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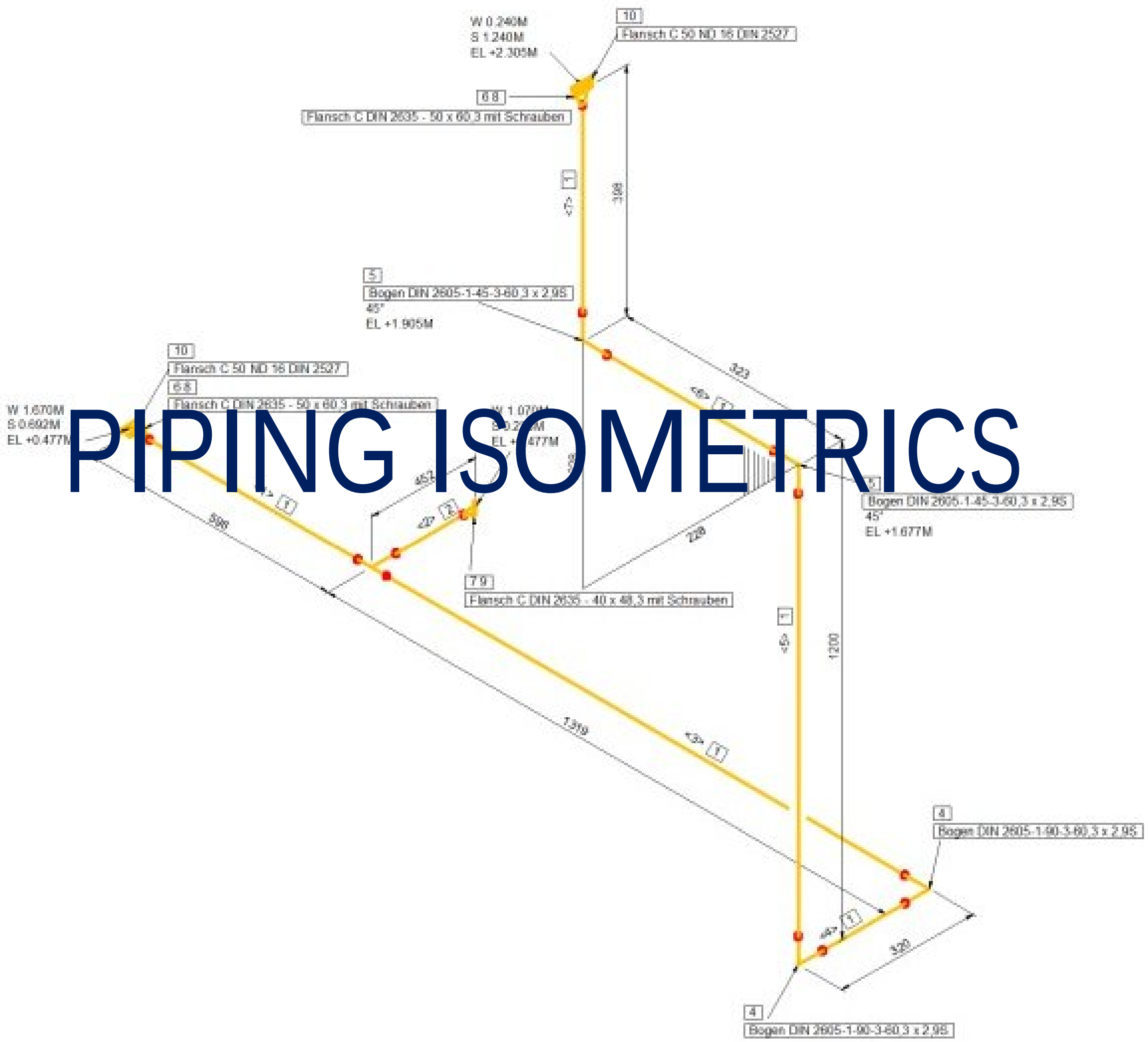
FIELD PIPING ENGINEERING

PIPING ISOMETRICS



ISOMETRIC DRAWINGS - Dimensions

What is an Isometric Drawing?

- An isometric drawing is a type of pictorial drawing in which three sides of an object can be seen in one view.
- It's popular within the process piping industry because it can be laid out and drawn with ease and portrays the object in a realistic view.

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ISOMETRIC DRAWINGS - Dimensions

What is an Isometric Drawing?

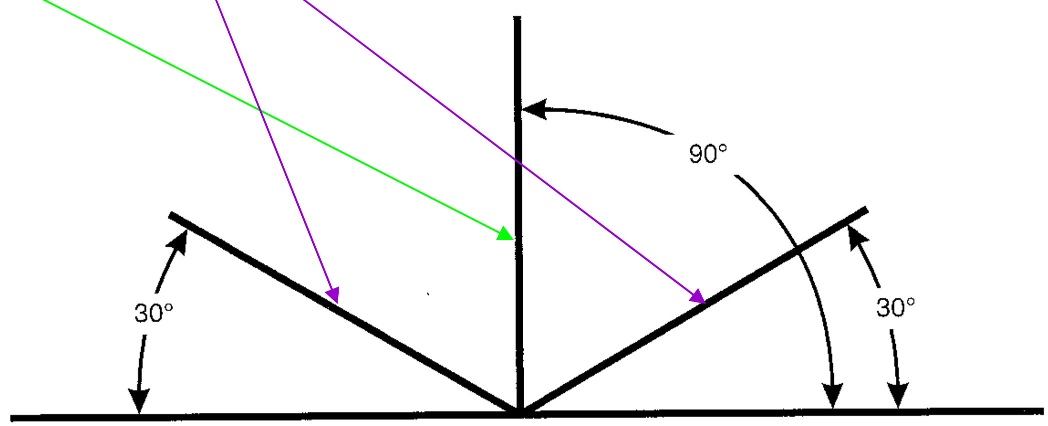
- Sometimes it is used in lieu of plans and elevations but typically it is used to supplement the plan drawings
- Isometrics are used as fabrication & shop drawings for pipe run fabrication
- Isometrics also provide a drafter with the ability to calculate angular offsets in the pipe run.

ISOMETRIC DRAWINGS - Layout

Isometric Layout:

Isometric lines: one vertical & two at 30° from horizontal

- Isometric lines *can* be measured
- Non-isometric lines: lines NOT parallel to the isometric lines – these lines cannot be measured



Example of isometric axis

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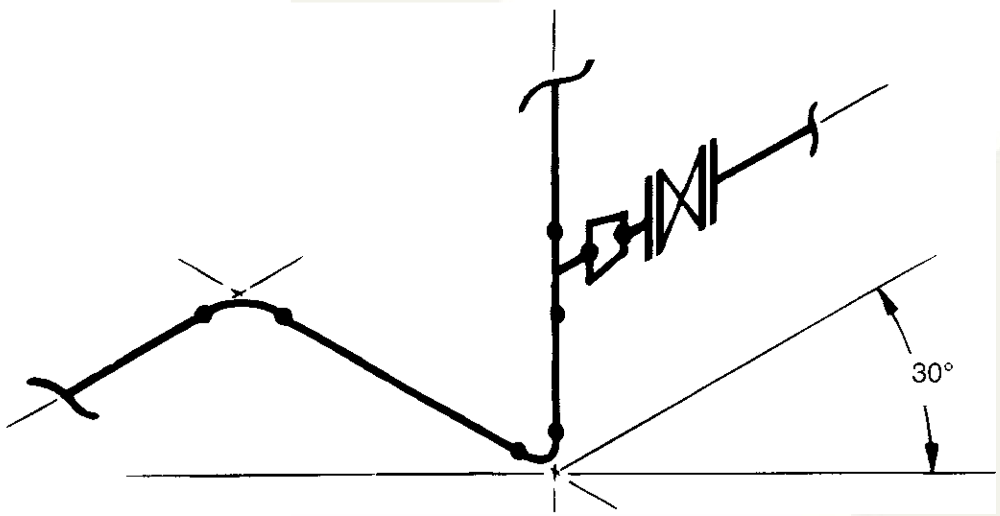
ISOMETRIC DRAWINGS - Layout

Isometric Layout:



In the example at left, note that all directions of the pipe match the three isometric axis lines

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ISOMETRIC DRAWINGS - Layout

Scale:

- Isometrics are rarely drawn to scale
- However, pipe lengths should be shown proportionately
- Many companies draw isometrics on b-size paper (11” x 17”) which is a limited space so sometimes proportion may be sacrificed
- It’s IMPORTANT that the written dimensions are accurate

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ISOMETRIC DRAWINGS - Layout

Direction & location:

- Location and direction help to properly orient the isometric drawing
- A north arrow give direction and should ALWAYS point to the upper-right corner of the paper
- Structural reference points that provide location can be shown on isometric
- Dimensions MUST always be given to points of reference; such as structures, existing equipment…etc
- Coordinates should also be shown on the isometric drawing

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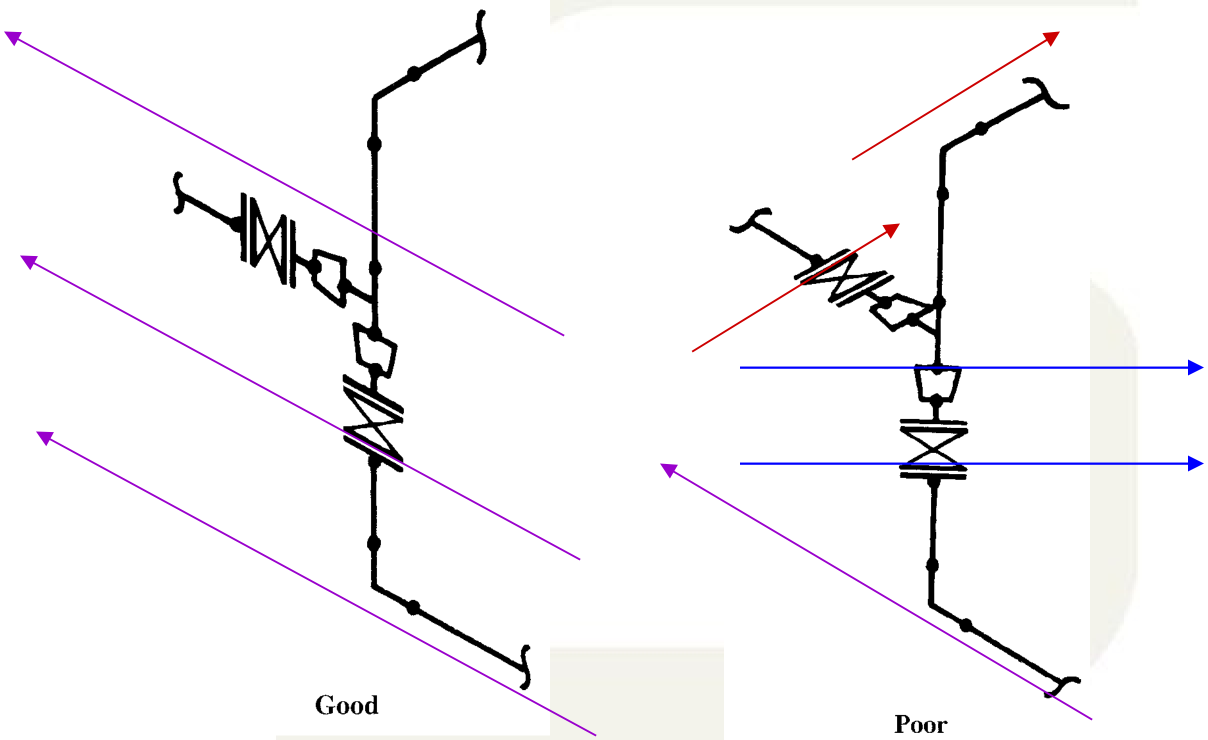
FITTING SYMBOLS AND ORIENTATION

- When orienting fittings and valves it’s important to know that there are good methods and poor methods in this orientation process

- The *general rule* for producing an isometric using GOOD techniques, is to draw the fittings so they are parallel to the last direction change or branch in the pipe

FITTING SYMBOLS AND ORIENTATION



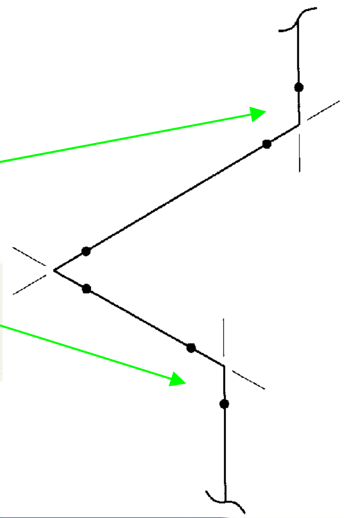
Not following the "general rule" leads to a chaotic looking isometric ... it doesn't look professional

FITTING SYMBOLS AND ORIENTATION

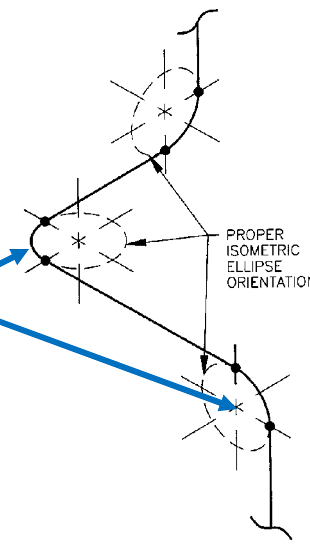
- Fittings are drawn the same shape as they appear on the plan & elevation drawings EXCEPT they're at an isometric angle.

- Elbows can be drawn a couple of ways… check with company standards

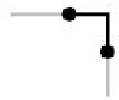
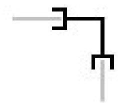
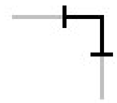
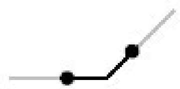
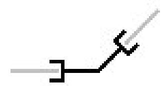
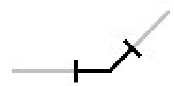
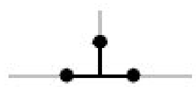
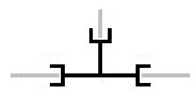
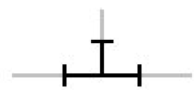
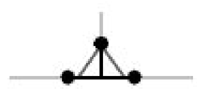
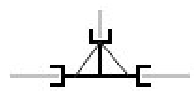
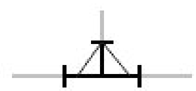
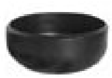
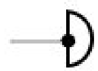
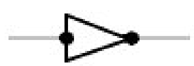
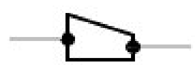
Square corner elbows



Curved Elbow Representation



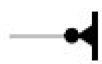
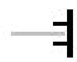
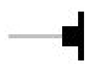
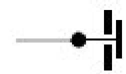
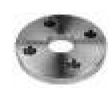
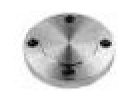
ISO SYMBOLS – Fittings

Image	Fittings	Butt weld Symbol	Socket Weld Symbol	Threaded Symbol	Fittings	Image
	Elbow 90°				Elbow 90°	
	Elbow 45°				Elbow 45°	
	Tee equal				Tee equal	
	Tee reducing				Tee reducing	
	Cap				Cap	
	Reducer concentric		...	...	Reducer concentric	...
	Reducer eccentric		...	...	Reducer eccentric	...
Image	Fittings	Butt weld Symbol	Socket Weld Symbol	Threaded Symbol	Fittings	Image

FIELD PIPING ENGINEERING

ISO SYMBOLS – Flanges

FIELD PIPING ENGINEERING

Flanges	Welding Neck	Socket Weld	Threaded	Slip-On	Lap-Joint	Blind	Flanges
Symbol							Symbol
Image							Image
Flanges	Welding Neck	Socket Weld	Threaded	Slip-On	Lap-Joint	Blind	Flanges

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ISO SYMBOLS – Valves

Image	Valves	Butt weld Symbol	Flanged Symbol	Socket or Threaded Symbol	Valves	Image
	Gate				Gate	
	Globe				Globe	
	Ball				Ball	
	Plug				Plug	
	Butterfly			...	Butterfly	
	Needle				Needle	
	Diaphragm	...			Diaphragm	
	Y-type				Y-type	

ISO SYMBOLS – Valves

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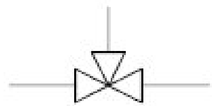
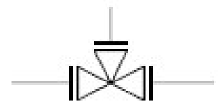
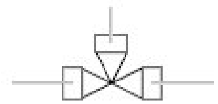
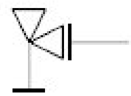
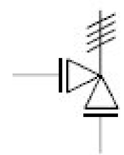
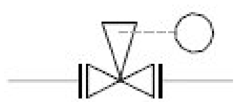
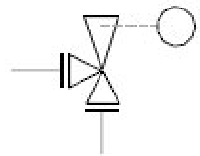
Image	Valves	Butt weld Symbol	Flanged Symbol	Socket or Threaded Symbol	Valves	Image
	Three-way				Three-way	
	Check				Check	
	Bottom	...		...	Bottom	
	Relief	...		...	Relief	
	Control straight	...		...	Control straight	
	Control angle	...		...	Control angle	

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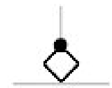
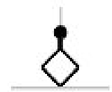
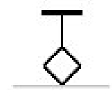
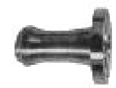
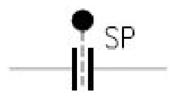
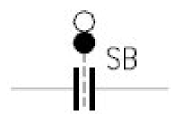
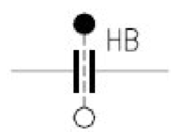
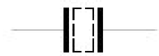
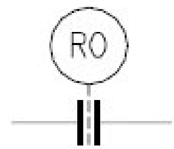
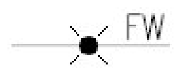
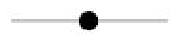
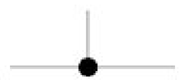
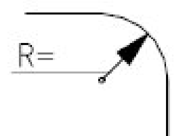
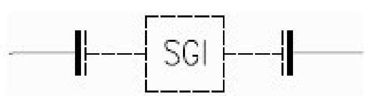
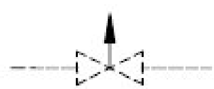
ISO SYMBOLS – Special Components

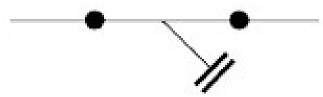
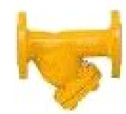
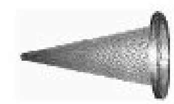
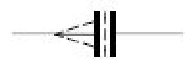
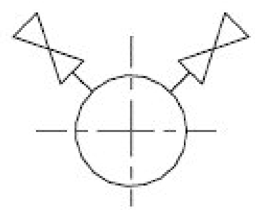
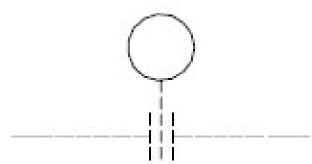
Miscellaneous	Symbol	Image	Miscellaneous
Branch outlet Weldolet®			Branch outlet Weldolet®
Branch outlet Nipolet®			Branch outlet Nipolet®
Flanged branch outlet Flangolet			Flanged branch outlet Flangolet
Spade			Spade
Spectacle blind			Spectacle blind
Hammer blind			Hammer blind
Spacer			Spacer

ISO SYMBOLS – Special Components

Miscellaneous	Symbol	Image	Miscellaneous
Restriction orifice			Restriction orifice
Field Weld			Field Weld Butt weld
Butt weld			
Pipe to pipe connection			Pipe to pipe connection
Pipe bend with special radius			Pipe bend with special radius
Sight glass			Sight glass
Direction of hand wheel / wrench			Hand wheel

FIELD PIPING ENGINEERING

ISO SYMBOLS – Special Components

Y-type strainer			Y-type strainer
Conical strainer			Conical strainer
Conical strainer built-in			
Orifice assembly (typical) showing position of taps			Orifice assembly
Meter run orifice assembly (typical) flanged / butt weld			Meter run
Miscellaneous	Symbol	Image	Miscellaneous

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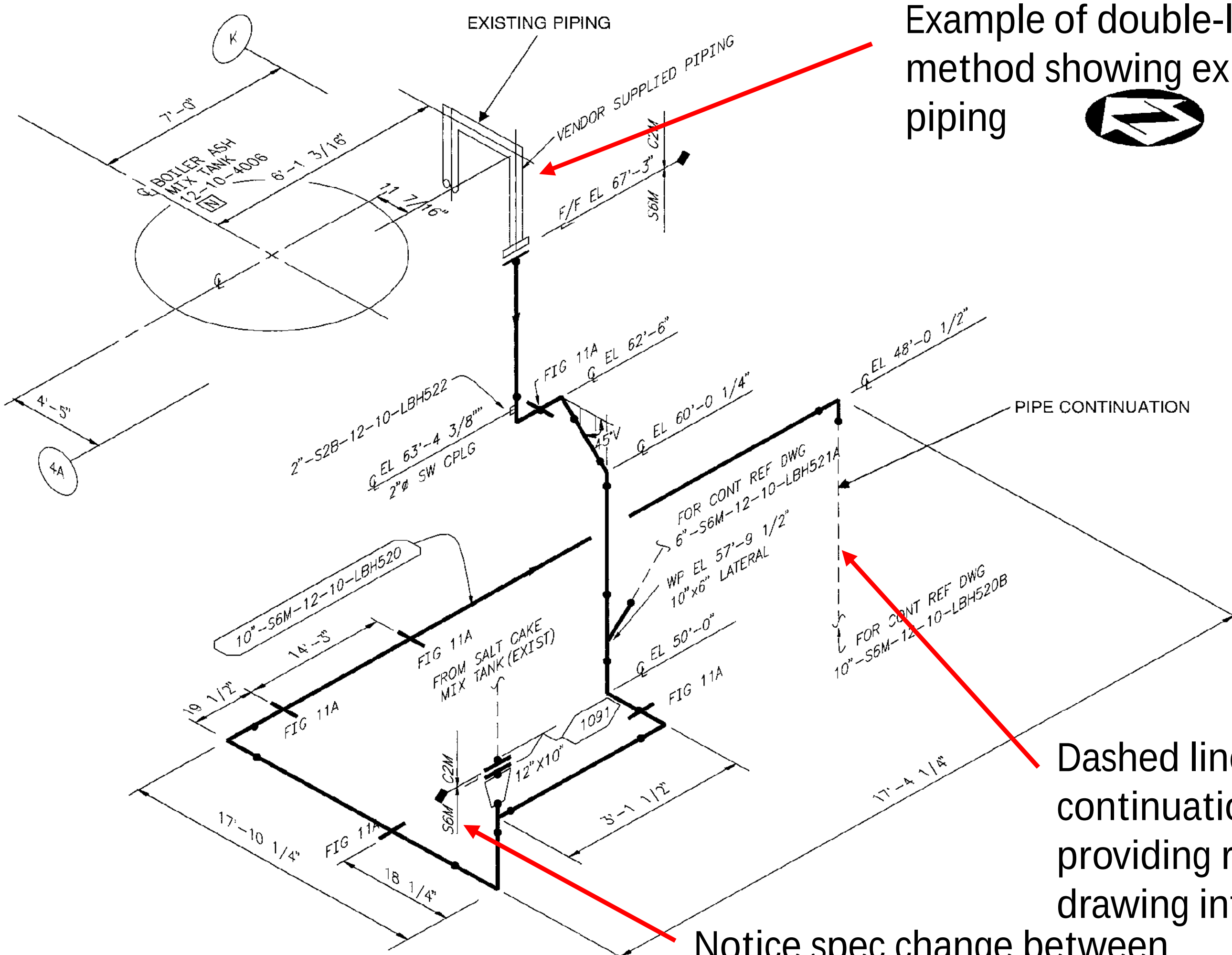
ISO DRAWINGS – Connected Piping



Example of double-line method showing existing piping

Dashed line showing pipe continuation and note providing reference drawing information.

Notice spec change between “new” and existing pipe & note for reference drawing

Pg. 220 text

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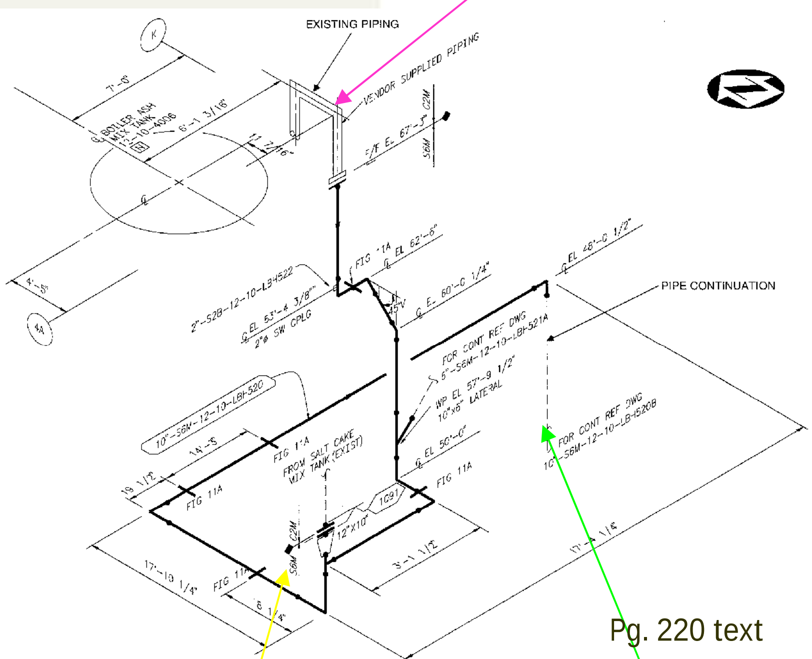
ISO DRAWINGS – Connected Piping

- One run of pipe per isometric drawing
- Branches of the pipe run or continuations are placed on other drawings … typically shown as short portion of dashed line on main pipe run
  - Usually a note indicates the name or specification of the branch line
- Existing piping is sometimes shown using double line method or dashed lines

Example of double-line method showing existing piping



Dashed line showing pipe continuation and note providing reference drawing information.

Notice spec change between “new” and existing pipe & note for reference drawing

ISOMETRIC DRAWING TECHNIQUES

To increase drawing efficiency:

- Create a prototype for isometric drawings
  - Set up grid, snap, isometric plane orientation, border and title block, BOM, text styles & dimension settings
- Develop library of isometric symbols
  - Valves, fittings, instruments, equipment… common drawing components
- Create dimension styles in all three isometric planes
- Construct menus that you can pick symbols from

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ISOMETRIC DRAWING OFFSETS

- ? Hatches on isometric drawings being applied, to indicate that a pipe runs at a certain angle and in which direction the pipe runs.
- ? Sometimes, small changes in the hatch, the routing of a pipe is no longer the east, but for example suddenly to the north.
- ? Is done with a fitting (typically a 45° elbow)

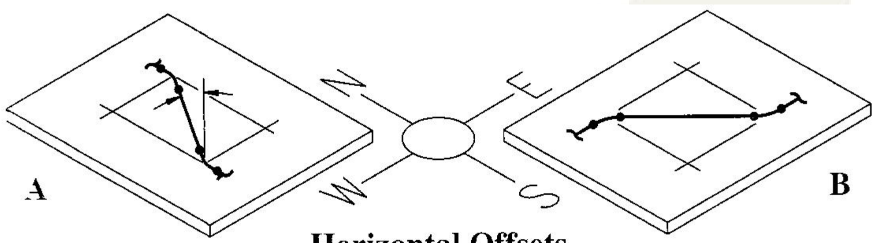
Types:

- Horizontal Offset
- Vertical Offset

ISOMETRIC DRAWING OFFSETS

Horizontal Offsets:

If you draw a horizontal pipe with a 45° elbow running form southeast to northwest technically correct, it would look like a vertical line… to prevent confusion, the offset is drawn 22 ½ ° from vertical to give the illusion of the angle.



Horizontal Offsets

FIELD PIPING ENGINEERING

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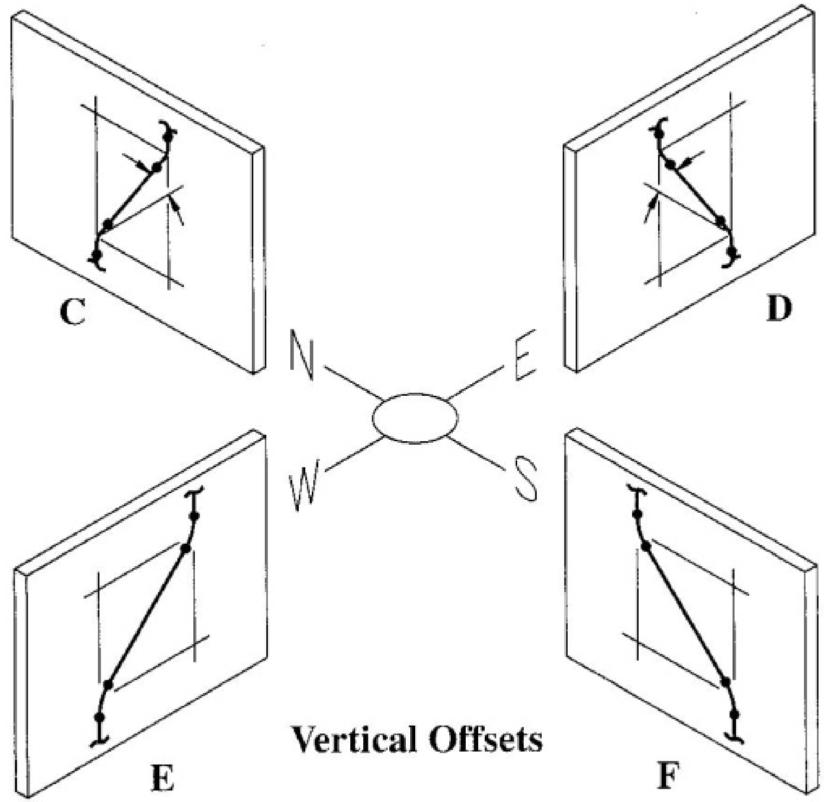
ISOMETRIC DRAWING OFFSETS

Vertical Offsets:

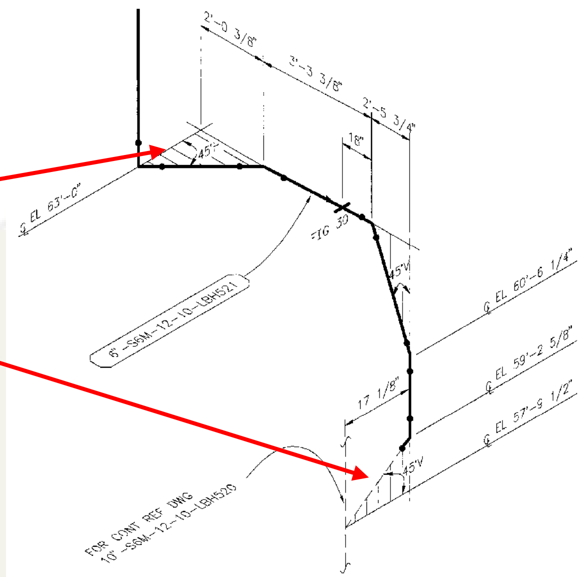
These offsets can get just as confusing as the horizontal offsets.



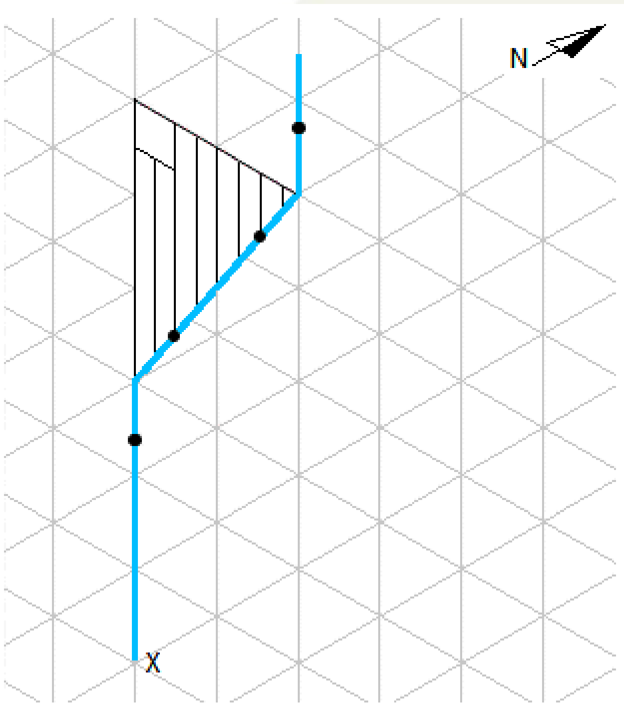
ISOMETRIC DRAWING OFFSETS

Squaring-in Plane:

That’s why many companies use a “squaring-in” plane within the plane of the offset



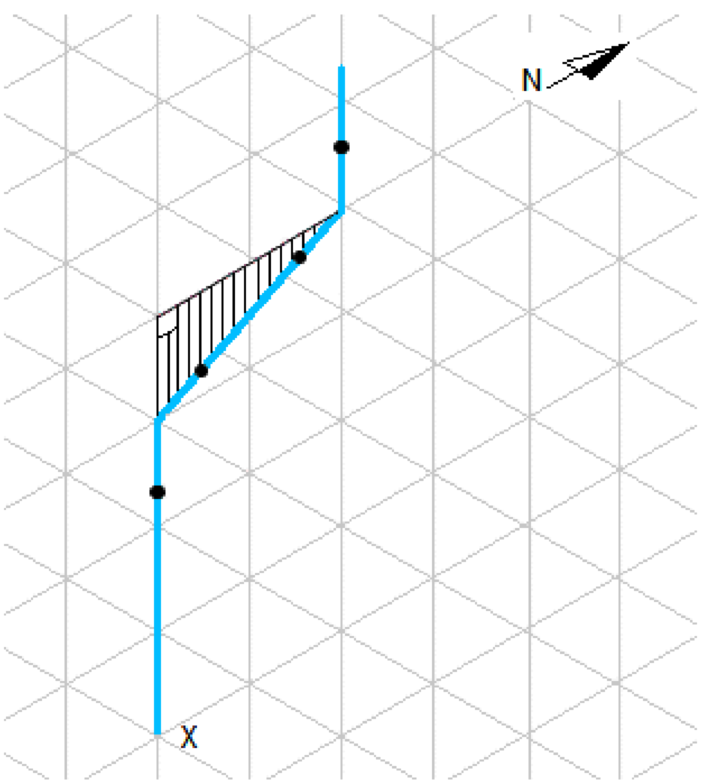
ISOMETRIC OFFSETS – Example 1



Routing starting point X

? Pipe runs up
? Pipe runs up and to the east
? Pipe runs up

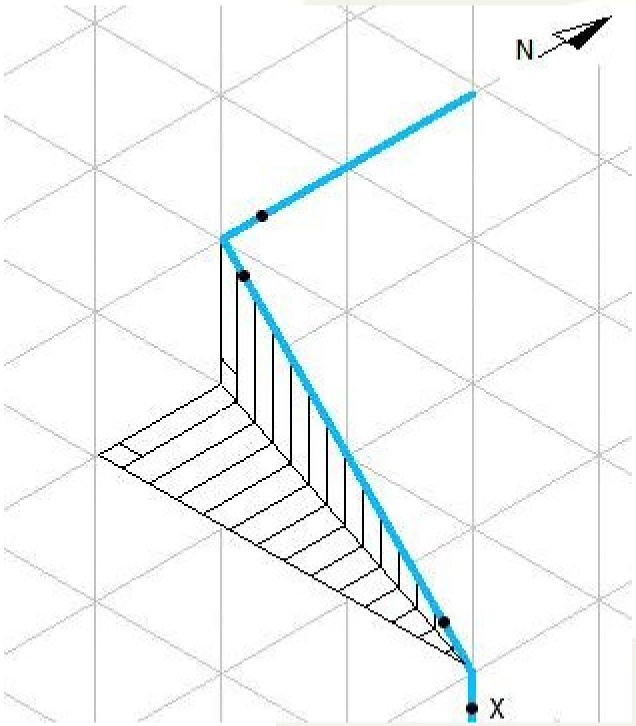
ISOMETRIC OFFSETS – Example 2



Routing starting point X

? Pipe runs up
? Pipe runs up and to the north
? Pipe runs up

ISOMETRIC OFFSETS – Example 3



Routing starting point X

? Pipe runs up
? Pipe runs up and to the north-west
? Pipe runs to the north

ISOMETRIC DRAWING OFFSETS

Calculating Isometric Offsets

Although you can "get away" with an educated guess as to making an angular offset easy to see when laying out an isometric, you can't make a "guess-ti-mate" when it comes to determining pipe lengths and angles.

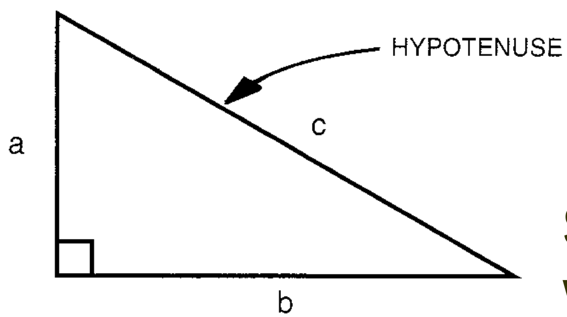
So, pull out the old calculator, paper, pencil & a BIG eraser and let's get started.

ISOMETRIC DRAWING OFFSETS

Calculating Isometric Offsets

The "basic" calculations any pipe drafter uses are those involving trigonometry and right angles.

Pythagoras, a 6th century B.C. Greek philosopher, came up with a way to deal with calculations involving right angles… and it's called the…



$$a = \sqrt{c^2 - b^2}$$
$$b = \sqrt{c^2 - a^2}$$
$$c = \sqrt{a^2 + b^2}$$

Pythagorean Theorem

Simply, what Pythagoras concluded was that when working with right angle triangles the square of the hypotenuse is equal to the sum of the squares of the two sides.

$$c^2 = a^2 + b^2$$

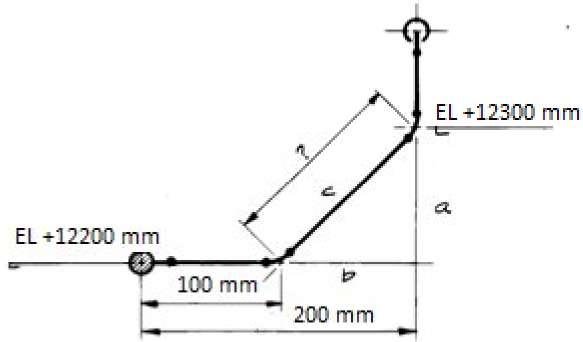
ISOMETRIC DRAWING OFFSETS

Calculating Isometric Offsets

Start off with what's given or what you can determine from the pipe drawing itself.

a) We are given an 45° angle rise, that clues us in on the fact that the two sides of our triangle are going to be the same length

b) By doing simple subtraction, we can come up with the length for side B: 200-100 = 100 mm OR you can subtract the elevations given and get the same dimension for side A.



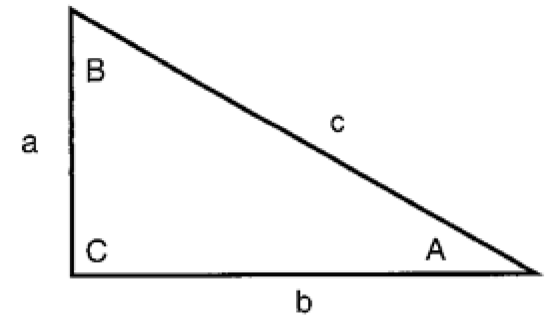
Since B = A: side A = 100 mm as well. So, C= Sq. Rt (100^2+100^2) = 141.21 mm

ISOMETRIC DRAWING OFFSETS

Calculating Isometric Offsets

"TRIG" function formulas:

There are three basic "trig" function formulas that are frequently used in piping:



Sin = SO/HYP

Cos = SA/HYP

Tan = SO/SA

When angle A is used, a is the side opposite (SO) and b is the side adjacent (SA).

When angle B is used, a is the side adjacent (SA) and b is the side opposite (SO).

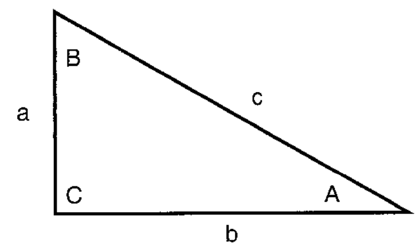
ISOMETRIC DRAWING OFFSETS

Calculating Isometric Offsets

“TRIG” function formulas:

Get familiar with the formulas for solving angles and lengths in piping offsets.

FORMULAS FOR RIGHT ANGLE TRIANGLES



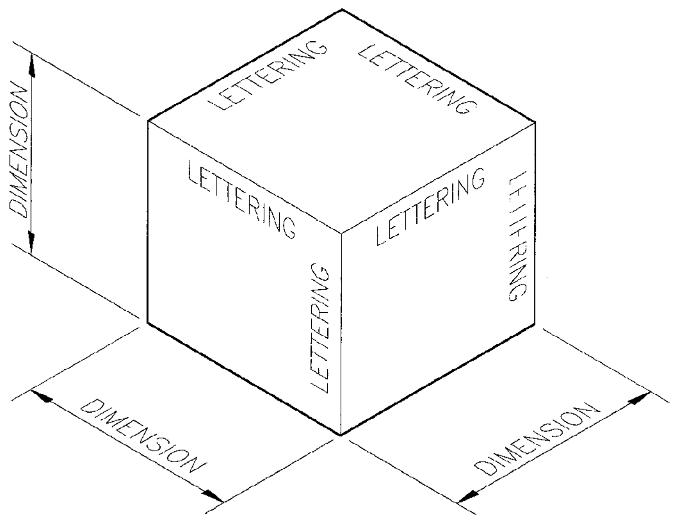
$$a = \sqrt{c^2 - b^2}$$
$$b = \sqrt{c^2 - a^2}$$
$$c = \sqrt{a^2 + b^2}$$

Known	Required					
	A	**B**	**a**	**b**	**c**	**Area**
a, b	$\text{Tan } A = \frac{a}{b}$	$\text{Tan } B = \frac{b}{a}$			$\sqrt{a^2 + b^2}$	$\frac{ab}{2}$
a, c	$\text{Sin } A = \frac{a}{c}$	$\text{Cos } B = \frac{a}{c}$		$\sqrt{c^2 - a^2}$		$\frac{a\sqrt{c^2 - a^2}}{2}$
A, a		$90° - A$		a Cot A	$\frac{a}{\text{Sin } A}$	$\frac{a^2 \text{ Cot } A}{2}$
A, b		$90° - A$	b Tan A		$\frac{b}{\text{Cos } A}$	$\frac{b^2 \text{ Tan } A}{2}$
A, c		$90° - A$	c Sin A	C Cos A		$\frac{C^2 \text{ Sin } 2A}{4}$

ISO DRAWINGS - Dimensions

Basic guidelines for lettering isometric drawings:

- If the pipe's vertical, the lettering should be written vertically and at 30° angle
- If pipe is in horizontal plane, the lettering will appear as if it is lying down and will be oriented on both 30° angles



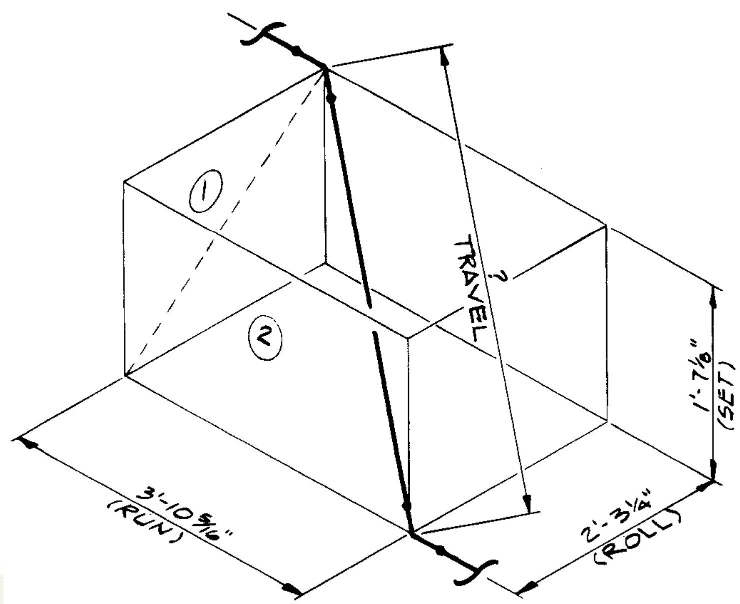
- Dimensions appear to be lying down if the pipe is horizontal or standing on end if the pipe is vertical.

ISO DRAWINGS - Dimensions

Solving Compound Angles:

When piping has to be "snaked" through equipment, steel, and other pipe, the pipe may be *rolled* along with the offset.

This type of piping design is called a rolling offset and forms a compound angle.



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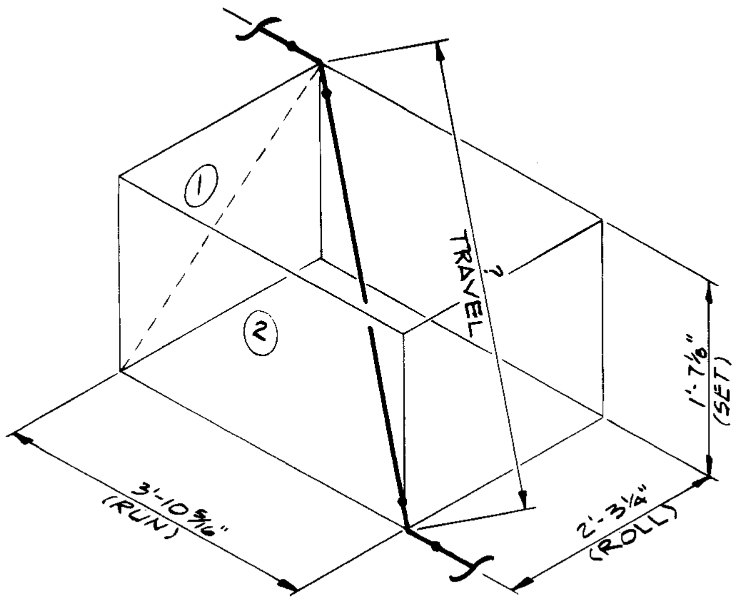
ISO DRAWINGS - Dimensions

FIELD PIPING ENGINEERING

Solving Compound Angles:

Four terms associated with a rolling offset configuration:

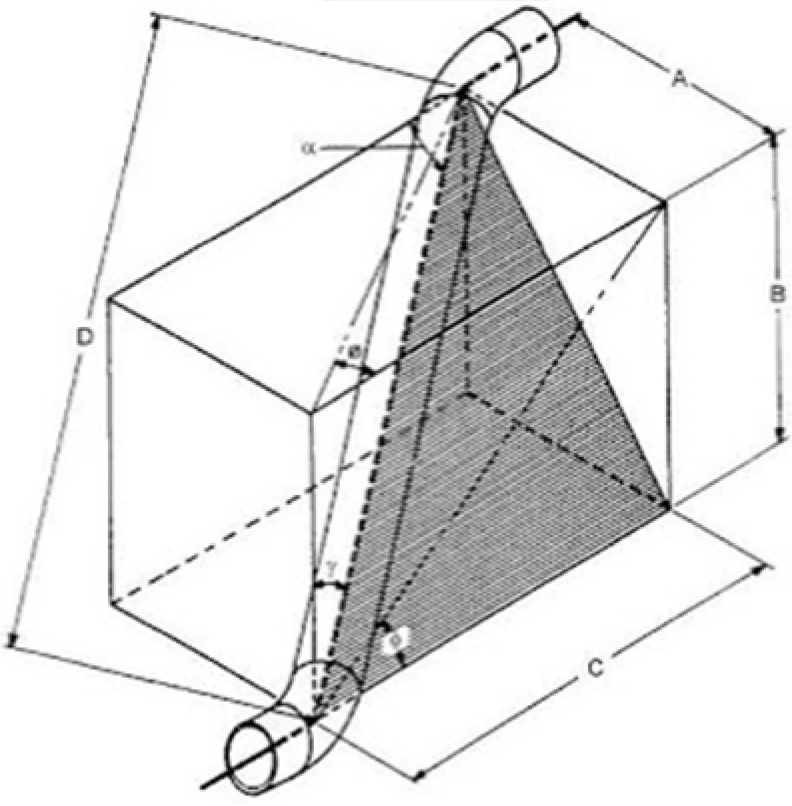
- ✓ RUN: Length of total offset in direction of pipe run
- ✓ SET: Depth of offset
- ✓ ROLL: Breadth of offset
- ✓ TRAVEL: True length of pipe through offset



FIELD PIPING ENGINEERING

ISO DRAWINGS - Dimensions

Dimensioning Calculations



GIVEN: A, B, C

$$D = \sqrt{A^2 + B^2 + C^2}$$

$$TAN\ \alpha = \frac{\sqrt{A^2 + B^2}}{C}$$

$$TAN\ \gamma = \frac{\sqrt{A^2 + C^2}}{B}$$

GIVEN: A, B, γ

$$C = \sqrt{(B\ TAN\ \gamma)^2 - A^2}$$

$$D = \frac{B}{COS\ \gamma}$$

$$SIN\ \alpha = \frac{COS\ \gamma \sqrt{A^2 + B^2}}{B}$$

GIVEN: A, B, α

$$C = \frac{\sqrt{A^2 + B^2}}{TAN\ \alpha}$$

$$D = \frac{\sqrt{A^2 + B^2}}{SIN\ \alpha}$$

$$COS\ \gamma = \frac{B\ SIN\ \alpha}{\sqrt{A^2 + B^2}}$$

GIVEN: A, C, α

$$B = \sqrt{(C\ TAN\ \alpha)^2 - A^2}$$

$$D = \frac{C}{COS\ \alpha}$$

$$SIN\ \gamma = \frac{COS\ \alpha \sqrt{A^2 + C^2}}{C}$$

GIVEN: A, C, γ

$$B = \frac{\sqrt{A^2 + C^2}}{TAN\ \gamma}$$

$$D = \frac{\sqrt{A^2 + C^2}}{SIN\ \gamma}$$

$$COS\ \alpha = \frac{C\ SIN\ \gamma}{\sqrt{A^2 + C^2}}$$

GIVEN: B, C, γ

$$A = \sqrt{(B\ TAN\ \gamma)^2 - C^2}$$

$$D = \frac{B}{COS\ \gamma}$$

$$COS\ \alpha = \frac{C\ COS\ \gamma}{B}$$

GIVEN: B, C, α

$$A = \sqrt{(C\ TAN\ \alpha)^2 - B^2}$$

$$D = \frac{C}{COS\ \alpha}$$

$$COS\ \gamma = \frac{B\ COS\ \alpha}{C}$$

WHEN α = 45°

$$D = \sqrt{2(A^2 + B^2)}$$

$$TAN\ \emptyset = \frac{A}{\sqrt{A^2 + B^2}}$$

$$TAN\ \phi = \frac{B}{\sqrt{A^2 + B^2}}$$

$$C = \sqrt{A^2 + B^2}$$

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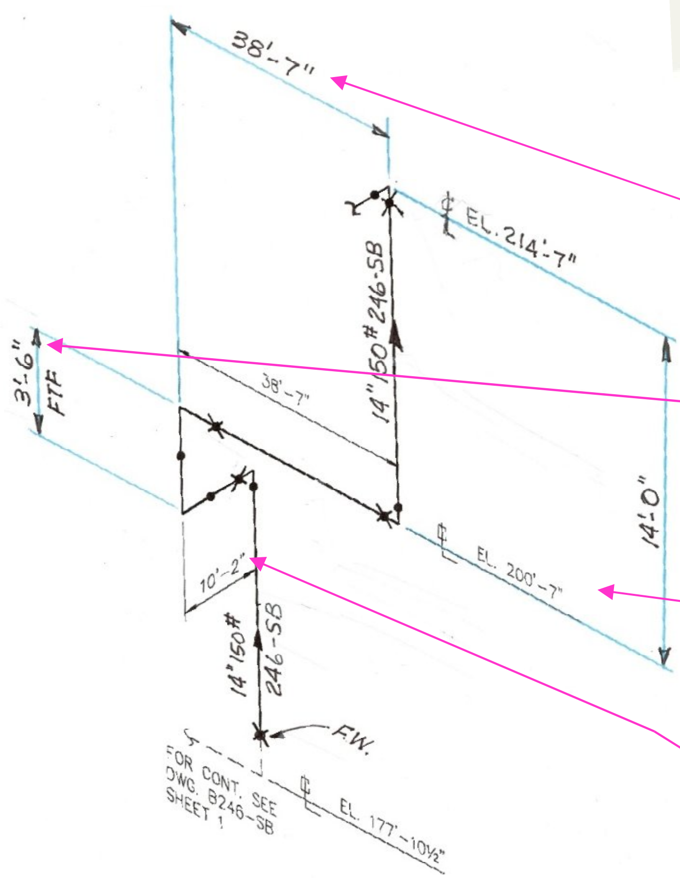
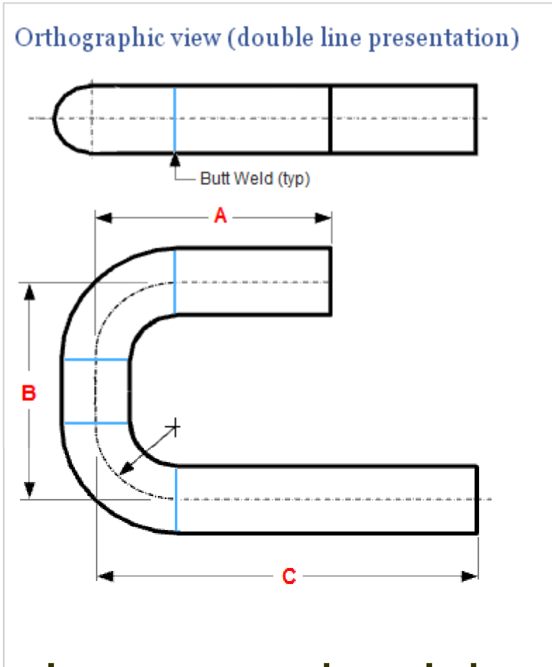
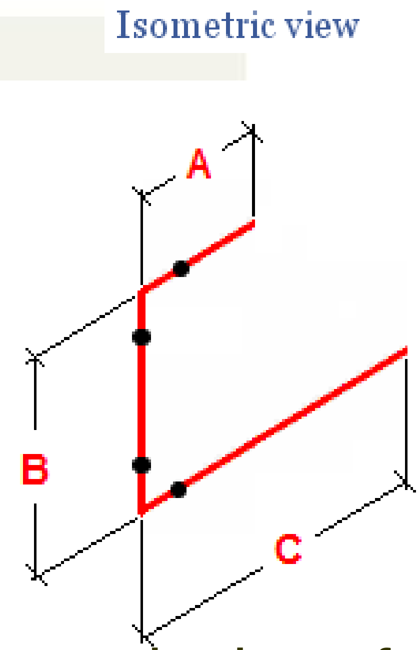
DIMENSIONING PRACTICES:



1. Best way to dimension a pipe is to its centerline at the intersection point
2. Try to keep all dimensions outside the piping view when possible
3. Dimensions should ALWAYS be shown between points in the same plane
4. One of the extension lines of the dimension should be a centerline of the run of pipe
5. Vertical lines of text should always be parallel with extension lines

ISO Vs ORTHOGRAPHIC





? The image on the right shows a isometric view of the same pipe as here on the left.

? The red lines show the pipe, the black dots are the butt welds and A, B & C are the dimensions of front to center line and center line to center line.

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ISO Vs ORTHOGRAPHIC

- ? Simplicity (Only one line drawn to represent a pipe)
- ? In a orthographic view it is not a problem if the pipe runs in one plane, but when a pipe in two or three planes (north to south, then down and then to the west, etc.) to be drawn, a orthographic view can be unclear.
- ? More number of drawings needed in orthographic views than ISO to represent the same piping system.
  - ? For example: for a complex pipeline system, 15 isometrics must be drawn. But in orthographic views maybe 50 drawings are needed to show the same as the ISO's.

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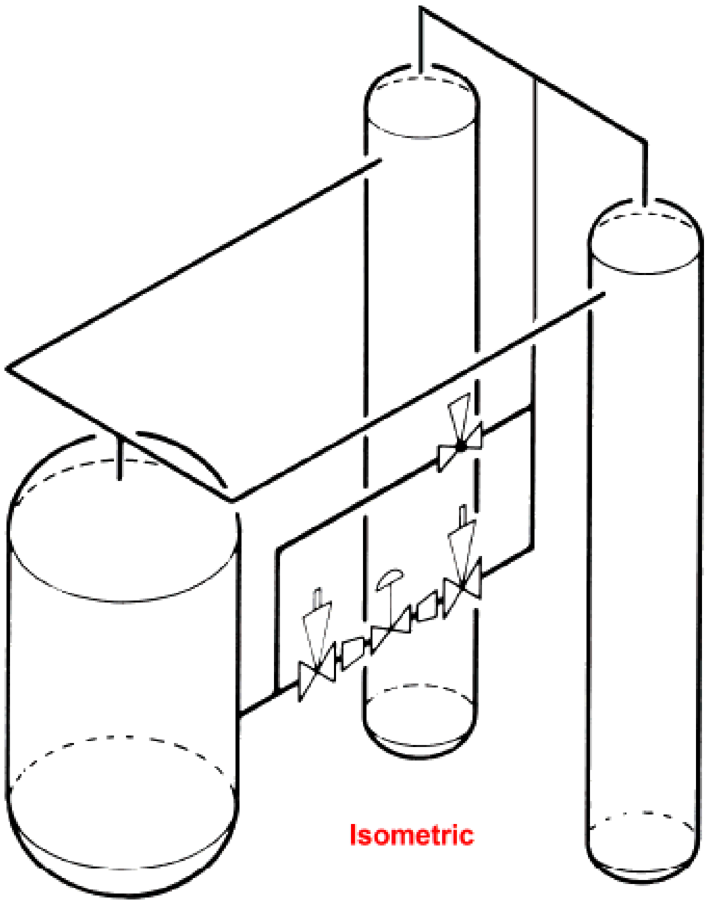
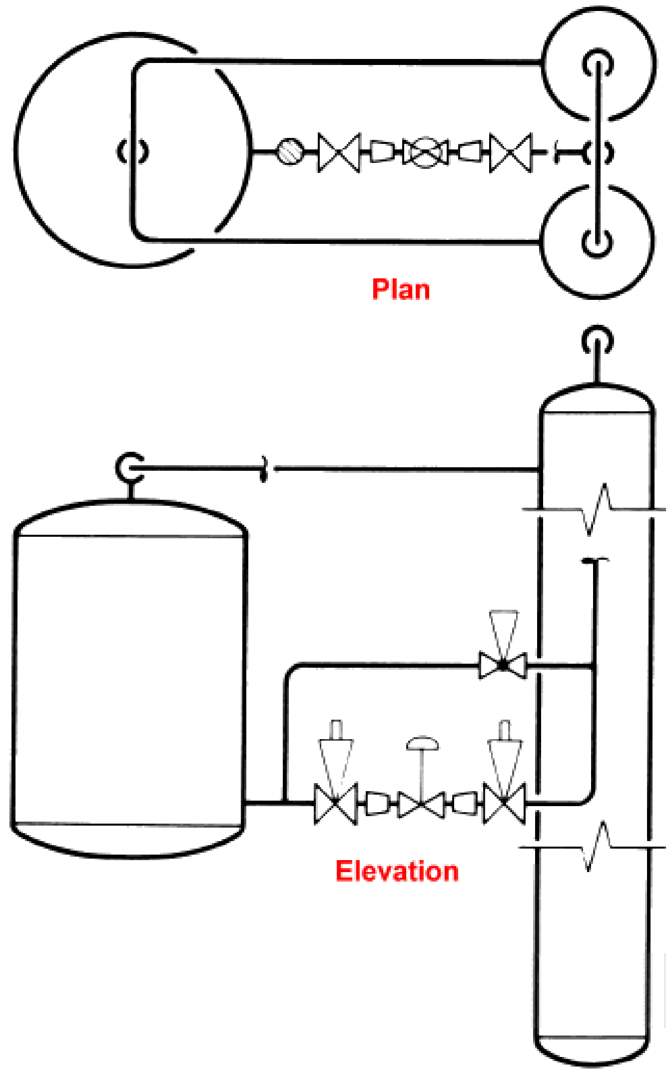
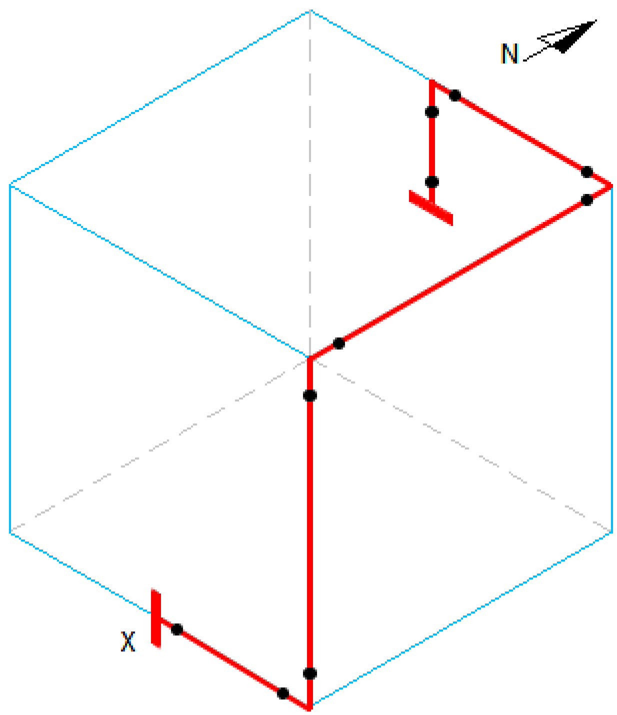
ISOMETRIC Vs PLAN Vs ELEVATION





FIELD PIPING ENGINEERING

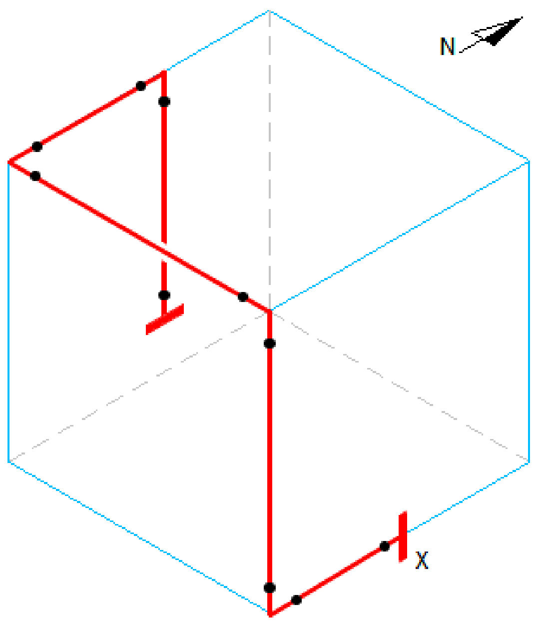
ISOMETRIC VIEWS – Example 1



Routing starting point X

- Pipe runs to the east
- Pipe runs up
- Pipe runs to the north
- Pipe runs to the west
- Pipe runs down

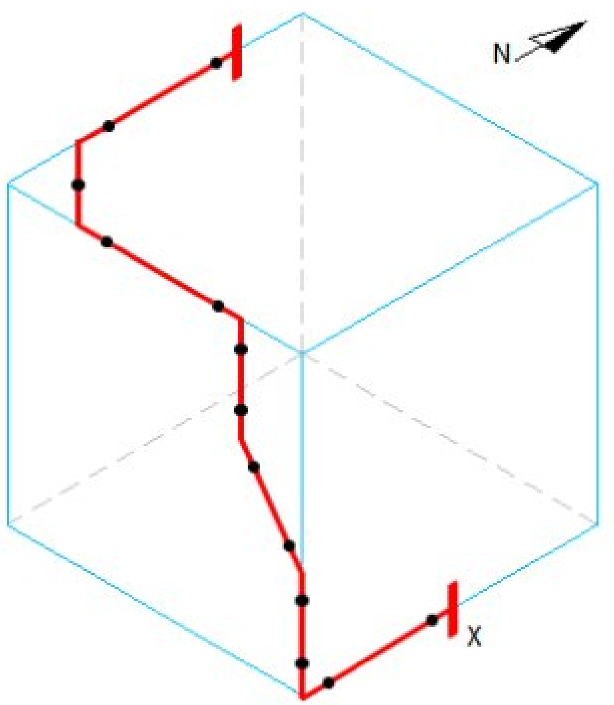
ISOMETRIC VIEWS – Example 2



Routing starting point X

- Pipe runs to the south
- Pipe runs up
- Pipe runs to the west
- Pipe runs to the north
- Pipe runs down

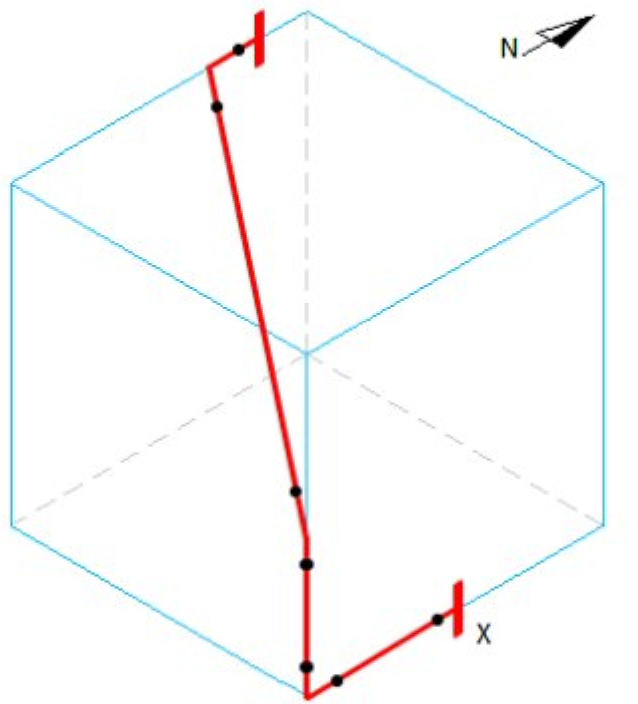
ISOMETRIC VIEWS – Example 3



Routing starting point X

- Pipe runs to the south
- Pipe runs up
- Pipe runs up and to the west
- Pipe runs up
- Pipe runs to the west
- Pipe runs to the north-west
- Pipe runs to the north

ISOMETRIC VIEWS – Example 4

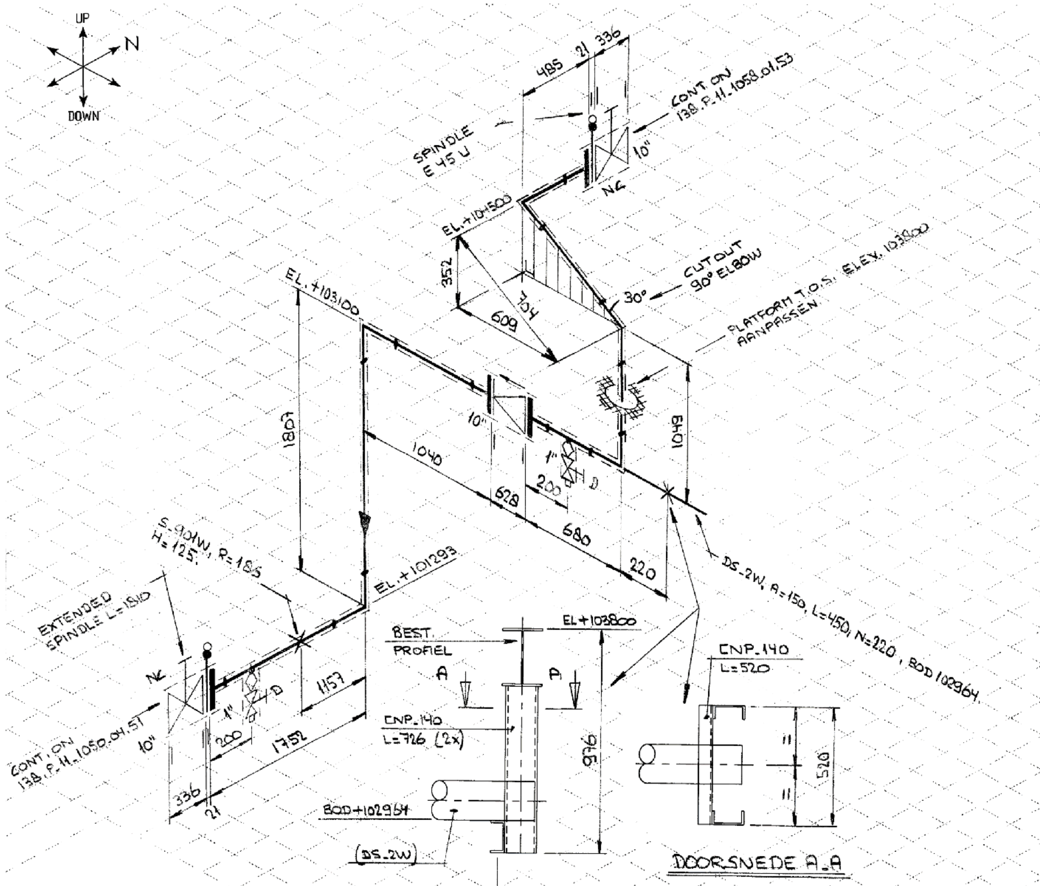


Routing starting point X

- Pipe runs to the south
- Pipe runs up
- Pipe runs up and to the north-west
- Pipe runs to the north

FIELD PIPING ENGINEERING

HAND-DRAWN ISOMETRIC



NOTES :

1. ALL DIMENSIONS SHALL BE VERIFIED BY PIPING CONTRACTOR BEFORE FABRICATION
2. FIELD WELDS AND OVERLENGTHS TO BE DETERMINED BY PIPING CONTRACTOR

REV	BY	DATE	DESCRIPTION	CHK'D
5				
4				
3				
2				
1	FC/MH	AUG-08	AS BUILT FOR PROJ. RMO/07045	
0	CCN	AUG.'07	FIRST ISSUE	

LIST OF MATERIAL REQUIRED

QTY	SIZE	MATERIAL	DESCRIPTION
0,6m	6"	A106B/A520	PIPE SCH. 40 (SUPPORT)
3,7m	10"	A106B/A520	PIPE SCH. 40
5	10"	A234_WPB	ELBOW 90° LR BW SCH.40
4	10"	A105_N	WN. FLANGE 150# RF SCH.40
2	10"	A515_GR.65	SPECTABLE BL. 150# RF
2	10"x1"	A105_N	NIPOLET PE 3000#
2	1"	A105_N	PLUG 3000# THR'D
2	10"	A216_WCB	GATE VALVE 150# RF
1	10"	A216_WCB	CHECK VALVE 150# RF SWING
2	1"	A105_N	GATE VALVE 800# SWxTHR'D
8	10"	SP.W.	GASKET 150# RF.
48	7/8"x120	A193B7/A194 2H	STUDS & NUTS
24	7/8"x140	A193B7 A194 2H	STUDS & NUTS
1	10"		EXTENDED SPINDLE L=1810

INSULATED	∠ 50 mm	~~NO~~	YES
x " STEAM TRACING	barg	NO	~~YES~~
P.E.D. APPROVAL/MODULE :	II / A1	~~NO~~	YES
DANGER CAT.	I	X-RAY	
DESIGN PRESS./TEMP.		17,6 barg	65 °C
OPERATING PRESS./TEMP		13,6 barg	15 °C
TEST PRESS./TEMP.		27,4 barg	°C

REFERENCE DRAWINGS

DRAWING NUMBER	DESCRIPTION
POSM.11.M.1026	P&I DIAGRAM

MAIN LINE SIZE 10"

SPECIFICATION : 1CS1P.1

LINE NUMBER: P.11.0150.1602

EXPLORE the WORLD of PIPING

JOB NO. : 07045

AREA	ISO	REV
138	P.11.0150.1602	1