Become familiar with piping material specifications.

Be able to select piping material in accordance with the material specifications.
All aspects of piping design are covered by specifications. The main specifications are:

Process and Utility Design, Layout, and Drawing (000 250 50001)

Shop Fabrication and Handling – Process and Utility Piping (000 250 50025)

Field Fabrication and Installation – Process and Utility Piping (000 250 50026)

Piping Material Specification Line Class – Process and Utility Piping (000 250 50003)
Piping Material Specification is developed by the Material Engineer

The Material Specification conforms to:
Process Flow Summary
Customer Specifications
Fluor Standard Specifications
Piping Codes (Federal and/or local or applicable foreign codes)

The Process Engineer, Material Engineer, and the Metallurgist all work together to develop each individual line class or specification.
The Process Engineer, Material Engineer, and the Metallurgist use the Process Flow Diagram (PFD) to create a Material Selection Diagram (MSD).
The Material Engineer uses the MSD to assign each individual line a line class on the Piping and Instrumentation Diagram (P&ID).
The Material Specification is very important because all piping material used for a project is covered within the specification. The Material Specification will guide a piping designer as to what fitting to use when. For example, when you need to use a slip-on flange rather than a weldneck flange.

Material Specifications will change from project to project depending on Client preference.

The Material Specification is divided into three sections:
Index
General Notes
Specific Line Classes
The Material Line Class Index lists all the line classes currently being used on the project along with a brief summary.

<table>
<thead>
<tr>
<th>LINE CLASS</th>
<th>OBJ</th>
<th>LAYER</th>
<th>MATERIAL</th>
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<th>TEMP RANGE</th>
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</table>
The General Notes section of the Material Specification contains general information related to the piping materials used such as references to other specifications such as pipe supports, insulation, and painting.
### Piping Material Specification General Notes:

**A. ASME (American Society of Mechanical Engineers)**

1. ASME B31.3 Power Piping
2. ASME B31.3 Process Piping
3. ASME B31.4 Liquid Transportation Systems for Hydrogen, LPG, Anhydrous Ammonia and Alcohols
4. ASME B16.5 Pipe Flanges and Flanged Fittings
5. ASME B16.34 Valves-Flanged, Threaded, and Welding End
6. ASME Boiler and Pressure Vessel Code, Section VIII, Division 1

**B. API (American Petroleum Institute)**

1. Publication 941 Steels for Hydrogen Service at Elevated Temperatures and Pressures in Petroleum Refineries and Petrochemical Plants

**C. NACE (National Association of Corrosion Engineers)**

1. Corrosion Data Survey
2. NACE MR-01-75 Sulfide Stress Corrosion Cracking Resistant Metallic Materials for Oilfield Service

**D.**

Where fabrication and design criteria in this specification are affected by city, county, province, state, or federal requirements, this specification shall be modified as necessary to ensure compliance.

The General Notes section of the Material Specification also contains general information related to the piping materials used such as references to applicable codes.
Piping Material Specification General Notes:

C. Terminology

1. Base Code

Piping system in this specification is categorized as Normal Fluid Service in accordance with the applicable Code for Pressure Piping, ASME B31.1, ASME B31.3, ASME B31.4, etc., unless indicated in the individual Line Class.

2. Design Conditions

Unless otherwise specified, pressures and temperatures refer to design conditions.

3. Pressure-Temperature Ratings

Pressure-temperature ratings for NPS 24 and smaller carbon steel, ferritic alloy steel, and austenitic stainless steel piping systems are based on ASME B16.5. Pressure-temperature ratings for NPS 26 through 60 carbon steel piping systems are based on ASME B16.47.
4. Corrosion Allowance

6. Pipe Wall Thickness

Unless otherwise specified, pressures specified in the individual line classes are positive pressure. Piping subjected to a negative pressure shall be investigated on an individual basis. Piping components specified in the applicable line class may not be suitable for vacuum conditions.

7. Vacuum Lines

8. Manufacturer Reference

Items specified or referenced by manufacturer and figure number are not intended to exclude items offered by other manufacturers. Products made by reputable manufacturers.

The criteria by which the Material Engineer has determined the pipe schedules used throughout the Material Specification is also contained in the General Notes.
This section of the General Notes defines any project-related or Process requirements which has an affect on the selection of piping materials.
Piping Material Specification General Notes:

E. **Thread Compound**

Thread compound requirements, unless otherwise specified in the individual line class, shall conform to the following (or Fluor Daniel Piping Material Engineering approved substitute):

- 460°F thru 2600°F (-50°F thru 500°F): Lubron 6404
- 2610°F thru 6210°F (4510°F thru 1150°F): Liquid-O-Ring #HT-1880
- Stainless steels and nickel alloys: Nickel-Eze for all temperatures
- Use Teflon tape only when specified in the individual Line Classes.

F. **Valve Operators**

1. Gate valves shall normally be handwheel operated. Manual gear operators, when specified, shall be fully enclosed type designed to bolt on to valve yoke and shall be field mountable. If gear operated valves are not specified in the individual Line Classes and an operator is required, the valves shall be identified with an item code number on the P&IDs and drawings.

2. Globe valves larger than those specified in the individual Line Classes are permitted. However, such valves shall be individually reviewed for possible gear operator requirements, and if an operator is required, the valves shall be identified with an item code number on P&IDs and drawings.

This section defines the criteria to be used in the selection or installation of components included in individual line classes.
Piping Material Specification General Notes:

H. Flanges
   1. Weld-neck flanges shall be used.
   2. Orifice flanges shall be used.

I. Lap Joint Sockets
   Lap joint socket weld fittings shall have the following:

J. Bolting
   1. Bolt length in accordance with ASME B16.11.
   2. Machine threads with external or internal threads.
   3. Stud bolts with nuts and washers.
   4. Bolt lengths in accordance with ASME B16.11.

K. Flange Finish
   Unless otherwise specified in accordance with ASME B16.11.

L. Short Radius Elbows
   Consideration shall be given to the use of short radius in lieu of long radius elbows for NPS 30 and larger for economic reasons with Process Engineering concurrence.

M. Lok-Ring Fittings
   Lok-Ring fittings are mechanically attached connectors that may be used in lieu of socket weld fittings where all-in labor rate is high or where the piping system is required to be assembled without any hot work permit.
   1. Class 150 Carbon Steel, Stainless Steel and Nickel Alloys.
   2. Corrosion allowance of 0.063" or less.
   3. Utility hydrocarbons except hydrogen and lethal services.

Construction Details

A. Pipe Bends
   1. Bends may be used in place of fittings subject to authorization by Piping Engineering.
   2. One and a half diameter hot induction bends may be used in lieu of butt welding elbows, 12 NPS and smaller. Three diameter or 5 diameter bends may be considered for 14 NPS and larger piping systems. Bends are normally economical on heavy wall (Schedule 80 or heavier) carbon steel and low chrome alloys.
Piping Material Specification General Notes:

B. Seal Welding

1. Seal welding is required for all services (except water and air) and any line subject to vibration. Seal welding for these conditions shall entail the following connections:

   a. On pipe
   b. On flow measurement apparatus
   c. With flat flanges
   d. On instrument connections
   e. On other connections

2. The welds that require seal welding shall be:

   a. API 610 Centrifugal pumps
   b. API 611 Steam turbines
   c. API 612 Special-purpose steam turbines
   d. API 617 Centrifugal compressors
   e. API 618 Reciprocating compressors
   f. API 672 Packaged plant and instrument air compressors

3. Thread compound or Teflon tape shall not be used on threads to be seal welded.

4. Ball and plug valves shall be disassembled prior to seal welding to prevent heat damage to stem packing and seals.

5. When seal welding one side of a valve, the threads on the other side shall be protected or chased after welding.

6. Screwed connections at instruments shall not be seal welded.

7. Seal welding of connections to equipment shall conform to the applicable, latest revision API Standard:
Piping Material Specification General Notes:

C. Valve Installation

1. The preferred orientation for swing and split-disc type check valves is horizontal; however, vertical orientation is an acceptable alternative in upward flow installations. Where allowed, split-disc wafer type check valves, when installed in horizontal lines, shall be installed with the shaft in the vertical position. Other types of check valves shall be installed in the horizontal position. Other orientations require Piping Engineering authorization.

2. The type of check valves shall be individually investigated for reciprocating pump or compressor discharge lines.

3. Valves installed against water storage tank nozzles shall be steel and shall be so identified on P&IDs and drawings with an item code number.

4. Flanged valves shall be used in place of socketweld in locations where isolation by blindfing is required.

5. Flanged valves shall be used in place of socketweld or screwed valves whenever mounted directly to vessels or other equipment that has been furnished with flanged connections. The rating of the valves shall match the nozzle connection.
E. **Postweld Heat Treatment (PWHT) and Non-Destructive Examination (NDE)**

Postweld heat treatment and non-destructive examination of pipe welds shall be in accordance with Specification 000.285.85002, Welding.

F. **Line Reductions**

1. When reducing in, to or from a screwed or socketweld fitting, use a swage nipple.

2. When reducing in buttwelding construction, use a butt weld reducer.

3. For large diameter piping, stub-on connections into butt weld cap may be used in lieu of reducers, subject to Stress Engineering authorization.

G. **Branch Connections**

Unless otherwise noted in the individual line class, branch connections shall be made in accordance with the Branch Charts BC-1 thru BC-4.
This section of the Material Specification defines how the line class or specifications are structured.
Another system of describing piping material specifications is outlined in “PIP”, an industry wide standard.

3.6 Example

An example of a complete piping Line Class designator is 3CS1S01. This designator means:

First Field: 3 = ASME Pressure Class 300
Second Field: CS = Carbon Steel Base Material Piping System
Third Field: 1 = Nominal Corrosion Allowance in multiples of 1/16"
Fourth Field: S = Socketweld Small Bore Construction and Butt weld and Flanged Large Bore Construction
Fifth Field: 01 = Sequence Number (first in this piping material/ pressure class series)
The Material Specification will also include a Branch Chart which will define what type of branch connection to use for each header-branch size combination.
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**Valves**

**Pipe**

**Fittings**

**Line Class Specs**

**SAMPLE**
# Line Class Specs

## Fittings

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<tr>
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<td>STAINERS</td>
<td>0046857</td>
<td></td>
<td>12-2</td>
<td>SWING CONC KS STL AVA OR WAV TIE</td>
<td>409-7</td>
<td>1154-1155</td>
</tr>
</tbody>
</table>

### Notes
- **SAMPLE**
- **Construction Details**
- **Nipples**
- **Swages**
- **Gaskets**
- **Stainers**
- **Bolting**
- **Blanks**
- **Branches**

**Construction**

- **Material:** Carbon Steel
- **Flange Rating:** 150 RF
- **Temperature Range:** -54 to 482°F
- **Finish:** Paint
- **Design:** Minimum Required Per ASME Code

**Comment:**

- **Example:** U.S. Metalworks
  - **SUB-FLange GASKET**
  - **Blanks**
  - **Branches**

**United Cathodic Protection Project**

**List of Projects:**
- **P & L Targets:**
  - **Project:**
  - **Location:**

**Sample:**

- **Item Name:**
  - **Code:**
  - **Date:**
  - **Rev:**
  - **Sheet:**
  - **Page:**
  - **Class:**
## Branch Reinforcement

### Header Size

<table>
<thead>
<tr>
<th>Diameter</th>
<th>Pressure</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-1/2</td>
<td>204</td>
<td>13.8</td>
</tr>
<tr>
<td>1</td>
<td>290</td>
<td>11.7</td>
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<tr>
<td>1-1/2</td>
<td>315</td>
<td>9.65</td>
</tr>
<tr>
<td>1</td>
<td>371</td>
<td>7.6</td>
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<tr>
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<td>5.5</td>
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<tr>
<td>1</td>
<td>492</td>
<td>4.5</td>
</tr>
<tr>
<td>1-1/2</td>
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<td>3.5</td>
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<td>1</td>
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<tr>
<td>1</td>
<td>722</td>
<td>0.5</td>
</tr>
</tbody>
</table>

### Pressure - Temperature Ratings

- **T**: Temperature
- **P (lbf/ln)g**: Pressure

**Legend:**
- **B**: Branch Weld
- **E**: Reducing Tee
- **P**: Branch Weld w/ Reinforcing Pad
- **S**: Stockolet
- **T**: Tee
- **W**: Weldolet (Note 05)

---

**Project Execution Services (PES)**

**FLUOR DANIEL, INC.**

**09700300**

**HOUSTON, TX.**

**LINE CLASS:** 1CS1502

**ANGLE:** 90°

**REV:** 3
Material Spec Break
P&ID Representation:

Usually a line number change
"A" "C"

Valve is higher rating or "C" Spec
Flange must be "C" Spec to bolt up to "C" Spec valve
Material Spec Break
Isometric Representation:

MUST CALL-OUT FLANGE BECAUSE NOT IN SPEC

BOLT UP TO "C" SPEC VALVE

LINE 2-33A

LINE 2-21C

PIPING ISOMETRICS
NOTE:
TEMP. 660°
3° BETWEEN WELDS
ISO #2 RATING

Exercise
Questions??
Exercise PI-E10
Test PI-T10