



Before You Begin



1.1 INTRODUCTION

In order to execute the piping designs of a project efficiently, it is essential that you initially identify and address all of the prerequisites that must be in place for the piping designers to start work. In order to do this you must first recognize all the questions that must be asked and answered, assemble all the needed tools, and make decisions accordingly. As you progress in your career you will find that this ability is required for any project, and that the best piping leads are those who can create missing tools when the need arises.

The intent of this chapter is to provoke your thought process: it focuses on the questions to ask and the tools required in order to begin a project. Do you have everything you need to proceed?

A first step is to assemble and then make yourself familiar with the engineering company and/or client standards, specifications, and procedures to be used on the project. Larger clients will have certain requirements in place and mandate that those requirements be used on the project, whereas smaller clients will likely default entirely to the engineering company. Generally speaking, all projects will use a combination of engineering company and client standards, specifications, and procedures. You must ensure that you know which you are using and where they come from. As a piping lead it is doubly important to familiarize yourself with these requirements, not just so you can guide your team, but because you will likely have to explain your design basis to other departments and sometimes even to the client themselves. It is also up to you to insist that they be respected and adhered to, or that a formal deviation be approved by the client. On this note, you must inform yourself of the deviation procedure to be used on the project.

- Examples of standards are as follows:
 - Standard fabrication and installation details/drawings such as shoe design and base ell supports.

- Drawing standards such as layering, text heights, and drawing symbols.
- Charts such as line spacing within racks.
- Examples of specifications are piping classes, equipment spacing requirements, and egress and ingress requirements (walkways, platforms, and ladders).
- Examples of procedures are drawing reviews, model reviews, checking, and as-building.

Below are some brief explanations of standards, specifications, and procedures, and their most likely sources. There are no guarantees, so you will have to investigate each in turn. As we progress into further chapters we will highlight these in more detail, discuss the importance of decision making at an early stage, and discuss the links between the topics. Once you have investigated, assembled, and made all your decisions, you are ready to go, and you have set yourself on a path toward a successful piping execution. By the time you have completed your initial set-up you will have a greater understanding of the project, the expectations, and how you will achieve those expectations. Knowing the reasons behind all of the decisions you have made or helped to make will put you in a position to recognize when things are going wrong, and will aid greatly later in correcting them.



1.2 STANDARDS

To determine whether the standards to be used are going to come from your own company or your client, you must consult with your project management team and the client.

Standards include the following:

- Standard drawings
- Charts
- Drawing templates and drawing standards
- Drawing numbering
- 3D model numbering
- Material commodity codes

1.2.1 Standard drawings

Standard drawings are typical fabrication and installation details of commonly encountered items. These are assigned a tag number for easy reference on the piping arrangements and isometrics. The use of a standard

avoids detailing the same thing time after time. Commonly, standard drawings are as follows:

- Shoes
- Anchors: fixed and directional
- Guides
- Base ell supports
- Dummy legs
- Trunnions
- Field supports
- Reinforcing pads
- Slide plates
- Tracing details
- Insulation details
- Instrument connection details
- Orifice tap orientations
- Block and bleed details
- Vents and drains
- Utility Stations
- Heat Trace Manifolds

Where suitable, a standard will cover more than one Nominal Pipe Size (NPS), so that one fit for purpose design may be used on a range of pipe sizes. For instance, all companies will have shoe designs that will cover a range similar to the ones below:

- NPS 6 and under
- NPS 8 to NPS 12
- NPS 14 to NPS 18
- NPS 20 to NPS 24

You will find that companies mercilessly plagiarize from each other, and most likely you will recognize standards that you have used before as you move from one company to another. You may even see a standard that you created or helped to create being used by another company.

Examples of standards are shown in [Figs. 1.1–1.7](#).

1.2.2 Charts

There are three charts that are the most important to the piping designers and must be in place:

- Branch connection (can vary by piping class and may be included within the piping classes)
- Line spacing
- Line spanning

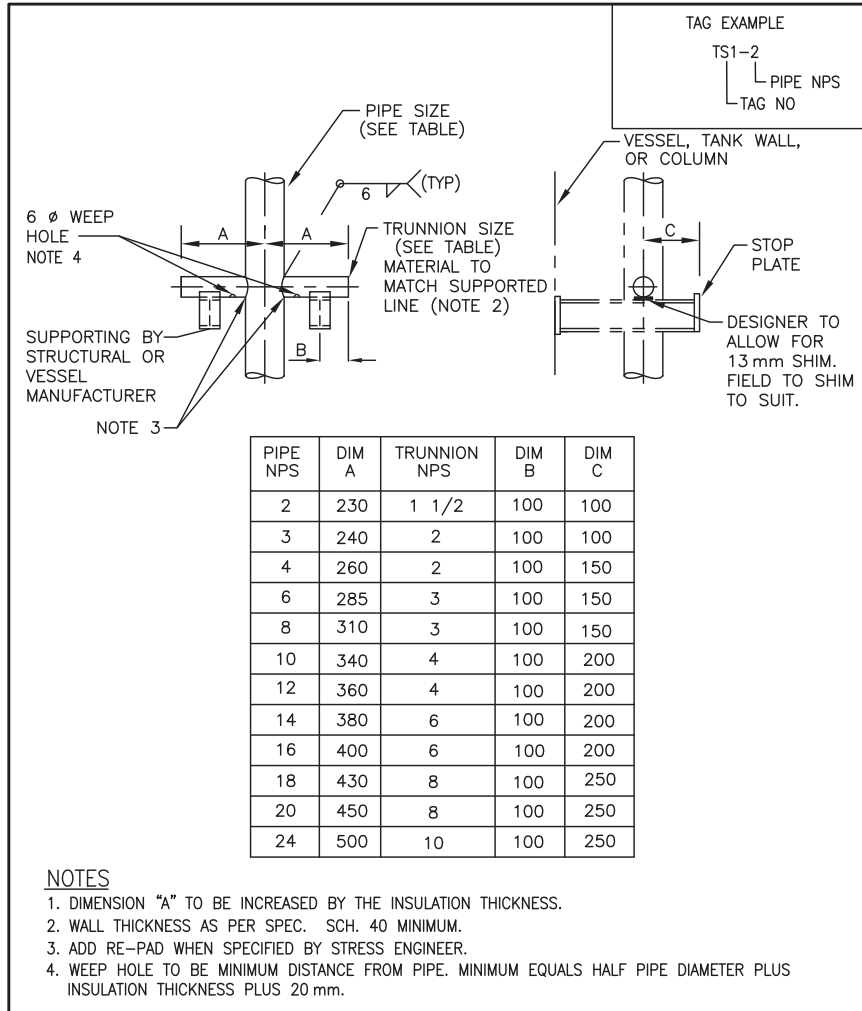


Figure 1.2 Trunnion support.

allows for approximately 3 in. (76 mm) of pipe length between the shell and a weld neck flange. This length is required for welding and removal of stud bolts. An example of a Nozzle Projection Chart is Table 1.5. A nozzle chart is useful for discussion with the mechanical group and study work prior to the receipt of vendor drawings.

1.2.3 Drawing templates and drawing standards

Drawing templates are required for the drawings that are to be created for the project. There are four common drawing templates for four plot sizes depending on drawing type and/or scale factor:

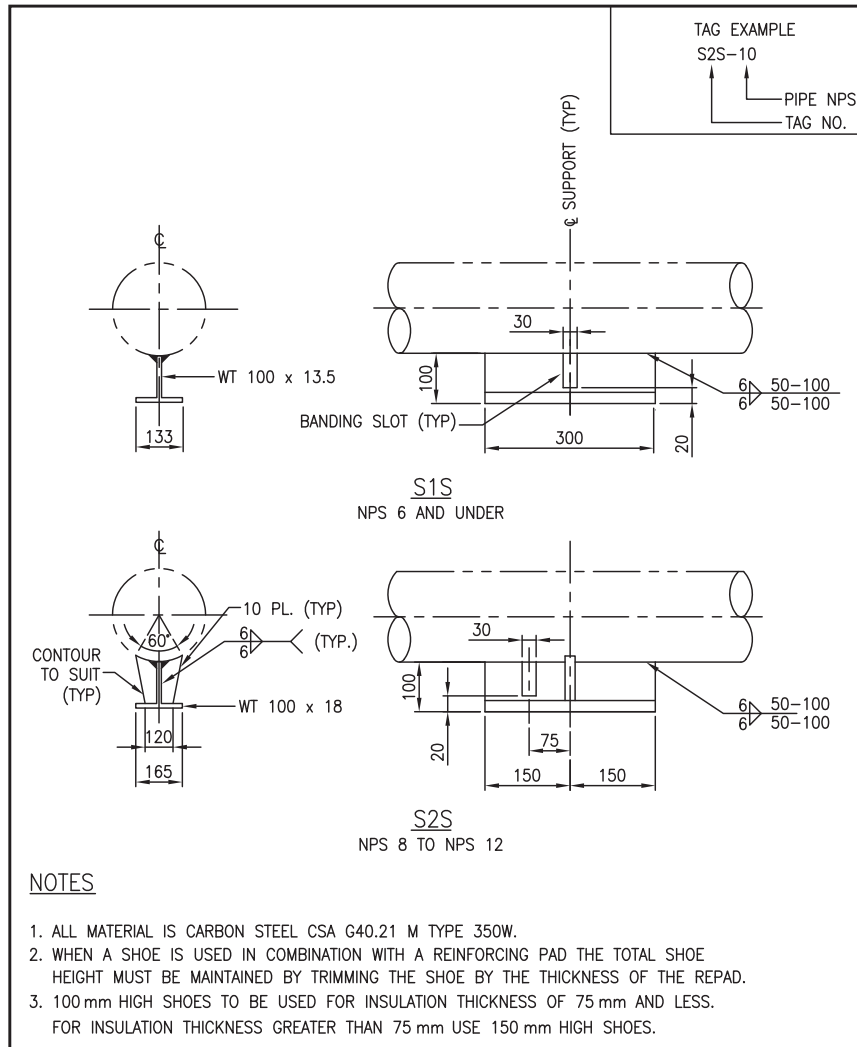


Figure 1.4 Pipe shoe.

- ISO A series paper sizes used in the rest of the world:
 - A4—210 mm × 297 mm (e.g., standards).
 - A3—297 mm × 420 mm (e.g., isometrics).
 - A1—594 mm × 841 mm (e.g., PFDs, P&IDs, and piping arrangements).
 - A0—841 mm × 1189 mm (e.g., plot plans, equipment location plans, and key plans).

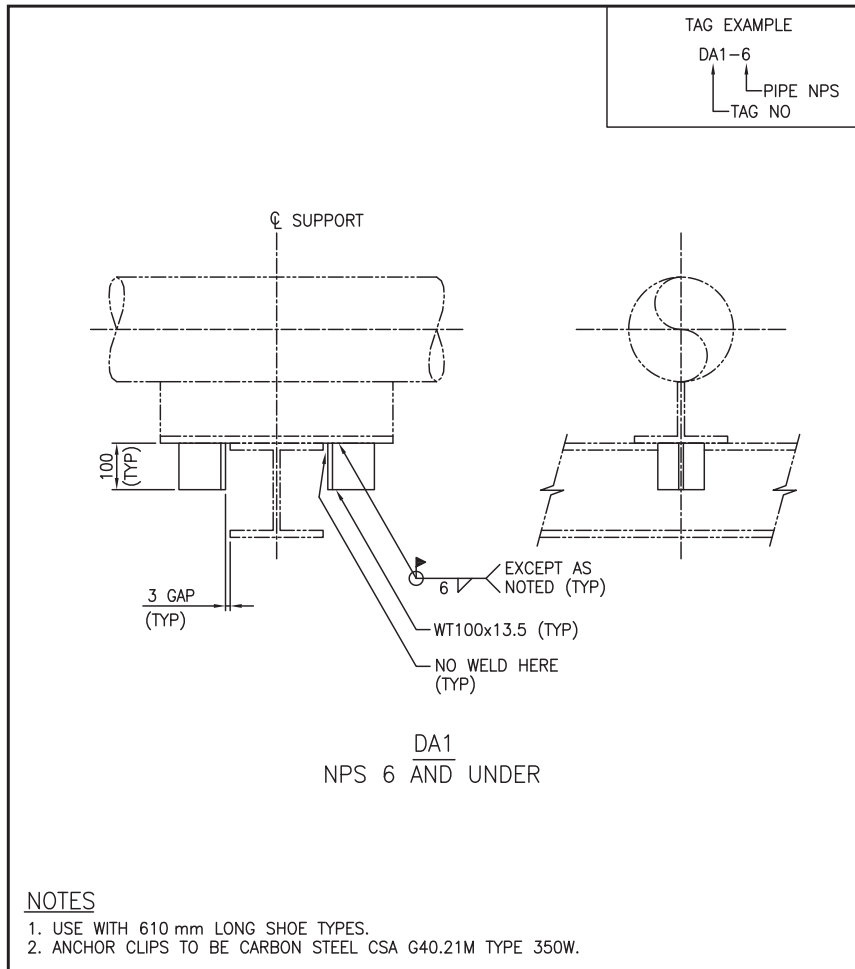


Figure 1.5 Directional anchor NPS 6 and under.

ANSI C (17" × 22") and ISO A2 (420 mm × 594 mm) paper sizes are usually reserved for reduced size plots of ANSI D and E, and ISO A1 and A0. This is due to being a convenient handling size while retaining a large enough drawing size for clarity and mark-ups.

It is most likely that the client will have drawing templates for three of the four drawing sizes, ANSI A, D, and E, or ISO A4, A1, and A0, that they will require you to use on their project. For the construction isometric template, ANSI B/ISO A3, the client will most often defer to the engineering company. This is because, unlike the other drawings,

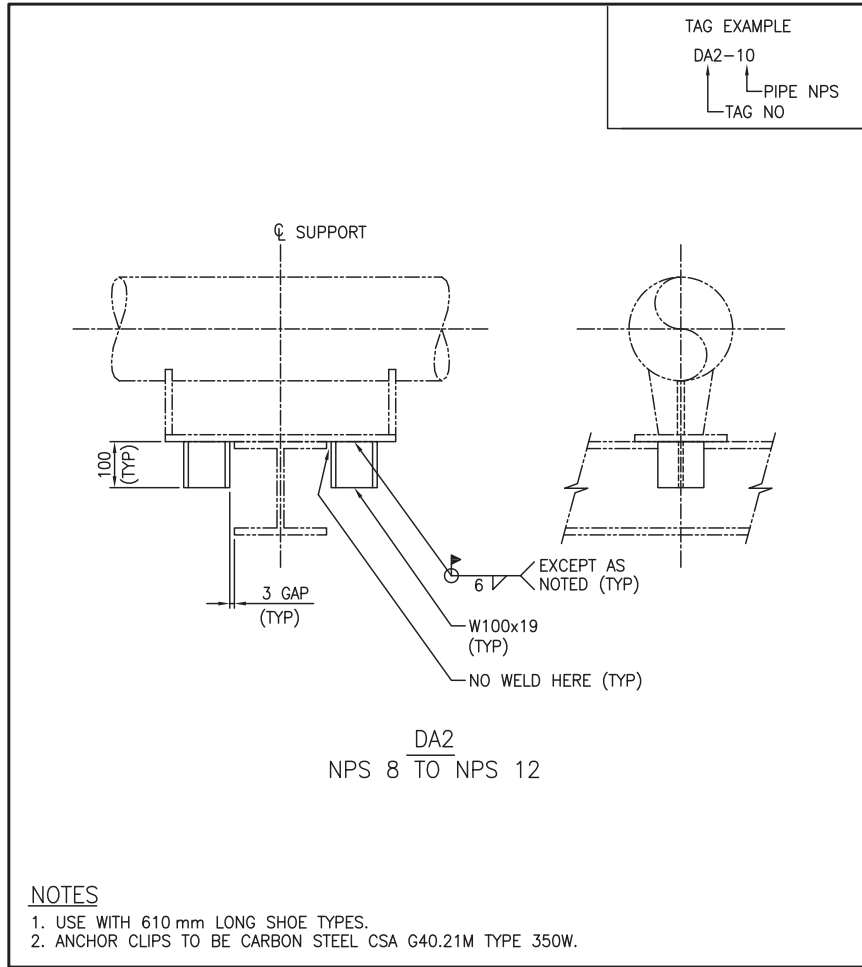


Figure 1.6 Directional anchor NPS 8 to NPS 12.

construction isometrics are not usually issued to future engineering companies to be revised on future projects. After project close-out, these isometrics commonly become for-information-only historical records retained for reference only, negating the need for client drawing template and drawing numbering formats. Additionally, on projects utilizing 3D CAD, engineering companies routinely incorporate a construction isometric template linked to the database for data extraction (e.g., data from the Line Designation Tables, LDT) as part of their CAD set-up.

Drawing templates have predetermined drawing standards as part of their set-up, so that when a drawing is plotted, the text heights, line weights, etc., will be to the correct dimensions.

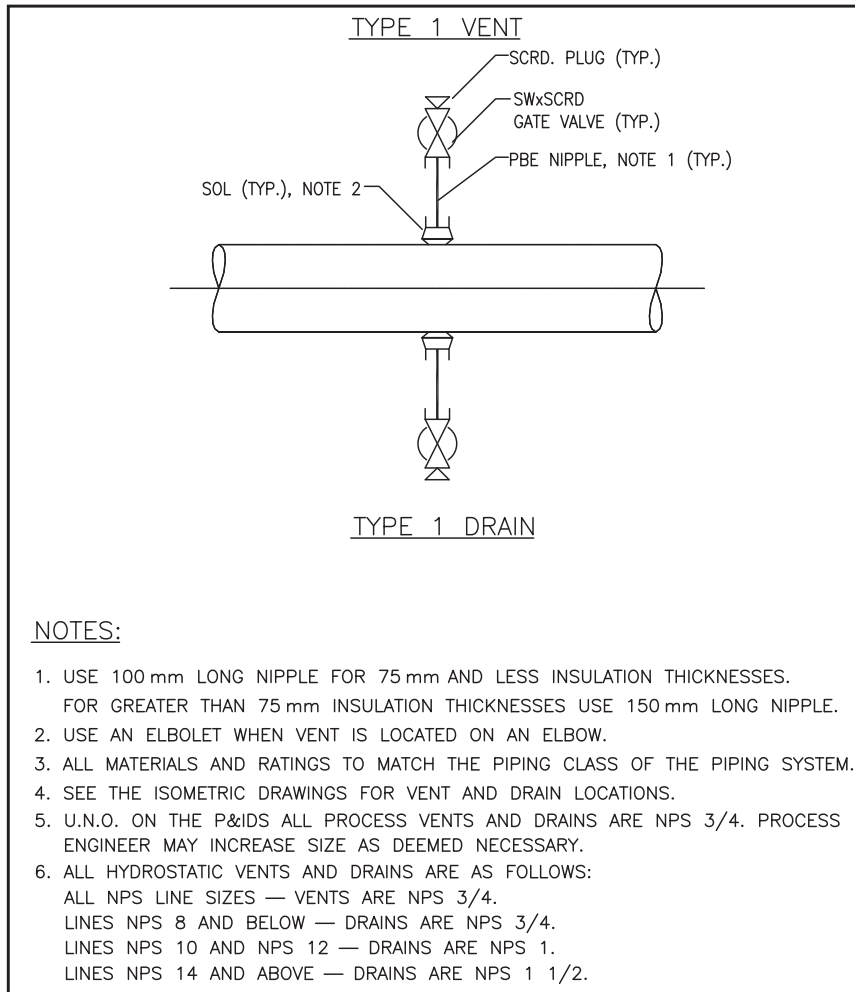


Figure 1.7 Single block vent and drain.

Drawing standards include the following:

- Titleblock with company logo
- Text heights
- Layering system
- Line weights
- Dimension styles

A client requirement to be investigated is the filling in of the title-block. The document management software used by the client may be set up to scrub meta-data from the attributes in the 2D CAD file and for this

Table 1.1 Branch connections process lines

		Branch Pipe Size (NPS)															
		1/2	3/4	1	1 1/2	2	3	4	6	8	10	12	14	16	18	20	24
Run Pipe Size (NPS)	1/2	T															
	3/4	RT	T														
	1	RT	RT	T													
	1 1/2	T&S	RT	RT	T												
	2	Olet	Olet	Olet	T&S	T											
	3	Olet	Olet	Olet	Olet	RT	T										
	4	Olet	Olet	Olet	Olet	WOL	RT	T									
	6	Olet	Olet	Olet	Olet	WOL	RT	RT	T								
	8	Olet	Olet	Olet	Olet	WOL	WOL	RT	RT	T							
	10	Olet	Olet	Olet	Olet	WOL	WOL	RT	RT	RT	T						
	12	Olet	Olet	Olet	Olet	WOL	WOL	WOL	RT	RT	RT	T					
	14	Olet	Olet	Olet	Olet	WOL	WOL	WOL	RT	RT	RT	RT	T				
	16	Olet	Olet	Olet	Olet	WOL	WOL	WOL	RT	RT	RT	RT	RT	T			
	18	Olet	Olet	Olet	Olet	WOL	WOL	WOL	WOL	RT	RT	RT	RT	RT	T		
	20	Olet	Olet	Olet	Olet	WOL	WOL	WOL	WOL	RT	RT	RT	RT	RT	RT	T	
	24	Olet	Olet	Olet	Olet	WOL	WOL	WOL	WOL	WOL	RT	RT	RT	RT	RT	RT	T

Olet = socketweld or threaded end and rating as defined in the applicable piping class

WOL = bevelled end and schedule as defined in the applicable piping class

T = Straight Tee with ends and schedule or rating as defined in the applicable piping class

RT = Reducing Tee with ends and schedule or rating as defined in the applicable piping class

T&S = Straight Tee and Swage with ends and schedule as defined in the applicable piping class

Note: Reducing Tees may be used in place of Olet/WOL if available.

Table 1.2 Branch connections instrument and utility air

		Branch Pipe Size (NPS)											
		1/2	3/4	1	1 1/2	2	3	4					
Run Pipe Size (NPS)	1/2	T											
	3/4	RT							T				
	1	RT							RT	T			
	1 1/2	T&S							RT	RT	T		
	2	T&S							T&S	RT	RT	T	
	3	T&S							T&S	T&S	RT	RT	T
	4	T&S							T&S	T&S	T&S	RT	RT

T = Straight Tee with threaded ends

RT = Reducing Tee with threaded ends

T&S = Straight Tee and Swage with threaded ends

reason many clients have strict instruction on exactly how certain information is to be typed in. For instance, drawing titles may have to be arranged on three or four lines of text in a particular order (e.g., Operating Area/Plant Name/Plant Area/Drawing Description) and certain characters and formats may be governed (e.g., date format of DD/MM/YYYY or MM-DD-YYYY).

Other forms of drawing standards that you will require are drawing symbols legend sheets and drafting abbreviations. Primarily, the legend sheets you will require are going to be the PFD and P&ID legend sheets from the client that contain all the approved symbols to be used on the drawings. Drafting abbreviations come from various industry organizations, e.g., ANSI, ASME, and ISA. The most commonly used ones are often summarized as a company standard. See [Appendix A](#) for an example of drafting abbreviations used on piping drawings.

1.2.4 Drawing numbering

Commonly, with the exception of the construction isometrics, clients have drawing numbering requirements. Each client mandates the drawing numbering to be used. File numbering, which ideally should equate to

Table 1.3 Line spacing chart

RATING		150#															
SIZE	1"	1 1/2"	2"	3"	4"	6"	8"	10"	12"	14"	16"	18"	20"	24"			
1"	115																
1 1/2"	130	130															
2"	135	145	155														
3"	155	165	180	180													
4"	180	180	180	205	205												
6"	205	205	205	230	230	255											
8"	230	230	230	255	255	305	335										
10"	255	255	280	280	305	335	360	385									
12"	305	305	305	335	335	360	385	410	435								
14"	335	335	335	360	360	385	410	435	460	485							
16"	360	360	360	385	385	435	460	485	510	510	535						
18"	375	385	385	410	410	435	460	485	535	535	560	585					
20"	410	410	410	435	435	460	485	535	560	560	585	610	640				
24"	460	460	485	485	510	535	560	585	610	610	640	665	690	740			

RATING		300#															
SIZE	1"	1 1/2"	2"	3"	4"	6"	8"	10"	12"	14"	16"	18"	20"	24"			
1"	130																
1 1/2"	130	130															
2"	130	155	155														
3"	155	180	180	180													
4"	205	230	230	230	255	280											
6"	255	255	255	280	280	305	335										
8"	280	280	280	305	305	360	385	410									
10"	305	335	335	335	360	385	410	435	450								
12"	360	360	360	385	385	410	435	460	490	510							
14"	385	385	385	410	410	460	490	510	535	535	560						
16"	410	410	435	435	460	490	510	535	560	560	585	610					
18"	435	460	460	460	490	510	535	560	585	610	640	665	690				
20"	460	460	485	485	510	535	560	585	610	610	640	665	690	740			
24"	510	510	535	535	560	585	610	640	665	665	690	720	740	790			

RATING		150#															
SIZE	1"	1 1/2"	2"	3"	4"	6"	8"	10"	12"	14"	16"	18"	20"	24"			
1"	130	130	155	180	205	230	255	305	330	360	385	410	460				
1 1/2"	130	130	155	180	205	230	255	305	330	360	385	410	460				
2"	130	155	155	180	205	230	280	305	335	360	385	410	485				
3"	155	180	180	205	230	255	280	335	360	385	410	435	485				
4"	180	180	205	230	255	280	305	335	360	385	410	435	510				
6"	205	230	230	230	255	280	305	335	360	385	435	435	460	535			
8"	255	255	255	280	280	305	335	360	385	410	460	460	485	560			
10"	280	280	280	305	305	360	385	410	435	435	485	485	535	585			
12"	305	335	335	335	360	385	410	435	460	485	510	535	560	610			
14"	360	360	360	385	385	410	435	460	485	510	535	560	585	640			
16"	385	385	385	410	410	460	485	510	535	535	560	585	610	665			
18"	410	410	435	435	460	485	510	535	560	560	585	610	640	690			
20"	435	460	460	460	485	510	535	560	585	610	640	665	690	740			
24"	510	510	535	535	560	585	610	640	665	665	690	715	740	790			

RATING		300#															
SIZE	1"	1 1/2"	2"	3"	4"	6"	8"	10"	12"	14"	16"	18"	20"	24"			
1"	130	130	155	180	205	255	280	305	360	385	410	435	510				
1 1/2"	130	130	155	180	205	230	255	280	335	360	385	410	460	510			
2"	130	155	155	180	205	230	255	280	335	360	385	435	460	535			
3"	155	180	180	205	230	280	305	335	385	410	435	460	535				
4"	205	205	205	230	255	280	305	335	360	385	410	460	490	560			
6"	230	230	255	255	280	305	335	360	385	410	460	490	510	585			
8"	255	280	280	280	305	335	360	385	410	435	490	510	535	610			
10"	305	305	335	335	360	385	410	435	460	460	510	535	560	640			
12"	335	335	360	360	385	410	435	460	490	485	535	560	585	665			
14"	360	360	385	385	410	435	460	485	510	510	535	560	610	665			
16"	410	410	435	435	460	485	510	535	560	585	610	640	665	715			
18"	435	435	460	460	485	510	535	560	585	610	640	665	690	740			
20"	460	460	485	485	510	535	560	585	610	610	640	665	690	740			
24"	535	535	560	560	585	610	640	665	690	715	740	765	815				

RATING		150#															
SIZE	1"	1 1/2"	2"	3"	4"	6"	8"	10"	12"	14"	16"	18"	20"	24"			
1"	130	130	130	155	180	205	230	255	305	335	360	385	410	460			
1 1/2"	130	130	130	155	180	205	230	255	305	335	360	385	410	460			
2"	130	155	155	180	205	230	280	305	335	360	385	410	490				
3"	155	180	180	205	230	255	280	335	360	390	410	435	490				
4"	205	205	205	230	230	255	280	305	335	360	390	410	435	510			
6"	230	230	255	255	280	305	335	360	390	385	435	435	460	535			
8"	255	280	280	280	305	335	360	385	410	435	460	485	510	560			
10"	305	305	335	335	360	385	410	435	460	460	485	510	535	585			
12"	335	335	360	360	385	410	435	460	490	485	510	535	560	610			
14"	360	360	385	385	410	435	460	485	510	510	535	560	585	640			
16"	410	410	435	435	460	485	510	535	560	585	610	640	665	690			
18"	435	435	460	460	485	510	535	560	585	610	640	665	690	740			
20"	460	460	490	490	485	535	560	585	610	610	640	665	690	740			
24"	535	535	560	560	585	610	640	665	690	720	740	765	815				

RATING		600#															
SIZE	1"	1 1/2"	2"	3"	4"	6"	8"	10"	12"	14"	16"	18"	20"	24"			
1"	130																
1 1/2"	130	130															
2"	130	155	155														
3"	155	180	180	180													
4"	205	205	205	230	230												
6"	230	230	255	255	280	305											
8"	255	280	280	280	305	335	360										
10"	305	305	335	335	360	410	410	435									
12"	335	335	360	360	385	410	435	460	485								
14"	360	360	385	385	410	435	460	485	510	510							
16"	410	410	435	435	460	485	510	535	560	585	610						
18"	435	435	460	460	485	510	535	560	585	610	640						
20"	460	460	485	485	510	535	560	585	610	610	640	665					
24"	535	535	560	560	585	610	640	665	690	715	740	765	815				

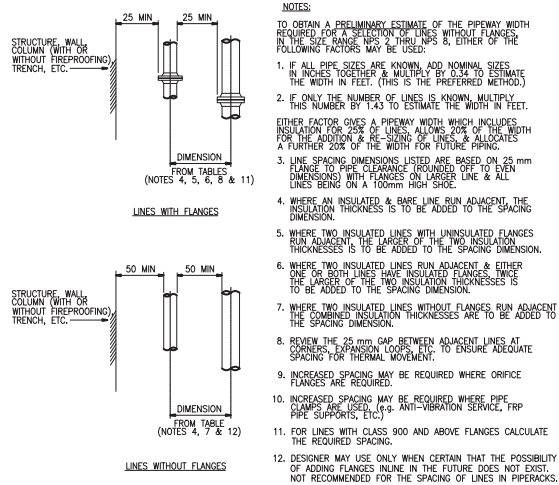


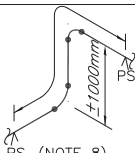


Table 1.4 Line spanning chart

PIPE SUPPORT SPACING										
PIPE SIZE (NPS)	PIPE O.D. (mm)	PIPE SCHEDULE (NOTES 2, 3, 4)	WALL THICKNESS (mm)	WEIGHT OF WATER-FILLED PIPE SPAN (KILOGRAMS)			 (NOTE 7)		 (NOTE 8)	
					ALLOWABLE SPAN (m)	DEFLECTION (mm)	FLAT TURN (m)	ELEVATED TURN (m)		
3/4	26.7	160	5.537	-	3.6	15	2.3	2.7		
		80	3.912	-	3.0	10	2.0	2.3		
1	33.4	160	6.350	21.77	4.8	6	3.1	3.6		
		80	4.547	18.14	4.0	13	2.6	3.0		
1 1/2	48.3	160	7.137	47.63	5.9	6	3.8	4.4		
		80	5.080	38.56	5.2	19	3.4	3.9		
2	60.3	80	5.537	61.69	6.1	25	4.0	4.6		
		40	3.912	48.53	5.7 (NOTE 5)	15	3.7	4.3		
3	88.9	80	7.620	155.13	7.9	6	5.2	6.0		
		40	5.486	123.84	7.2	15	4.7	5.4		
4	114.3	80	8.560	264.89	8.9	6	5.8	6.7		
		40	6.020	207.75	8.1	15	5.3	6.1		
6	168.3	80	10.973	633.21	10.7	6	6.9	8.0		
		40	7.112	469.47	9.8	15	6.4	7.4		
8	219.1	80	12.700	1128.99	12.0	6	7.8	9.0		
		40	8.179	832.80	11.2	5	7.3	8.4		
		20	6.350	703.52	10.5	4	6.8	7.9		
10	273.1	80	15.062	1892.39	13.3	6	8.7	10.0		
		40	9.271	1354.88	12.2	5	7.9	9.2		
		20	6.350	1054.15	11.1	4	7.2	8.3		
12	323.9	80	17.450	2853.09	14.5	6	9.4	10.8		
		STD	9.525	1989.47	13.3	15	8.6	10.0		
		20	6.350	1451.04	11.5	4	7.5	8.6		
14	355.6	80	19.050	3575.67	15.2	6	9.9	11.4		
		STD	9.525	2477.97	13.8	15	9.0	10.3		
		20	7.925	1989.00	12.5	4	8.1	9.4		
16	406.4	80	21.412	4959.58	16.1	6	10.5	12.1		
		STD	9.525	3465.45	14.5	15	9.4	10.9		
		20	7.925	2536.94	12.9	4	8.4	9.7		
18	457	80	23.800	6597.50	17.1	6	11.1	12.8		
		STD	9.525	4867.01	15.1	15	9.8	11.3		
		20	7.925	3167.89	13.2	3	8.6	9.9		
20	508	80	26.187	8521.19	18.0	5	11.7	13.5		
		STD	9.525	4333.17	14.2 (NOTE 6)	3	9.2	10.7		
24	610	80	30.937	13308.85	19.6	5	12.8	14.7		
		STD	9.525	6094.92	14.7 (NOTE 6)	3	9.5	11.0		

- NOTES:
1. SPANS ARE BASED ON INSULATED CARBON STEEL PIPE (A106-B) FILLED WITH WATER FROM -29°C TO 260°C.
 2. XS PIPE AND SCH. 80 HAVE THE SAME WT IN ALL NPS SIZES THRU NPS 8. FROM NPS 10 THRU NPS 24 XS PIPE HAS A WALL THICKNESS 12.7 mm.
 3. STD PIPE AND SCH. 40 HAVE THE SAME WT IN ALL NPS SIZES THRU NPS 10. FROM NPS 12 THRU NPS 24 STD PIPE HAS A WALL THICKNESS OF 9.525 mm
 4. STD PIPE AND SCH. 20 HAVE THE SAME WT IN NPS 20 NPS AND NPS 24.
 5. ALLOWABLE SPAN MAY BE INCREASED TO 6.0m FOR NPS 2 SCH. 40 ON STRAIGHT RUNS ALONG PIPEWAYS.
 6. NPS 20 AND NPS 24 MAY REQUIRE PADS OR SADDLES.
 7. 65% OF ALLOWABLE SPAN
 8. 75% OF ALLOWABLE SPAN.
 9. SEE STRESS GROUP IF VALUES SHOWN ARE EXCEEDED.

Table 1.5 Nozzle projection chart

	NPS	Flange class rating					
		150	300	600	900	1500	2500
Min. outside projection	3/4	150	150	150	150	150	150
from shell to	1	150	150	150	150	150	200
face-of-flange	1 1/2	150	150	150	150	200	200
	2	150	150	150	200	200	200
	3	175	175	200	200	200	250
	4	175	200	200	200	250	300
	6	200	200	200	250	300	350
	8	200	200	250	250	300	400
	10	225	225	250	300	350	500
	12	225	250	250	300	400	550
	14	250	250	250	350	400	—
	16	250	250	300	350	400	—
	18	250	250	300	350	450	—
	20	275	275	300	350	450	—
	24	300	300	300	350	500	—

All dimensions are in mm.

Dimensions do not include insulation or reinforcing pad thicknesses.

the drawing number, is also mandated in order for the client to be able to accept the drawing files back into the document management system and be able to retrieve them when required. While numbering systems vary by company, most have a hierarchy numbering system using abbreviated identifiers along the following lines:

- Area of operation
- Facility
- Discipline, e.g., mechanical, piping
- Type of drawing, e.g., piping arrangement
- Three- or four-digit sequential drawing number
- Two- or three-digit sequential sheet number

Isometric drawing numbering will require separate investigation. An often used practice is to include the line number as part of the drawing number for easy identification. Sheet numbers identify longer runs where a piping system has been broken into multiple isometric details for clarity, e.g., SHT 1 OF 5, SHT 2 OF 5,SHT 5 OF 5.

1.2.5 3D model numbering

What is the model numbering convention to be used for the project? Again, this may be a client or engineering company standard, but it must

be decided right at the beginning of the project. If you are directed to use a company standard, make sure that your client is in agreement. These models will later have to be closed-out and renumbering/renaming can cause considerable work that is likely not included in the budget. As with drawing file numbering, models require a file numbering system that is approved by the client. In today's 3D integrated design world, where all disciplines are referencing the other disciplines' models, and working more-or-less in real time, you and your designers must intimately know the model numbering system. This is in order to correctly name the piping models and identify other disciplines' models that are required to be referenced.

One way that I have seen model numbering done is to follow the Engineering Work Package (EWP) numbering. This makes sense because assembling information is not just the domain of the designers. Often the CAD support group or the material control group will be requested to generate reports of a particular EWP, or a group of EWPs, and a common numbering system for the models and the EWPs will help to locate and compile the information. Common reports are as follows:

- Material Take Off (MTO), either bulk or item specific for
 - pipe and fittings
 - insulation
 - valves
 - shop material (also known as fabrication material)
 - field material (also known as erection material)
- Weld count and diameter inches of welding
- Weights of materials

As all of the reports are generated from the databases that are built as the models are developed, having a direct correlation to the EWP number makes life easier for the downstream people, such as material controllers and purchasers.

1.2.6 Material commodity codes

Material commodity codes are a piping component numbering system used for the identification, ordering, and tracking of materials. Originating in the 3D model material library database, these numbers appear on the MTO reports and the isometric Bills of Material (BOM) and in the documentation used by the purchasers, suppliers, fabricators, and warehousing. These codes are commonly an alpha-numeric string

(e.g., “F” for flange) which uniquely identifies a component. Although ISO 15926 is making inroads, industry standards do not currently exist for material commodity coding of piping components, so companies have to develop their own key element identifiers or engage the services of an outside consultant to develop these for them. So why should this be a concern for the piping lead? If you are using your company piping classes and the material commodity coding is in place, then for the most part you and your designers will have no interest in material commodity codes other than curiosity. However, if material commodity codes are to be used on the project, and development is required because your company does not currently have a commodity coding system, or the client wants you to use their commodity coding system, then you will need to take into consideration the time involved for the development and implementation by the material control group and IT. Development and implementation can impact your ability to start 3D modeling.

As not all projects use material commodity codes, you will have to ascertain whether they are to be used on your project or not. If they are, are they to be to your company’s standards or the client’s? Will the adoption of a commodity code numbering system cause you any delays?



1.3 SPECIFICATIONS

Many clients and engineering companies will have a set of company specifications for each discipline built on code, safety and insurance requirements, and preferred engineering practices. Most specifications are engineering related, but some are directly related to the layout of the plant. As has already been said, these are related to walkways, platform and ladder requirements, egress and ingress, and equipment spacing, but they often also include other information of importance to the piping designers such as pump and exchanger piping layouts, and transportation requirements for modules and spools. As the lead, you must review these and catalog for your team all of the pertinent specifications and where they may be found, commonly on the company network or a client web based site.

The most obvious and essential specifications to be secured are the piping classes.

1.3.1 Piping classes

The piping classes are one of the most important specifications for the piping designer. These are developed by the piping engineer, and most often have been applied on numerous projects, sometimes for many years. Piping classes are developed around the applicable piping code, and list components and materials manufactured to the standards listed within the code. This allows component use with no further investigation and avoids calculations and material selections being repeated time and time again for the same application. The piping classes list the following:

- ASME code (B31.1 in power plants and B31.3 in process plants)
- Fluid service (process commodities)
- Flange rating
- Corrosion allowance
- Temperature range
- Pressure limits
- Non-Destructive Examination (NDE)
- Heat treatment
- NPS range, and pipe schedule wall thickness (WT) or calc. wall
- End preparation
- Valves
- Listed standards/components and materials accepted by the code for
 - pipe
 - fittings
 - flanges
 - orifice flanges
 - unions
 - plugs
 - nipples
 - spectacle blinds, spades, and spacers
 - olets
 - gaskets
 - bolting

An example of a piping class is [Table 1.6](#).

Piping classes have an abbreviated identifier. An example of this is the following three-digit identifier and [Table 1.7](#):

- Flange rating
- Service
- Pipe material

Components manufactured to standards not listed in the code, or not fabricated to a standard, are not listed within the piping classes. These are known as unlisted or specialty items (SP) and they are listed in the specialty item list. These include such items as strainers and expansion joints. In order to be used within the piping system, specialty items must conform to the engineering and testing requirements set out in the code.

Neither do piping classes take into account out-of-spec items such as a flat face flange needed in a raised face piping system to match with a pump casing flange or Class 300 flanges needed in a Class 150 system to match with the instrumentation.

On 3D CAD projects designers will have to request that these out-of-spec items be added to the piping class material database on a case-by-case basis (given that instruments such as control valves are very commonly specified to a minimum of Class 300 to accommodate the

Table 1.6 Example piping class

PIPING CLASS AAA – CLASS 150 RATING

SERVICE: Sweet Hydrocarbons, Fuel Gas.

PRESSURE LIMIT @ TEMPERATURE:

Temp. °F (°C)	-20 to 100 (-29 to 38)	200 (93)	300 (149)	400 (204)	500 (260)
MAWP, psig (kPag)	285 (1965)	260 (1793)	230 (1586)	200 (1379)	170 (1172)

ASME B31.3 LATEST EDITION

Required Corrosion Allowance:	1.6 mm/ $\frac{1}{16}$ "
Material Group:	P1 Groups 1 and 2; Carbon Steel
Inspection:	100% Visual Inspection, 100% RT of circumference on 10% of butt welds per welder/welding operator, progressive production basis.
Heat Treatment:	On welds >19mm/ $\frac{3}{4}$ " in thickness (ASME B31.3 Table 331.1.1)
Maximum Hardness:	200 Brinell Number

Table 1.6 Continued
Pipe, Flanges and Fittings:

ITEM/CODE	NPS SIZE	RATING	CONNECTION	MATERIAL STANDARD
PIPE: ASME B36.10M	¾ – 1½ ¾ – 1½ 2 – 24	Sch 160 Sch 80 Std.	Thr'd End (TE) Plain End (PE) Bevelled End (BE)	A106 Gr. B A106 Gr. B A106 Gr. B
NIPPLES: ASME B36.10M	½ – 1½	XXS	TE, PE	A106 Gr. B
SWAGES: ASME B16.9	¾ – 1½	XXS	TE, PE	A234 Gr. WPB
FLANGES: ASME B16.5	¾ – 1½ 2 – 24	Class 150 RF Class 150 RF (Std)	Thr'd, SW WN	A105N A105N
ORIFICE FLANGES: ASME B16.36	1 – 1½ 2 – 24	Class 300 RF Class 300 RF (Std)	Thr'd, SO WN	A105N A105N
INSTRUMENT FLANGES: ASME B16.5	¾ – 1½ 2 – 24	Class 300 RF Class 300 RF (Std)	Thr'd, SW WN	A105N A105N
FITTINGS: ASME B16.11 ASME B16.9	¾ – 1½ 2 – 24	3000# Std.	Thr'd, SW BW	A105N A234 Gr. WPB
UNIONS: ASME B16.11	¾ – 1½	3000#	Thr'd, SW	A105N
OLETS: ASME B16.11 ASME B16.9	¾ – 1½ 2 – 24	3000# Std	TOL, SOL WOL	A105N A105N
BLINDS: ASME B16.5	¾ – 12 14 – 24	Class 150 RF Class 150 RF	Spectacle Blinds Spades/Spacers	A516 Gr. 70N A516 Gr. 70N
PLUGS: ASME B16.14	½ – 1½	3000# Solid Hex Head	Thr'd	A105N
BOLTING: ASME B18.2.1			Studs Hex Nuts	A193 Gr. B7 A194 Gr. 2H
GASKETS: ASME B16.20	¾ – 24	Class 150 RF	Spiral Wound 3.2 mm	316 SS, non- asbestos, inner ring

Table 1.6 Continued**Valve Specifications:****(ASME B16.5, B16.10, B16.11, B16.25, B16.34, API 598)**

VALVE TYPE	NPS SIZE	RATING	CONNECTION	VALVE CODE (Varies by company)
GATE: API 600, 602	½ – 1 ½ 2 – 12 14 – 24	Class 800 Class 800 Class 800 Class 150 Class 150, C/W Gear Operator	Thr'd SW SW x Thr'd RF RF	Describes valve design, e.g. bolted bonnet, flexible wedge, regular port, OS & Y.
GLOBE: API 600	¾ – 1 ½ 2 – 4 6 – 24	Class 800 Class 800 Class 800 Class 150 Use Gate Valve	Thr'd SW SW x Thr'd RF RF	Describes valve design, e.g. bolted bonnet, stem guided, OS & Y.
BALL: API 608	¾ – 1 ½ 2 – 6 8 – 24	Class 800 Class 800 Class 800 Class 150 Class 150, C/W Gear Operator	Thr'd SW SW x Thr'd RF RF	Describes valve design, e.g. split body, floating ball, regular port.
CHECK: API 594, 600	¾ – 1 ½ 2 – 24	Class 800, Lift Class 800, Lift Class 150, Swing	Thr'd SW RF	Describes valve design, e.g. bolted cap, swing disc.
NEEDLE:	¾ – 1	Class 6000, MNPT x FNPT Class 6000, FNPT x FNPT	Thr'd Thr'd	Describes valve design.

Table 1.6 Continued
Valve Materials (ASTM, NACE, Specified Material)

VALVE TYPE	BODY	BONNET	TRIM	BOLTING STUDS/NUTS
GATE:	A216 WCB or A105	A216 WCB or A105	Stellite – API Trim 8, 13Cr	A193 Gr. B7 A194 Gr. 2H
GLOBE:	A216 WCB or A105	A216 WCB or A105	Stellite – API Trim 8, 13Cr	A193 Gr. B7 A194 Gr. 2H
BALL:	A216 WCB or A105	A216 WCB or A105	PTFE/316SS	A193 Gr. B7 A194 Gr. 2H
CHECK:	A216 WCB or A105	A216 WCB or A105	Stellite – API Trim 8, 13Cr	A193 Gr. B7 A194 Gr. 2H
NEEDLE:	T316SS	Packed T316SS	NACE MR 0175	
<p>NOTES</p> <ol style="list-style-type: none"> 1. Socket welded piping is preferred over threaded where possible. Use threaded joints at the outlet of vent and drain valves, at outlet of instrument root valves, and to match equipment. 2. Spectacle blinds shall be used up to NPS 12. Spades and spacers shall be used in sizes NPS 14–24. 3. Ball valves have limited maximum temperature (Teflon seats: 200°C, PEEK seats: 220°C). 4. For allowable branch connections refer to Branch Connections Chart. 5. Refer to ASME B16.5 Table 2-2.2 or Table F2-2.2 for Pressure-Temperature Ratings of 316SS Thermowell flanges. 				

instrument weight with a reduced potential for flange leakage, it is appropriate that all Class 150 specifications databases be prebuilt with optional Class 300 flanges).

As requesting the addition of out-of-spec items can be a source of frustration for both the piping designer making the request and the material controller receiving the request, you will require an approval procedure for adding out-of-spec components into the piping classes libraries. The piping designers' concerns center on the time required for request completion and possible reluctance to add a component. Likewise, material controllers have valid concerns about adding components that appear unnecessary. As this can result in conflict and given that neither of them own the piping classes, it is highly recommended that all

Table 1.7 Piping class identifiers

Flange Rating	Service	Pipe Material
A – 150	A – Sweet Hydrocarbons	A – Carbon Steel A106B
B – 300	B – Sour Hydrocarbons	B – Carbon Steel A333 Gr. 6
C – 600	C – Process Water	C – CS Galvanized
D – 900	D – Process Steam	D – SS 316
E – 1500	E – Chemicals	E – SS 304
F – 2500	F – Acids	F – FRP
	G – Caustics	G – Plastic PVC
	H – Utilities	H – Polypropylene Lined
		J – PTFE Lined

requests be vetted through the piping engineer for approval; the piping engineer is the custodian of the piping classes, and is the appropriate person for the authorization and expedition of changes and additions.

Calculated wall, or “calc. wall” as it is often listed in the piping classes, is another subject to be addressed by yourself and the piping engineer as soon as possible. If you start the modeling with the calculated wall it can later become a problem to update the models once the pipe schedule has been determined. This is particularly true when a piping class encompasses several process commodities and the NPS ranges of pipe vary in calculated WT according to the differing design conditions.

I strongly suggest that you discuss this sooner rather than later with the piping engineer and the material controller. I also strongly suggest that the calculated wall be based on the worst case design conditions for the piping class. The potential for mistakes in design, fabrication, and material control when WT choices exist for a given pipe size can outweigh any cost saving that may be realized on the pipe and fittings themselves. It is also possible that a calculated pipe schedule may prove to be less commercially available than a slightly heavier pipe schedule. Schedule 160, for instance, is usually very available, whereas Schedule 140 usually is not as available.

Finally, the set-up of the piping classes for the use by the designers when creating the 3D models is a joint exercise between the material control group who create the database content and the CAD support group who ensures the functionality. Prior to the start of modeling you

must have these piping classes databases checked against the original (likely in Word format) specifications. The accuracy of all MTO reports and BOM lists on the isometrics rests on the accuracy of the piping class databases and the importance of ensuring the integrity of these databases cannot be overstated.

Having said this, it is also strongly recommended that the piping designers be required to habitually refer back to the original specifications. An impression exists on 3D projects that reference to the original piping classes and branch charts is unnecessary because the choices of available components, including branch fitting choices, have been predetermined and limited per the piping class databases. This is to say that the belief is that the databases provide all the information needed about the allowable piping components (spec driven). However, mistakes in set up and checking do happen, and as a safeguard all your designers should be held accountable to understand the root documents and to verify differing information.

Once the piping classes have been approved they are frozen for the duration of the project. Changes may happen to the piping classes during the project, but these must follow a deviation process.



1.4 PROCEDURES

Projects revolve around procedures, and without these you cannot execute your project. Procedures are the “Highway Code” that keeps everyone on the same page. However, procedures are often either poorly written or not enforced, which is as bad as having no procedure. Read the procedures thoroughly and understand them, because it will be up to you to enforce them later, and possible to expand on them.

Engineering company procedures will commonly include the following:

- Stick files
- Interdiscipline drawing reviews, both internal (engineered drawings) and vendor
- Line numbering
- Stress analysis
- CAD set-up and support
- 3D model reviews
- Checking

- Manhour estimating
- Progress reporting
- Management of change

Client procedures have been developed to standardize the drawing and model deliverables. These include the following:

- Drawings to be as-built
- Project close-out

These last two procedures are usually owned by your client's document management department and enforced by your own company's document management. That does not mean though that you do not have a say. These procedures have areas of overlapping accountabilities between designers and document controllers. Because no procedure is perfect for all situations, the client's document management department is most often conducive to small deviations and are willing to work with you from a designer's input point of view. On smaller projects you may well have direct access to speak with them, whereas on larger projects you will have to request a deviation through your project management team. Deviations to client procedures identified during the initial set-up should be documented in the Project Execution Plan (PEP). You will need to inform your project management team of all deviations to the document management procedures initiated by yourself and agreed to by the client.

The following are brief discussions on all the above-mentioned procedures/activities that you, as a piping lead, must be aware of, and that the piping group has a direct or indirect involvement in. In [Chapter Two](#), CAD and Design Automation in Piping Design, we will discuss in more detail the procedures below that the piping group manage directly or have a major involvement in.

1.4.1 Stick files

Whether electronic computer based or in hard copy paper format, a stick file is the best tool to use for capturing and managing changes. It is a central depository for all mark-ups from all disciplines and ensures that all changes are clearly communicated and surprises are avoided.

The trend in recent years has been to do everything in an electronic computer based environment and shun hard copy paper formats as inefficient and undesirable in the context of project record keeping. This is a perfect example of where the worlds of manual and electronic procedures have collided. While possible to utilize an electronic stick file procedure

using a mark-up tool such as Adobe Reader or Bluebeam Revu, in practice it is still very much human nature to defer to marking up a hard copy print of a drawing due to this still being easier and more familiar. I advocate that a hard copy stick file is still best, scanned prior to back-drafting for record.

A decision will need to be made on either an electronic or a manual stick file procedure.

If electronic is the choice, then you will need to know where the drawings are to be deposited and how they are to be accessed and edited with mark-ups. You will also need to receive alerts when comments are made.

Similarly, if manual is the choice, you will need to have a procedure around mark-ups and notification, and you will need to identify an area where your master stick files will reside. Preferably this will be close by and with reference tables to lay the stick files on. Ideally, you will have room for roller boards. Roller boards, where the drawings are tapped down, work wonderfully to stop people wandering off with your stick files.

1.4.2 Interdiscipline drawing reviews

Drawings are produced in every project. Drawings represent the culmination of the design, and a finalization of all discussions and decisions to date. A review by all disciplines that have had input is required in order to establish that the designs are as expected by all stakeholders. It is your accountability to ensure that the piping drawings are made available for review and comment. Likewise to master stick files, interdiscipline drawing reviews may be by electronic or hard copy methods, either through network access or hard copy circulation. Electronic reviews require a network place where the drawings are stored. Hard copy reviews require a circulation procedure and filing cabinets for storage. Both review methods require a way of sending notifications to the reviewers.

Vendor drawings also require a review procedure. While you are not responsible for initiating vendor drawing reviews, you are responsible to ensure the integrity and availability of the latest vendor drawings for reference and mark-up by your team.

Regardless of the interdiscipline drawing review procedure employed, the document control group play a key role. You will need to liaise with the document control lead for an understanding of their processes and to ensure that your needs are going to be met. In the case of electronic mark-ups, it may also be needed to arrange training for your team on the document control software.

1.4.3 Line numbering

Line numbering is a standard. The elements that make up a line number and the order of placement are standardized by each client or engineering company. The sequencing of the elements may change between companies, but all line numbers contain the following:

- Piping class
 - NPS
 - Sequential line number
 - Insulation thickness and type
 - Tracing requirements
- Some standards may also include the following:

- Unit number
- Commodity abbreviation of the process fluid

When it comes to the task of assigning line numbers to the P&IDs, a procedure is required. Does a line reduction within a header system constitute the assignment of another line number? Is a pump suction line that splits to a pair of A and B pumps two or three line numbers? You will discover that there are different thoughts on the subject. Line numbering may not be the responsibility of the piping group, and it may fall under the auspices of the process engineers', but you as a piper have a vested interest that requires discussion. The overuse of line numbers can result in piping runs being broken down into a greater number of isometrics.

Whoever does it, and to whatever procedure, line numbering needs to be done sooner rather than later, as modeling cannot begin without line numbers having been assigned.

1.4.4 Stress analysis

How are you going to interface with the stress group? Which lines will be stressed first? How will you track stress analysis? Where will you store the stress mark-ups? And how will the stress requirements be disseminated to the pipers? These are questions that we will investigate in more detail in [Chapter Two](#), CAD and Design Automation in Piping Design. It is a complex matter, and not one to be overlooked. If you do not have a company procedure to fall back on, you will need to develop one.

1.4.5 CAD set-up

CAD support is a major contributor to the success of any project. Ensure that the appropriate company and client CAD procedures are going to be used:

- Maintaining databases
- Plotter and printer set-ups
- Model back-ups, usually nightly
- Project close-out

The above will be of little interest to the designer and should be happening seamlessly in the background. However, there are project set-up requirements that are of particular importance in order for the designer to do his/her work. But, because there are many ways of doing things, the CAD support group will require direction from you, the piping lead, for the following to be input:

- Work areas
- Client or company piping classes
- Client or company piping standards, e.g., shoes, base ell supports, anchors, and guides
- Color coding of pipe, equipment and temporary steel per the client or company standards. For example is pipe to be color coded
 - by piping classes: Class 150, 300, 600, etc.
 - or
 - by commodity: sub-sets of water, steam, oil, gas, etc.
- Link for automatic data extraction from the LDT into the isometric titleblocks
- Clash report procedure

Another consideration is the generation of reports and the reports' format. Other groups will rely on reports generated from the databases for such as purchasing and estimating purposes. Establishing the reporting needs is an essential part of the CAD set-up. The databases used for these reports are built during the development of intelligent P&IDs and 3D models, and consist of the following examples:

- LDT
- Equipment Lists
- Instrument Lists
- Specialty Item Lists
- Valve Lists
- Corrosion Coupon Lists
- Car Seal Lists
- Spring Supports List
- Bulk Material Reports
- MTO Reports
- Weld Diameter Inch Reports
- Weights of Materials Reports

A project directory structure is also required where drawings and models are deposited. This structure should ideally be mirrored by each discipline so that finding models is easy for all. As a side note, designers love to copy into their personal drives and work from there on unofficial models. This practice must be discouraged as it can cause obvious communication problems. There is nothing wrong with copying to do some studies, but the results must be imported into the master model as soon as possible, and all work should primarily only be done in the master model.

Which software and version of that software are you using? Lock it in and do not let anyone tell you that an upgrade during your project is an easy matter. The software and version may be mandated by the client, in which case the decision is off of your shoulders, but if it is a company choice do not change once you start. Changing the current version to an untested version during a project inevitably leads to untold grief and extra, unbudgeted hours. No disrespect to the CAD support group, but even if they tell you that it has been tested, do not let your project be the ultimate test case for the newest version, no matter how much they protest that this will solve many of the problems currently encountered. Testing is nebulous, and their testing of some functionality and file conversion on a small scale will not be representative of the full usage by the designers and conversion of dozens or possibly hundreds of models and databases.

Security is another issue to be addressed. Your client may be very interested in this aspect of his/her project, but even if they are not, it is in your own interest to make sure that you are comfortable with the security measures that are in place. Security means access. Who has access to edit the models? Minimally, there should be restrictions on the following:

- Each discipline. A discipline must not be able to edit the other disciplines' models.
- Stages of design. Freeze models when they are ready for checking. Unfreeze but freeze again after the changes required by checking have been made. Designers are perfectionists and if there are no controls stopping them from doing so, they may go back into their models and make changes during checking and even after it has been Issued For Construction (IFC). While keenness can be admired, unmanaged and unchecked changes that surface will cause an embarrassment at the least, and can lead to other costly problems.

Several other decisions that you may also be required to have input into with the CAD support manager, office manager, and project manager are as follows:

- The number of CAD stations you will need.

- The types of software and number of licenses.
- The space and furniture requirements for common areas, e.g., plotters, printers, stick files, filing cabinets, lay down tables.

If manual stick file and interdisciplinary drawing reviews are being used, when you meet with the office manager be sure to order all of the stamps you will need, i.e., a date stamp, “RECEIVED,” “MASTER STICK FILE,” “WORKING COPY,” “PIPING COPY,” “CHECK PRINT,” “SUPERSEDED,” and “FOR INFORMATION ONLY.” You could also order stamps for “STRESS COPY” and “FOR BID PURPOSES ONLY. NOT TO BE USED FOR CONSTRUCTION,” but these can be added to the drawings as blocks at the time of issue.

Designers require lots of support from the CAD support group. You will require a clear line of communication between the two groups for the following:

- General questions about CAD execution and CAD commands
- Copying of databases
- Modeling of specialty items
- Adding of specialty items and out-of-spec components into the piping specifications and material libraries
- Retrieving lost data and corrupted files

Larger engineering companies may well utilize software whereby a request is sent and a ticket number assigned. Smaller companies may well utilize an e-mail request. However this is to be done, make sure that you have a documented procedure that can be distributed to the designers.

1.4.6 3D model reviews

Model reviews are commonly conducted at the 30%, 60%, and 90% stages of design completion, and involve buy-in by all stakeholders up to that stage. Definitions are required for each of these stages so that everyone has the same understanding of what is to be accomplished prior to and during the reviews, and the designers stay focused on the parameters to be established leading up to the reviews. The best way for this to be accomplished is to have written documentation with a model review matrix.

1.4.7 Checking

It goes without saying that checking is a requirement of any project, but how are you going to go about this? What are you going to check? You need a checking procedure to give guidance and ensure consistency.

1.4.8 Manhour estimating

Manhour estimating and manpower planning can be quite a daunting task, and there are books written on this subject alone. Generally speaking, companies employ schedulers for this task, but as a lead you will be required to have input into the piping hours budget and piping schedule. The schedulers will be of valuable assistance in helping you with this task. However, it does not end there. After the piping budget and piping schedule have been established, the task of work allocation—literally the decision on which designers will work in which areas and according to a priority that supports the schedule—rests with the piping lead.

A sometimes overlooked requirement for manhour estimating and manpower planning is to know the deliverables. If these are not clear, do not make assumptions. Get direction from your project management team on the client's expectations. This is to ensure that you have a clearly documented basis for your estimating that can be used later to support a revision to the budgeted hours should the need arise.

1.4.9 Progress reporting

Your project management will expect progress reports. Larger engineering companies will have their own procedures to accomplish this. If you are in a smaller company, chances are that you will need to establish a form of reporting in conjunction with the project management. Reporting is essential, not just because periodic payments from the client may be tied to the progress, but because it is necessary to understand where you are in the project, whether or not you are staying within the budgeted hours, and to identify when you are going off track in order to take corrective action.

1.4.10 Management of change

Change is inevitable in any project, and management of change is crucial to the success of the project. You must manage the trends and scope changes for the piping effort. A trend is an unbudgeted event that increases the number of hours required to complete an activity. For instance, a deviation to a piping class or vendor information that arrives later than planned and causes delays and rework constitutes a trend. A scope change is a modification, deletion, or addition to the original scope that was not budgeted for, such as the addition of a piece of equipment.

In order to recognize trends and scope changes, a clear understanding of the original project scope and budget is required.

Scope changes are quite easy to spot and usually emanate from the client, whereas trends can be contentious and usually have to emanate from you, the piping lead. Are the hours that are being expended normal design development or are they a trend? You are going to find yourself in this debate many times in your career. The simple answer is that there are no simple answers. However, situations such as those below are clues:

- If you have to change your plans and focus due to delayed arrival of information, leading to productivity being lost, this is a trend.
- If you were given information with assurances as to the completeness and accuracy of this information for the level of design, and you have to rework your design because it turned out not to be so, this is a trend.
- If you were required to move ahead with preliminary information into detailed design and later, when firmer information is available, have to rework the design, this is a trend.
- If you or your group has to spend an abnormal amount of time assisting another department or a vendor, this is a trend.

If for whatever reason you find yourself losing productivity and/or reworking a design more than once and are in danger of exceeding the budgeted hours, discuss the situation with your project engineer. A trend may be in order.

You will learn that timing is everything and design developments, such as a line size increase, or scope changes, such as a pump addition, that come during the earlier study stage can be accommodated quite readily without much, if any, schedule impact. But try accommodating the same just before IFC and you will be looking at significant rework, schedule delays, and cost impacts.

The surprising thing, considering its importance, is that managing change is often done poorly or not at all. Formally raising, approving/rejecting, and documenting these will avoid misunderstandings and wasted hours. I have seen more than one project where the lack of documentation caused significant discord between the engineering company and the client. Clients have a tendency to request changes throughout the project and consider them design development, not trends or scope changes. Engineering companies have a tendency to jump to attention and rush in to accommodate the client. The client believes that his/her requests are going to be accommodated without extra cost or schedule

impact while the engineering company assumes that the client realizes otherwise. They are not on the same page, and likely will not be until much later, after further discussions, possibly some hard feelings, and likely after all the changes have already been made.

We must generate change notices to capture the impact that trends or scope changes will have or are having on the piping effort. This documentation allows for a time of assessment to cost and schedule and for a conscious choice to be made on how to proceed. Are the changes necessary? For example, are they safety related, or are they just nice to have? Can something be done about the potential productivity loss related issues?

Your project management will expect change to be recognized, documented, and submitted for approval. As the eyes and ears of the piping group, the piping lead is expected to keep his finger on the pulse, and not jump the gun and allow unapproved design changes nor keep reworking the same area due to someone else's inability to make up his/her mind. You are expected to see change coming, to anticipate the consequences, and to raise flags ahead of time. Do not put yourself in the unenviable position of trying to explain later why you are going over on budget and schedule. You may end up making changes back to the original design and lose credibility as a lead. Only a junior would use the excuse that someone else told them to do it. Do not forget that you are a senior member of the team with a budget that you are responsible for.

It is important that trends and scope changes be addressed as soon as possible, but you will have very little control over how long these will take. There are three options:

- Continue with the design as planned until the change is approved, recognizing that the longer it takes to be approved the more work there may be to undo in the design.
- Incorporate the changes into the design as if they are approved. For this you must get assurances from the project team in writing that the paperwork to proceed is a formality and will be forthcoming.
- Put the design in question on hold until approval is received.

The golden rule is that without an approved trend or scope change, no changes are to be made. This is a very reasonable, necessary, and important requirement for the project, and all companies should have a procedure for submission and approval/rejection. Your company should have forms for trending and scope changes. They will not always have the

same title at each company, but will be along the lines of “Engineering Notice of Trend” and “Scope Change Request.”

1.4.11 As-builts

It may seem unnecessary to consider as-builts at the beginning of the project, given that it is one of the last tasks to be completed. However, you will need to establish exactly what your client requires to have as-built in order to complete your manhour estimates. Your client may only require this of critical documents and will define “critical” for you. Critical documents can be defined as documentation that government regulatory bodies and the company deem must be kept current for the continued safe operation of a facility.

While by no means an exhaustive list, the documents generally listed that involve the piping group are as follows:

- P&IDs
- LDT
- Plot plan and equipment location plans
- Underground piping plans
- Heat tracing (commonly hot oil, steam, or glycol)

It is possible that you may also be required to as-built the 3D models and the piping arrangements.

The client procedure must list and give direction in the documents to be as-built.

Depending on whether your company or the client is handling the construction management, the client or company procedures must give direction on

- how the as-built changes will be captured, e.g., redline mark-ups in the field
- how the as-builts are to be turned over to the engineering group
- how the engineering company is to turn the completed as-built documentation over to the client

Internally, at your engineering company, you must plan for the following:

- Reviewing the as-builts, i.e., that the noted changes that occurred during construction were documented and approved
- Drafting and checking of the field collected as-built information
- Sign-off

1.4.12 Project close-out

At the end of the project, a close-out will be required. This generally involves handing over all the models, databases and drawings to your engineering company's document control group for close-out with the client's document control group. Make sure that you have an internal close-out procedure and a close-out procedure from the client, and that you fully understand the requirements of both. If one or both of these has not been provided, you may need to develop them in conjunction with your own people and the client.



1.5 PIPING EXECUTION PLAN

There are two key documents that are the basis for the project: the Design Basis Memorandum (DBM) and the Project Execution Plan (PEP). A Piping Execution Plan and a Design and Drafting Execution Plan will form part of the PEP, and you as the piping lead are expected to be a leading contributor in the writing of these sections. The Piping Execution Plan may be a section unto itself or it may be a subset of the Design and Drafting Execution Plan.

The Piping Execution Plan and the Drafting Execution Plan are where all the decisions that have been made are captured in writing. General decisions on drafting that involve all disciplines, such as CAD software, are captured in the Design and Drafting Execution Plan, and specific piping related decisions are captured in the Piping Execution Plan.

The following is a brief discussion of the DBM and the PEP, as they are the guiding documentation for you and your designers and the basis for everything that is to follow.

1.5.1 Design Basis Memorandum (DBM)

The DBM defines the project scope and describes the technical basis for detailed engineering. The typical content of a DBM includes the following sections:

- Project Overview and Facility Description
- Facility Design Basis, e.g., Specifications and Standards
- Safety Design Basis
- Process Design Basis

- Civil and Structural Design Basis
- Mechanical Design Basis
- Electrical Design Basis
- Instrumentation and Controls Design Basis
- Any additional relevant basis information

1.5.2 Project Execution Plan (PEP)

The PEP describes how the project will be executed and typically contains the following sections:

- Cost Estimate
- Schedule
- Organization Plan
- Project Controls Plan
- Quality Assurance Plan
- Safety and Health Plan
- Regulatory Compliance Plan
- IT Plan
- Contracting and Procurement Plan
- Document Control Plan
- Engineering Execution Plan
- Design and Drafting Execution Plan
- Construction Execution Plan
- Commissioning Plan

Your designers must read and understand these documents because they constitute the official instruction for the project that everyone has to follow. Two key sections in the PEP are the Contracting and Procurement Plan and the Construction Execution Plan.

1.5.3 Contracting and Procurement Plan and Construction Execution Plan

The Contracting and Procurement Plan and the Construction Execution Plan outline the procurement and construction philosophies and are the basis from which many other decisions and planning by the piping lead will stem:

- Modularized and field erected piping splits
- EWP boundaries
- Model boundaries
- Shop and field material splits

- Procurement splits
- EWP drawing packages
- Scopes of Work (SOW)

These documents may be in a preliminary stage when you first start and you may have to help define the contents. Failure to clearly establish the Procurement and Construction Execution Plans at an early stage and starting into detailed design without them can result in material, modeling, and drawing boundaries that may not later match the final desired EWP breakdown. This can lead to confusion for the fabricators and erectors, or added hours to rectify the splits.



1.6 CONCLUSION

You must investigate and secure all of the above, and should any of the above not be readily available, you must raise the flags with your project management team as to where it may be secured from and adopted for the project.

There is a lot to consider, and many questions to be answered, and much will be discussed in more detail in the subsequent chapters.