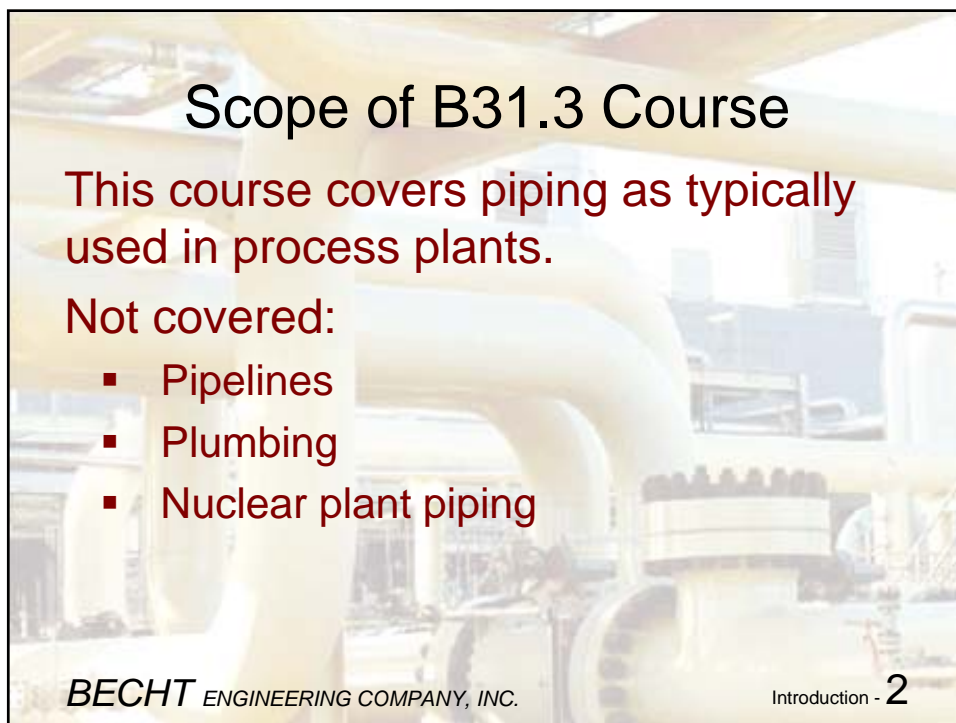




# ASME B31.3 Process Piping

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## Scope of B31.3 Course

This course covers piping as typically used in process plants.

Not covered:

- Pipelines
- Plumbing
- Nuclear plant piping

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## Topics Covered

1. Introduction
2. Metallic Pipe & Fitting Selection
3. Materials
4. Pressure Design
5. Valve Selection
6. Flexibility Analysis
7. Layout and Support
8. Flexibility
9. Support and Equipment Load Limits
10. Flexibility Analysis Methods

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## More Topics Covered

11. Designing with Expansion Joints
12. Fabrication and Installation
13. Inspection, Examination and Testing
14. Category M Fluid Service
15. Nonmetallic Piping Systems
16. High Pressure Piping
17. Inspection, Repair, Alteration and Rerating
18. What's Different in B31.1

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## 1. Introduction

- General Definitions
- Piping Development Process
- Piping System Standards
- B31.3 Scope
- Organization of the Code
- Fluid Service Definitions

## Definitions: (300.2)

***piping***: assemblies of piping components used...[for] fluid flows. Piping also includes pipe supporting elements, but does not include support structures...or equipment...

***piping system***: interconnected piping subject to the same design conditions

## More Definitions:

***pipng components:*** mechanical elements suitable for joining or assembly into pressure-tight fluid-containing piping systems...pipe, tubing, fittings, flanges, gaskets, bolting, valves and devices such as expansion joints, flexible joints, pressure hoses, traps, strainers, inline portions of instruments and separators.

## & More Definitions:

***design pressure:*** the pressure at the most severe condition of internal or external pressure and temperature expected during service

***design temperature:*** the temperature at which, under the coincident pressure, the greatest thickness or highest component rating is required



## Piping Development Process

1. Establish applicable system standard(s)
2. Establish design conditions
3. Make overall piping material decisions
  - Pressure Class
  - Reliability
  - Materials of construction
4. Fine tune piping material decisions
  - Materials
  - Determine wall thicknesses
  - Valves
5. Establish preliminary piping system layout & support configuration
6. Perform flexibility analysis
7. Finalize layout and bill of materials
8. Fabricate and install
9. Examine and test

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Introduction - 9

## Piping System Standards

Provide a set of requirements for obtaining a safe, reliable and economical installation.

Are frequently called Codes; for example, B31 piping system standards are called Codes.

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Introduction - 10

## ASME Piping System Standards

- B31.1 Power Piping
- B31.3 Process Piping
- B31.4 Liquid Transportation Pipelines
- B31.5 Refrigeration Piping
- B31.8 Gas Transportation Pipelines
- B31.9 Building Services Piping
- B31.11 Slurry Transportation Pipelines

## More ASME Piping System Standards

- BPE-1 Bioprocessing Equipment
- PVHO-1 Pressure Vessels for Human Occupancy
- HPS High Pressure Systems
- B&PV Code, Section III for Nuclear Power Plants

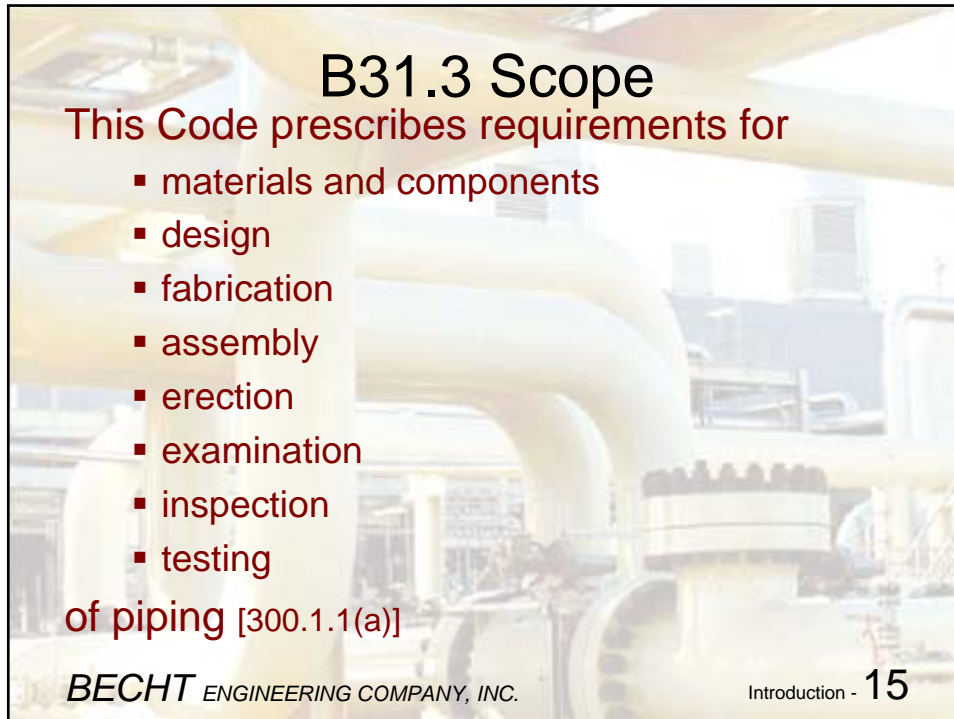
## Other Piping System Standards

- NFPA 13 – Installation of Sprinkler Systems
- NFPA 24 – Installation of Private Mains
- NFPA 50 – Bulk Oxygen Systems
- NFPA 54 – National Fuel Gas Code
- CGA – Handling of Anhydrous Ammonia (K61.1)
- Chlorine Institute #6 – Piping Systems for Chlorine

See the longer list, pages 2-3 in the supplement.

## B31.3 Scope

Rules for the Process Piping Code Section B31.3 have been developed considering piping typically found in petroleum refineries; chemical, pharmaceutical, textile, paper semiconductor, and cryogenic plants; and related processing plants and terminals. (300.1)



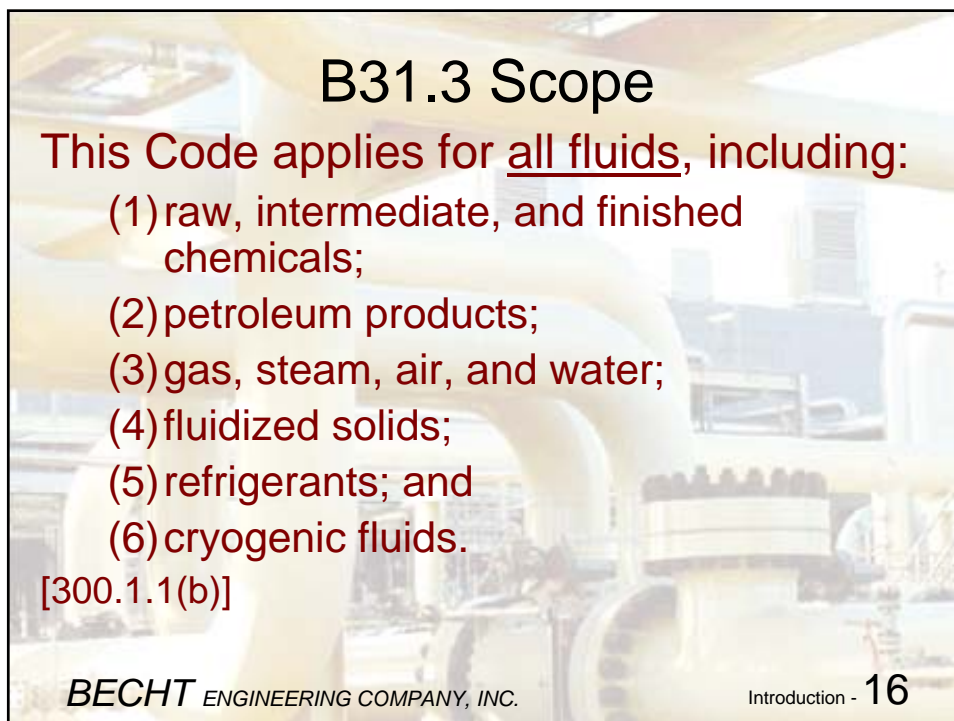
## B31.3 Scope

This Code prescribes requirements for

- materials and components
- design
- fabrication
- assembly
- erection
- examination
- inspection
- testing

of piping [300.1.1(a)]

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## B31.3 Scope

This Code applies for all fluids, including:

- (1) raw, intermediate, and finished chemicals;
- (2) petroleum products;
- (3) gas, steam, air, and water;
- (4) fluidized solids;
- (5) refrigerants; and
- (6) cryogenic fluids.

[300.1.1(b)]

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## B31.3 Scope

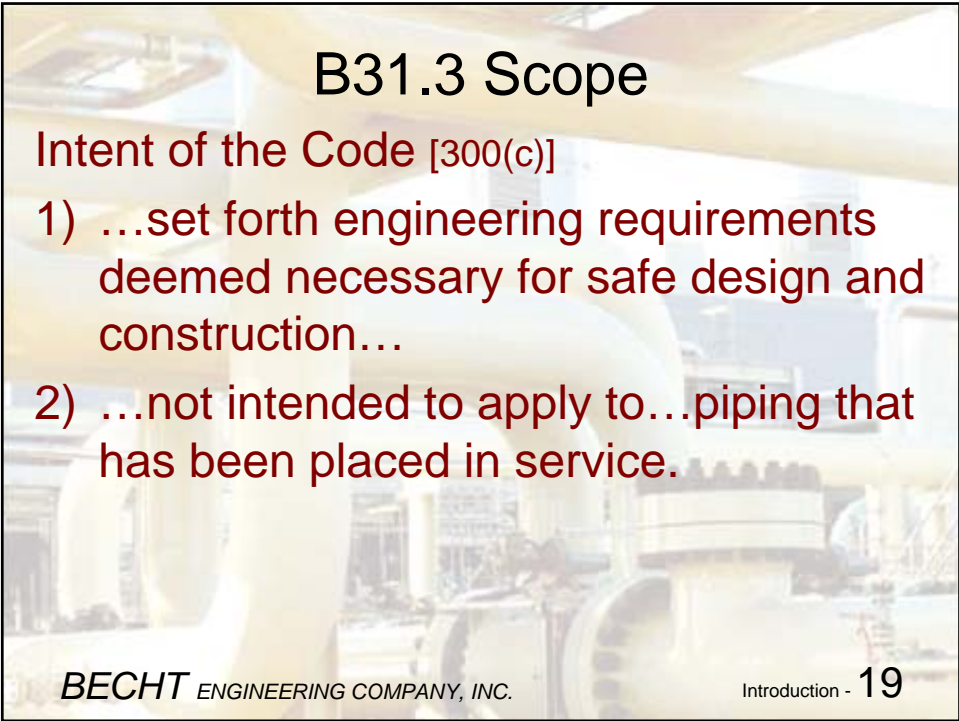
### Exclusions: (300.1.3)

- Piping systems designed for
  - pressure  $>0$  and  $<15$  psig (105 kPa)
  - nonflammable
  - nontoxic
  - not damaging to human tissue, and
  - temperature  $-20$  to  $366^{\circ}\text{F}$  ( $-29$  to  $186^{\circ}\text{C}$ )

## B31.3 Scope

### More Exclusions: (300.1.3)

- boilers and piping required to conform to B31.1
- tubes and manifolds of fired heaters
- pressure equipment such as pressure vessels and pumps, including internal piping

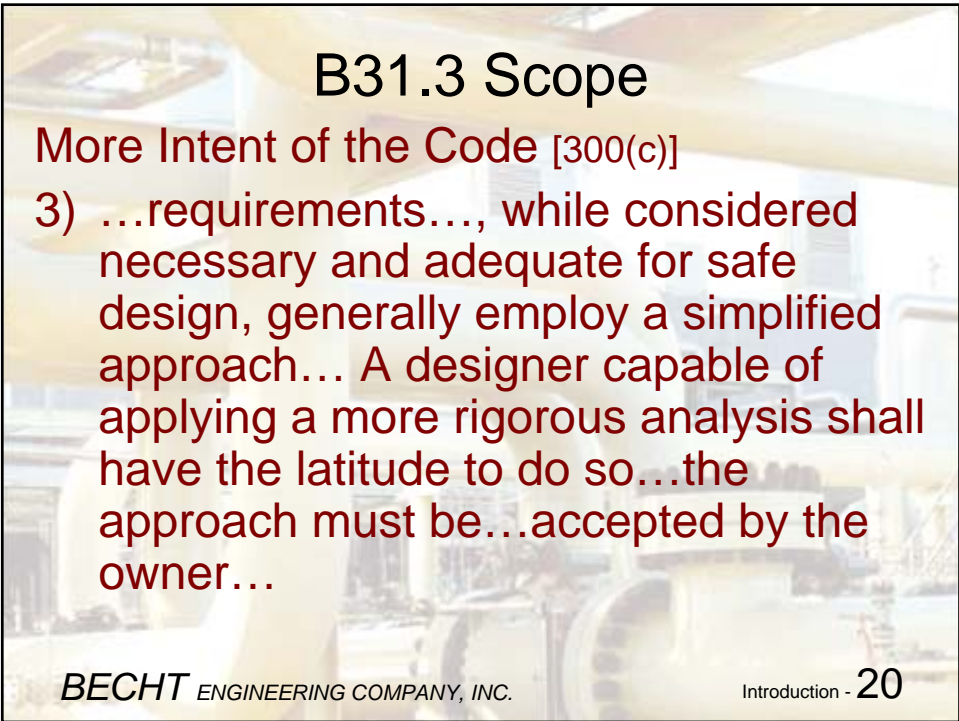


## B31.3 Scope

Intent of the Code [300(c)]

- 1) ...set forth engineering requirements deemed necessary for safe design and construction...
- 2) ...not intended to apply to...piping that has been placed in service.

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## B31.3 Scope

More Intent of the Code [300(c)]

- 3) ...requirements..., while considered necessary and adequate for safe design, generally employ a simplified approach... A designer capable of applying a more rigorous analysis shall have the latitude to do so...the approach must be...accepted by the owner...

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## B31.3 Scope

More Intent of the Code [300(c)]

- 4) ...Piping elements neither specifically approved nor specifically prohibited...may be used provided they are qualified...
- 5) The engineering design shall specify any unusual requirements...

## B31.3 Scope

More Intent of the Code [300(c)]

- 6) Compatibility of materials with the service and hazards from instability of contained fluids are not within the scope of this Code.

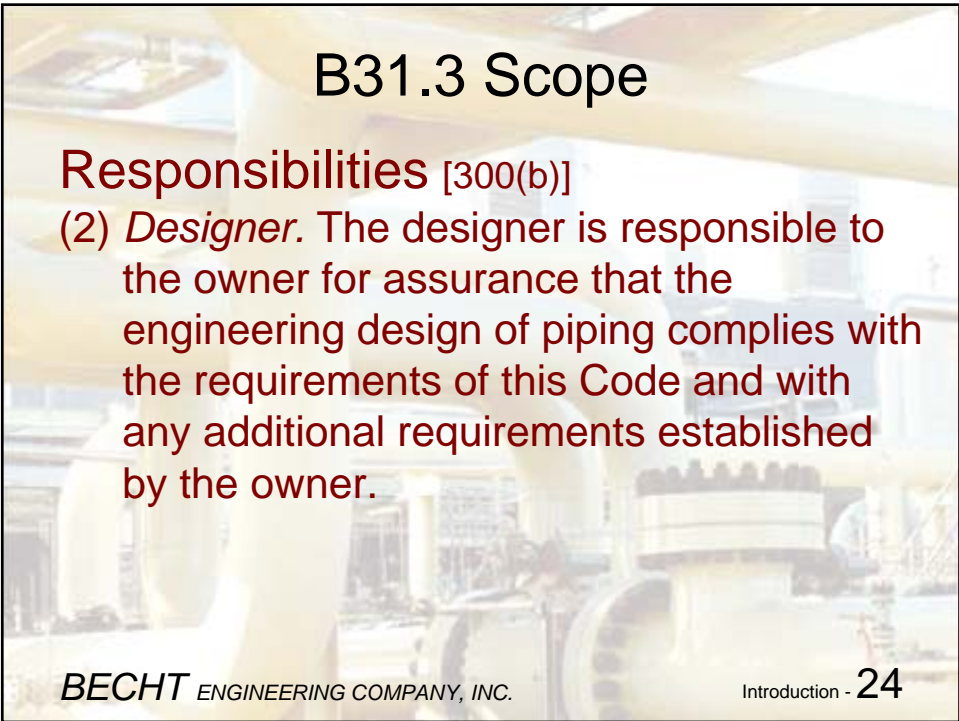


## B31.3 Scope

**Responsibilities [300(b)]**

(1) *Owner.* ...for compliance with this Code, and for establishing the requirements for design, construction, examination, inspection, and testing which will govern the entire fluid handling or process installation of which the piping is a part. The owner is also responsible for designating piping in certain fluid services and for determining if a specific Quality System is to be employed...

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## B31.3 Scope

**Responsibilities [300(b)]**

(2) *Designer.* The designer is responsible to the owner for assurance that the engineering design of piping complies with the requirements of this Code and with any additional requirements established by the owner.

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## B31.3 Scope

**Responsibilities [300(b)]**

**(3) *Manufacturer, Fabricator, and Erector.***  
The manufacturer, fabricator, and erector of piping are responsible for providing materials, components, and workmanship in compliance with the requirements of this Code and of the engineering design.

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## B31.3 Scope

**Responsibilities [300(b)]**

**(4) *Owner's Inspector.*** The owner's Inspector (see para. 340) is responsible to the owner for ensuring that the requirements of this Code for inspection, examination, and testing are met. If a Quality System is specified by the owner to be employed, the owner's inspector is responsible for verifying that it is implemented.

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## Organization of the Code

“Base Code” Chapters:

- I Scope and Definitions
- II Design
- III Materials
- IV Standards for Piping Components
- V Fabrication, Assembly, and Erection
- VI Inspection, Examination and Testing

## Organization of the Code

- VII Nonmetallic Piping and Piping Lined with Nonmetals (A)
- VIII Piping for Category M Fluid Service (M) & (MA)
- IX High Pressure Piping (K)

These chapters follow the same format as the “base Code”, and refer to the base Code requirements whenever applicable.

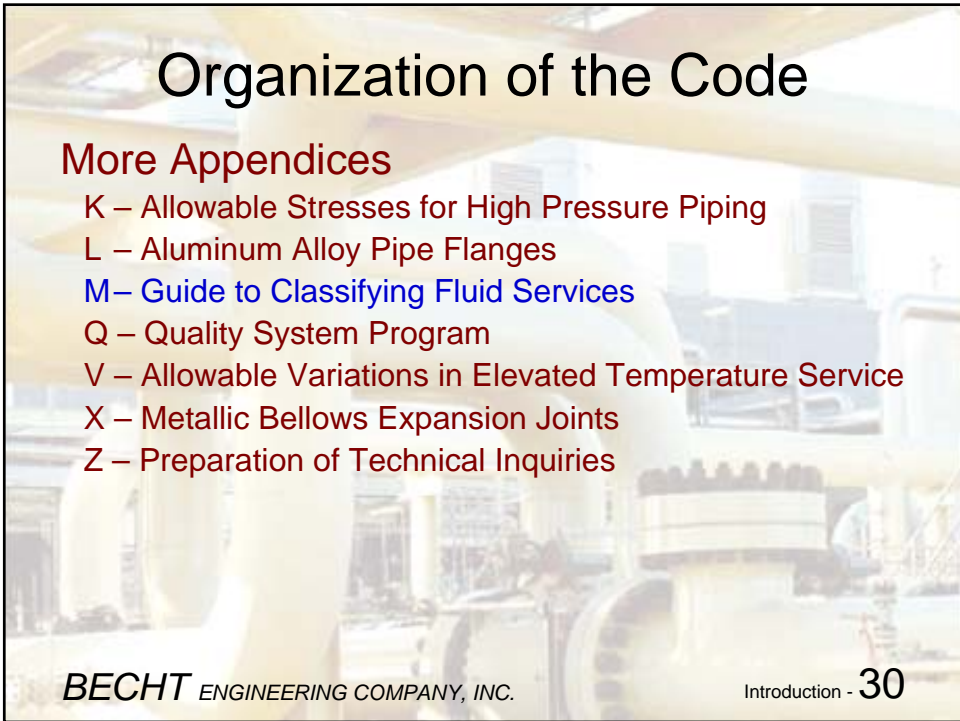


## Organization of the Code

**Appendices**

- A – Allowable Stresses & Quality Factors – Metals
- B – Stresses and Allowable Pressures – Nonmetals
- C – Physical Properties of Piping Materials
- D – Flexibility & Stress Intensification Factors
- E – Reference Standards
- F – Precautionary Considerations
- G – Safeguarding
- H – Sample Calculations
- J – Nomenclatures

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## Organization of the Code

**More Appendices**

- K – Allowable Stresses for High Pressure Piping
- L – Aluminum Alloy Pipe Flanges
- M – Guide to Classifying Fluid Services
- Q – Quality System Program
- V – Allowable Variations in Elevated Temperature Service
- X – Metallic Bellows Expansion Joints
- Z – Preparation of Technical Inquiries

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## B31.3 Fluid Service Definitions

- Fluid Service
- Category D
- Category M
- High Pressure
- Normal

## B31.3 Fluid Service Definitions

**Fluid Service:** a general term concerning the application of a piping system, considering the combination of fluid properties, operating conditions and other factors which establish the basis for design...

- What fluid properties are important?
- What operating conditions are important?
- What other factors are important?



## B31.3 Fluid Service Definitions

**Category D:** The fluid handled is nonflammable, nontoxic and not damaging to human tissue. The design pressure does not exceed 150 psig (1035 kPa). The design temperature is greater than -20°F (-29°C) and does not exceed 366 °F (186°C).

Often characterized as “utility”

## B31.3 Fluid Service Definitions

**Category M:** A fluid service in which the potential for personnel exposure is judged to be significant and in which a single exposure to a very small quantity of a toxic fluid, caused by leakage, can produce serious irreversible harm to persons upon breathing or on bodily contact, even when prompt restorative measures are taken.

Often characterized as “lethal”

## B31.3 Fluid Service Definitions

**High Pressure:** A service for which the owner specifies the use of Chapter IX [of B31.3] for piping design and construction... considered to be in excess of Class 2500 (PN 420).

Characterized as “high pressure”

**Normal:** Everything else.

Often characterized as “process”

## B31.3 Definitions

**Severe Cyclic Conditions:** Conditions applying to specific piping components or joints in which  $S_E$  ... exceeds  $0.8 S_A$ , and the equivalent number of cycles exceeds 7000; or conditions which the designer determines will produce and equivalent effect.

**Flammable:** A fluid which under ambient or expected operating conditions is a vapor or produces a vapor that can be ignited and continue to burn in air.

## Fluid Service Selection

**Workshop**: What B31.3 fluid service definition is most nearly applicable for the following services:

Steam condensate	650 psig (45 bar) Steam
Chlorine	Heat transfer oil
Sulfuric acid	Styrene monomer
Gasoline	Lime-water slurry

See Supplement page 7 for details.