

B31.3: PROCESS PIPING CODE DESIGN

The code that keeps petroleum refineries
and chemical processors running



INSIDE THIS GUIDE

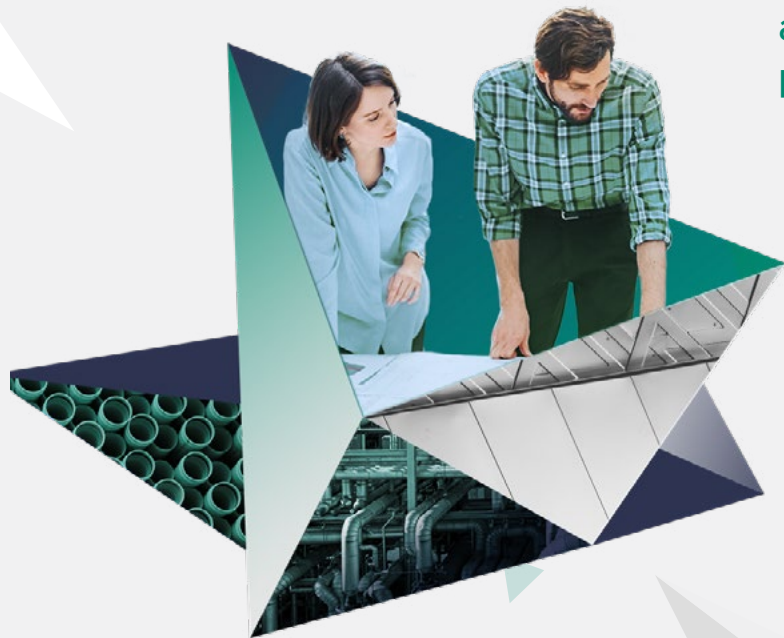
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PROCESS PIPING SYSTEMS FOR HIGH-PRESSURE INDUSTRIES

The standard for
safe piping in
petroleum refineries
and chemical
processing plants.



Process piping is the most effective way to process fluids and gases in an industrial processing facility. It helps organizations safely convert raw chemicals, gases, and liquids into more valuable products. Process piping is commonly used in the **chemical processing and petroleum refinery industries**.

This guide will explore the practical application of the B31.3 Process Piping Code across petroleum refinery and chemical processing industries. Learn the fundamentals of B31.3, along with common industry challenges and best practices for applying the code. Plus, you'll gain valuable insight from our industry expert, who has answered some frequently asked questions about B31.3 training.

PETROLEUM REFINEMENT AND CHEMICAL PROCESSING

The oil and gas industry uses petroleum refining and chemical processing for the purpose of heating, distilling and desalting crude oil.

Petroleum refinement and chemical processing are methods used to create usable resources. Oil companies need to efficiently convert crude oil into commonly used products like gas, petrol, kerosene and jet fuel in order to realize any significant value. This process primarily takes place in large, complex oil refineries that have a multitude of processes, which can vary depending on the production intent of the plant.

Piping systems in refineries are critical pieces of mechanical hardware. In every processing facility, there are products that need to get from point A to point B. Piping is the vehicle that moves

these liquids and gases through the facility. For example, the pipes used in the transportation of key ingredients such as crude oil in an industrial petroleum refinery are components of a process piping system. Similarly, the movement of ingredients such as carbon, sulphur and chlorine that are used to create certain plastics in a chemical processing facility also rely on process piping systems.

In the United States, **B31.3** is the recognized code for process piping for petroleum refineries, petrochemical plants and chemical processors.



WHAT IS THE B31.3 PROCESS PIPING CODE?

B31.3 Process Piping Code is the code that governs the design, fabrication, compwwwnt standards, installation, inspection and testing of process piping.

Organizations rely on engineers who can design process piping that's up to standard. The B31.3 Code provides guidance, limitations and minimum safety requirements for the design and assembly of process piping systems.

Process piping systems entail a vast, complicated and interconnected system of separators, pressure hoses, traps, gaskets, and many more components. These components are uniquely placed together to separate and control the movement of fluids within the piping system. Such complexities call for engineering professionals that can expertly interpret and apply the B31.3 Code to designs.

The B31.3 Code enables you to:

- **Identify** what issues to take into consideration when designing process piping
- **Explain** the pressure design of piping and piping components
- **Analyze** piping flexibility and gauge the limitations of piping and piping components
- **Identify** pipe supports, leak testing, piping failures and their causes

Piping codes address the following design requirements:¹

- Allowable stresses and stress limits
- Allowable dead loads and load limits
- Allowable live loads and load limits
- Materials
- Minimum wall thickness
- Maximum deflection
- Seismic loads
- Thermal expansion

¹The difference between codes, standard and recommended practice. The Piping Talk, 2019.

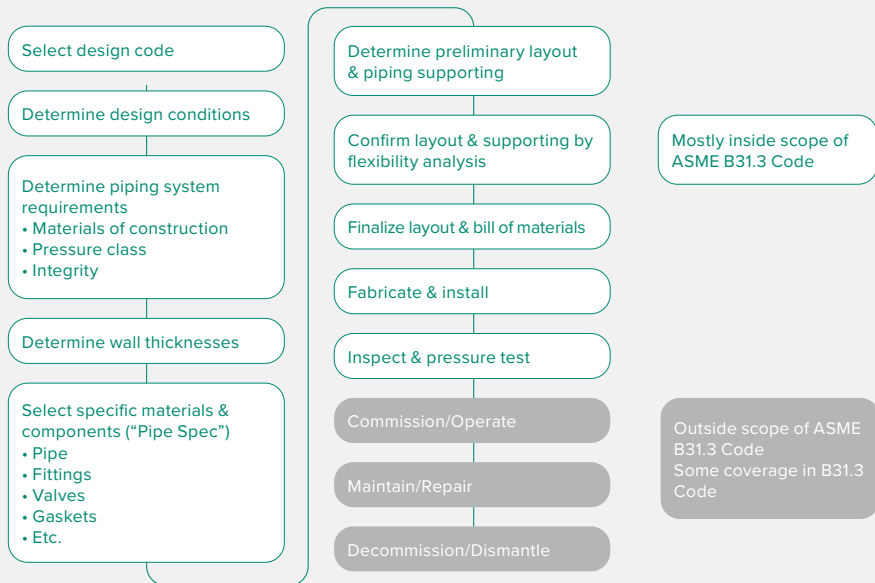
B31.3 PROCESS PIPING FUNDAMENTALS

A regulatory code cannot act as a one-size-fits-all design handbook. This is why B31.3 is designed to be broad and permissive for many applications, giving designers as many options as possible without compromising on safety.

In recent years, many engineers have started to rely on either computer programs to do the design analysis for them, or pre-written specifications from third party companies. However, computer analysis can often overcomplicate a design, while buying specifications will result in engineers paying more to construct a design in the long run.

Before all else, understanding the code should be step one; by learning B31.3, engineers can design solid piping systems while also benefiting from time and cost savings.

Development of a piping system



The white sections of the flow chart indicate areas of design that are within the scope of the B31.3 Code. These sections indicate everything an engineer is able to calculate, simply by following guidance from the B31.3 Code. From determining the design conditions, right through to inspections and testing, engineers can use B31.3 to help them get the best results while spending the least amount of money.

B31.3 is intended to be applied to:²

- Piping for all fluid services
- Metallic and non-metallic piping
- All pressures
- All temperatures

² A. Bhatia., *Process Piping Fundamentals, Codes and Standards*. CED Engineering.

KEY CHALLENGES FOR REFINERIES AND CHEMICAL PROCESSORS

The petroleum market is characterized by huge shifts in supply and demand; fluctuations continuously cause operational disruptions for organizations. And while each refinery and processing plant serves a different need, there are several global challenges set to cause chaos for every facility in the coming years.

Increasing volume of product output

Following the recent and prolonged decline in petroleum refining revenue, reversing trends are anticipated to provide a boost to the industry over the next five years.³ Oil prices rose by 50% in 2021,⁴ and the oil and gas industry is expected to benefit from further renewed demand, with the value of chemical products imported into the U.S. expected to increase. But hiked demand means an increase in pressure on the industry mechanics and processes. It's crucial that the process piping that facilitates the movement of materials produced in the oil and gas industry is working at 100% capacity.

Complying with tightening environmental restrictions

Since 2011 all major importing countries have adopted strong policies on carbon emissions and vehicle efficiency.⁵ As more governments around the world commit to sustainability pledges, oil and gas industry operators will have to cope with changing environmental regulations. The petroleum refining industry has become a primary focus for change within many countries, including the U.S. Tightening restrictions are forcing every company to take a closer look at their current process piping systems, ensuring those and any future instalments are up to standard.

Preserving the integrity of pipes, systems and technology

The mechanical integrity of process piping is critical to effectively manage process safety, environmental hazards, and business risks in the oil and gas, chemical, petrochemical and power industries. Companies want to achieve cost-effective risk management while staying in compliance with state and federal regulations. However, the scale and complexity of the facility, significant inspection costs, a wide variety of inspection techniques and other factors present significant challenges in establishing a maintenance strategy for process piping.

³ [IBIS World](#), 2021

⁴ [Reuters](#), 2021

⁵ J. Mitchell, V. Marcel, B. Mitchell., [What Next for the Oil and Gas industry?](#), 2021.

BENEFITS OF B31.3 IN PETROLEUM REFINING & CHEMICAL PROCESSING

B31.3 Code is the one most commonly used for a number of reasons—not least to ensure consistency in as many areas of engineering as possible. While there are many different codes that can be used to provide guidance for piping design, all of these codes derive from the same, original research.

Crisis prevention

Ensuring that pipes, systems, and technology are functioning correctly preserves the integrity of the refinement process. With companies set to experience increased production output in the coming years, crisis prevention will become even more important. Any breakdowns could be costly and dangerous—applying B31.3 helps ensure that equipment runs smoothly and reliably.

Design consistency

While every code derives from the same research, there can often be crucial differences in how each of the codes are applied. In light of tightening environmental restrictions, every company must ensure any instalments are up to standard. Using B31.3 across an organization facilitates both design and interpretation accuracy.

Equipment longevity

The equipment used by petroleum refinement plans is complex. Replacements can be expensive; B31.3 ensures that pipes are installed correctly and that they're maintained well, so companies can be confident that the integrity of their piping systems will remain solid for years to come.



PROCESS PIPING BEST PRACTICE

As with any type of engineering design, there are standards of best practice to consider when designing process piping using the B31.3 Code.

Plan a degree of freedom

When fitting equipment together, it's wise to expect that not everything will measure up to the centerline perfectly. Plan a pipe route that does not rely on unrealistically precise placement of large equipment with no plan for what happens if the mounting surface isn't perfect.

Plan clean routes

Not only do mechanical contractors need to connect the pipe system, they also need to provide adequate support. A straight and organized piping system is easier, faster, and cheaper to build and support.

Keep it simple

When designing, it's easy for engineers to overcomplicate the analyses by letting the computer do the heavy lifting. However, a lot of useful information can be collected simply by calculating the wall thickness, the expansion coefficient and the weight of the pipe.



HEAR FROM OUR EXPERT

We asked our expert, Jim Meyer, some of our most commonly asked questions about process piping and the B31.3 Code.

Do I have to be a petroleum refinery engineer to learn and apply the B31.3 Code?

The B31.3 Code started out as a code to govern the design of refinery process piping, but has since evolved to become much more generic—engineers can use the code to help them design any type of piping system.

Why is it important for engineers to learn the B31.3 Code?

The code is required by most large organizations, but engineers are relying on computers to design a lot of the process piping designs. However, this is starting to take away the engineer's ability to think critically about the design. Now, designs are stronger from an accuracy standpoint, but weaker from a theoretical perspective. It's important to understand the code, rather than depending on computers to do the work.

What are the benefits of corporate audiences taking B31.3 training?

When a group of engineers from the same organization come to a training session, we can use their current challenges as working examples. This helps ensure that engineers are using the B31.3 Code as a reference point, and thinking about problems in a similar way.



Jim Meyer, PE

Jim is an expert in piping for oil refining, petrochemical, chemical, power generation, and industrial facilities. His program management skills are industry-leading and he has coordinated the piping analysis and professional development to meet various piping code requirements. Jim's involvement with the American Society of Mechanical Engineers (ASME) has spanned over four decades and has led to leadership positions on numerous ASME Codes and Standards bodies.

BRINGING B31.3 CODE APPLICATIONS TO LIFE

No matter their experience level, there will always be engineering professionals who are either looking to upskill or want to refresh old knowledge.

While the B31.3 Code was first introduced to guide engineers when building process piping for refineries, more and more industries have come to make use of the code. B31.3 has evolved to become the generic standard that provides safe guidelines for the design of almost any piping system.

In this case study, ASME Learning and Development was asked to help a world-leading space flight organization to help train their engineers to build robust, solid and sophisticated piping systems.

The challenge

The contractor has a team of fifteen design engineers who design, build and test propulsion systems that require specialized piping to handle the liquid propellants. These fifteen engineers work alongside another team of fifteen on the client's side. Across the entire team of thirty, only five had sound knowledge of how to apply and interpret B31.3.

The approach

We recommended that the best way to improve piping proficiency within the teams was for the company to sign them up to our B31.3 Process Piping Design course. Due to the pandemic, remote learning was the only way this company would be able to attend the classes. Despite some skepticism from some of the more traditional engineers, fears were quickly put to rest once the course commenced. The lessons were delivered virtually over five days, with the instructor taking a deep dive into how other industries apply the code, as well as drilling into use cases specific to the class.

The results

Engineers at every experience level found the B31.3 Process Piping Design course both highly engaging and beneficial to their day-to-day work. The younger engineers report that their designs have improved thanks to now having a deeper understanding of the code, while veteran engineers said they benefited not only from renewed knowledge, but also fresh insight.

COURSE OVERVIEW

There are multiple courses on the B31.3 Code for process piping, but the one ASME recommends for corporate audiences is the B31.3 Process Piping Design.

The live virtual classes focus on addressing all of the challenges commonly faced by engineers who design process piping. The curriculum ensures engineers are kept informed of best practices in piping design, creation, maintenance, testing, and preservation. Training also supports employers' goals to increase efficiencies, reduce emissions, and extend the life of their equipment.

B31.3 Process Piping Design

This official ASME learning path runs for four consecutive days and consists of multiple classes, with a balance between lectures and practical learning.

The course trains participants to comply with the requirements of the B31.3 Process Piping Code. This course features a deep overview of the code, including the operations, scope, and criteria to ensure attendees can interpret and apply B31.3 effectively. Classes are led by problem solving and real-time applications—with the key objective being to examine how engineers employ the B31.3 Code requirements to effectively design and prevent piping failures.

This course is relevant for those involved in the design, manufacture, fabrication, examination and testing of process piping—including engineers, managers and quality personnel.

Topics include:

- History of Piping Codes
- Piping failure modes
- Piping design conditions
- Piping design criteria
- Pressure Design of Straight Pipe
- Pressure design of piping components
- Guarding against piping collapse
- Providing adequate piping flexibility
- Stress Intensification factors
- Simplified piping analysis and layout
- Pipe support design
- Pipe support design methods
- Requirements for specific piping systems
- Piping Data



MORE ABOUT OUR COURSES

All of our courses are delivered virtually, with the ability to tailor the content to suit corporate audiences.

The courses also make use of working examples so that learnings can be applied to projects that the company is working on. This is particularly useful for aligning larger groups of engineers, who will benefit from collectively working towards a solution with each other in real time.

ASME's group training enables entire teams to quickly and cost effectively get on the same page to establish a uniform approach. On-demand courses allow learners to educate themselves and learn new skills at their own pace with ASME L&D's flexible online courses. ASME's on-demand courses are available in self study format, which are completed online and followed up with graded assessments.

Virtual Classrooms:

ASME B31.3 Process Piping Design

ASME B31.3 Process Piping Materials Fabrication, Examination & Testing

ASME B31.3 Process Piping Design, Materials, Fabrication, Examination and Testing Combo Course

ASME B31.3 and B31.1 Practical Piping Design for Process and Power Applications

Detail Engineering of Piping Systems

On Demand:

Practical Piping Design

Essentials - B31.3 Process Piping Code

LET'S TALK ABOUT IT

Learn how to design safe process piping systems that meet the international standard.

ASME is a world-class provider of mechanical engineering courses. Our courses are designed with a focus on both theory and real life working examples of B31.3 Code, making it easy for engineers to apply their learnings to their everyday work. The instructors are practitioners and subject matter experts, who adapt content so that it can be applied to participants' real professional challenges.

Connect with ASME L&D to learn how we can create a bespoke learning experience for your engineers that will equip them with the skills needed to ensure the team is performing at its best.

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