Chapter 18

Piping

Piping Plant Bulks

Piping plant bulks include transfer lines, utility piping, duct and tubed tracing.

	Description	Type
1	Transfer lines, yard pipe runs, above/below grade Insulated and traced pipe runs. For above-grade piping, hangers are supplied, but support steel, pipe racks, etc. must be specified elsewhere. If buried pipe is specified, trenching, coating, wrapping, sand bed and backfilling is provided.	**YARD PIPE**

Custom Pipe Spec: Enter either custom pipe spec (see Design Basis or material, not both.

Pipe Material: Enter either custom pipe spec (see Design Basis) or material, not both. See piping materials listed later in this chapter. Default: *CS*.

Length: Min: 1.0 FT [0.35 M]

Pipe Diameter: Range: 0.5 - 72 IN DIAM [15 - 1,800 MM DIAM]

Gauge Pressure: Default: determined from custom pipe spec or 150 PSIG [1,000 KPA].

Temperature: Default: determined from custom pipe spec or 68 DEG F [20 DEG C].

Pipe Thickness: Leave blank if schedule is specified.

Pipe Schedule/Gauge: Leave blank if thickness is specified.

STD	- Standard wall pipe	100	- Pipe schedule
XS	- Extra-strong pipe	120	- Pipe schedule
XXS	- Double extra-strong	140	- Pipe schedule
5	- Pipe schedule	160	- Pipe schedule
10	- Pipe schedule	7G	- SS gauge pipe only
20	- Pipe schedule	10G	- SS gauge pipe only
30	- Pipe schedule	11G	- SS gauge pipe only
40	- Pipe schedule	12G	- SS gauge pipe only
60	- Pipe schedule	14G	- SS gauge pipe only
80	- Pipe schedule		

Flange Class: Default: determined from custom spec or pipe material, temperature and pressure.

150 - Class 150
300 - Class 300
600 - Class 600
900 - Class 900
1500 - Class 1500
2500 - Class 2500
125 - Class 125 WOG
250 - Class 250 WOG

Configuration: Default: *ABOVE*

ABOVE - Above-grade
BURIED - Buried

Depth Buried Pipe: Below grade depth to top of pipe for buried pipe only. This is the distance from grade level to the top of the buried pipe. The trench depth is determined by the below grade depth, the pipe diameter and sand bed (6 IN [150 MM] in depth). Range: 24 - 120 IN [600 - 3,000 MM]. The default value will be taken as 36 IN [1,000 MM] minimally, or the depth of footings specified for general civil data.

- continued -

Piping Plant Bulks continued

	Description	Type

YARD PIPE - continued

Special Pipe Descr.: Insulation, tracing, jacketing options. Default: *NONE*
- PPROT - Personnel protection insulation
- AC-T - Anti-condensation insulation/tube tracer
- AC-E - Anti-condensation insulation/elec tracer
- FP-T - Freeze protection insulation/tube tracer
- FP-E - Freeze protection insulation/elec tracer
- FULL - Fully jacketed pipe
- EXPD - Exposed-weld jacketed pipe
- T-SP - Spiral traced/tube conn./no cement
- T-SPC - Spiral traced/tube conn./heat cement
- P-SP - Spiral traced/pipe conn./no cement
- P-SPC - Spiral traced/pipe conn./heat cement
- T-LO - Longit. traced/tube conn./no cement
- T-LOC - Longit. traced/tube conn./heat cement
- P-LO - Longit. traced/pipe conn./no cement
- P-LOC - Longit. traced/pipe conn./heat cement
- E-AMB - Electrical traced/ambient temp control
- E-PRO - Electrical traced/process temp control
- NONE - Standard heat or cold insulation

Steam Pressure - Gauge: Steam supply pressure for traced or jacketed pipe only. Default: *25* PSIG [*175* KPA]

Maintenance Temp.: For electrical tracing - process maintenance temperature; Max: 250 DEG F [120 DEG C] over ambient. Default: 220 DEG F [105 DEG C]

Weld X-Ray %: Min: 100; Default: See Area Design Basis.

Number of Elbows: Default: *0*

Number of Reducers: Default: *0*

Number of Tees: Default: *0*

Number of Flanges: Enter number of flanges in addition to those for valves. Default: *0*

Number of Blinds: Default: *0*

No. Spectacle Blinds: Default: *0*

No. of Threadolets: Default: *0*

No of Gate Valves: Default: *0*

No of Globe Valves: Default: *0*

No of Ball Valves: Default: *0*

No. Butterfly Valves: Default: *0*

No. Check Valves: Default: *0*

No Control Valves: Size: same as pipe size to 4 IN [100 MM], smaller than pipe otherwise. Default: *0*. See “Control Valve Options” in Chapter 21 for default size reductions.

No. of Safety Valves: Default: *0*

No. of Regulating Valve: Default: *0*

No. of Angle Valves: Default: *0*

No. Plug Valves: Default: *0*

No. Orifice Plates: Default: *0*

No. Knife Gate Valve: Default: *0*

Personnel Protect %: Personnel protection percent coverage. Default: *100*

CV Minimum Class: For fluid control valves only. Default: *3*.
- 3 - Minimum 300 class fluid control valve
- 1 - Minimum 150 class fluid control valve

CV Reduced Size: Fluid positioning CV only. Default: Reduced 0 to 4 line sizes based on size.
- L - Line size control valves
- R - Standard size control valves

Piping Plant Bulks continued

	Description	Type
2	Utility service lines, stations: standard configuration Utility headers: runs of pipe providing up to 15 different services. Utility station: short runs of small-bore pipe providing local air, water, steam and condensate drain services.	**UTIL-PIPE**

Pipe Material: See piping materials listed later in this chapter. Default: *CS* (Carbon steel).

No. Utility Stations: A utility station consists of three 100 FT [30 M] lines of 1 INCH [25 MM] diameter pipe for air, water and steam service, and one 50 FT [15 M] condensate line of 0.75 IN [20 MM] diameter. Default: *1*. Enter "0.0" to exclude all utility stations.

Length Parameter: Pipe lengths = 1 x length parameter, except firewater loop/lat. = 2 x, hp steam = 0.5 x. Default: 100 FT [30 M].

Header Diam. Symbol: Diameter symbol defines size of any line not specified. See Utility Piping Services later in this chapter.
L - Low/small diameter
M - Medium diameter
H - High/large diameter
V - Very large diameter

Dia. Firewater Loop: Default: determined by diameter symbol, enter 0.0 to delete if diameter symbol set.

Dia. Firewater Latrl: Default: determined by diameter symbol, enter 0.0 to delete if diameter symbol set.

Dia. Potable Water: Default: determined by diameter symbol, enter 0.0 to delete if diameter symbol set. Line will be insulated base on location: US - uninsulated, UK - insulated.

Dia. Cooling Water: Default: determined by diameter symbol, enter 0.0 to delete if diameter symbol set.. Line will be insulated base on location: US - uninsulated, UK - insulated.

Dia Cool Water Retrn: Default: determined by diameter symbol, enter 0.0 to delete if diameter symbol set. Line will be insulated base on location: US - uninsulated, UK - insulated.

Dia. Lp Steam Header: Default: determined by diameter symbol, enter 0.0 to delete if diameter symbol set.

Dia. Mp Steam Header: Default: determined by diameter symbol, enter 0.0 to delete if diameter symbol set.

Dia. Hp Steam Header: Default: determined by diameter symbol, enter 0.0 to delete if diameter symbol set.

Dia. Condens. Return: Default: determined by diameter symbol, enter 0.0 to delete if diameter symbol set.

Dia. Plant Air Headr: Default: determined by diameter symbol, enter 0.0 to delete if diameter symbol set.

Dia. Instr Air Headr: Default: determined by diameter symbol, enter 0.0 to delete if diameter symbol set.

Dia. Fuel Gas Header: Default: determined by diameter symbol, enter 0.0 to delete if diameter symbol set.

Dia. Inert Gas Headr: Default: determined by diameter symbol, enter 0.0 to delete if diameter symbol set.

Dia. Chemical Sewer: Default: determined by diameter symbol, enter 0.0 to delete if diameter symbol set.

Dia. Flare Header: Default: determined by diameter symbol, enter 0.0 to delete if diameter symbol set.

Piping Plant Bulks continued

	Description	Type
3	Buried concrete pipe, manholes, elbows, tees: trench, backfill Includes trenching and backfilling. **Mat'l of Construction:** Default: *R-CON* **Diameter:** Range: 12 - 98 IN [300 - 2,450 MM] **Number of Manholes:** Default: *0* **Number of Elbows:** Default: *0* **Number of Tees:** Default: *0*	**RCON-PIPE**
4	Process ductwork, round Stiffeners and support hangers are designed, but support steel, racks, etc. must be specified elsewhere. **Material:** Default: *GALV* GALV - Galvanized CS CS - Carbon steel SS - Stainless steel AL - Aluminum **Diameter:** If the duct capacity is specified, the duct dimension is determined from the capacity and the gas velocity. The velocity may be specified, or the system uses a variable velocity between 2000 and 4000 RPM [36600 - 72100 M/H] depending on the specified pressure. The calculated duct dimension is rounded to a standard size. **Design Press. - Gauge:** Should be specified (indicate + or -) for design of duct thickness and stiffeners; -60 - 60 IN H2O [114,930 - 14,930 PA]. Default: *-20* IN H2O [*-4,980* PA]. **Duct Gauge Number:** Leave blank if thickness is entered; enter thickness if thicker than 8 gauge. Range: 8 - 30. **Duct Wall Thickness:** Default: determined by size and pressure, leave blank if duct gauge number entered. **Duct Class:** The duct class indicates the quantity and abrasiveness of particulate material. Default: *1*. 1 - Non-abrasive applic. 2 - Mod-abras./lo concern. 3 - Hi-abras.lo concern. 4 - Hi-abras./hi conern. **Configuration:** Seam configuration; applies to class 1 duct only. Default: *LONG* LONG - Longitudinal seam SPIR - Spiral seam **Insulation Thickness:** Default: 0.0 IN [0.0 MM]. **Capacity:** If the duct dimension is specified, the capacity field is ignored. **Partical Density:** Density of concentrated particulates for duct classes 2, 3 and 4. Default: *25* PCF [*400* KG/M3]. **Stiffener Size:** Default: size and spacing determined from duct pressure, dimensions and thickness. **Stiffener Spacing:** Default: size and spacing determined from duct pressure, dimensions and thickness. **Support Weight**: Hanger weight (each); support steal, racks, etc. must be specified elsewhere. The system determines the support weight based on standard spacing of 12 FT [3.5 M] and the duct loads. The calculated weight and spacing may be replaced with an input weight and spacing. **Support Spacing:** Default: *12* FT [*3.5* M]. **Number of Elbows:** Default: *0* **Number of Tees:** Default: *0* **Number of Reducers:** Default: *0* **Number of Dampers:** Default: *0* **No. of Access Doors:** Default: *0* **No. Flex. Connection:** Default: *0*	**DUCT-RD**

Piping Plant Bulks continued

	Description	Type
5	Process ductwork, square Stiffeners and support hangers are designed, but support steel, racks, etc. must be specified elsewhere.	**DUCT-SQ**

Material: Default: *GALV*
GALV - Galvanized CS
CS - Carbon steel
SS - Stainless steel
AL - Aluminum

Width: If the duct capacity is specified, the duct dimension is determined from the capacity and the gas velocity. The velocity may be specified, the system uses a variable velocity between 2000 and 4000 RPM [36600 - 73100 M/H] depending on the specified pressure. The calculated duct dimension is rounded to a standard size.

Design Press. - Gauge: Should be specified (indicate + or -) for design of duct thickness and stiffeners. -60 - 60 IN H2O [-14,930 - 14,930 PA]. Default: *-20* IN H2O [*-4,980* PA].

Duct Gauge Number: Leave blank if thickness is entered; enter thickness if thicker than 8 gauge. Range: 8 - 30.

Duct Wall Thickness: Default: determined by size and pressure, leave blank if duct gauge number entered.

Duct Class: The duct class indicates the quantity and abrasiveness of particulate material. Default: *1*.
1 - Non-abrasive applic.
2 - Mod-abras./lo concern.
3 - Hi-abras.lo concern.
4 - Hi-abras./hi conern.

Insulation Thickness: Default: *0.0* IN [*0.0* MM]

Capacity: If the duct dimension is specified, the capacity field is ignored.

Particle Density: Density of concentrated particulates for duct classes 2, 3 and 4. Default: *25* PCF [*400* KG/M3].

Stiffener Size: Default: size and spacing determined from duct pressure, dimensions and thickness.

Stiffener Spacing: Default: size and spacing determined from duct pressure, dimensions and thickness.

Support Weight: Hanger weight (each); support steel, racks, etc. must be specified elsewhere. The system determines the support hanger weight based on standard spacing of 12 FT [3.5 M] and the duct loads. The calculated weight and spacing may be replaced with an input weight and spacing.

Support Spacing: Default: *12* FT [*3.5* M].

Number of Elbows: Default: *0*

Number of Tees: Default: *0*

Number of Reducers: Default: *0*

Number of Dampers: Default: *0*

No. of Access Doors: Default: *0*

No. Flex. Connection: Default: *0*

Piping Plant Bulks continued

	Description	Type
6	Fluid heat tracing existing equipment The item of equipment and its insulation are not included; these are assumed to be specified elsewhere in the project. **Material:** Default: *CU* CU - Copper SS - Stainless steel **Tracer Tube Length:** This is the total length of tubing required to heat trace an item specified elsewhere in the estimate. This length does not include the run to and from supply and return headers, as these lengths are specified in the Dist./Supply Header and the Dist./Return Header fields. **Tracing Symbol:** T-SP - Traced: tube conn. - spiral tracer - no cement T-SPC - Traced: tube conn. - spiral tracer - with cement P-SP - Traced: pipe conn. - spiral tracer - no cement P-SPC - Traced: pipe conn. - spiral tracer - with cement **Dist./Supply Header:** Distance specified is from traced equipment item to supply and return headers. The headers are not included in this item, but are specified by the user elsewhere in the estimate for Area Pipe Specifications or as a separate bulk item description. Min: 5.0 FT [1.6 M]; Default: *25* FT [*7.5* M]. **Dist./Return Header:** Distance specified is from traced equipment item to supply and return headers. The headers are not included in this item, but are specified by the user elsewhere in the estimate for Area Pipe Specifications or as a separate bulk item description. Min: 5.0 FT [1.6 M]; Default: *25* FT [*7.5* M]. **Heating Medium:** Default: *STM* STM - Steam heating medium OTHR - Other heating medium **Steam Pressure - Gauge:** Default: *25* PSIG [*175* KPA].	**EQPT-TRACE**
7	Fluid heat tracing for existing pipe runs The traced pipe and its insulation are not included; these are assumed to be specified elsewhere in the project. **Material:** Default: *CU* CU - Copper SS - Stainless steel **Traced Pipe Length:** The pipe being traced is not included, but must be specified elsewhere. **Traced Pipe Diameter:** The pipe being traced is not included, but must be specified elsewhere. **Tracing Symbol:** T-SP - Traced: tube conn. - spiral tracer - no cement T-SPC - Traced: tube conn. - spiral tracer - with cement P-SP - Traced: pipe conn. - spiral tracer - no cement P-SPC - Traced: pipe conn. - spiral tracer - with cement T-LO - Traced: tube conn. - longit. tracer - no cement T-LOC - Traced: tube conn. - longit tracer - with cement P-LO - Traced: pipe conn. - longit tracer - no cement P-LOC - Traced pipe conn. - longit tracer - with cement **Dist./Supply Header:** Distance specified is from traced pipe to supply or return header. Min: 5 FT [1.6 MM]; Default: *25* FT [*7.5* M]. **Dist./Return Header:** Distance specified is from traced pipe to supply or return header. Min: 5 FT [1.6 MM]; Default: *25* FT [*7.5* M]. **Heating Medium:** Default: *STM* STM - Steam heating medium OTHR - Other heating medium **Steam Pressure - Gauge:** Default: *25* PSIG [*175* KPA].	**PIPE-TRACE**

Piping Plant Bulks continued

	Description	Type
8	Launders, square/rectangular, rubber lined Steel launder lined with 0.25 INCH [6.0 MM] natural rubber. **Mat'l of Construction:** Default: *RBLCS* (Rubber-lined carbon steel) **Cover Type:** Default: *NONE* COVRD - Plate cover NONE - No cover	**LAUNDER-SQ**
9	Launders, half-round, rubber lined Steel launder lined with 0.25 INCH [6.0 MM] natural rubber. **Mat'l of Construction:** Default: *RBLCS* (Rubber-lined carbon steel) **Cover Type:** Default: *NONE* COVRD - Plate cover NONE - No cover	**LAUNDER-RD**
10	Coat and wrap pipe for burial: manual or machine Application may be by hand or machine. **Application Symbol:** HAND - Manual MACH - Machine	**COAT+WRAP**
11	Hot tap: production line to branch line Split tee or nipple, flange and valve provided; branch must be specified elsewhere. **Material Selection:** Default: *GRBW* GRBW - API5L and 5LS Gr. B X42W - API5LX Grade X42 X52W - API5LX Grade X52 X60W - API5LX Grade X60 X65W - API5LX Grade X65 A 53 - A 53 A 106 - A 106 A333C - 3.5 Ni A335C - 1.25Cr - .5Mo - Si 304P - SS304 304LP - 304L 316P - SS316 316LP - 316L 321P - SS321 AL - Aluminum CU - Copper NI - Nickel MONEL - Monel INCNL - Inconel **Flange Class:** Default: *600* 150 - Class 150 300 - Class 300 600 - Class 600 900 - Class 900 1500 - Class 1500 2500 - Class 2500 125 - Class 125 WOG 250 - Class 250 WOG	**HOT TAP**

Piping Plant Bulks continued

	Description	Type
12	Permanent scraper launcher and receiver A pair (launcher and receiver) is provided for each item. **Material Selection:** Default: *X52W* X52W - API5LLX-X52 welded X42W - API5LX-X42 welded X60W - API5LX-X60 welded X65W - API5LX-X65 welded GRBW - API5L - gr B/5LS welded X52S - API5LX-X52 seamless X42S - APIFLX-X42 seamless X60S - API5LX-X60 seamless X65S - API5LX-X65 seamless GRBS - API5L - gr B seamless **Flange Class:** Default: *600* 150 - Class 150 300 - Class 300 600 - Class 600 900 - Class 900 1500 - Class 1500 2500 - Class 2500 125 - Class 125 WOG 250 - Class 250 WOG	**SCRAPER-LR**
13	Pipe, valve, and fittings at well head Standard valve and fitting configuration plus 70 FT [20 M] of pipe. **Material Selection:** Default: *X52W* X52W - API5LLX-X52 welded X42W - API5LX-X42 welded X60W - API5LX-X60 welded X65W - API5LX-X65 welded GRBW - API5L - gr B/5LS welded X52S - API5LX-X52 seamless X42S - APIFLX-X42 seamless X60S - API5LX-X60 seamless X65S - API5LX-X65 seamless GRBS - API5L - gr B seamless **Pipe Diameter**: Default: *8* IN DIAM [*200* MM DIAM] **Type of Well:** Default: *PROD* PROD - Production well INJEC - Injection well	**WELL HEAD**

Note: Items 12 and 13 are available in ICARUS 2000, ICARUS Process Evaluator and COST® only.

14 High density polyethylene pipe, fusion bonded **HDPE-PIPE**

Length: Min: 1.0 FT [0.35 M]
Diameter: 2-54 IN DIAM [50-1350 MM DIAM]
Pressure: Default: based on SDR and temperature
Temperature: Default: 73 DEG F [23 DEG C]
Number of Elbows: Default: *0*
Number of Reducers: Default: *0*
Number of Tees: Default: *0*
Number of Wyes: Default: *0*
Number of Blinds: Default: *0*
Depth of Pipe: 24-120 IN [600-3000 MM]
SDR: Default: varies with diameter
Buried Option: *BURIED*, ABOVE

15 Sprinkler fire system (water / water+foam) **SPRNK**

Pipe Material: *A 53*, 304P, 316P
Outlet Arrangement: *PLANE*, ARRAY
Location: *OUT*, IN
Hazard Type: *EFLH*, EFOH1, EFOH2, EFXH1, EFXH2, EPXH2, CBXH2, PFXH2
System Type: *WSPNK*, WSPRY, FSPNK, FSPRY
Pipe System Type: *DRSYS*, WTSYS, DPPNU, DPHYD, DELEC
Detector Type: *SPRKR*, FXTMP, R-O-R, SMKAL, NONE
Foam Tank Option: *NONE*, BALPR, PRTNK, ARPMP
Pipe Sizing Method: *HYDLC*, PSCHD

16 Foam fire systems **FOAM**

Pipe Material: *A 53*, 304P, 316P.
Outlet Arrangement: *PLANE*, ARRAY
System Type: *LOEXP*, MDEXP, HIEXP
Pipe System Type: *DRFXP*, WTFXP, DLFXP, PORT
Foam Deliver Option: FCHMB, MONTR, *NOZLE*, HNDLN, SPRKR
Foam Tank Option: *NONE*, BALPR, PRTNK, ARPMP

17 Standpipe and hose fire systems **SPHOS**

Pipe Material: *A 53*, 304P, 316P
System Type: *C-I*, C-II, C-III
Pipe System Type: *DRAUT*, DRSMA, DRMNL, WTAUT, WTMNL

18 Emergency eyewash and shower units **WSHWR**

Material: *A 53*, 304P, 316P
Wash Unit Type: EYE1, *EYE2*, FACE, COMB
Drain Requirement: *YES*, NO

Pipe Diameters

Pipe Diameters - Inch-Pound (ANSI B36.19)

IN				
0.5[1]	.75	1	1.25[1]	1.5[1]
2	2.5[1]	3	3.5[1]	4
5[1]	6	8	10	12
14	16	18	20	24
30	36	42	48	54*
60*	72*			

* Elbows and tees are fabricated from like-diameter pipe. Estimate includes more welds to fabricate fittings.
[1] Non-standard pipe sizes are not created by models unless specified.

Pipe Diameters - Metric

MM				
15[1]	20	25	32[1]	40[1]
50	65[1]	80	90[1]	100
125[1]	150	200	250	300
350	400	450	500	600
750	900	1050	1200	1350
1500	1800			

* Elbows and tees are fabricated from like-diameter pipe. Estimate includes more welds to fabricate fittings.
[1] Non-standard pipe sizes are not created by models unless specified.

Pipe Schedule

Use ANSI B36.10 for all materials, all country locations.

Exceptions:

Japan - does have schedule of 2.0SS 0.5 - 12 IN diameter.
Japan - schedule 40, 60, 80, and 100JS > 20 IN diameter is thinner.

Standard Equations for Pipe Diameter (ICARUS 2000, ICARUS Process Evaluator & COST®)

Liquid Lines

GPM Range	Velocity
0 - 90	7
91 - 250	8
251 - 500	9
501 - 1000	10
1001 - 2000	11
2001 - 3000	12
3001 - 4000	13
> 4000	14

Slurry Lines

GPM Range	Velocity
0 - 3000	3
3001 - 5000	5
5001 - 7000	7
> 7000	8

Diameter = 0.6384*(GPM/Velocity)**0.5
  IF (Diameter > 4.0) THEN
    Diameter = Diameter - 1.00
  ELSE
    Diameter = Diameter - 0.25

Gas Lines

Minimum Flowrate = 100000.0 for velocity calculations
Maximum Flowrate = 1.0E07 for velocity calculations

	Flowrate LBS/HR	**Velocity FPS**
Velocity = Log-Log	X1 = 1.0E05	Y1 = 30.0
	X2 = 1.0E07	Y2 = 100.0

Specific Volume = 10.73*(Fahrenheit+460.0)/(Molewt*(Pressure+15.0))

Diameter = 0.226*((Flowrate*Specific Volume)/Velocity)**0.50

IF (Diameter > 18.0) Use one pipe size smaller

Steam Lines

Minimum Flowrate = 10000.0 for velocity equations
Maximum Flowrate = 1.0E06 for velocity equations

	Flowrate LBS/HR	**Velocity FPS**
Velocity = Log-Log	X1 = 1.0E04	Y1=20.0
	X2 = 1.0E06	Y2=100.0

TempSteam = 100.0*(Pressure+30.0)**0.25

SpecificVolume = 0.596*(TempSteam+460.0)/(Pressure+15.0)

Diameter = 0.226*(Flowrate*SpecificVolume/Velocity)**0.50

IF (Diameter > 18.0) Use one pipe size smaller

Relief Lines

SQ IN	DIA IN	SQ IN	DIA IN
0.196	1.0	1.287	2.0
2.853	3.0	6.38	4.0
16.0	6.0	26.0	8.0

Utility Piping Services

Utility headers are sized based the following:

- The Utility Header Diameter System (L, M, H, V) as specified for Area Pipe Specifications and retabulated in the following table.
- By specifying the desired diameter for that service. If the Utility Header Symbol is designated, then a run of each service line is provided by the system in default of a non specified diameter. The default diameter corresponding to the service type is listed in the following table.

  A user-specified diameter for a service header overrides the diameter associated with the Utility Header Diameter Symbol. Service headers may be omitted by either:

  - Specifying "0.0" diameter for the undesired service.
  - Omitting the Utility Diameter Symbol, whereby only diameter-specified headers are provided.

Service		Nominal Pipe Diameter: IN [MM] Diameter Symbol				
Symbol	**Type**	**L**	**M**	**H**	**V**	**—**
	Water					
F (b)	Firewater - loop	6 [150]	8 [200]	12 [300]	16 [400]	excluded
F (b)	Firewater - lateral	4 [100]	6 [150]	6 [150]	6 [150]	excluded
P	Potable water	2 [50]	2 [50]	4 [100]	6 [150]	excluded
C	Cooling water and return line	6 [150]	8 [200]	12 [300]	14 [350]	excluded
	Steam*					
L (i)	Low pressure steam	3 [80]	4 [100]	8 [200]	12 [300]	excluded
M (i)	Medium pressure steam	3 [80]	4 [100]	8 [200]	12 [300]	excluded
H (i)	High pressure steam	3 [80]	4 [100]	6 [150]	8 [200]	excluded
	Air					
P	Plant air	2 [50]	3 [80]	4 [100]	6 [150]	excluded
I	Instrument air	2 [50]	2 [50]	3 [80]	[100]	excluded
	Gas					
F	Fuel gas	2 [50]	2 [50]	4 [100]	6 [150]	excluded
I	Inert gas	2 [50]	2 [50]	4 [100]	6 [150]	excluded
	Other					
CS (b)	Chemical sewer	8 [200]	10 [250]	12 [300]	14 [350]	excluded
FL	Flare line	10 [250]	14 [350]	16 [400]	24 [600]	excluded
US	Utility station	1 [25]	1 [25]	1 [25]	1 [25]	excluded

* One condensate return line is provided upon selection of any combination of steam services.
(b) Buried
(i) Insulated

Default Piping Materials

Equipment Fabrication Materials	Temperature Range F	Temperature Range C	Piping Material Symbol
Questimate and ICARUS Project Manager			
All Materials	all	all	A 106 (up to 2 IN [50 MM]) A 53 (2 IN [50 MM] and larger)
ICARUS 2000, ICARUS Project Evaluator and COST			
All Carbon and Low Alloy Steel	-425 to -51 -50 to -21 -20 to 650 -20 to 650 651 to 1000 1001 to 1200 1201 to 1500	-253 to -46 -45 to -29 -28 to 343 -28 to 343 344 to 537 538 to 648 649 to 815	304P A333A A 106 (up to 2 IN [50 MM]) A 53 (2 IN [50 MM] and larger) A335C A335F 304P
Clad Vessels			Material corresponding to process-side cladding material
Lined Vessels: Brick or monolithic lined	all	all	Carbon steel - see above
Lined Vessels: rubber lined	all	all	RBLCS
Lined Vessels: organic (except rubber), glass, lead zinc lined	all	all	TFELS
High Alloy Steel (Stainless)	-425 to 650 651 to 1500	-252 to 343 344 to 815	304P 316P
Aluminum	-425 to 300	-253 to 148	AL
Copper and Copper Alloys: Except for HE and RB HE and RB only	-20 to 400	-28 to 204	 CU Carbon Steel - see above
HASTELLOY	all	all	HAST
INCONEL	all	all	INCNL
KARBATE (graphite)	all	all	TFELS
MONEL	all	all	MONEL
Nickel	all	all	NI
Titanium	all	all	TI
Epoxy/Polypropylene (PPL)	all	all	TFELS
Wood	all	all	316P

Pipe Materials - Ferrous Materials

Carbon Steel

System Material Symbol	ASTM	BS	JIS	DIN	Composition	Recommended Maximum Temperature Degrees F	Recommended Maximum Temperature Degrees C	Length Type*
A 53 or CS	A-53 (B)	3601 ERW410	G3454 STPG G3452 SGP	17172 StE240.7		1100	593	1
GALV	(B)	ERW410	STPG G3452 SGP	StE240.7	Galvanized CS	1100	593	1
A 106 or CS	A-106 (B)	3602 HFS410	G3456 STPT	17175 St45.8		1100	593	1
A333A	A-333 (6)	3603 410LT50	G3460 STPL380	SEW-680 TTSt35N		1100	593	1

* See page 18-19 for length type definitions

API Pipe

System Material Symbol	API	BS	JIS	DIN	Composition	Recommended Maximum Temperature Degrees F	Recommended Maximum Temperature Degrees C	Length Type*
GRBW	5L/5LS (B)	3601 ERW410	G3454 STPG	17172 StE240.7		1100	593	1
X42W	5LX (X42)					1100	593	1
X52W	5LX (X52)					1100	593	1
X60W	5LX (X60)					1100	593	1
X65W	5LX (X65)					1100	593	1

* See page 18-19 for length type definitions

Low and Intermediate Alloy Steel

System Material Symbol	ASTM	BS	JIS	DIN	Composition	Recommended Maximum Temperature Degrees F	C	Length Type*
	A-335	3604	G3458	17175				
A335B	(12)	620-440	STPA22	13CrMo44	1Cr - .5Mo	1200	648	1
A335C	(11)	621	STPA23	13CrMo44	1.25Cr - .5Mo - Si	1200	648	1
A335D	(22)	622	STPA24	10CrMo910	2.25Cr - 1Mo	1200	648	1
A335F	(5)	625	STPA25	12CrMo195G	5Cr - .5Mo	1200	648	1
	Low Temperature Service					**Minimum Temp.**		
	A-333	3603	G3460	SEW 680				
A333C	(3)	503LT100	STPL450	10Ni14	3.5Ni	-150	-101	1

* See page 18-19 for length type definitions

High Alloy Steel

System Material Symbol	ASTM	BS	JIS	DIN	Composition	Recommended Maximum Temperature Degrees F	C	Length Type*
	A-312	3605	G3459	2462				
304P	TP 304	304S18	SUS304TP	X5CrNi1810	18Cr - 8Ni	1500	815	1
304LP	TP 304L	304S14	SUS304LTP	X2CrNi1911	18Cr - 8Ni	1500	815	1
316P	TP 316	316S18	SUS316TP	X5CrNiMo17122	16Cr - 12Ni - 2Mo	1500	815	1
316LP	TP 316L	316S14	SUS316LTP	X2CrNiMo17132	16Cr - 12Ni - 2Mo	1500	815	1
321P	TP 321	321S18	SUS321TP	X6CrNiTi1810	18Cr - 10Ni - Ti	1500	815	1
	Guage Pipe (Very Light Wall)							
	A-312	3605	G3459	2462				
304PG	TP 304	304S18	SUS304TP	X5CrNi1810	18Cr - 8Ni	1500	815	2
316PG	TP 316	316S18	SUS316TP	X5CrNiMo17122	16Cr - 12Ni - 2Mo	1500	815	2

* See page 18-19 for length type definitions

Pipe Materials - Non-Ferrous Materials

Non-Ferrous Materials

System Material Symbol	ASTM	BS	JIS	DIN	Composition	Recommended Maximum Temperature Degrees F	C	Length Type*
AL	B-241	1474	H4080	1746	Aluminum	350	176	1
	U.S. to 10 INCH [250 MM]							
	A96061	6061	A6061T					
	U.S. above 10 INCH [250 MM] and all others							
	A95083	5083	A5083T	AlMg4.5Mn				
CU	B-42	2871	H3300	1754	Copper	400	204	3
	C10200	C103	C1020T	OF-Cu				
NI	B-161	3074	H4552	17740	Nickel	600	315	3
	N02200	NA11	NNCT	Ni99.2	99Ni			
MONEL	B-165	3074	H4552	17751	Monel	800	426	3
	N04400	NA13	NCuT	NiCu30Fe	67Ni - 30Cu			
INCNL	B-167				Inconel			
	N06600				72Ni - 15Cr - 8Fe	1200	648	3
TI	B-337		H4630	17850	Titanium	600	315	3
	R50400		TTP35					
HAST	B-619		H4552	17751	Hastelloy	1250	676	3
	N10276		NMCr	NiMo16Cr15	54Ni - 16Mo - 15Cr			
A 20	B-464				Alloy 20	800	426	3
	N08020				35Ni - 35Fe - 20Cr -Cb			
ZR	B-658				Zirconium	700	371	3
	R60702				99.2Zr			

* See page 18-19 for length type definitions

Plastic and Resin Materials

Material Class	Pipe Material	System Material Symbol	Recommended Maximum Temperature Degrees F	Recommended Maximum Temperature Degrees C	Length Type*
Plastics and Resins	Fiberglass Reinforced** Epoxy Resin	FRP	260	125	
	Polyvinyl Chloride, Maximum 8 INCH [200 MM] diameter	PVC	140	60	4
	Chlorinated Polyvinyl Chloride, Maximum 8 INCH [200 MM] diameter	CPVC	200	93	4

* See below for length type definitions
** Thickness/schedule not adjustable

Length Types

Type	Length 10 FT [3 M]	15 FT [4.6 M]	20 FT [6.1 M]	30 FT [9.1 M]
1			< = 1.5 IN	> = 1.5 IN
2				All D
3			All D	
4		All D		
5	All D			

Random lengths assumed for pipe of different materials and diameters.

Lined Steel Pipe

Lined piping of the materials in the following table are developed irrespective of the equipment or pipe temperature. The user must give consideration to temperature-material selections for these materials, as the system does not produce a warning or error condition if the recommended maximum temperature is exceeded.

Lined Steel	System Material Symbol	Recommended Maximum Temperature		Spool Type
		Degrees F	Degrees C	
Remote shop fabricated carbon steel pipe and fittings, lined with:				
Epoxy	EPLCS	260	125	4
Glass	GSLCS	450	230	2
Natural rubber, (1/4 INCH [6 MM] thick)	RBLCS	175	80	4
Nitrile rubber (1/4 INCH [6 MM] thick)	NITRL	175	80	
Hypalon rubber (1/4 INCH [6 MM] thick)	HYPLN	175	80	
Butyl rubber (1/4 INCH [6 MM] thick)	BUTYL	175	80	
Neoprene rubber (1/4 INCH [6 MM] thick)	NEPNE	175	80	
Ebonite (1/4 INCH [6 MM] thick)	EBONT	175	80	
Cement	CMLCS	–	–	
Polypropylene	PPLCS*	225	110	1
Polyvinylidene Fluoride (KYNAR)	PVDF*	275	135	1
Polyvinylidene Chloride (SARAN)	PVDC	175	80	3
Fluorinated Ethylene Propylene (FEP TEFLON)	FEP	400	200	4
Polytetrafluoroethylene (TFE TEFLON)	TFELS*	450	230	1
Remote shop fabricated stainless steel pipe and fittings, lined with:				
Polytetrafluoroethylene (TFE TEFLON)	TFESS*	450	230	1

* Can use bends up to 4 IN instead of elbows.

Spool Type Chart

Spool Type	Spool Diameter	Default Spool Length	Maximum Spool Length
1	All	20 FT spools [6.1 M]	40 FT [12 M]
2	< = 1 INCH	2 FT spools [0.6 M]	2 FT [0.6 M]
	> 1 and < 2 IN	6 FT spools [1.9 M]	6 FT [1.9 M]
	> 2 IN	10 FT spools [3.1 M]	10 FT [3.1 M]
3	All	10 FT spools [3.1 M]	10 FT [3.1 M]
4	All	20 FT spools [6.1 M]	20 FT [6.1 M]

ICARUS systems automatically include two flanges per spool.

For yard pipe (Plant bulks - YARD PIPE), specifying the number of flanges overrides the default. An error message appears if the number of flanges you specified causes the spool piece to exceed the maximum length for that particular spool piece type and diameter.

For installation bulk piping (Component - Pipe Item Details), specifying the number of flanges overrides the default. If the number of flanges specified causes the spool piece to exceed the maximum length for that particular spool piece type and diameter, the default spool length is used. However, the system will not generate a message that there are too few flanges.

The spool pieces are shipped pre-flanged and ready for bolt-up to valves and flanged fittings in the field.

The following is a yard pipe example:

Yard Pipe Example:

200 FT [61 M] Yard Pipe	10 IN diameter	TFELS (material)
System generates:	10 sections	20 flanges
Spool length = 20 FT [61 M]		

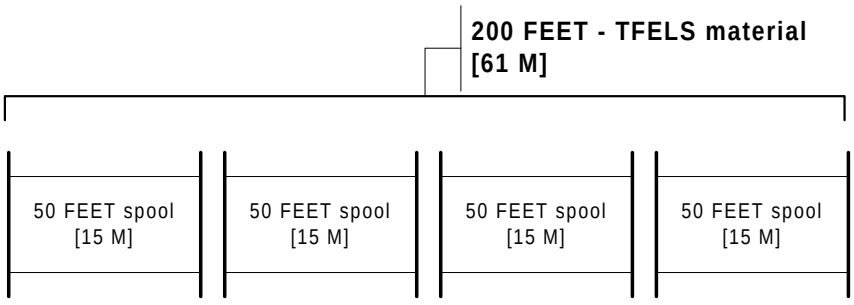
---

200 FT [61 M] Yard Pipe	10 IN diameter	TFELS (material)
User enters:		10 flanges
System generates:	5 sections	10 flanges
Spool lengths = 40 FT [12 M]		

---

200 FT Yard Pipe	10 INCH diameter	TFELS (material)
User enters:		8 flanges
System generates:	"ERROR: Too few flanges on this run of pipe"	

System cannot generate this run of yard pipe. When the user enters '8 flanges,' the system tries to break the yard pipe into 4 sections (spools):



2 Flanges per spool

Looking at our Spool Type Chart, we see that TFELS is a Type 1 spool and cannot exceed a maximum length of 40 FEET [12 M] on a single spool piece, therefore, the system generates an error message.

- Continued -

Yard Pipe Example (continued)

To determine the minimum number of flanges on a spool piece of yard pipe:

(1) Determine the length of the pipe.

(2) Determine the Spool Type.

(3) Look at the maximum length of spool for the Spool Type.

(4) Calculate:

Minimum Number of flanges = (Length of Pipe / Maximum Length) x 2

Example:

Material =	TFELS	Spool Type = 1 (see Spool Type Chart)
Length =	200 FT [61 M]	Maximum spool length = 40 FT [12.2 M]

The minimum number of flanges a user could enter for this run of pipe is:

(200 FT / 40 FT) x 2 =
[61.96 M/ 12.2 M] x 2 =
(5) x 2 = 10 flanges
[5.000] x 2 = 10 flanges

Entering less than 10 flanges will generate an error in your estimate.

Note: Odd sizes will roundup to the next integer.

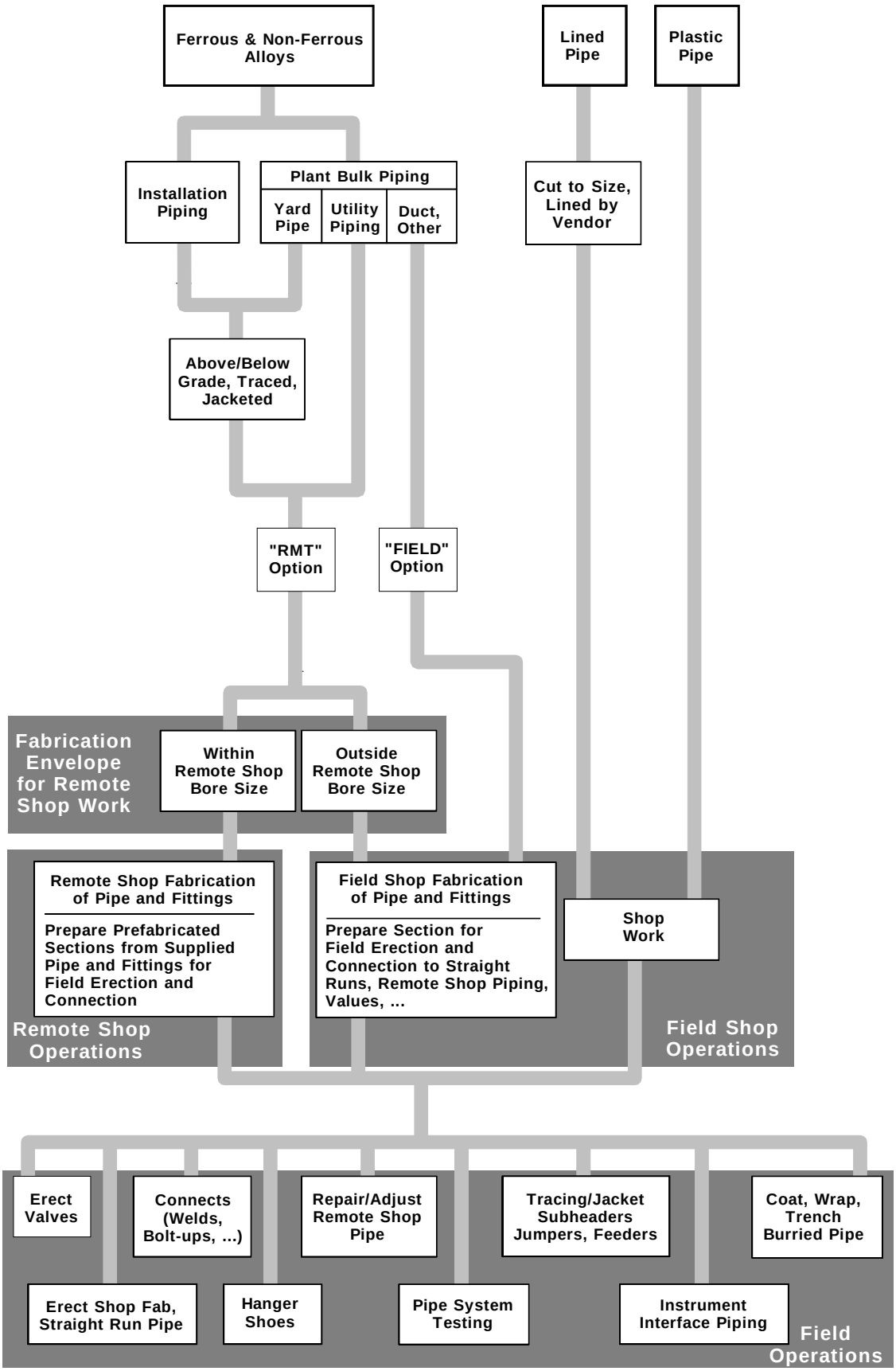
Material =	TFELS	Spool Type = 1 (see Spool Type Chart)
Length =	208 FT [63.4 M]	Maximum spool length = 40 FT [12.2 M]

(208 FT / 40 FT) x 2 =
[63.4 M / 12.2 M] x 2 =
(5.2) x 2 =
[5.200] x 2 =
(rounds up to the next integer)

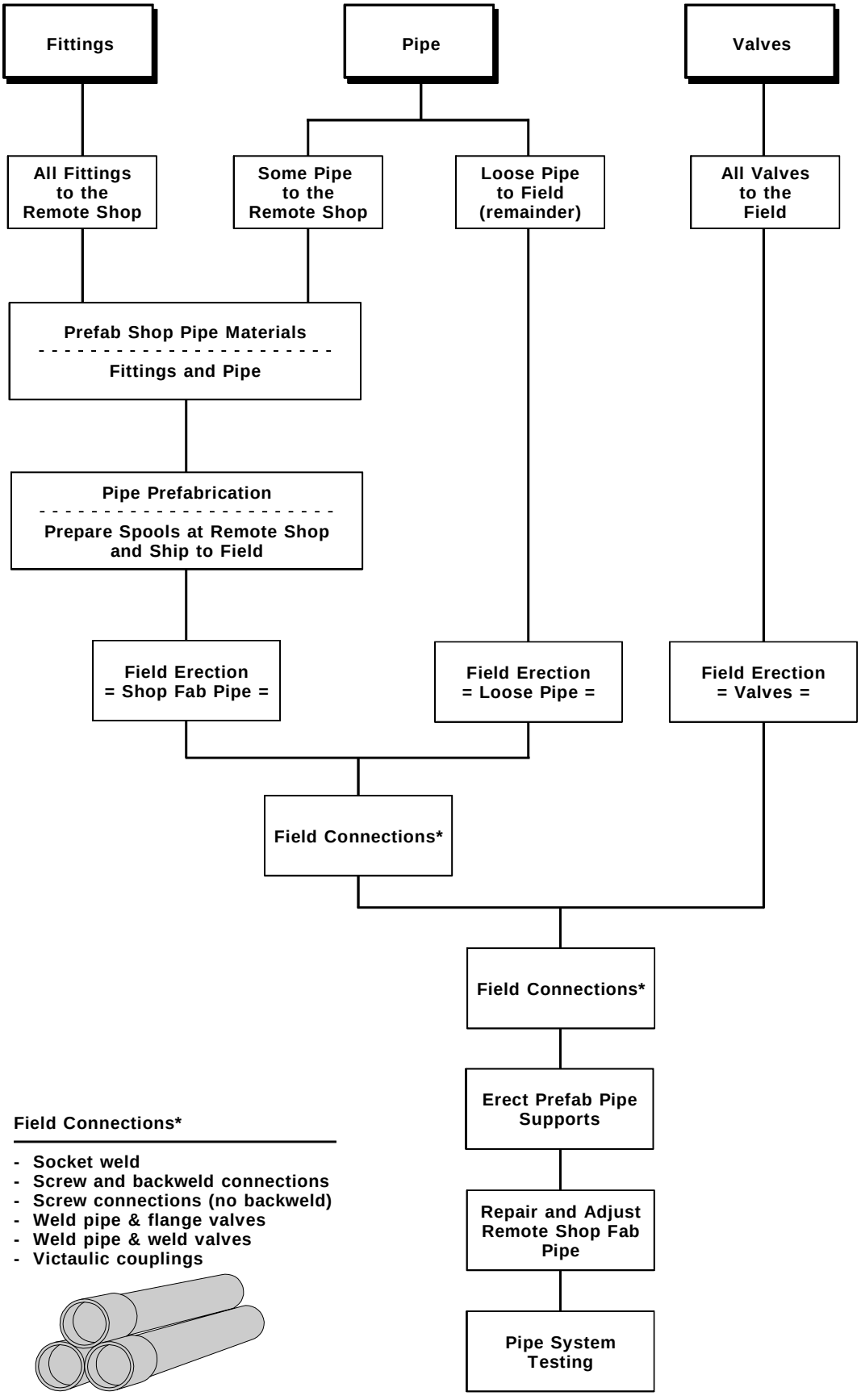
(6) x 2 = 12 flanges

Entering less than 12 flanges will generate an error in the estimate.

Remote & Field Shop Piping for Various Materials



Remote Shop Piping Procedures



Small Bore Piping Procedures