INTRODUCTION TO PIPING ENGINEERING

- **FUNCTION OF PIPING ENGINEERING**
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    - **PIPE FITTINGS CLASSIFICATION**
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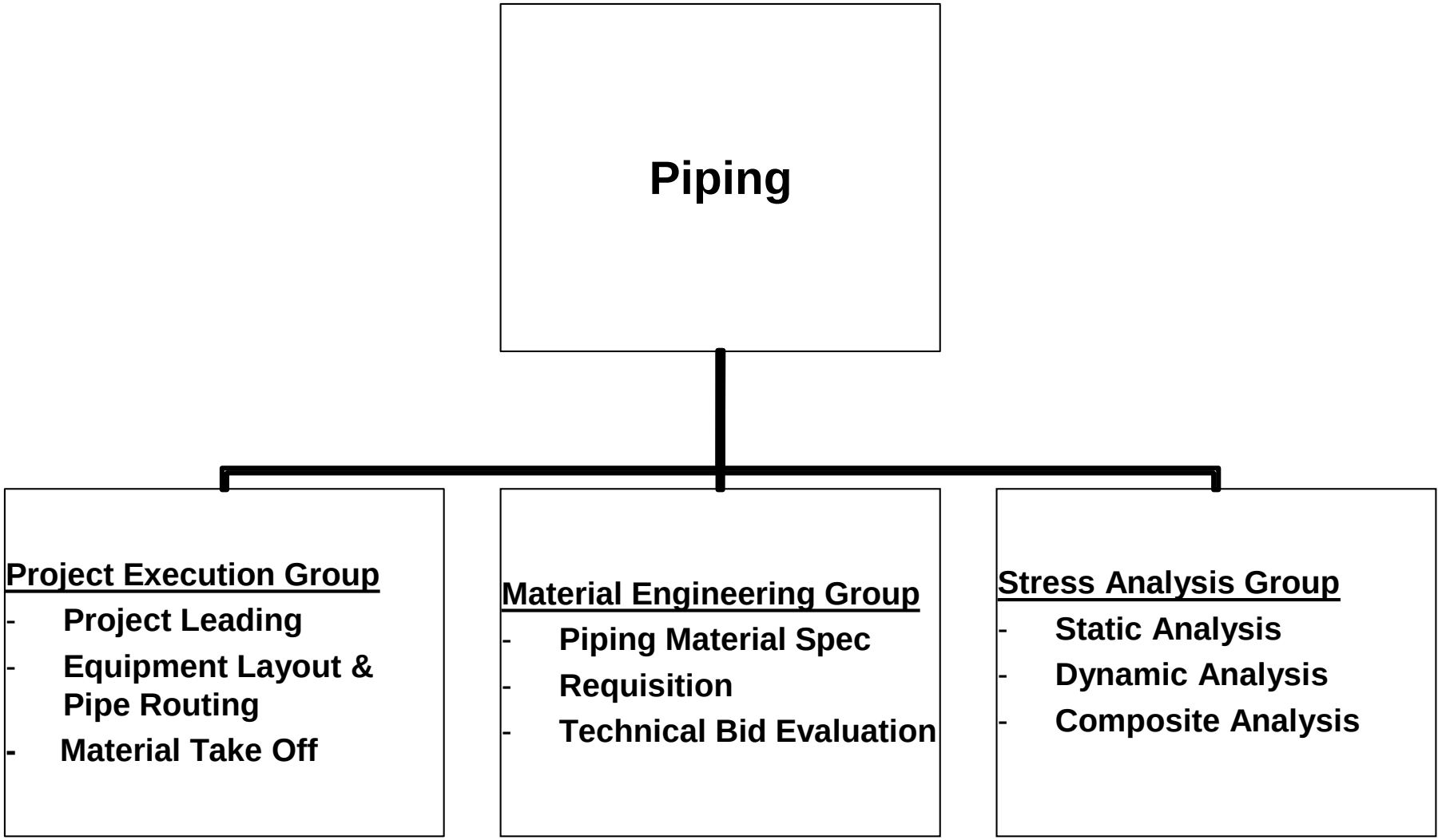
    - **BASIS FOR MATERIALS SELECTION**
    - **MATERIAL SELECTION DIAGRAM**
    - **MATERIAL SELECTION AS A FUNCTION OF TEMPERATURE**


Piping
Project Execution Group
- Project Leading
- Equipment Layout & Pipe Routing
- Material Take Off
Material Engineering Group
- Piping Material Spec
- Requisition
- Technical Bid Evaluation
Stress Analysis Group
- Static Analysis
- Dynamic Analysis
- Composite Analysis

FUNCTION OF PIPING ENGINEERING

THE FUNCTION OF THE PIPING ENGINEERING IS TO APPLY KNOWLEDGE OF FLUID FLOW, STRESS ANALYSIS, MATERIAL PROPERTIES, ENGINEERING JUDGEMENT AND CONVERT THE PROCESS ENGINEER'S SPECIFICATION INTO DRAWINGS AND DATA FROM WHICH MATERIALS CAN BE PURCHASED, FABRICATED AND ASSEMBLED INTO PIPING SYSTEMS WHICH FULFIL THE REQUIREMENT OF THE PROCESS.

THIS MUST BE FULFILLED AT THE MINIMUM DESIGN COST WITHOUT SACRIFICING THE QUALITY AND DESIRED FUNCTION, THE PIPING SYSTEM WILL OPERATE WITHOUT PHYSICAL FAILURE OR EXCESSIVE PRESSURE LOSSES FOR THE ENTIRE SPAN OF DESIGNED PLANT LIFE.

Plant Layout

Plant Layout

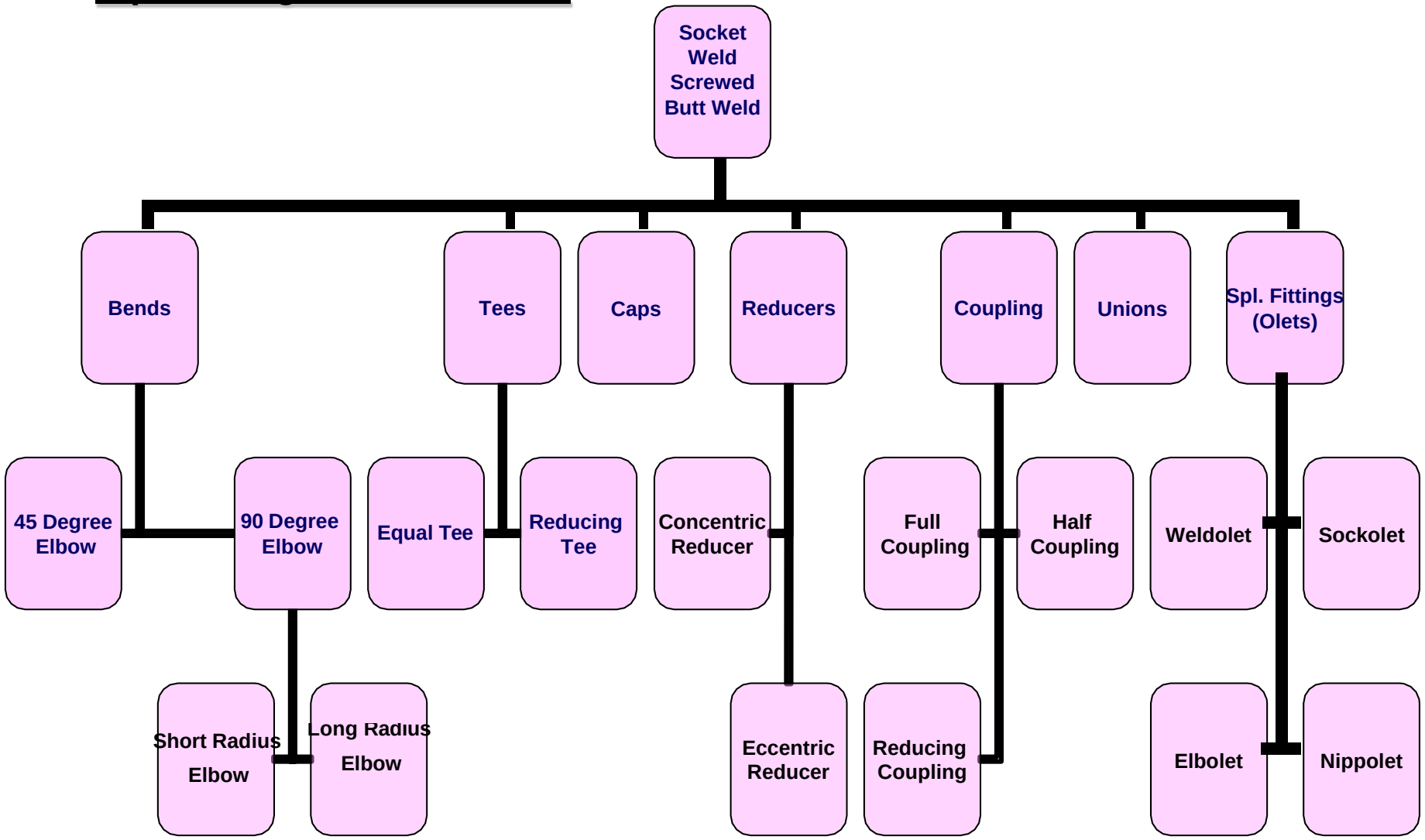
A Process plant, which consist of the various different sections such as raw material storage, intermediate and finished product storage, process units, control rooms, Flare system, Raw material loading and uploading facilities, utilities generation and distribution etc. should be arranged so as to follow the general route of the raw material to process, to Intermediate/Finished product storage, to dispatch.

Generally block concept is prevalent for the plant layout where in the entire plot area is divided into blocks. The size of the blocks depends upon the facilities to be accommodated.

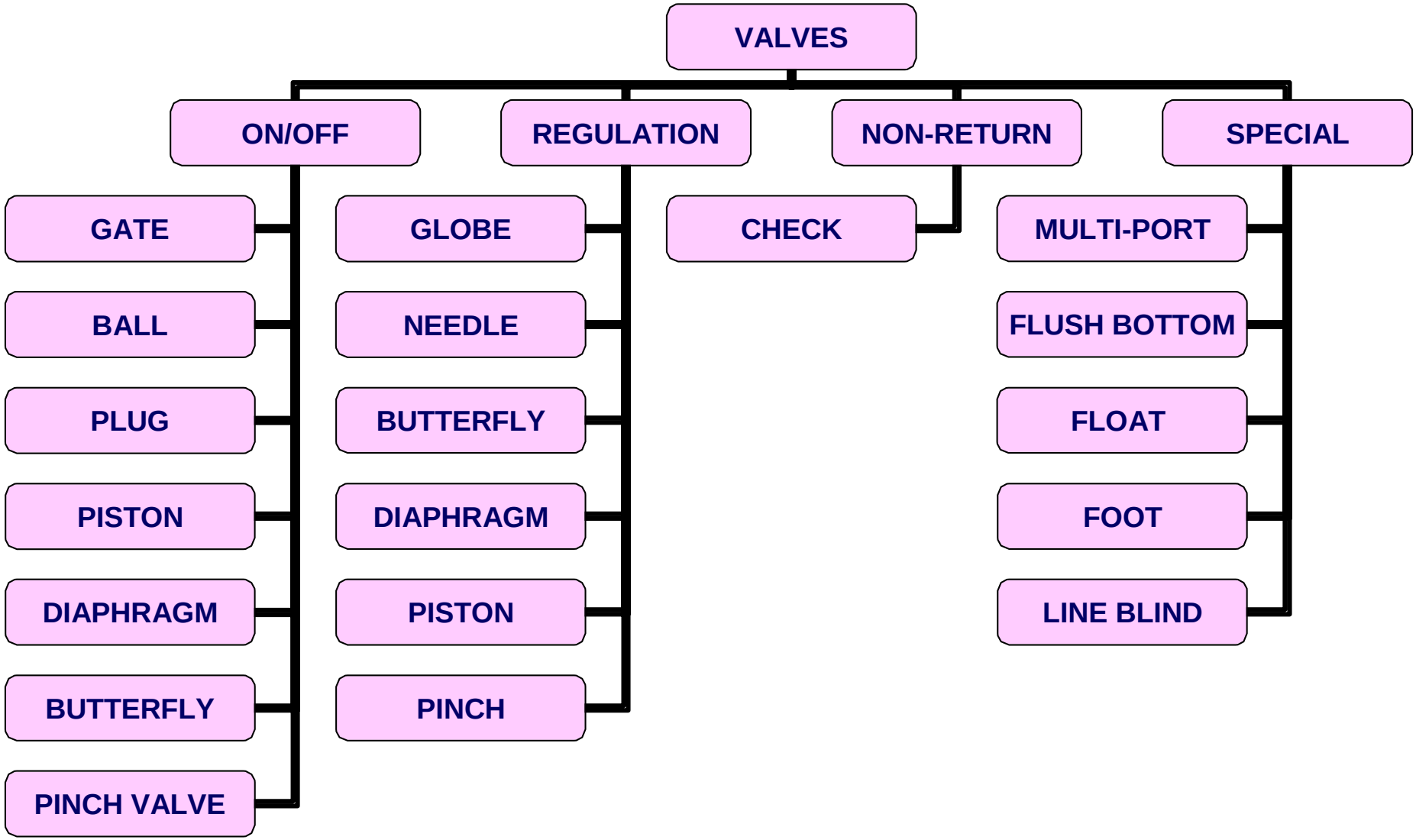
Following points are to be considered while locating the blocks .

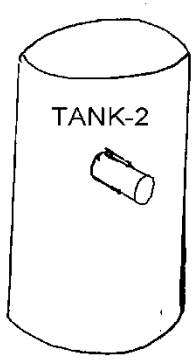
- Process unit block shall be centrally located with straight approach from the main gate.
- The blocks shall be so arranged considering the prevalent wind direction that flammable gases should not be carried by the wind on to source of ignition.
- Utility blocks shall be located adjacent to unit blocks.
- Flare shall be located upwind of process units so that the inflammable gas from plant is not carried towards flare.
- Equipment requiring frequent maintenance shall have easy accessibility.

Pipe Fittings Classification



VALVE CLASSIFICATION BASED ON FUNCTION





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

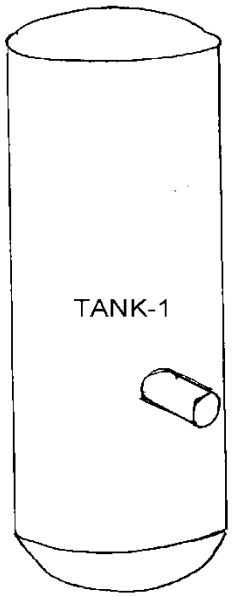
Now let us start with a plant where we see three tanks.

Tank-1, Tank-2 and Tank-3

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

LET US BRING THE PIPES.



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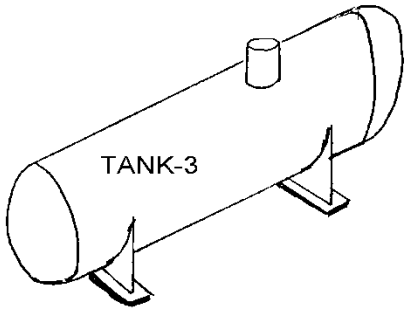
This is the plane white sheet we start with

Let us start drawing a simple piping system

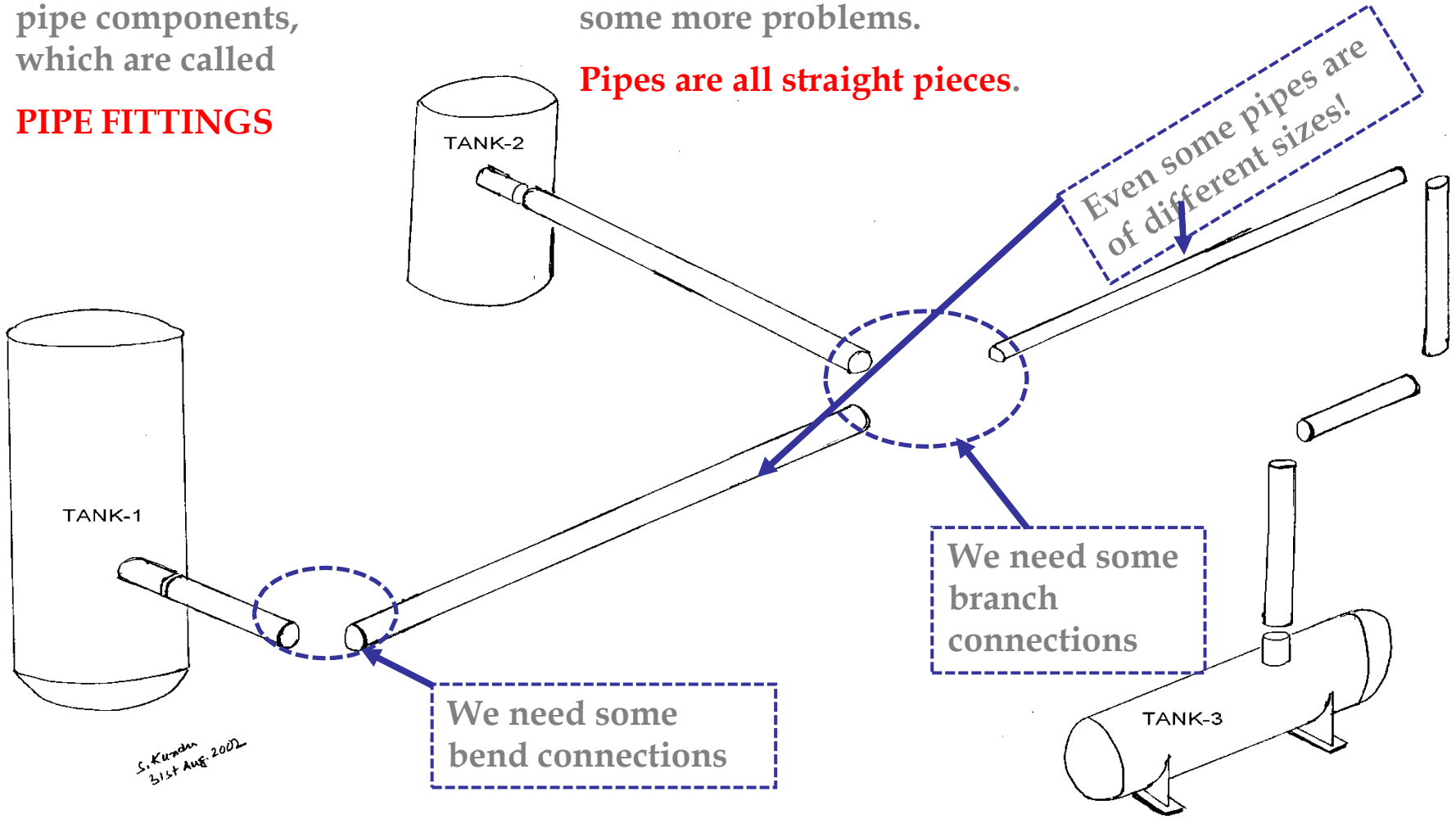


To solve these problems we need the pipe components, which are called

PIPE FITTINGS

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

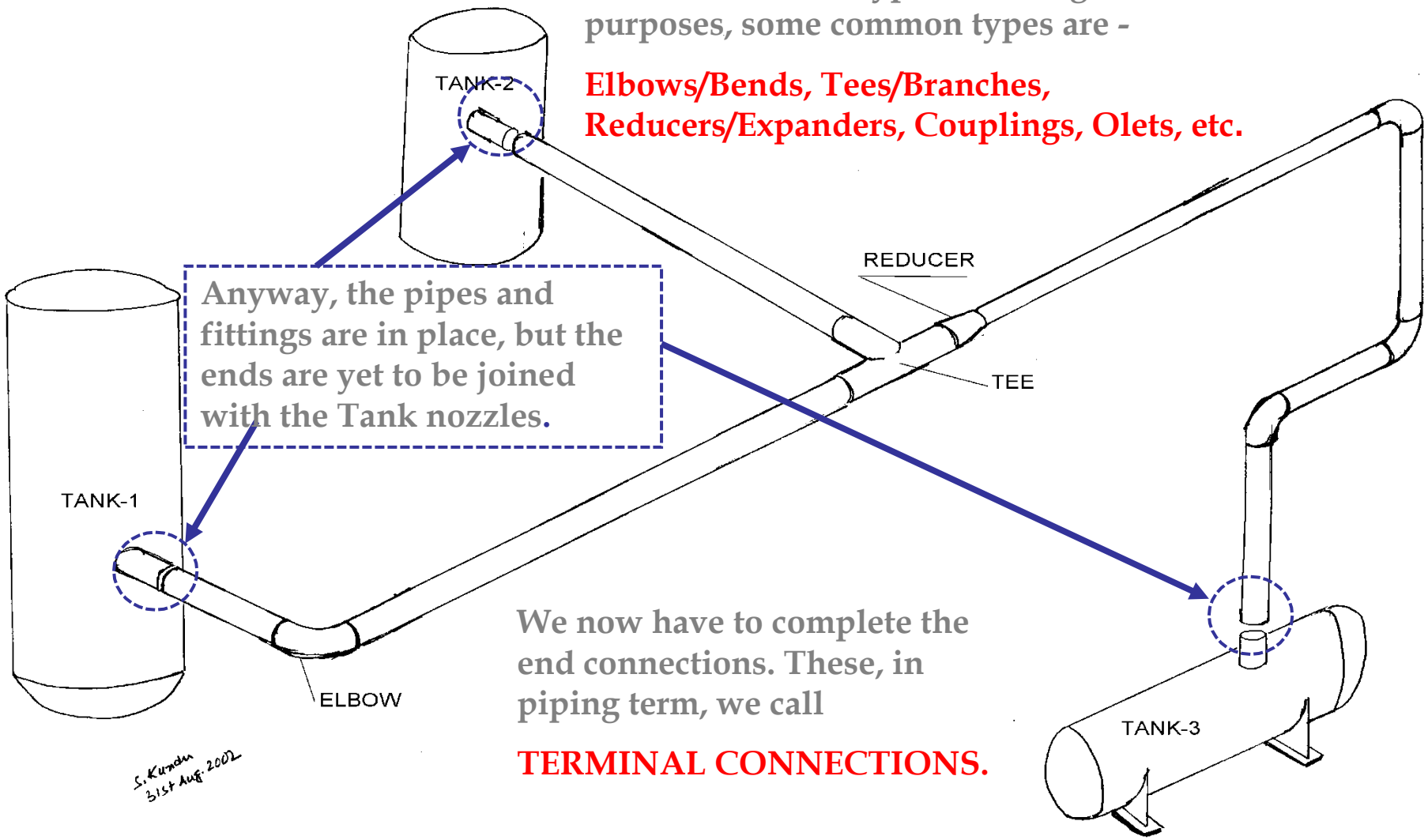
Pipes are all straight pieces.



These are the pipe fittings,

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

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



Anyway, the pipes and fittings are in place, but the ends are yet to be joined with the Tank nozzles.

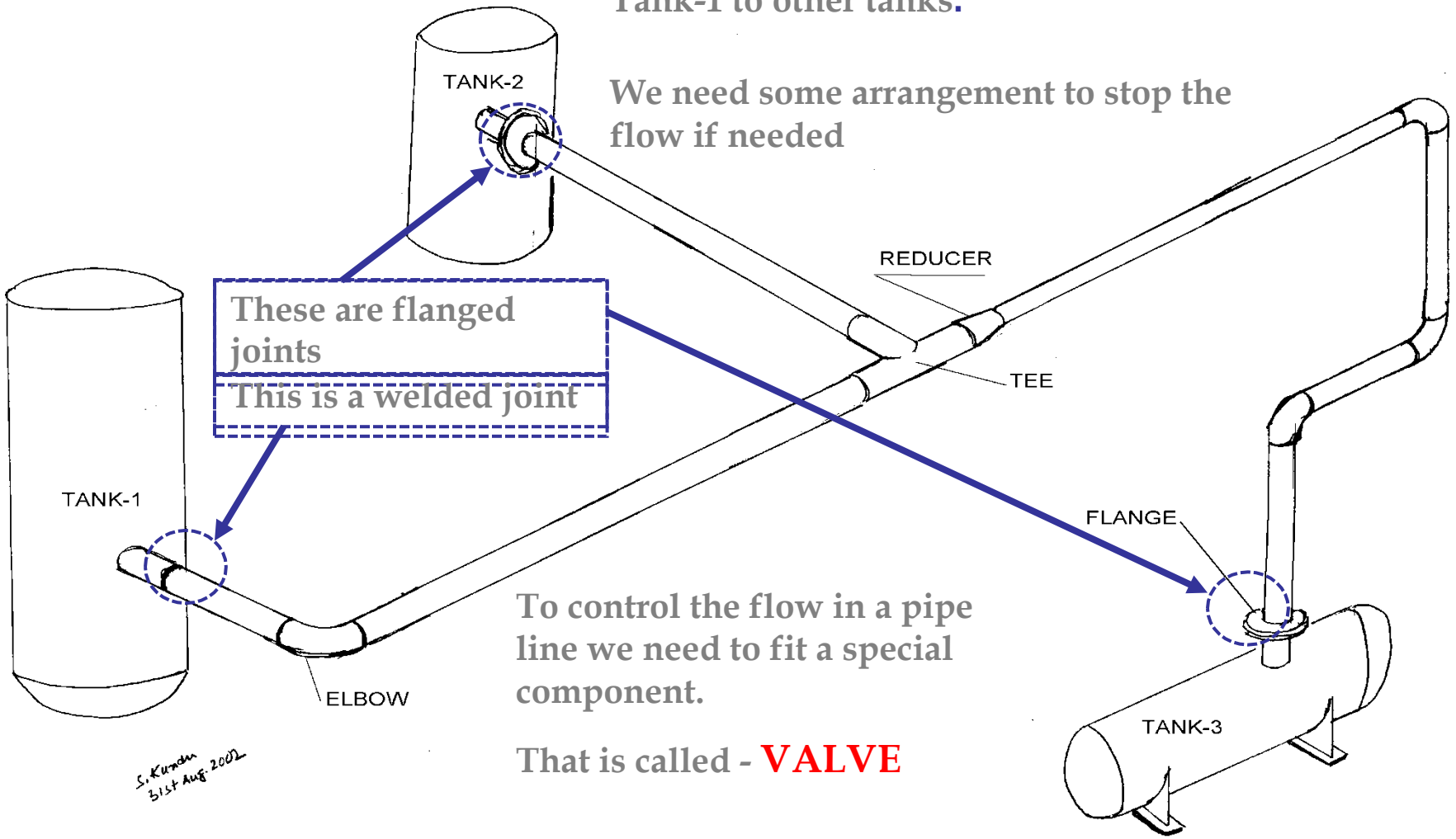
We now have to complete the end connections. These, in piping term, we call

TERMINAL CONNECTIONS.

So far this is a nice arrangement.

But there is no control over the flow from Tank-1 to other tanks.

We need some arrangement to stop the flow if needed

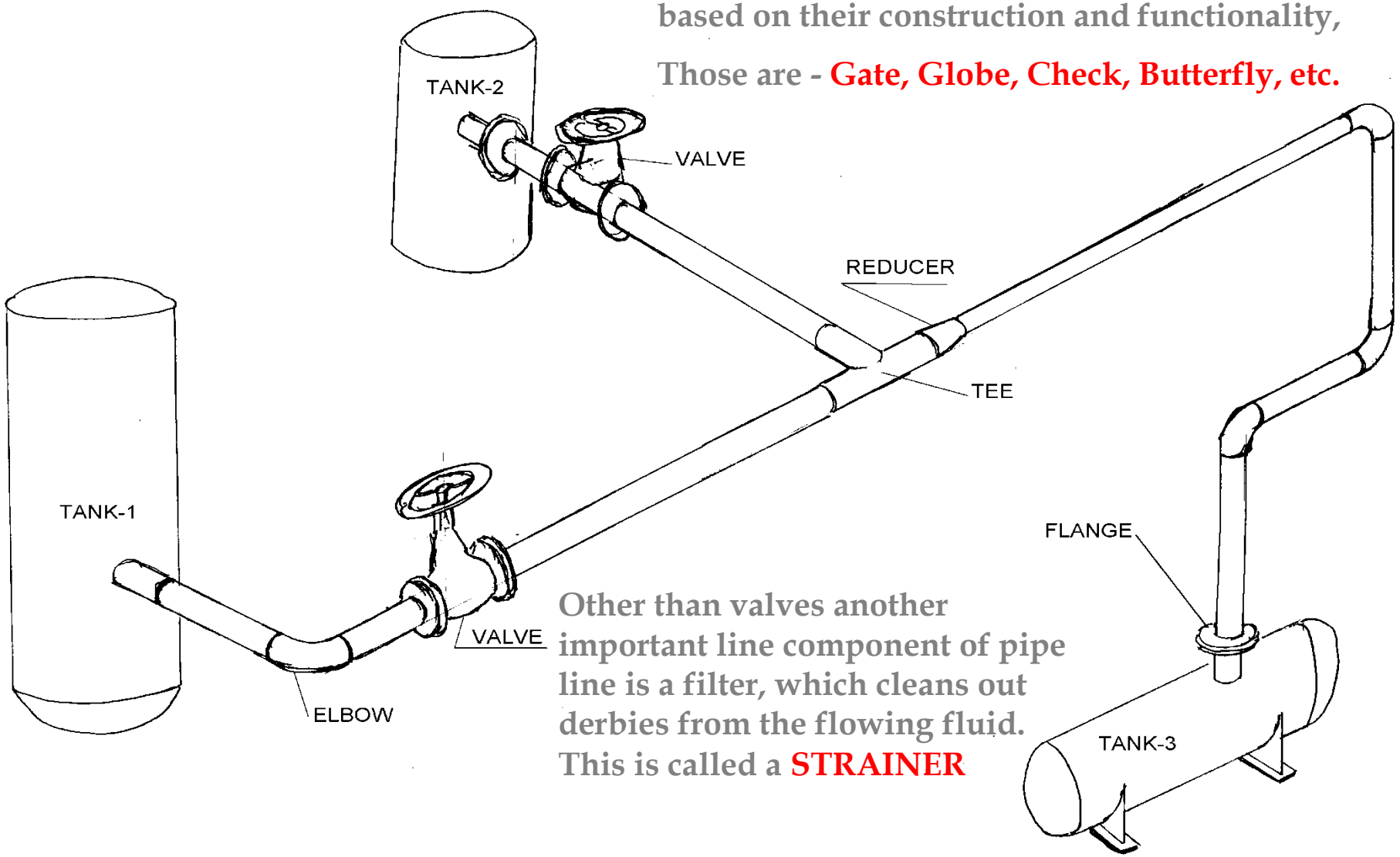


To control the flow in a pipe line we need to fit a special component.

That is called - **VALVE**

There are many types of valves, categorized based on their construction and functionality,

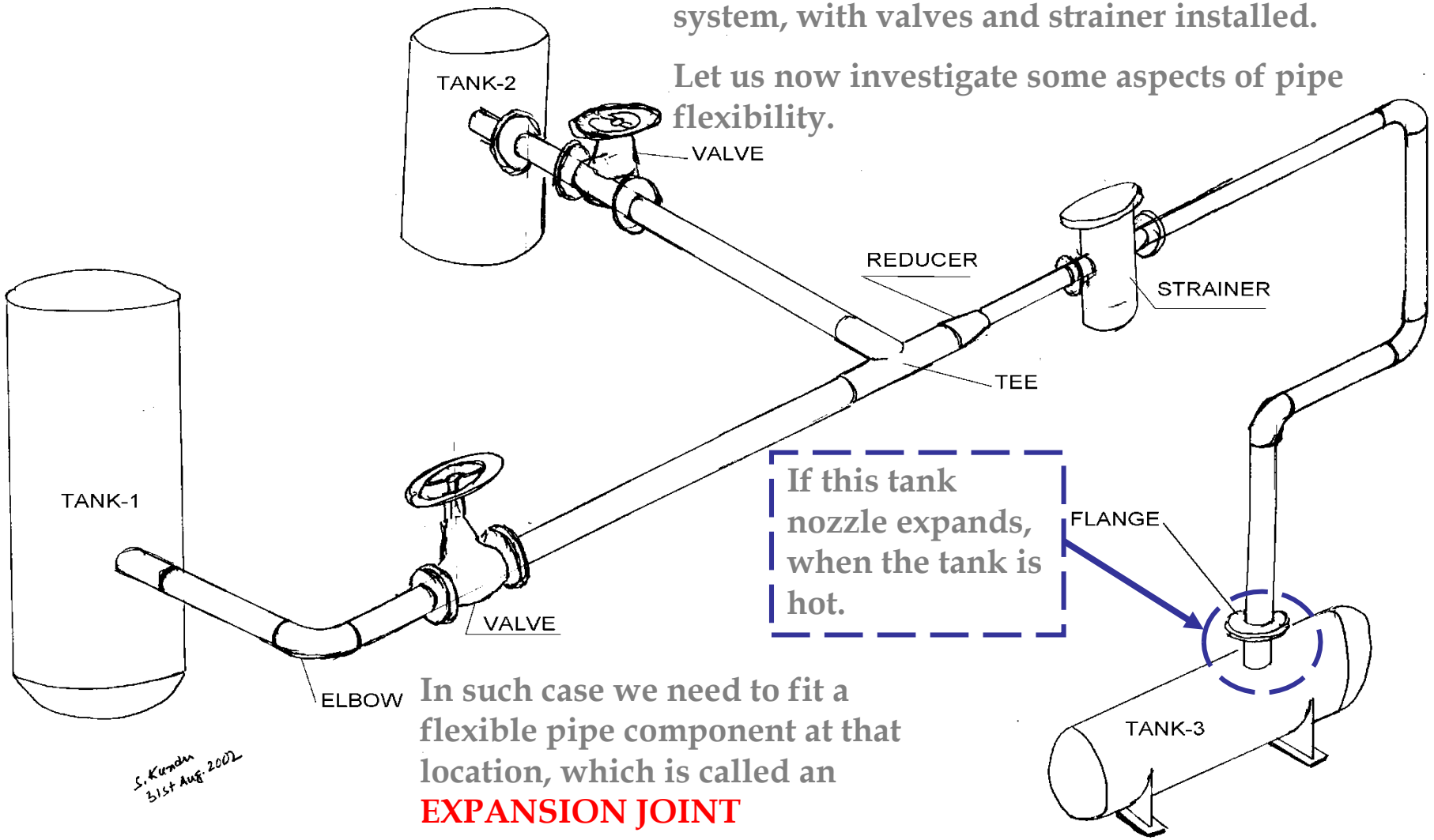
Those are - **Gate, Globe, Check, Butterfly, etc.**



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**

Here we see a more or less functional piping system, with valves and strainer installed.

Let us now investigate some aspects of pipe flexibility.



If this tank nozzle expands, when the tank is hot.

In such case we need to fit a flexible pipe component at that location, which is called an **EXPANSION JOINT**

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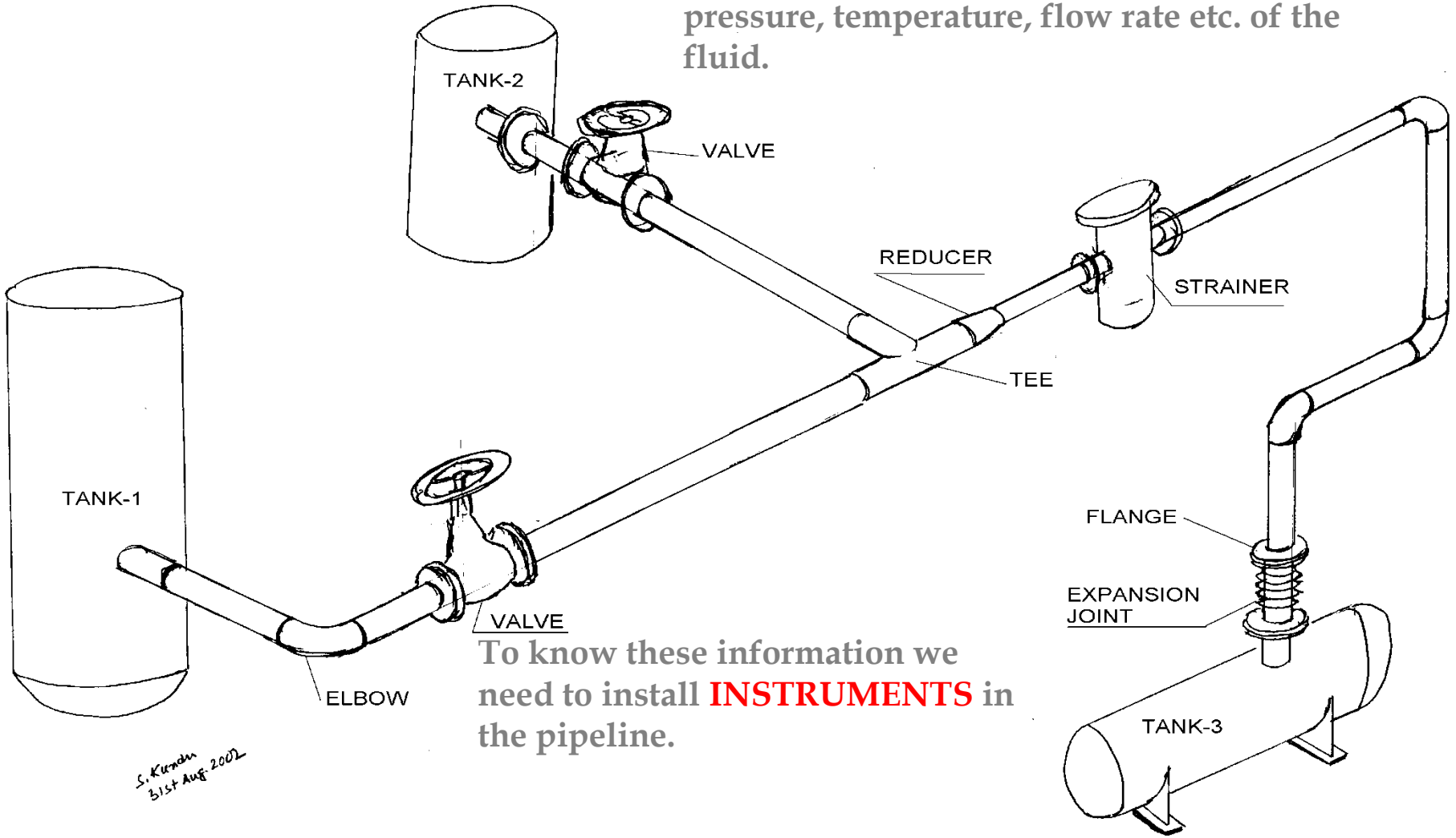
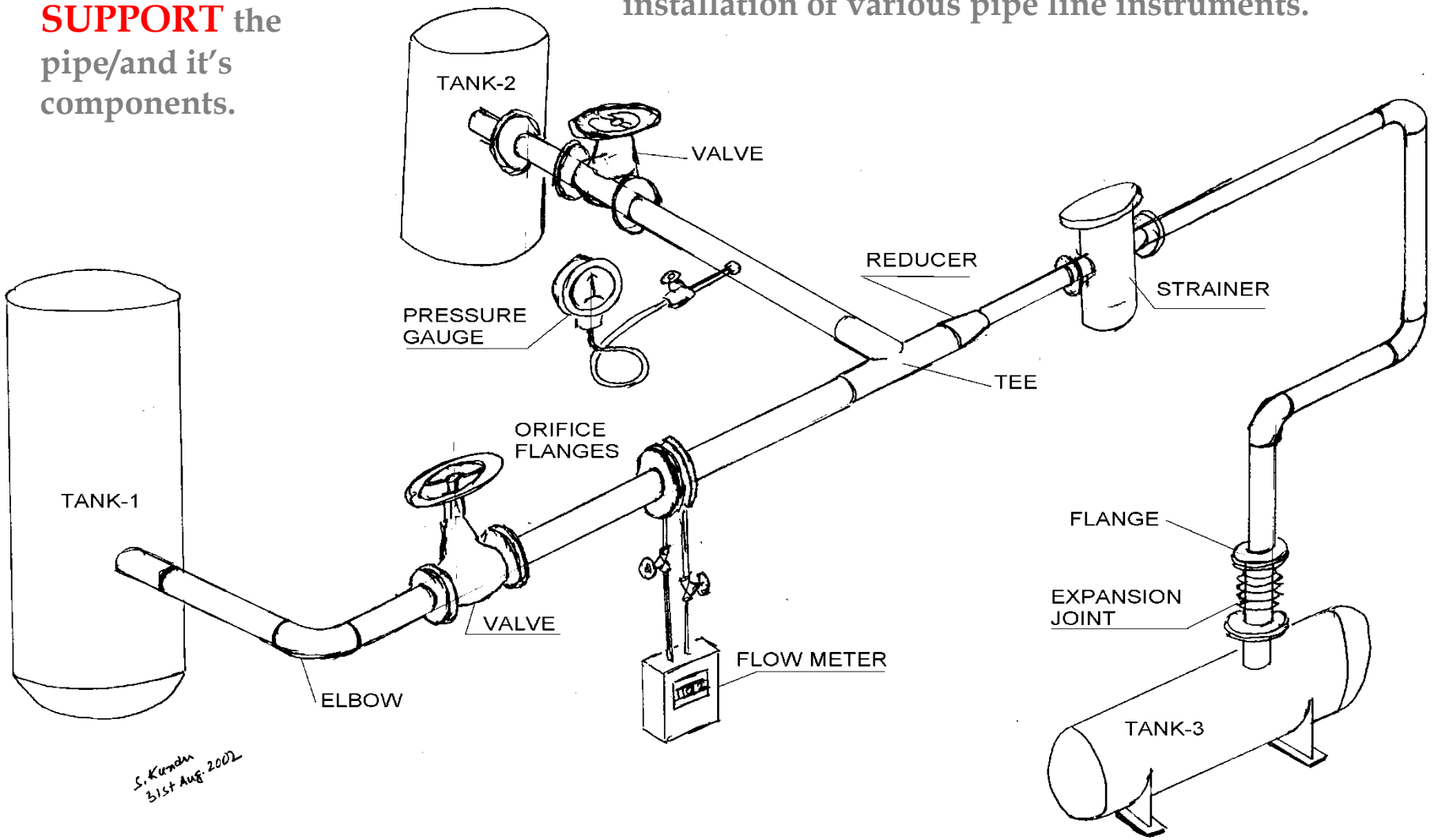
When some fluid is flowing in a pipe we may also like know the parameters like, pressure, temperature, flow rate etc. of the fluid.



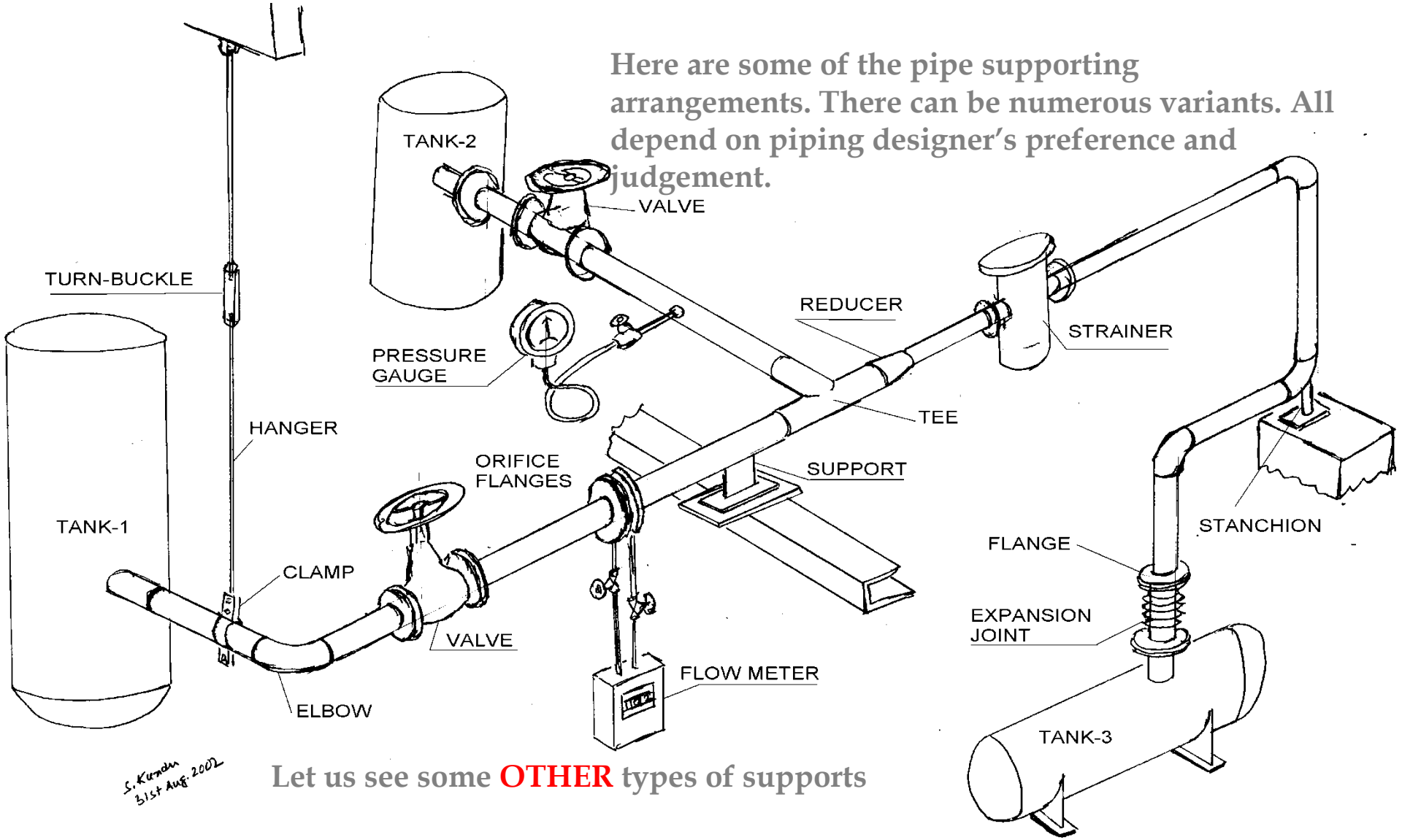
To know these information we need to install **INSTRUMENTS** in the pipeline.

Next we shall look into how to **SUPPORT** the pipe/and it's components.

There are various types instruments to measure various parameters. Also there are specific criteria for installation of various pipe line instruments.



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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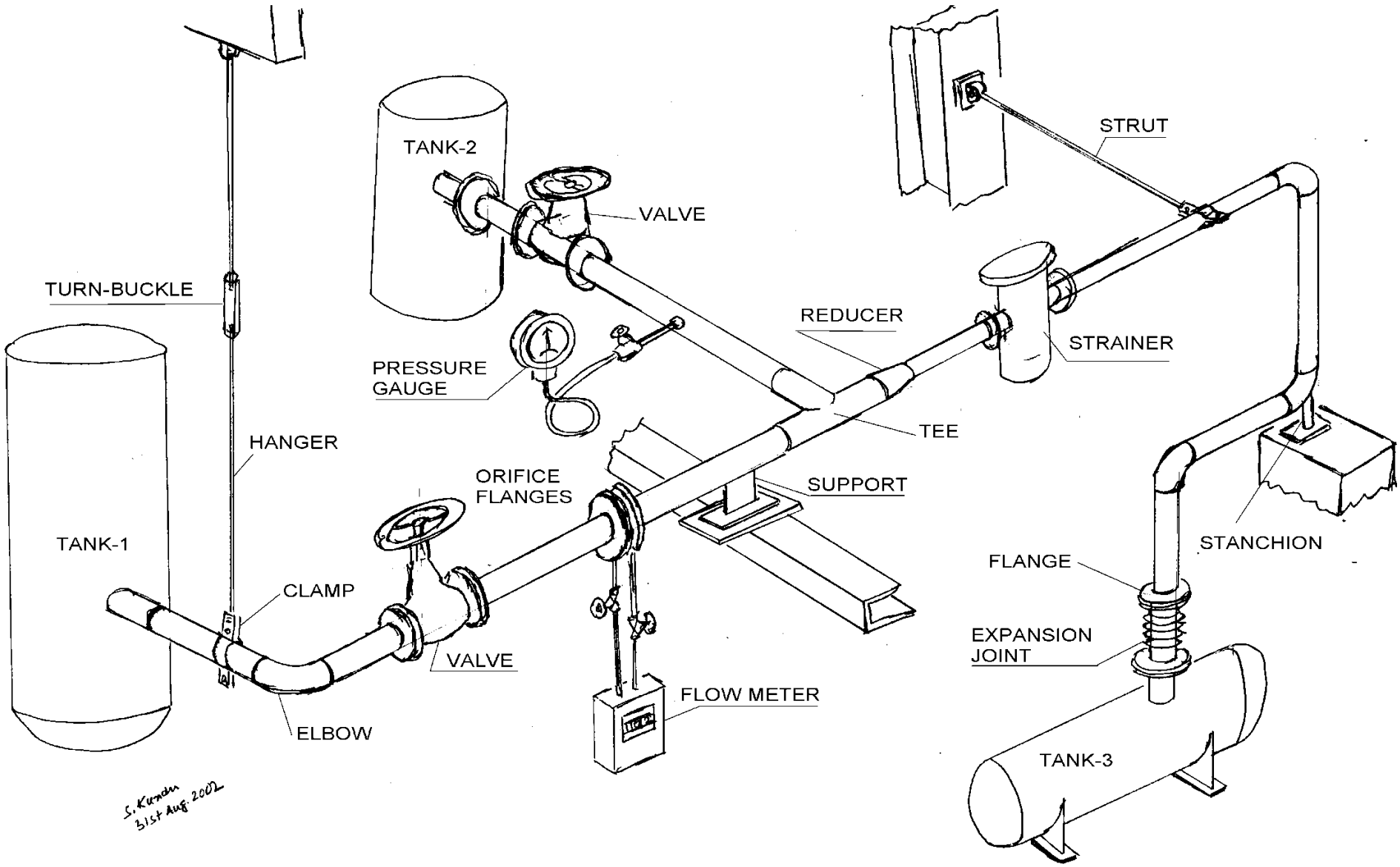
Let us see some **OTHER** types of supports


TANK-2
VALVE
STRUT
TURN-BUCKLE
REDUCER
STRAINER
PRESSURE
GAUGE
TEE
HANGER
ORIFICE
FLANGES
SUPPORT
TANK-1
STANCHION
FLANGE
CLAMP
EXPANSION
JOINT
VALVE
FLOW METER
ELBOW
TANK-3
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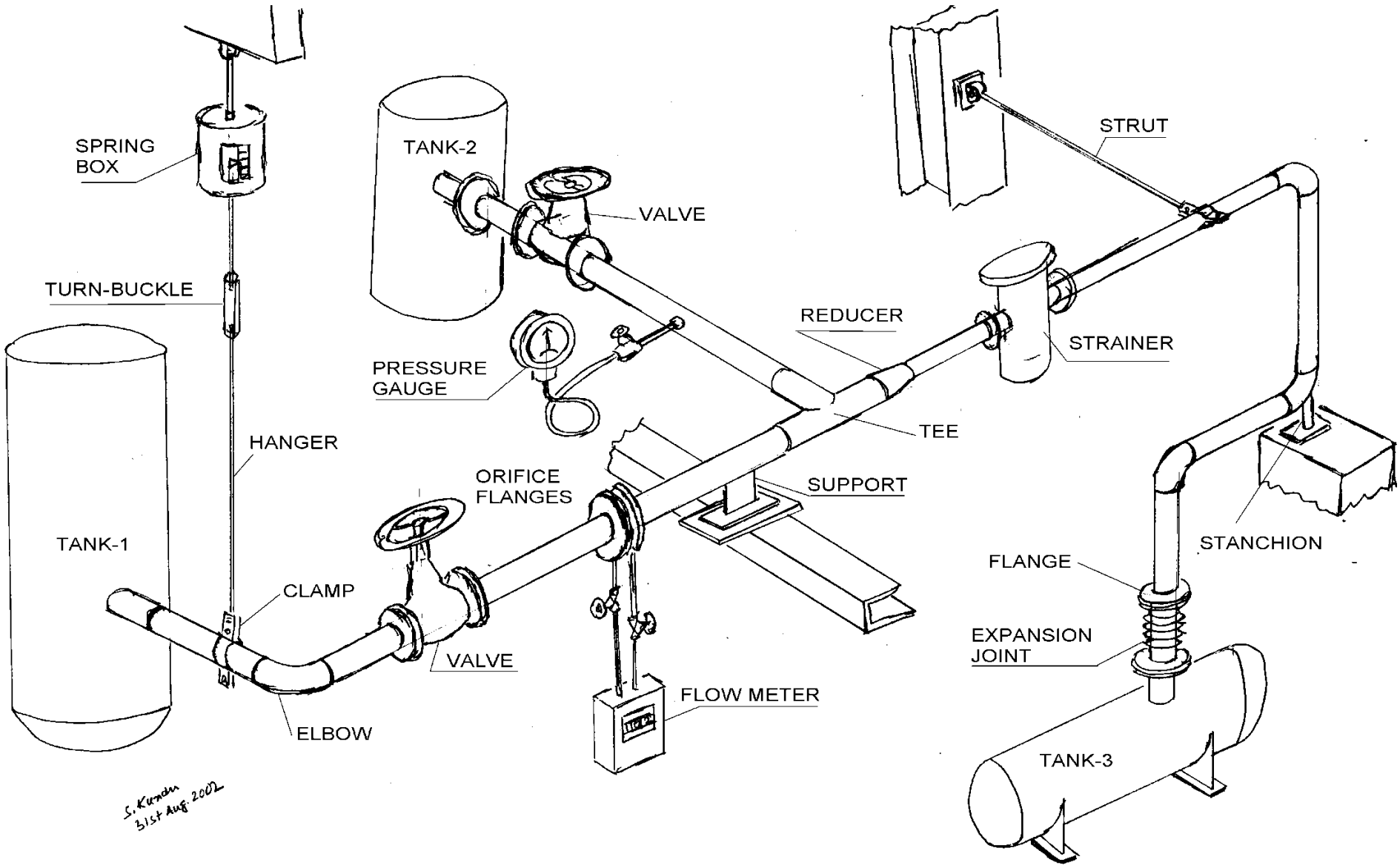
SPRING BOX
TANK-2
VALVE
STRUT
TURN-BUCKLE
REDUCER
STRAINER
PRESSURE GAUGE
TEE
HANGER
ORIFICE FLANGES
SUPPORT
TANK-1
STANCHION
FLANGE
CLAMP
EXPANSION JOINT
VALVE
FLOW METER
ELBOW
TANK-3
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31st Aug 2002

Stress Analysis

Objective

Pipe stress analysis provides the necessary techniques for engineers to design piping systems without overstressing and overloading the piping components & connected equipment.

The objective of stress analysis can be listed as follows:

A) To limit the stresses in the piping system to the limiting value.

B) To limit the deflection in the piping system to the limiting value.

C) To limit the loads on nozzles of connected equipment.

D) To limit the loads on supports.

E) To check for leakage at flange joints.

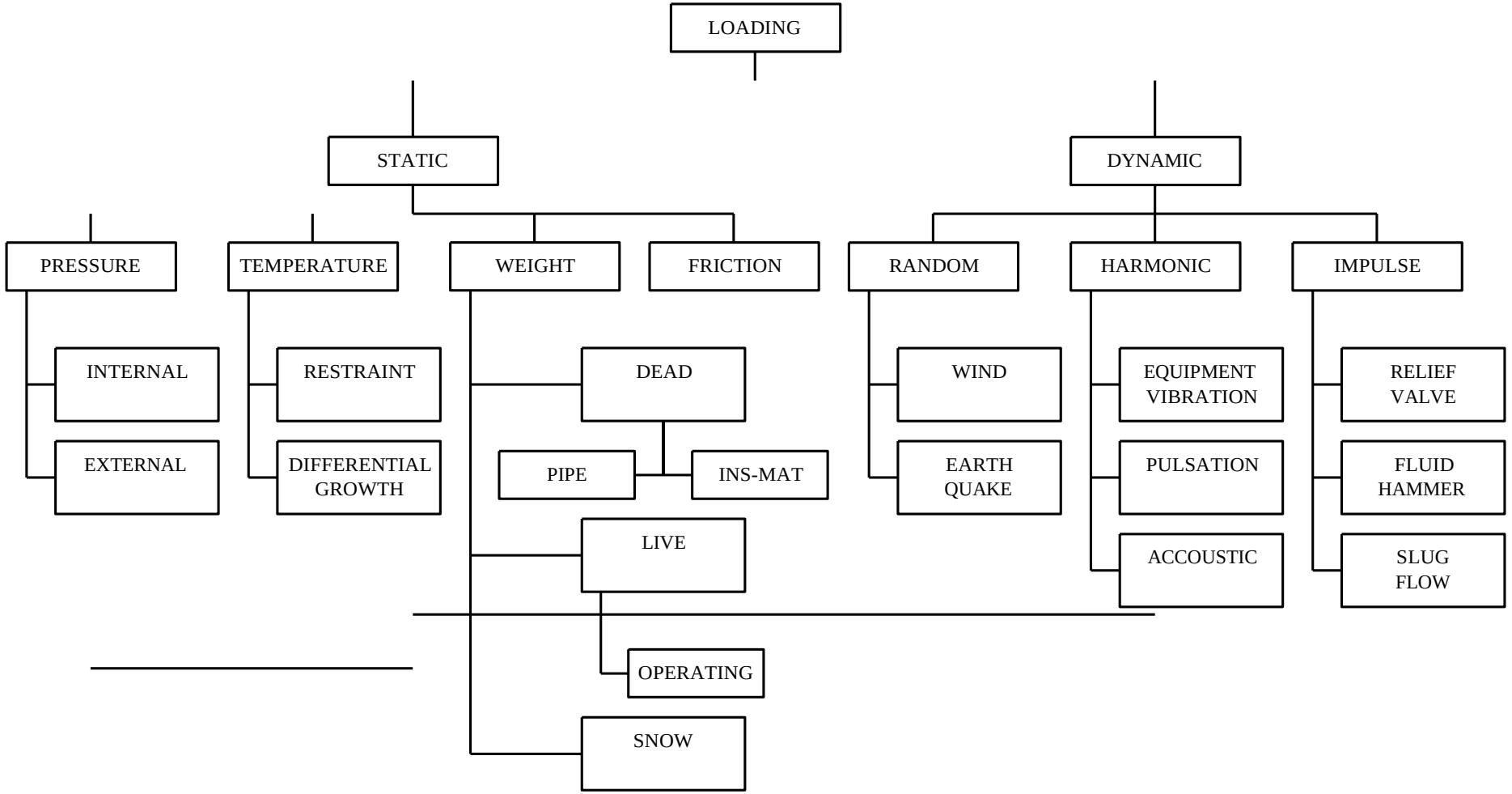
F) Unintentional disengagement of pipes from supports.

G) Excessive displacement .

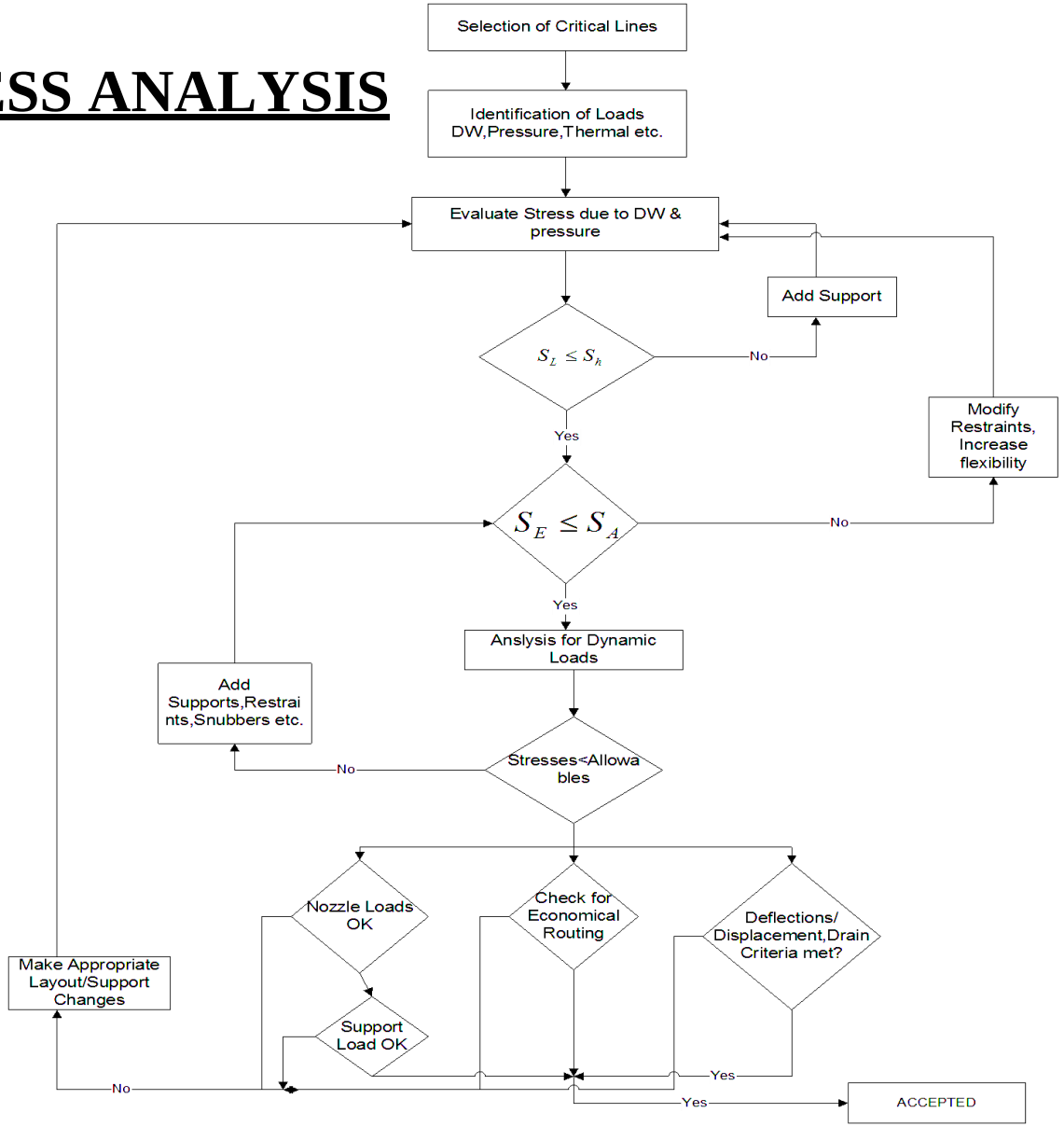
Requirements of supports in piping system are:

- To carry the weight of the pipe, fittings, valves with / without insulation, with operating / test fluid.
- To provide adequate stiffness to the piping against external loads such as wind load, ice, snow, seismic load etc.
- To avoid overstressing of the piping material.
- To avoid of sagging of pipe which creates draining problem.
- To control the thermal expansion / contraction in desired manner
- To withstand and dampen vibration produced by connected equipment such as pump, compressor etc.

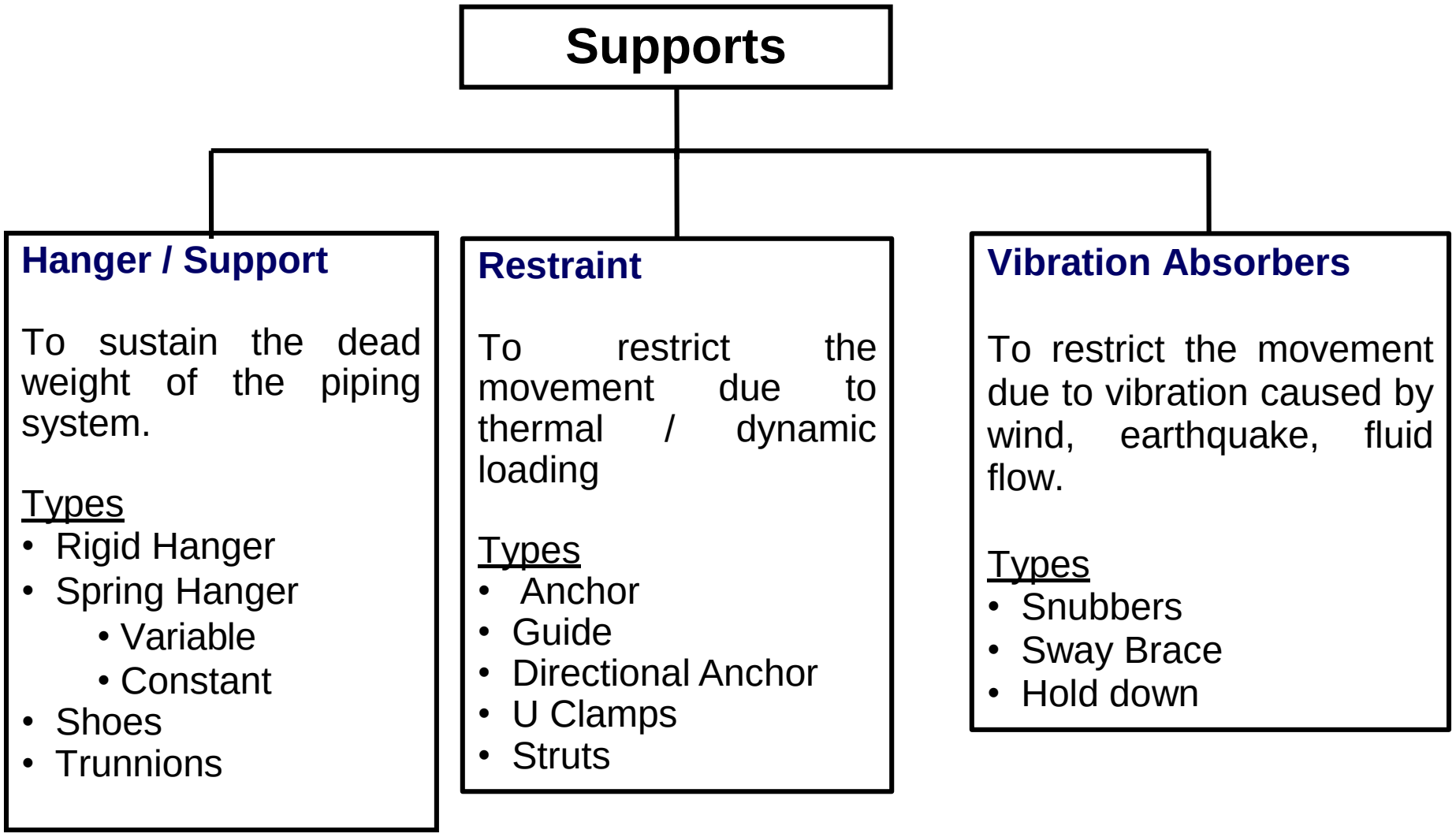
LOADS ON PIPING



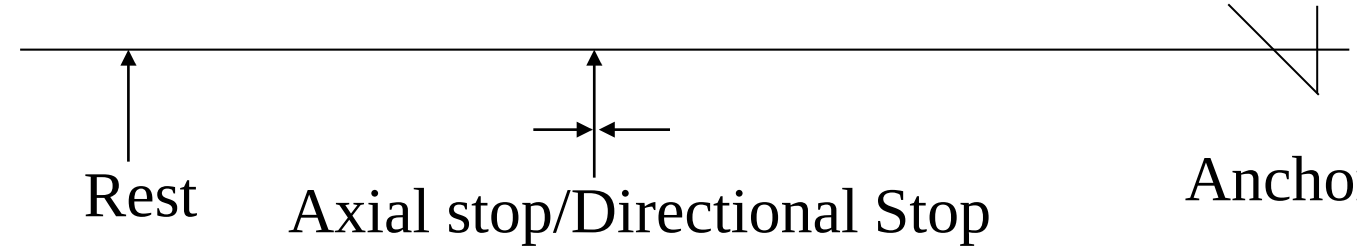
STEPS IN STRESS ANALYSIS

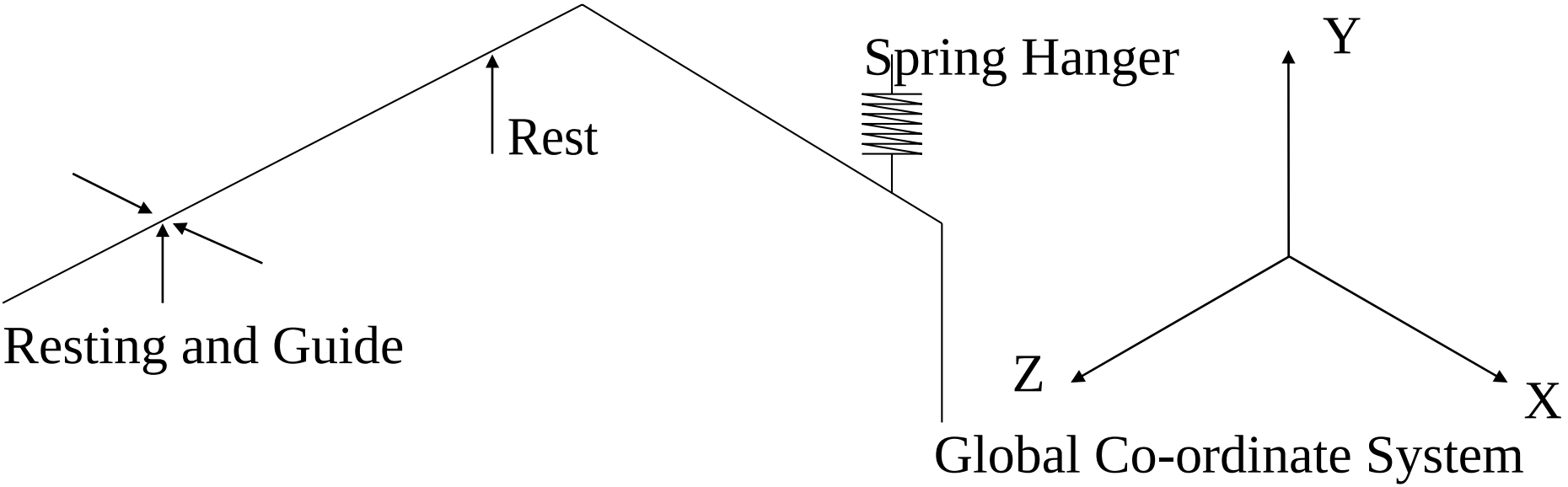


Type of Supports



Familiarization with Stress symbols





MATERIAL GROUP

Basis For Materials Selection

Materials of construction are selected and corrosion allowances are determined on the basis of anticipated corrosion or material degradation under the most severe combination of process variables (e.g., stream composition, velocity, temperature and pressure) resulting in sustained maximum normal operating conditions.

Appropriate temperature and pressure margins should be added to the sustained maximum normal operating conditions to determine the design conditions upon which the high temperature mechanical design is based. Typically, these margins are up to +50F (28C) above operating temperature and up to +10% of the operating pressure (up to a maximum of 50 psi (0.35 MPa)).

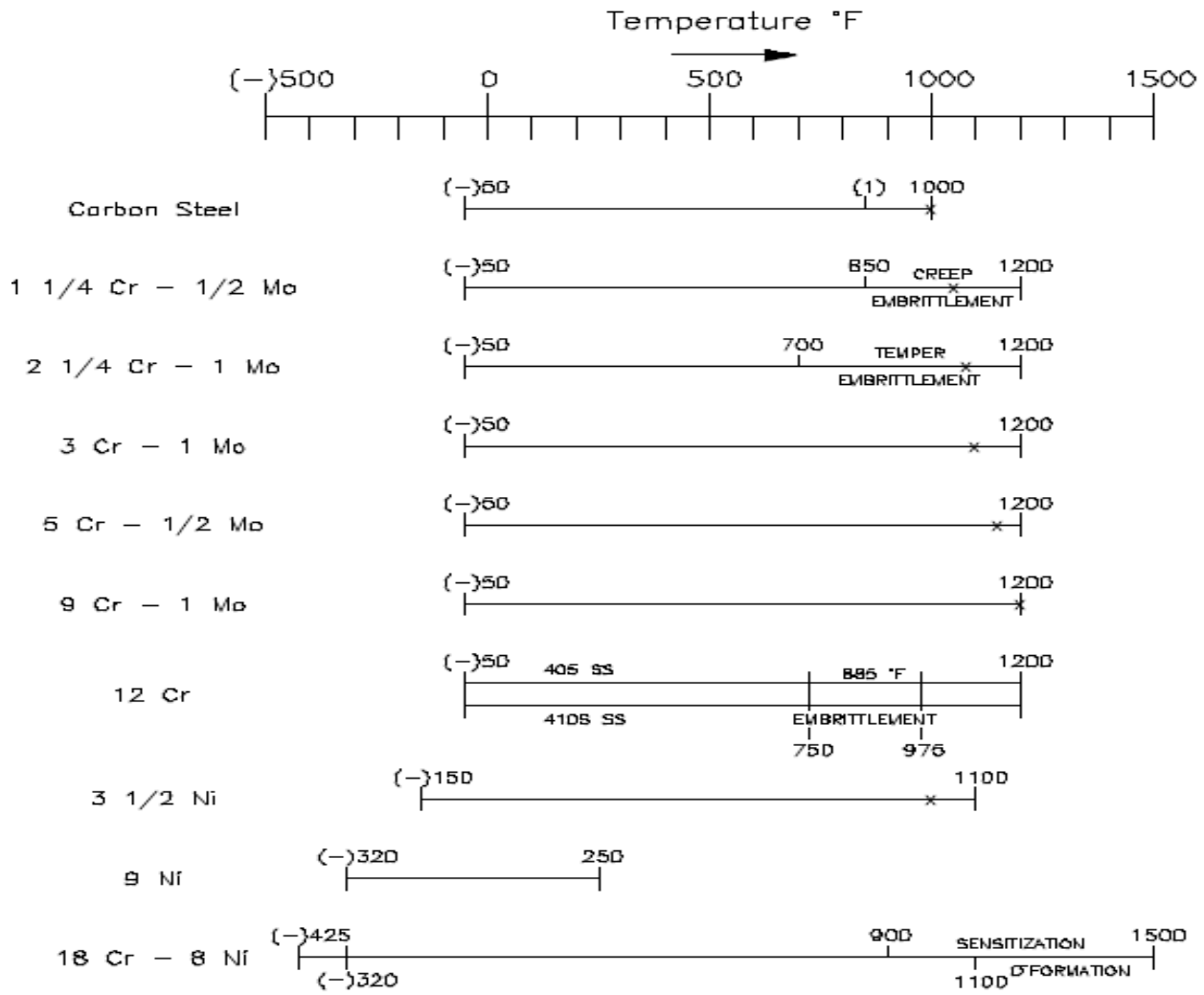
MATERIALS SELECTION DIAGRAM LEGEND

			TYPICAL CORRESPONDING ASTM MATERIAL SPECIFICATIONS AND GRADES [1]					
LEGEND	COMMON NAME	UNS NUMBER [3]	PLATE	FORGINGS[2]	TUBING	PIPE	FITTINGS	CASTINGS
CAST IRONS								
CI	Cast Iron	F10006	---	---	---	---	---	A48, A278
DI	Ferritic Ductile Iron	F32800	---	---	---	A716, A746	---	A395
Ni-Resist	Ni-Resist[4] Type 1	F41000	---	---	---	---	---	A436 Tp 1[4]
CARBON AND LOW ALLOY STEELS								
CS	Carbon Steel[5]	---	A285 A516	A266 Cl 1, 2 or 4	A179 (smls) A214 (wld)	A53 Gr B A106 Gr B, (smls) API 5L[6]	A105 A234 Gr WPB	A216
LTCS	Low Temp Carbon Steel[7]	---	A516[8]	A350 Gr LF1 or 2	A334 Gr 1 or 6	A333 Gr 1 or 6, (smls)	A350 Gr LF1 or 2 A420 Gr WPL 6	A352 Gr LCA, B or C
1 Cr	1 Cr-1/2 Mo	K11562	A387 Gr 12	A336 Cl F12	A213 Gr T12	A335 Gr P12, (smls)	A182 Gr F12	[9]
1-1/4 Cr	1-1/4Cr-1/2 Mo	K11597	A387 Gr 11	A336 Cl F11	A213 Gr T11	A335 Gr P11, (smls)	A182 Gr F11 A334 Gr WP11	A217 Gr WC11
2-1/4 Cr	2-1/4Cr-1Mo	K21590	A387 Gr 22	A336 Cl F22	A213 Gr T22	A335 Gr P22, (smls)	A182 Gr F22 A234 Gr WP 22	A217 Gr WC9
5 Cr	5Cr-1/2Mo	K41545	A387 Gr 5	A336 Cl F5	A213 Gr T5	A335 Gr P5, (smls)	A182 Gr F5 A234 Gr WP5	A217 Gr C5
9 Cr	9Cr-1Mo	---	A387 Gr 9	A336 Cl F9	A213 Gr T9	A335 Gr P9, (smls)	A182 Gr F9 A234 Gr WP9	A217 Gr C12
9Cr-V	9Cr-1Mo-V	---	A387 Gr 91	A336 Cl F91	A213 Gr T91	A335 Gr P91, (smls)	A182 Gr F91 A234 Gr WP91	---

			TYPICAL CORRESPONDING ASTM MATERIAL SPECIFICATIONS AND GRADES [1]					
LEGEND	COMMON NAME	UNS NUMBER [3]	PLATE	FORGINGS[2]	TUBING	PIPE	FITTINGS	CASTINGS
FERRITIC AND MARTENSITIC STAINLESS STEELS								
12 Cr	Ferritic or Martensitic 12 Cr	S40500 S41000 S41008	A240[10,21] Tp405 410 410S	---	A268 Gr Tp 405 410	---	---	A217 Gr CA15 A487 Gr CA15, CA6NM
AUSTENITIC STAINLESS STEEL								
304 SS 304L SS	Type 304 SS Type 304L SS	S30400 S30403	A240[11,22]	A336[11]	A213, (smls)[11] A249, (wld)[11]	A312, (smls)[11] A358, (wld)[11]	A182[11] A403[11]	A351[12]CF8 GrCF3
316 SS 316L SS	Type 316 SS Type 316L SS	S31600 S31603	A240[11,22]	A336[11]	A213, (smls)[11] A249, (wld)[11]	A312, (smls)[11] A358, (wld)[11]	A182[11] A403[11]	A351[12]CF8M GrCF3M
321 SS 321H SS	Type 321 SS Type 321H SS	S32100 S32109	A240[11,22]	A336[11]	A213, (smls)[11] A249, (wld)[11]	A312, (smls)[11] A358, (wld)[11]	A182[11] A403[11]	[13]
347 SS 347H SS	Type 347 SS Type 347H SS	S34700 S34709	A240[11,22]	A336[11]	A213, (smls)[11] A249, (wld)[11]	A312, (smls)[11] A358, (wld)[11]	A182[11] A403[11]	A351[12] Gr CF8C
DUPLEX STAINLESS STEEL								
Alloy 2205	2205 Duplex SS	S31803	A240[16,22]	A182 Gr 51	A789[16]	A790[16]	A182 Gr 51	---
Ferralium	Ferralium 255	S32550	A240[16,22]	---	A789[16]	A790[16]	---	---
CD-4MCu	CD-4MCu	J93370	---	---	---	---	---	A351[12] Gr CD-4MCu
SUPER STAINLESS STEELS AND NICKEL ALLOYS								
254 SMO[14]	254 SMO SS	S31254	A240[16,22]	A182 Gr F44	A249[16]	A312[16]	A403[16]	---
310S SS	Type 310S SS	S31008	A240[22] Tp 310S	A182 Gr F310	A249 Gr Tp 310S	A312 Gr Tp 310S	A403 WP 310	---
Alloy 20	20 Cb-3	N08020	B463[16,23]	B462	B468[16]	B464[16]	B366 WP 20CB	A351[12,20] Gr CN7M
AL-6XN[15]	AL-6XN	N08367	B688[16,23]	B564[16]	B676, (wld)[16] B690, (smls)[16]	B675, (wld)[16] B690, (smls)[16]	B366 WP6XN	---

			TYPICAL CORRESPONDING ASTM MATERIAL SPECIFICATIONS AND GRADES [1]					
LEGEND	COMMON NAME	UNS NUMBER [3]	PLATE	FORGINGS[2]	TUBING	PIPE	FITTINGS	CASTINGS
Sanicro 28[17]	Sanicro 28	N08028	B709	---	B668, (smls)	---	---	---
Alloy 800	Alloy 800	N08800	B409[16,23]	B564[16]	B163, (smls)[16]	B407, (smls)[16]	B366 WPNIC	---
Alloy 825	Alloy 825	N08825	B424[16,23]	B564[16]	B163, (smls)[16]	B423, (smls)[16]	B366 WPNICMC	---
904L SS	904L SS	N08904	B625[16,23]	---	B677, (smls)[16] B674, (wld)[16]	B677, (smls)[16] B673, (wld)[16]	---	---
Alloy 600	Alloy 600	N06600	B168[16,23]	B564[16]	B163, (smls)[16] B516, (wld)	B167, (smls)[16] B517, (wld)	B366 WPNC1	A494 CY-40
Alloy 625	Alloy 625	N06625	B443[23]	B564[16]	B444, (smls)	B444, (smls)	B366 WPNCMC	A494 CW-6MC
Alloy C276	Alloy 276	N10276	B575[16,23]	B564[16]	B622, (smls)[16]	B622 (smls)[16] B619, (wld)[16]	B366 WPHC276	A494 CW-2M
Alloy C22[18]	Alloy C22	N06022	B575[16,23]	B564[16]	B622, (smls)[16]	B622 (smls[16] B619, (wld)[16]	B366 WPHC22	---
Alloy 400	Monel 400	N04400	B127[23]	B564[16]	B163, (smls)[16]	B165, (smls)[16]	B366 WPNC	A494 M-35-1
Alloy 200	Nickel 200	N02200	B162[16,23]	---	B163, (smls)[16]	B161, (smls)[16]	B366 WPN	A494 CZ100
COPPER ALLOYS								
Admiralty	Admiralty Brass	C44300	B171[16,24]	---	B111, (smls)[16] B395 (smls)[16]	---	---	---
Naval Brass	Naval Brass	C46500	B171[16,24]	---	---	---	---	---
70/30 Cu/Ni	70/30 Cu/Ni	C71500	B171[16,24]	---	B111, (smls)[16] B395, (smls)[19]	B467, (smls)[16] B608, (wld)[16]	---	B369 UNS C96400
90/10 Cu/Ni	90/10 Cu/Ni	C70600	B171[16,24]	---	B111, (smls)[16] B395, (smls)[19]	B467, (smls)[16] B608, (wld)[16]	---	B369 UNS C96200
OTHER ALLOYS								
Ti-2	Titanium Grade 2	R50400	B265 Gr 2[25]	B381 Gr F-2	B338 Gr 2	B337 Gr 2	---	B367
Ti-12	Titanium Grade 12	R53400	B265 Gr 12[25]	B381 Gr F-12	B338 Gr 12	B337 Gr 12	---	---

MATERIALS SELECTION AS A FUNCTION OF TEMPERATURE



X Forms excessive scale above this temperature if exposed to air or steam.
(1) Weakens by graphitization of carbides at prolonged temperature above 850 °F.


Thank you