow. It lets flow go one way and will not let it reverse. When you have a check valve in a line, you have made a one-way street. The flow can go one way.

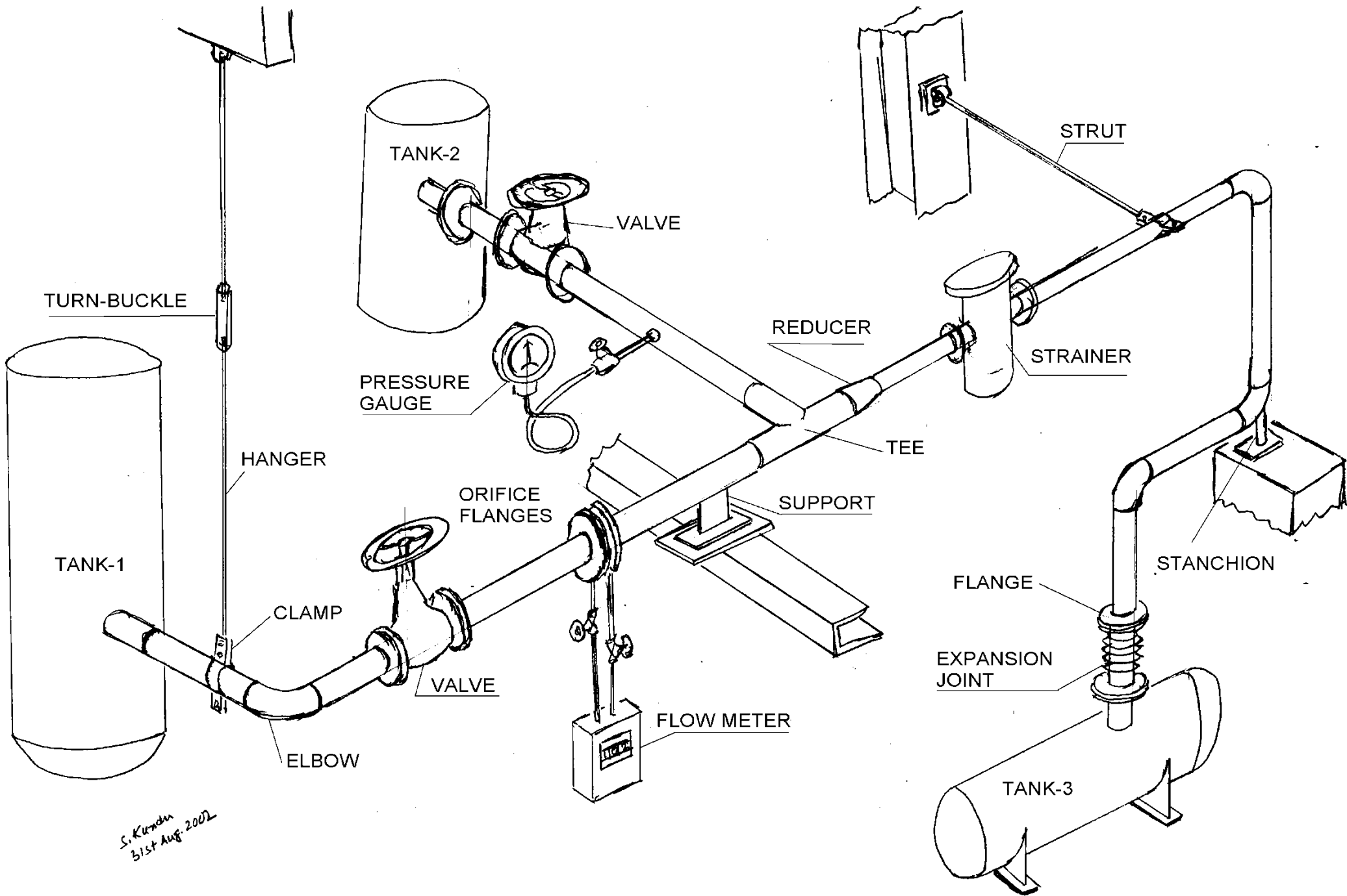
When some fluid is flowing in a pipe we may also like know the parameters like, pressure, temperature, flow rate etc. of the fluid.

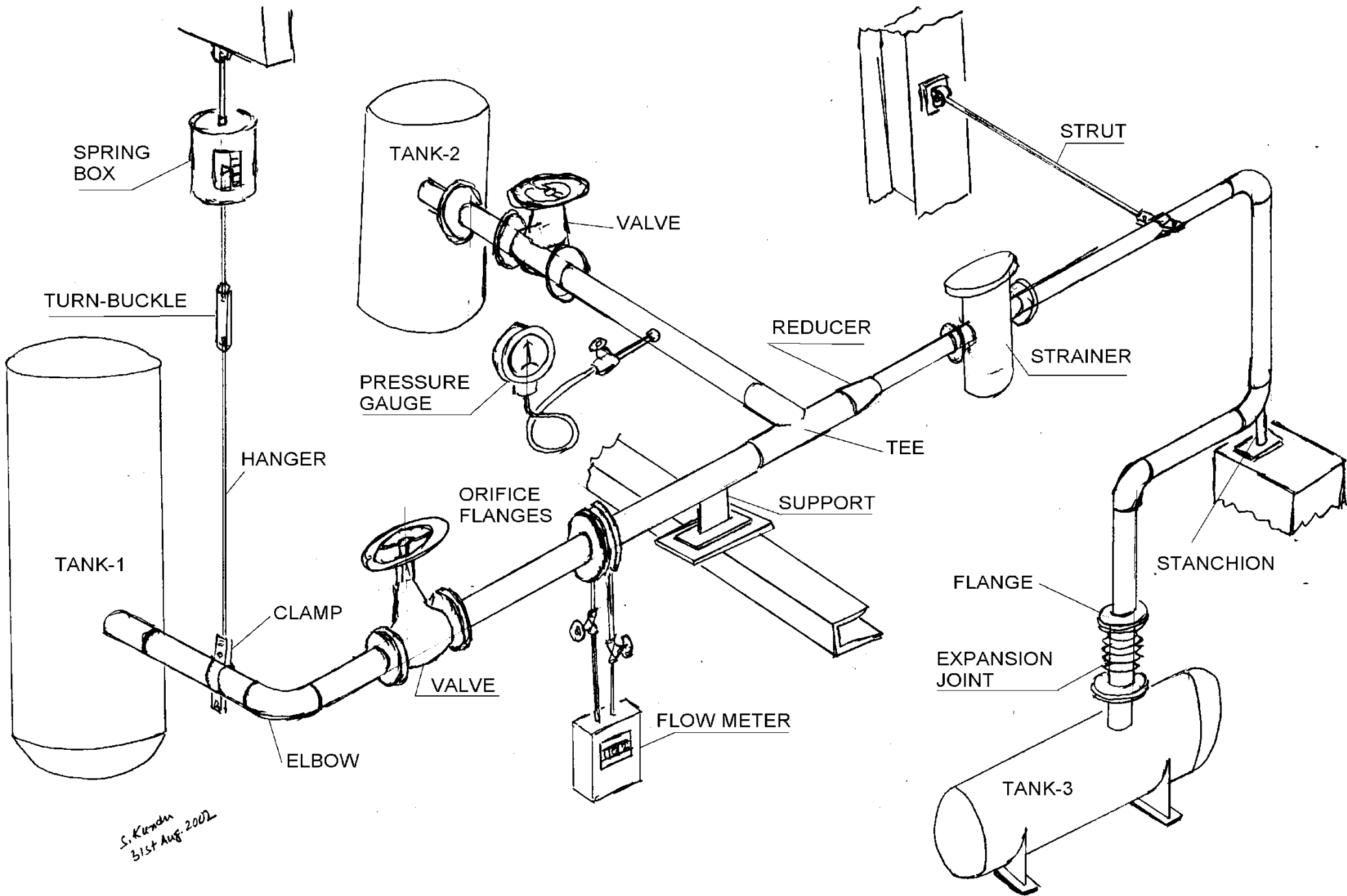


Here are some of the pipe supporting arrangements.
There can be numerous variants. All depend on
piping designer's preference and judgement.



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31st Aug-2002





PIPING FLEXIBILITY

All piping must be designed for thermal expansion under start up, operating and shut down conditions without over stressing the piping, valves or equipments. Adequate flexibility for the steam out conditions at temp of 120deg.c provisions for expansion or contraction shall normally be made with bends, off-sets.

- **DESIGN CONDITIONS:**
- Operating conditions: - normal design conditions of pressure & temperature are expected to co-exist. These usual operations include all manipulations & control functions such as throttling, blowing, and bypassing.
- Temporary conditions: - these do not include more severe temporary conditions such as those incidentals to start up, steam out or abnormal.

PIPING LAYOUT

- Detailed equipment layout including key plan.
- Preparation of piping studies.
- Fixing the orientation.
- Piping supports.
- Line isometric & vessel trims.
- Model preparation& field engg.
- **BASIS OF EQUIPMENT LAYOUT:**
 - Equipment layout shall be developed based on the following data:
 - P&IDs (Piping & instrumentation diagram)
 - Overall plot plan
 - Wind direction
 - Equipment data sheets
 - Indicative equipment layout from process licensor.

→ Pipe sizes are selected, pipe material and pipe wall thickness are selected.

→ Types of Valves are planned

→ Also the types of instruments required are planned

We represent the whole thing in a drawing which is called Piping and Instrumentation Drawing, in short P&ID. For P&ID generation we use **SPP&ID** software.

All the pipe lines system information in the drawing has to enter for P&ID .

So the SPP&ID drawing is an Intelligent drawing which under it's surface carries all the information about a pipe like, Pipe size, Flowing Fluid, etc.

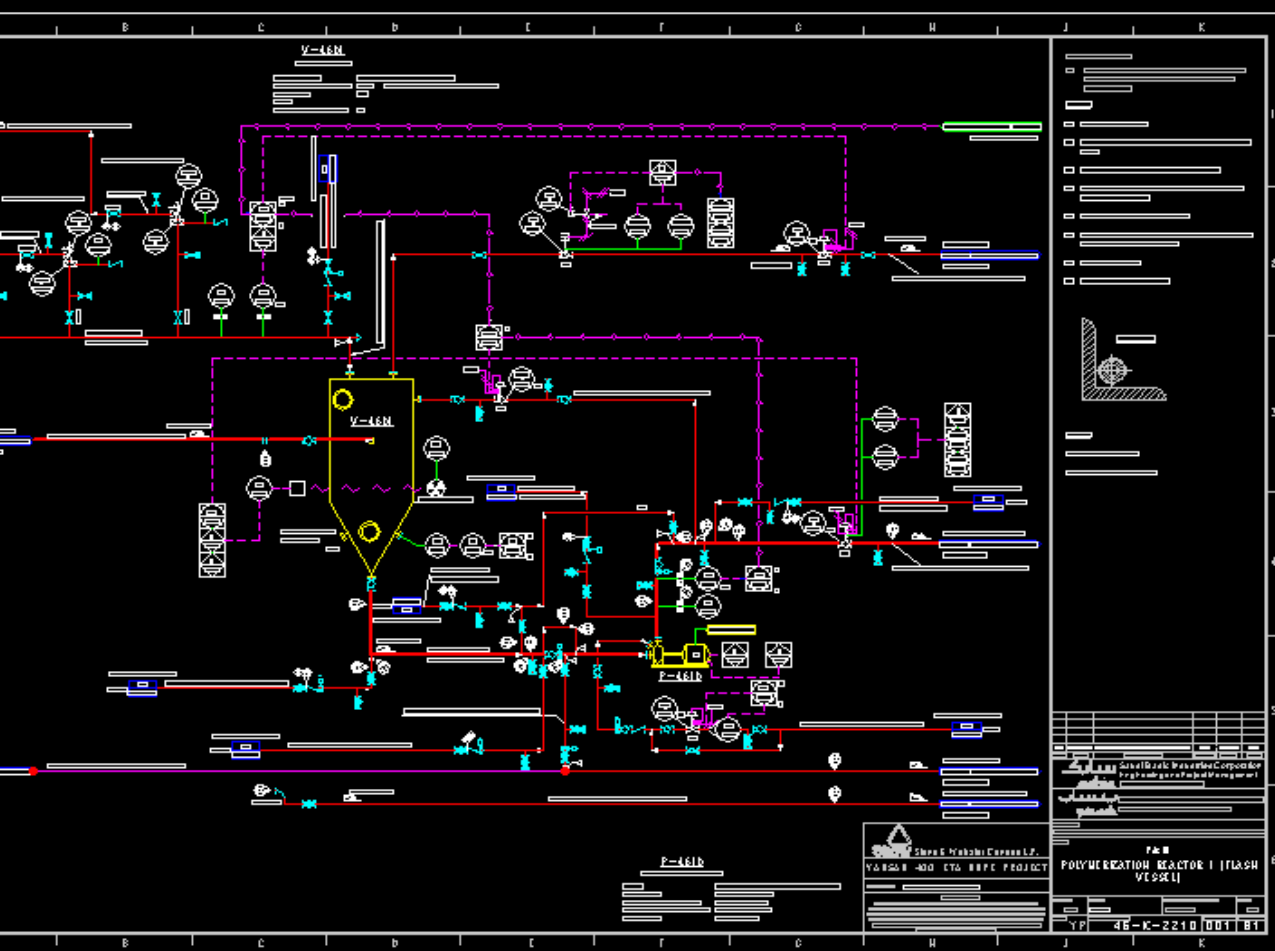
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Rout...

This is screen picture of P&ID made by SPP&ID
If we click on any line it will show the Data embedded.



Catalog Explorer

- [-] Fittings
 - Gaps
 - Labels - Piping Component
 - Labels - Piping Segments
 - Macrocomponents
 - Piping OPC's
 - Relief Devices
- [-] Routing
 - Process Lines
 - Utility Lines
 - Segment Breaks

- Process Lines
- Nozzles
- Labels - Piping Components
- Labels - Piping Segments
- Diameter Change
- Segment Breaks
- 2 Way Common
- Signal Line
- Labels - General Instrument
- D C S
- P L C
- Single Function
- Flanges and Unions
- Graphics
- Spectacle Blanks and Spacers
- Functions
- Labels
- Labels - Equipment
- Descriptions

Flow Direction

- Heat Tracing Media
- Insulation Req
- JP Heat Tracing Media
- Line Number

Properties

Pipe Run - 461110-PES



Identification	
Catalog Name	
Contract Package	
Description	
ERP Asset No	
Fluid Code	PES
Fluid System	Process
HydroTest Packa	
Inventory Tag	
Item Tag	461110-PES
Loop Tag	
Name	
Package Item Ta	
Part Number	
Pipe Run Class	Piping
Pipe Run Type	Piping, seco
Plant Group Name	46
Plant Group Type	Unit
Plant Item Type	Pipe Run
Requisition No	
SP ID	05BE71773E
Tag Seq No	1110
Tag Suffix	
Test Sys Item Tag	
Physical	
Cleaning Require	
Coating Require	
Code Category H	
Corrosion Allowan	
Estimated Length	
Fabrication Categ	
Flow Direction	
Heat Trace Mediu	
Heat Trace Mediu	
Heat Trace Requ	
Insulation Density	
Insulation Nomina	
Insulation Purpose	IS
Insulation Spec	

INSULATION

Insulation of piping & fitting is required for the following purpose:

- Heat conservation.
- Process stabilization to assist process control.
- Steam tracing.
- Steam jacketing.
- Fire hazard protection to prevent fast boil- off of liquid.

MATERIALS USED FOR INSULATION:

- **HOT INSULATION**

- High quality & good appearance.
- Low chloride content.
- Chemically inert.
- Impervious to hot water & steam.
- Non corrosive to steel & aluminum.

- **COLD INSULATION**

- All materials used for insulation, fixing, sealing, etc. shall be used as under:
- | <u>Operating temp range</u> | <u>Insulation material</u> |
|-----------------------------|----------------------------|
| -195 to +85 deg.c | PUF or Polystyrene |
| -195 to +120 deg.c | PUF |
| -30 to +120 deg.c | PUF or polystyrene |
- Other requirements for insulating materials remain same as for hot insulation.

Pipe Stress Analysis

- ⊕ We need to check and confirm the pipe is not going to fail with these loading.
- ⊕ This process of checking the stress developed in the piping due to various loading is called **Pipe Stress Analysis/Flexibility analysis**.
- ⊕ In the process of Analysis we apply various postulated loading on the pipe and find out the stress resulted from these loading.
- ⊕ Then we check with governing codes if those stresses generated are acceptable or not.
- ⊕ We check support load & movement for various loading condition.
- ⊕ We also check out the terminal point loading generated from pipe to the equipment connected to the pipe. This loading are to be within acceptable limits of the equipment suggested by the vendors.
- ⊕ We also find out the pipe growth due to change in temperature and need to keep the movement of pipe within acceptable limits.
- ⊕ **Pipe Stress Analysis is an Interactive and Iterative process.** Each step is checked
- ⊕ If a check fails we have to go back, modify the layout and restart the analysis.

PIPE STRESS ANALYSIS

Inputs

- ⊕ **Geometric layout of Pipe**
- ⊕ **Pipe supporting configuration**
- ⊕ **Pipe Diameter and Thickness**
- ⊕ **Pressure inside Pipe**
- ⊕ **Cold and Hot temperatures of Pipe**
- ⊕ **Weight of Pipe and insulation**
- ⊕ **Weight of carrying Fluid**
- ⊕ **Pipe material Property (Young's Modulus, Thermal Expansion Coefficient)**

Tools we use

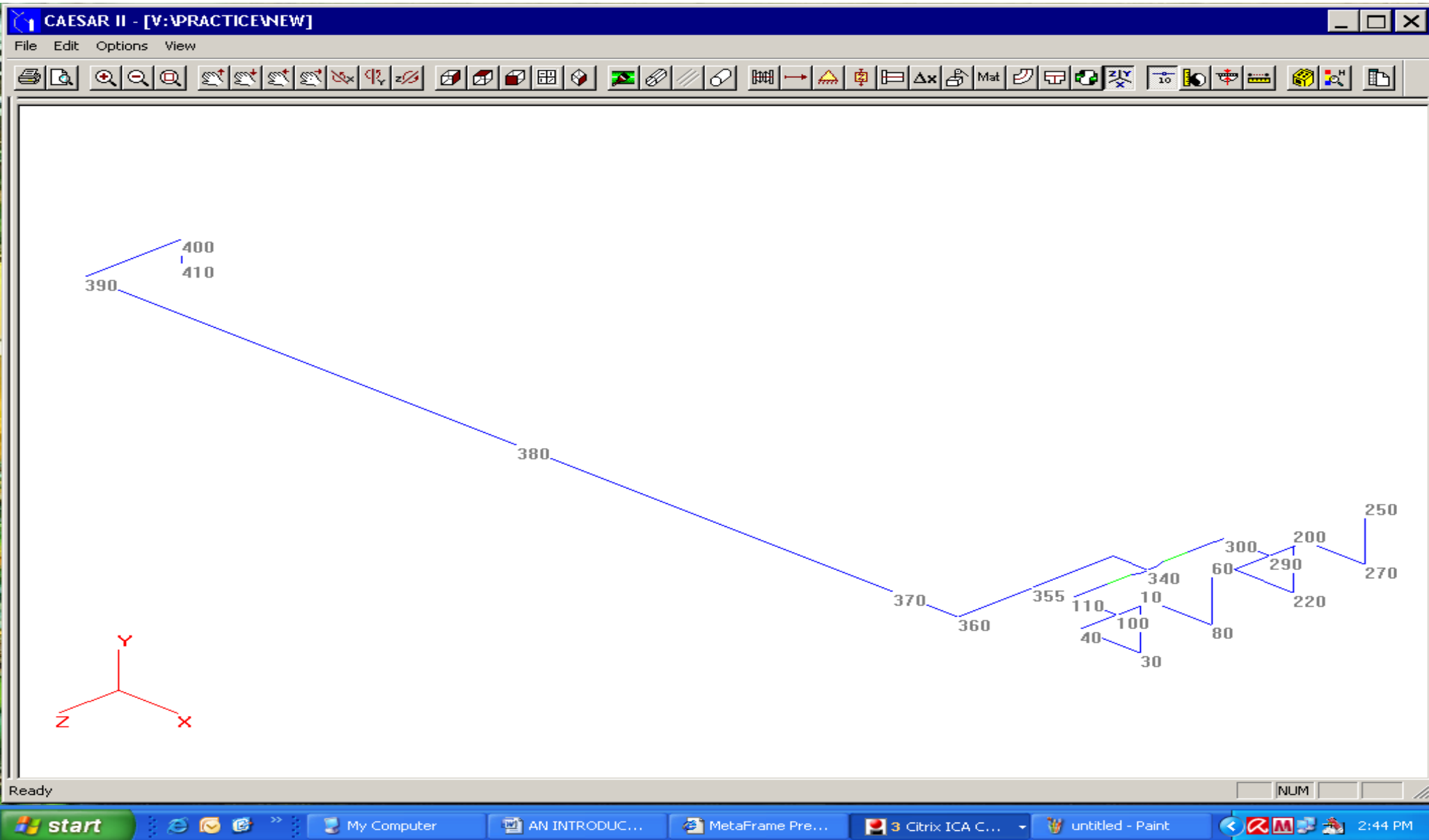
- ⊕ **PIPSYS** - is an integrated pipe stress analysis module of PLADES 2000
- ⊕ **CEASER** - Commercial Piping analysis software

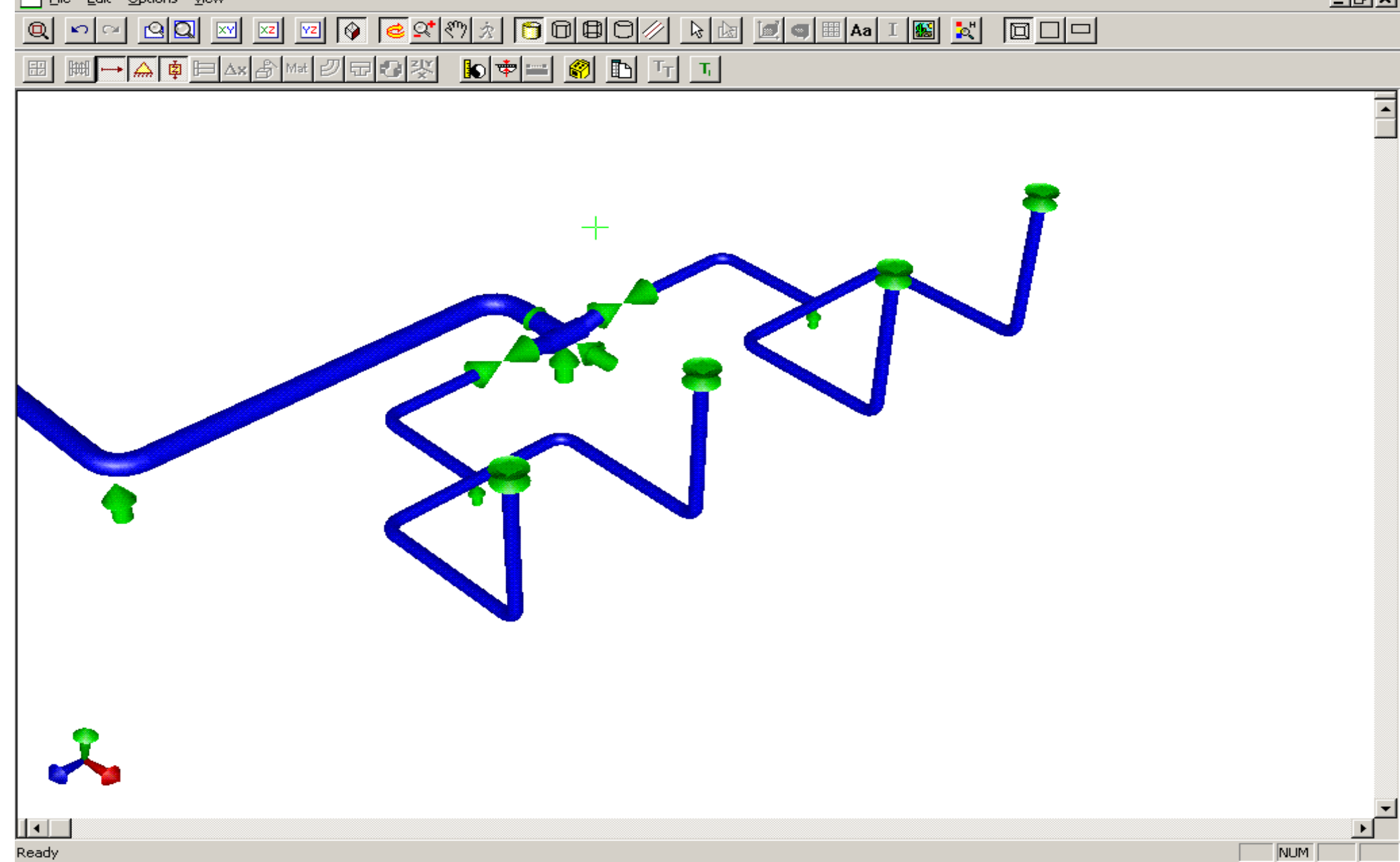
Outputs

- ⊕ **Stress of the pipe at various loading conditions**
- ⊕ **Load at various supports and restrains.**
- ⊕ **Movement of pipe at support locations**
- ⊕ **Pipe terminal point loading.**

Codes and Standards

- ⊕ **In general Power Plant Piping have to comply stipulations of ASME ANSI B31.1**





THANK YOU

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31st Aug 2002