

STAINLESS STEEL VS PLASTIC: THE ENGINEER'S ULTIMATE GUIDE TO PIPING MATERIALS ON CRUISE SHIPS

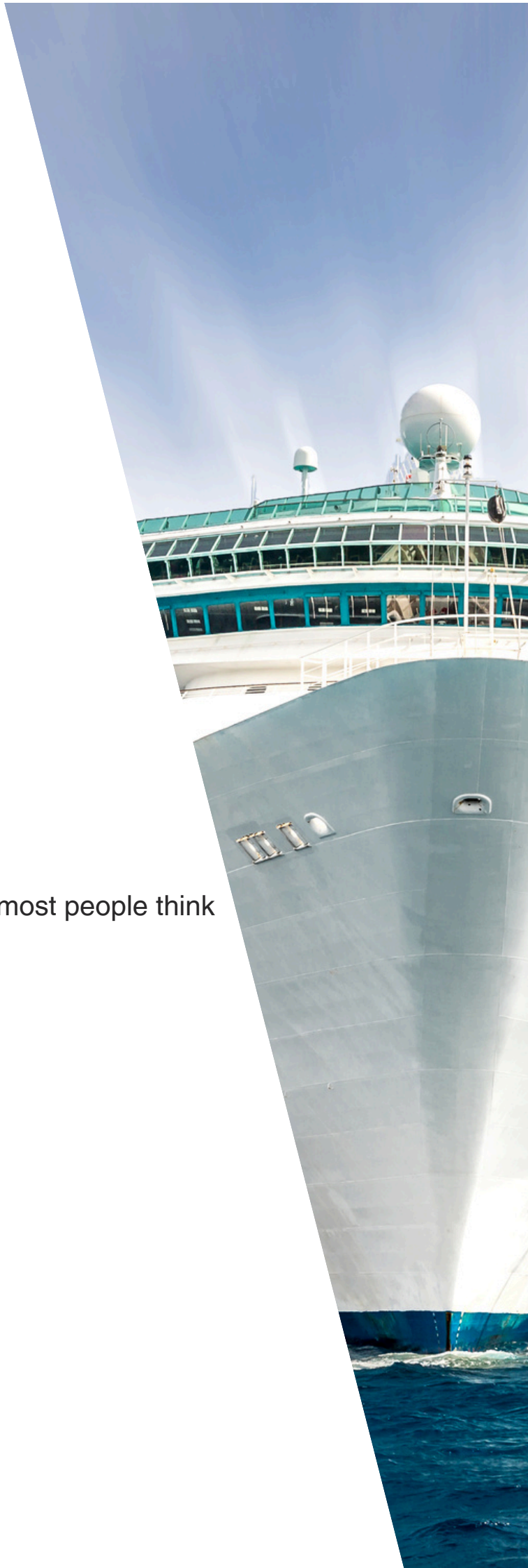
How to choose the right piping for reliability, longevity
and zero downtime



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Executive summary

Cruise ships rely on complex piping systems that distribute essential liquids and gases throughout the vessel. Although hidden behind walls and ceilings, these systems are among the most critical for safe and uninterrupted operations. Choosing the right piping material has a direct impact on reliability, safety, and long-term operational cost.

Based on observations from Michele Verdoliva's work in senior technical roles and his grounding in the engineering methodologies established at Carnival Corporation, a recurring industry insight emerges: material selection during construction has a lasting impact on a vessel's operational performance and maintenance profile.

This guide offers a clear, engineering-based comparison of stainless steel versus plastic piping to help owners, operators, and technical teams make informed decisions that reduce downtime and protect the vessel's lifetime value.



The difference between stainless steel and plastic is not an opinion, it's physics.

Michele Verdoliva | Marine Engineering Master Partner

Why piping matters more than most people think

Piping is a vital system on every cruise ship. Around 90% of the piping runs through public areas (also includes cabin area), which magnifies the operational and reputational impact of a failure. A single leak often requires opening walls, ceilings, and finished areas creating disruption that passengers immediately notice.

Cruise ships operate under a single rule: the ship must never stop. Yet, piping failures are one of the fastest ways to cause downtime.

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Key points:

- A break in the piping is always a visible disaster.
- Reliability is fundamental to both safety and operation.
- Major piping replacements are nearly impossible outside scheduled docks.
- Dock periods are short - typically every 5 years.

A failure at sea becomes a crisis that could have been prevented at build stage.



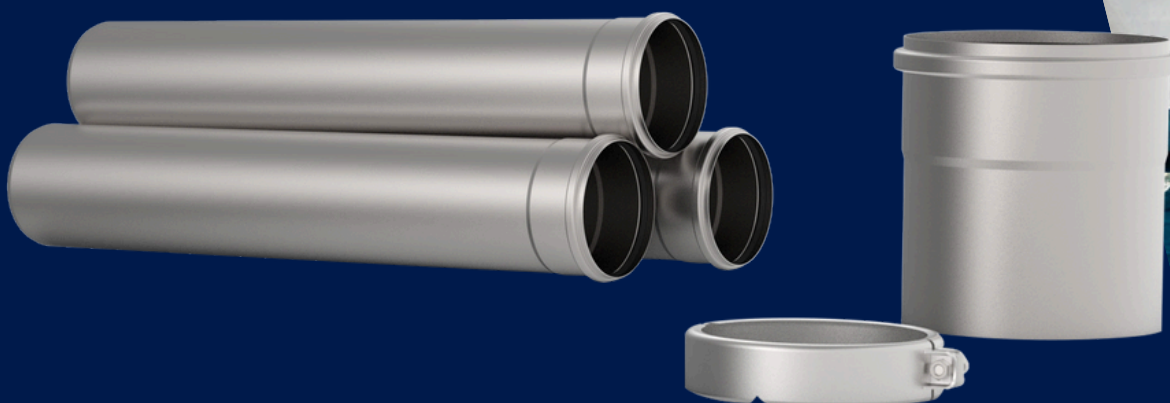
A cruise ship should never stop, but piping failure is the fastest way to make it stop.

The cost of piping failure

The impact of a piping failure reaches beyond the visible leak. When a pipe bursts, especially in public areas, where most piping is located, the disruption is immediate and dramatic. A leak happening above a cabin, can cause replacement of cabins - and nowadays it's common that all cabins are occupied. Flooding can spread quickly into guest spaces or technical zones, triggering a chain reaction of problems: passengers are inconvenienced, reputations take a hit and crew must execute emergency repairs while still trying to maintain normal operations.

Insurance exposure increases, structural elements may be compromised, and what began as a small leak can rapidly escalate into a major technical incident. The ship may experience downtime or be forced into unscheduled maintenance, and even a short interruption can translate into significant financial losses. In many cases, a single failure can end up costing far more than the initial investment that would have prevented it.

There are documented examples of vessels experiencing substantial flooding within the very first week of operation, simply because the piping material chosen during construction could not withstand actual conditions at sea. These early failures are not anomalies; they are predictable outcomes of choosing lower-grade materials under the pressure of budget- driven decisions.



Stainless steel vs plastic

THE TECHNICAL COMPARISON

CATEGORY	STAINLESS STEEL	PLASTIC
Durability	Designed for long lifespan (30+ years). Stable under heat, load, and environmental pressures.	Cheaper and lighter, but becomes brittle over time. Degrades faster under pressure, heat, and environmental stress.
Pressure resistance	Maintains structural integrity under high pressure, including vertical systems and lower decks.	Struggles with vertical loads; prone to deformation, cracking, and pressure-related failures.
Common leak points	Far less prone to failure at curves, couplings, and high-pressure runs. Handles dynamic stress well.	Frequently fails at curves, couplings, vertical pipes, and areas with dynamic or thermal stress.
Installation consideration	Heavier and more labor-intensive to install, but delivers long-term stability and reliability. Weight gain is marginal and rarely meaningful.	Lightweight, easier, and cheaper to install – attractive to shipyards under budget pressure.
Safety & reliability	Provides stronger, safer operation with fewer disruptions and significantly reduced risk of catastrophic failure.	Lower reliability, higher risk of leaks, and shorter lifespan, especially under real operational loads.
Sustainability	Stainless steel is a recyclable material. Manufactured using up to 85% recycled material.	Plastic is a potential environmental concern during production and a latent pollution hazard at time of disposal
End-of-life-value	Stainless steel retains financial value and is in global demand; material value recovered during recycling	Low or no residual value; disposal typically incurs cost

Total cost of ownership

Plastic piping often appears attractive due to its lower upfront cost, which is the primary reason many shipyards select it. While weight savings are sometimes cited as a benefit, in practice these gains are marginal and rarely meaningful at the vessel level. Decisions are therefore largely driven by construction budgets and vendor agreements that optimise yard margins rather than long-term vessel performance.

The picture changes once the ship enters operation.

Replacing piping mid-life is extremely difficult and, in many cases, nearly impossible without major disruption. If issues surface at sea or within the first years of service, the financial impact can escalate rapidly. What begins as a cost-saving decision during construction can end up costing the owner millions.

Ships today also operate far longer than before, often exceeding 30 years. Early material choices therefore carry consequences that extend across decades. A small saving at build stage can become a long-term liability affecting reliability, maintenance budgets, and even the vessel's reputation.

Owners can insist on stainless steel instead of plastic, but it comes with a higher initial price. The real question is whether that additional investment today avoids far greater costs tomorrow.

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When you pay millions for a ship, the piping aspect is underestimated.

Industry reality check

Despite the high stakes, poor material decisions are still common during newbuild projects. This usually isn't due to negligence, but to the way priorities, budgets and incentives are structured. Here's some of the reasons why wrong decisions happen:

- Newbuild teams often focus on short-term budget wins
- Plastic feels like a modern, cost-effective choice - until it fails.
- Vendor incentives don't always match owner priorities.
- Engineers may not always fully understand the long-term risks of plastic under real operational loads.
- Lifetime extensions of cruise ships (at least 30 years) make early decisions even more critical.



Quick-decision guide

WHEN YOU SHOULD CHOOSE STAINLESS STEEL

While every vessel is different, certain conditions make the choice straightforward. In these situations, the long-term reliability and safety of stainless steel far outweigh the initial cost difference. You should choose stainless steel when:

- The system includes high-pressure vertical piping
- Routes pass through public or high-value areas
- Long-term reliability is a priority
- The vessel is expected to operate for 30–40 years
- The cost of downtime outweighs upfront savings
- A failure would cause operational disruption or reputational damage

If failure is not an option, the choice is stainless steel.



Expert recommendation

With more than a decade as a senior director in technical departments, including experience with design foundations at Carnival Corporation, Michele Verdoliva has seen firsthand the consequences of poor material choices. Failures consistently come back to basic engineering principles and physics. Plastic may save money today, but stainless steel protects the ship for decades.

Conclusion

SHORT-TERM SAVINGS OFTEN LEAD TO LONG-TERM CONSEQUENCES.

When it comes to piping on cruise ships, the material chosen at construction directly shapes the vessel's reliability, safety, and lifetime performance.

Stainless steel consistently delivers a level of durability and stability that plastic cannot match, especially on ships expected to operate for half a century. Plastic piping may appear cost-effective upfront, which is why shipyards frequently select it. Their decisions are often driven by budget targets and vendor arrangements that prioritize immediate savings rather than long-term operational integrity. But the reality shifts once the ship enters service. Replacing piping mid-life is extremely challenging and, in many cases, nearly impossible without significant disruption.

If failures occur at sea or even within a ship's first years, the financial impact can escalate quickly. What began as a small budget win can turn into a multi-million-dollar loss. As ships remain in operation longer than ever before, the material choices made during construction carry consequences that extend across decades. A modest saving today may become a costly liability tomorrow, affecting maintenance demands, operational stability, and even the vessel's reputation.

Owners can advocate for stainless steel from the beginning, accepting a higher initial investment in exchange for dramatically reduced long-term risk. Ultimately, the decision comes down to priorities: upfront savings or reliable performance over the full life of the ship.



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