



# Custom Manufacturing

## to Empower Your NPD Success!

Metal, Plastic & Silicone Integration Service



## II. Understand Your Marine Project Needs

Before diving into materials or mold design, it's essential to define the **actual operating conditions** and **functional requirements** of your marine plastic component. A clear understanding of these needs forms the foundation for sound product design and successful injection molding outcomes.

### 1. Define the Environmental Exposure

- **Saltwater Contact:** Will the part be submerged, splash-exposed, or used in intermittent contact with seawater?
- **UV and Outdoor Exposure:** Is it installed in direct sunlight, tropical conditions, or high-altitude/high-UV zones?
- **Temperature Extremes:** Will the product face thermal cycling (day/night exposure), or freezing and thawing in offshore environments?
- **Humidity and Ventilation:** Enclosed components require special attention to moisture buildup and condensation resistance.

### 2. Determine Structural and Mechanical Demands

- **Impact Loads:** Will it be dropped, hit, or dragged — such as by deck tools or fishing gear?
- **Static or Dynamic Loads:** Should it support weight, absorb shock, or endure vibration?
- **Assembly & Fastening:** Will it house inserts, gaskets, or electronics that require precision alignment or tight tolerances?

### 3. Clarify Functional Expectations

- **Cosmetic Durability:** Should it maintain color, texture, or gloss after long-term UV and salt exposure?
- **Sealing & Waterproofing:** Does the part need to be IP-rated or resistant to saltwater ingress?
- **Floatation or Buoyancy:** Does it need to stay afloat and maintain shape over time?
- **Branding and Labeling:** Will logos, color schemes, or printed labels be exposed to the elements?

### 4. Consider Manufacturing Volume and Method

- **Prototypes vs. Mass Production:** Will you begin with 3D printing, vacuum casting, or move directly to injection molding?

# Custom Manufacturing

## to Empower Your NPD Success!

Metal, Plastic & Silicone Integration Service



- **Injection Molding Scale:** Is this a low-volume tool, a bridge production run, or a multi-cavity mold for high volume?
- **Lifecycle Expectations:** Should the component last one season, 5 years, or a decade in outdoor service?

By outlining your project's environmental and mechanical requirements up front, you reduce the risk of selecting an unsuitable material or overengineering your part. This clarity also helps your design and manufacturing team make more informed decisions throughout the entire development process.

### III. Know the Different Types of Marine Plastics

Not all plastics are built to survive in the unforgiving conditions of saltwater environments. UV degradation, chemical attack, and mechanical fatigue can quickly compromise standard plastics. That's why selecting the right **marine-grade plastic** is one of the most critical early decisions in both product design and injection molding.

Below are some of the most commonly used plastics in marine applications — each with unique strengths, limitations, and processing considerations:

#### 1. ASA (Acrylonitrile Styrene Acrylate)

- **Best for:** Outdoor housings, enclosures, exposed covers
- **Advantages:**
  - Exceptional **UV resistance** — superior to ABS
  - Maintains color and gloss in sunlight
  - Good dimensional stability
- **Considerations:**
  - Slightly lower impact strength than PC+ABS
  - Limited resistance to some solvents
- **Molding Notes:** Requires medium mold temperatures and benefits from polished tool surfaces for aesthetics.

#### 2. PC+ABS (Polycarbonate + ABS blend)

- **Best for:** Structural parts, casings, brackets

# Custom Manufacturing

## to Empower Your NPD Success!

Metal, Plastic & Silicone Integration Service



- **Advantages:**
  - Excellent **impact resistance** and toughness
  - Good balance between stiffness and processability
  - Available in **UV-stabilized** grades
- **Considerations:**
  - Less chemical resistance to seawater than PP or nylon
  - Must be dried before molding
- **Molding Notes:** Works well in complex tools; requires well-controlled temperature and gating to avoid cosmetic issues.

### 3. Polypropylene (PP and Glass-Filled PP-C)

- **Best for:** Buoyancy parts, hinges, non-load-bearing components
- **Advantages:**
  - Excellent **chemical resistance** to saltwater
  - Low moisture absorption
  - Lightweight and affordable
- **Considerations:**
  - Lower UV stability unless stabilized with additives
  - Limited strength unless glass-filled
- **Molding Notes:** Shrinks more than other materials; benefits from large draft angles and proper cooling design.

### 4. Nylon (PA6 / PA66 / PA12)

- **Best for:** Mechanical components, bushings, underwater housings
- **Advantages:**
  - High mechanical strength
  - Good abrasion and wear resistance

# Custom Manufacturing

## to Empower Your NPD Success!

Metal, Plastic & Silicone Integration Service



- PA12 offers lower moisture uptake and better saltwater performance

- **Considerations:**

- Standard PA6/PA66 absorb water and can swell
- Must be dried thoroughly before molding

- **Molding Notes:** Mold at higher temperatures; glass-filled grades need attention to warpage.

### 5. HDPE / LDPE (High/Low-Density Polyethylene)

- **Best for:** Large parts, floatation devices, non-precision components

- **Advantages:**

- Very good **chemical and saltwater resistance**
- Flexible and impact-resistant
- Naturally UV-stable grades available

- **Considerations:**

- Limited structural strength
- Not ideal for tight-tolerance components

- **Molding Notes:** Low processing temperature; prone to sink marks in thick sections.

### 6. TPU / TPE (Thermoplastic Polyurethane / Elastomers)

- **Best for:** Overmolded grips, gaskets, flexible couplings

- **Advantages:**

- Excellent flexibility and abrasion resistance
- Saltwater- and UV-resistant grades available
- Ideal for sealing or comfort features

- **Considerations:**

- Not structural — used in combination with rigid substrates

- **Molding Notes:** Requires precise control of flow and adhesion during overmolding.

# Custom Manufacturing

## to Empower Your NPD Success!

Metal, Plastic & Silicone Integration Service



### 7. Specialty Marine-Grade Blends (e.g., KIBILAC® PW-957)

- **Best for:** Advanced enclosures, premium outdoor assemblies
- **Advantages:**
  - Designed specifically for **marine UV and salt spray resistance**
  - Enhanced mechanical properties and surface quality
- **Considerations:**
  - Higher cost; best suited for high-performance applications
- **Molding Notes:** Often compatible with standard ASA/PC tooling setups

Each of these materials comes with trade-offs. Understanding their **performance profiles and processing behavior** will guide your selection and help avoid costly redesigns or early failures.

## IV. Product Design Guidelines for Marine Plastic Parts

Even the best marine-grade plastic can fail if the design doesn't align with environmental demands and manufacturing realities. Successful marine components require a smart balance of geometry, wall thickness, draft angles, and assembly features — all tailored to resist long-term saltwater exposure, UV degradation, and mechanical wear.

Below are the key product design strategies for robust and injection-moldable marine plastic parts:

### 1. Use Wall Thickness Strategically

- **Uniform wall thickness** minimizes warpage and sink marks during molding.
- Aim for **1.5–3.5 mm** depending on the material type.
- Avoid abrupt transitions — instead, use **smooth thickness transitions or ribs** to strengthen thin areas.

### 2. Incorporate Draft Angles for Easy Ejection

- Add **1°–2° draft per side** for vertical walls to allow for smooth ejection from the mold.
- For textured surfaces (common in marine grips and enclosures), increase draft to **2°–5°** to avoid drag marks.

### 3. Reinforce with Ribs, Bosses, and Fillets



# Custom Manufacturing

## to Empower Your NPD Success!

Metal, Plastic & Silicone Integration Service



- **Ribs** enhance strength without adding weight — keep rib thickness  $\leq 60\%$  of the adjoining wall to prevent sink.
- Use **fillets** on sharp corners to reduce stress concentration and improve flow.
- **Bosses** for fasteners should be short and well-supported to avoid cracking.

#### 4. Design for UV and Saltwater Defense

- Use **raised edges** or **overhangs** to protect labels, logos, or electronic interfaces from direct sun and water.
- Allow for **ventilation** or drainage holes in sealed housings to prevent condensation buildup.
- Consider **enclosed snap-fits** instead of external tabs to reduce UV degradation points.

#### 5. Minimize Stress Points and Avoid Sharp Corners

- Use **radiused corners** (0.5 mm or more) to reduce internal stress buildup — especially important in PC or nylon parts.
- Avoid **thin isolated features** that can warp or break under impact or thermal cycling.

#### 6. Consider Buoyancy and Mass Distribution

- For floatation devices or buoy-mounted components, balance mass evenly and include **internal ribs** or **foam filling zones**.
- Use **hollow structures** with internal lattice if lightness is critical.

#### 7. Prepare for Post-Molding Requirements

- Add **guide features** or alignment pegs for multi-part assemblies.
- Design **flat pads or clamp zones** if additional machining, drilling, or assembly will occur after molding.

A well-optimized part design reduces internal stress, improves UV durability, and ensures your plastic component survives both the molding process and the real-world marine environment it was built for.

# Custom Manufacturing

## to Empower Your NPD Success!

Metal, Plastic & Silicone Integration Service



## V. Injection Molding Considerations for Marine Applications

Injection molding is the most efficient way to produce high-quality, repeatable marine plastic parts — but only if the process is tuned to the demands of both the **material** and the **environmental exposure**. From mold design to process parameters, every decision affects durability, consistency, and performance at sea.

Here are the key injection molding factors to consider when producing marine-grade components:

### 1. Choose the Right Mold Design

- **Multi-gate or balanced gating** improves flow for large parts or complex geometries.
- Add **venting channels** to release air and prevent burn marks — especially important for ASA, PC+ABS, or PA materials.
- Use **corrosion-resistant mold steels** (like H13 or stainless inserts) to reduce rust risk in high-humidity environments.

### 2. Control Mold and Melt Temperatures

- Ensure **material-specific temperature control**:
  - ASA: ~240–270 °C
  - PC+ABS: ~250–290 °C
  - Nylon: ~260–300 °C (dried prior to molding)
- Use **consistent mold temperature control** (typically 60–90 °C) to reduce warpage and improve surface quality.

### 3. Dry Materials Properly

- Many marine-grade plastics are **hygroscopic** — they absorb moisture, which can cause splay, voids, or poor bonding.
- Dry PC, nylon, and PC+ABS thoroughly before molding (usually 2–4 hours at 80–110 °C depending on resin).

### 4. Use Suitable Fillers and Additives

- Add **UV stabilizers, antioxidants, and color masterbatches** for parts exposed to sunlight.



# Custom Manufacturing

## to Empower Your NPD Success!

Metal, Plastic & Silicone Integration Service



- For increased rigidity or dimensional stability, use **glass-fiber-reinforced** resins (e.g., 20% GF PP or PA).
- Select **marine-safe colorants** and additives that won't leach or degrade in saltwater.

### 5. Ensure Smooth Surface Finishes

- Use **polished or textured mold surfaces** depending on cosmetic and functional needs.
  - High-gloss for consumer-visible surfaces (e.g., ASA housings)
  - Textured for anti-slip or matte finishes (e.g., TPE grips)
- Avoid weld lines and sink marks through proper flow control and consistent mold fill rates.

### 6. Test for Marine-Specific Conditions

- Perform **salt spray testing, UV weathering, and water immersion testing** during prototyping.
- Simulate long-term environmental exposure using **accelerated aging** if possible.

### 7. Plan for Consistency in Production

- Optimize cycle time without overheating material — prolonged exposure degrades performance.
- Monitor for **warping, short shots, or gate blush** — common in large outdoor parts.
- Consider **automated part removal** or water mist cooling for parts with high thermal mass.

Injection molding marine components requires a careful mix of **technical process control** and **real-world foresight**. Properly molded parts resist fading, cracking, and failure — even after years of salt, sun, and stress.

## VI. Assembly and Post-Molding Integration for Marine plastic Parts

Once marine plastic parts are molded, they often need to be **assembled, sealed, or finished** before they can be used in real-world applications. In saltwater and UV-exposed environments, improper assembly can compromise the entire system — even if the material and molding were done right. This section outlines key strategies for **joining, sealing, labeling, and protecting** marine plastic components after molding:

### 1. Select Proper Fastening and Joining Methods

- **Self-tapping screws or thread-forming fasteners** work well with PC+ABS, PP, or ASA if boss design is optimized.

# Custom Manufacturing

## to Empower Your NPD Success!

Metal, Plastic & Silicone Integration Service



- For higher strength or disassembly, use **brass or stainless threaded inserts** — either molded-in or heat-inserted.
- **Ultrasonic welding, laser welding, and adhesive bonding** are viable for creating sealed enclosures or joining dissimilar materials.

💡 Tip: Choose corrosion-resistant fasteners (marine-grade stainless steel) to avoid galvanic reactions in humid environments.

## 2. Design Effective Seals and Gaskets

- Use **TPE or silicone gaskets** for waterproofing — especially in housings or lids exposed to spray or submersion.
- Incorporate **gasket grooves or overmolded sealing zones** into the mold to reduce assembly steps.
- Ensure surface **flatness and proper clamping force** to maintain long-term sealing integrity.

## 3. Apply Durable Surface Markings or Labels

- Avoid paper or printed stickers that degrade in sun and saltwater.
- Use **laser marking, pad printing with marine-grade inks, or molded-in logos** for long-term durability.

4. For functional labeling (e.g., indicators or instructions), consider **UV-cured digital printing or engraved overlays**.

## 5. Plan for Field Service and Replacement

- Design **snap-fit tabs, screws, or modular interfaces** to allow users to replace or upgrade components.
- Minimize over-reliance on adhesives or welded joints if regular access or disassembly is needed.

## 6. Consider Post-Molding Cleaning and Protection

- Clean parts with **mild detergent** to remove mold release agents before further processing.
- Optional: Apply **UV-resistant coatings, hydrophobic surface treatments, or anti-fouling films** for added protection.

Well-planned integration after molding helps ensure your marine components not only perform reliably but also meet appearance, serviceability, and user experience goals over their full life cycle.

# Custom Manufacturing

## to Empower Your NPD Success!

Metal, Plastic & Silicone Integration Service



## VII. Common Design and Manufacturing Pitfalls to Avoid

When developing plastic components for marine use, even small oversights in design or processing can lead to premature failure — especially in harsh environments where **UV radiation, saltwater corrosion, and mechanical stress** are constant. Avoiding these common mistakes is just as important as getting the materials and molding right. Below are the typical pitfalls in design and manufacturing — and how to avoid them:

### 1. Ignoring UV and Saltwater Exposure in Material Selection

- **The problem:** Choosing standard indoor-grade ABS, PP, or PA without UV stabilizers leads to fading, embrittlement, or surface cracking.
- **The fix:** Use **UV-stabilized grades**, or marine-grade blends like **ASA, PC+ABS with UV additives, or PA12** for long-term outdoor use.

### 2. Overlooking Moisture Absorption of Engineering Plastics

- **The problem:** Nylon (PA6/PA66) absorbs water, which can affect strength, dimensional stability, and tolerance fit — especially in submerged applications.
- **The fix:** Use **PA12** or **moisture-stable blends** for parts exposed to water, or design for water absorption tolerance.

### 3. Poor Wall Thickness Control

- **The problem:** Inconsistent wall thickness leads to **warping, sink marks**, and residual stress in molded parts — which become critical in marine parts exposed to thermal cycling.
- **The fix:** Maintain **uniform wall thickness**, use smooth transitions, and reinforce with ribs instead of thick sections.

### 4. Insufficient Draft Angle

- **The problem:** Steep vertical walls without draft create ejection problems and surface drag, especially for parts with texture or gloss finish.
- **The fix:** Always add **at least 1°–2° draft** on all vertical faces; increase for textured or cosmetic surfaces.

### 5. Ignoring Corrosion Risks in Mold Tooling and Inserts

- **The problem:** Standard tool steel corrodes quickly in high-humidity molding shops or when molding hygroscopic plastics with water-based cooling.

# Custom Manufacturing

## to Empower Your NPD Success!

Metal, Plastic & Silicone Integration Service



- **The fix:** Use **stainless steel inserts, nickel-plated cavities**, or corrosion-resistant steels like **H13 or S136** for long-term tooling life.

### 6. Using Incompatible Adhesives or Fasteners

- **The problem:** Fasteners rust in salty air; adhesives fail under UV or water exposure.
- **The fix:** Specify **marine-grade stainless fasteners** and **UV/moisture-resistant adhesives** compatible with your resin.

### 7. Neglecting Assembly Tolerances and Fit

- **The problem:** Marine plastics expand, contract, and flex more than metals — tight fits may crack or deform over time.
- **The fix:** Design with **expansion gaps**, flexible snap-fits, or compressible gaskets to accommodate movement.

By recognizing these avoidable pitfalls early, you can streamline development, minimize warranty claims, and extend product lifespan — even under the most punishing marine conditions.

## VIII. Testing and Validation of Marine Plastic Components

Even the best material choice and product design require **real-world validation** before mass production. Marine plastic components face conditions that are difficult to fully predict through simulations alone, so **laboratory and field testing** play a crucial role in ensuring long-term reliability.

### 1. Salt Spray and Corrosion Testing

- **Purpose:** Evaluate resistance to saltwater and saline environments.
- **Method:** Standard salt fog chambers (ASTM B117 or ISO 9227) expose samples to a continuous salt mist.
- **Application:** Confirms material integrity, sealing effectiveness, and fastener resistance under prolonged salt exposure.

### 2. UV Weathering and Outdoor Exposure

- **Purpose:** Assess long-term resistance to UV-induced discoloration, embrittlement, and surface degradation.
- **Method:** Accelerated weathering using QUV testers or xenon arc lamps (ASTM G154, ISO 4892).

# Custom Manufacturing

## to Empower Your NPD Success!

Metal, Plastic & Silicone Integration Service



- **Application:** Validates the performance of ASA, PC+ABS, or UV-stabilized PP under tropical sun and outdoor use.

### 3. Mechanical Stress and Impact Testing

- **Purpose:** Ensure toughness under real handling and operational loads.
- **Method:** Drop tests, impact resistance (Izod/Charpy), and cyclic fatigue tests in both dry and wet states.
- **Application:** Confirms that snap-fits, housings, and floaters can withstand repeated knocks, drops, and flexing in marine use.

### 4. Water Absorption and Immersion Tests

- **Purpose:** Measure dimensional changes, swelling, and loss of strength due to water absorption.
- **Method:** Submersion tests at controlled times and temperatures (ASTM D570 for water absorption).
- **Application:** Critical for hygroscopic plastics like nylon and PC blends, which may expand or lose stiffness over time.

### 5. Field Trials and Real-Life Deployment

- **Purpose:** Validate performance in true operating environments.
- **Method:** Prototypes are deployed on vessels, buoys, or submerged rigs for months of exposure.
- **Application:** Confirms lab results, uncovers hidden failure modes (biofouling, abrasion, creep under load).

By combining **accelerated lab testing** with **real-world marine trials**, manufacturers can build confidence in product reliability, avoid costly recalls, and provide customers with performance data that supports product warranties.

## IX. Case Studies: Marine Plastic Components in Action

Real-world applications provide the best proof of how **material selection**, **design decisions**, and **injection molding processes** determine success in marine environments. Below are three representative case studies that highlight different approaches to achieving durability, UV stability, and saltwater resistance in plastic components.

# Custom Manufacturing

## to Empower Your NPD Success!

Metal, Plastic & Silicone Integration Service



### Case Study 1: ASA Housing for Coastal Monitoring Device

- **Challenge:** A coastal monitoring station required sensor housings that could endure **direct sunlight, salt spray, and high humidity** over 5+ years without discoloration or cracking.
- **Solution:** ASA was chosen for its **outstanding UV resistance** and color stability compared to ABS. The housing was designed with:
  - **2° draft angles** to aid mold release,
  - **reinforced ribs** to maintain rigidity,
  - and **integrated sealing grooves** for a silicone gasket.
- **Manufacturing Notes:** Mold tooling was polished to a fine surface finish to reduce porosity and prevent surface degradation. Balanced gating ensured smooth flow around rib features.
- **Result:** The housings retained gloss and mechanical integrity after accelerated UV and salt spray testing, outperforming initial ABS prototypes.

### Case Study 2: PC+ABS Case for Underwater Tracking Device

- **Challenge:** An underwater tracking system used by marine researchers needed a casing that could withstand **repeated immersion, rough handling, and occasional impact** from boat decks.
- **Solution:** A **UV-stabilized PC+ABS blend** was selected for its **impact strength** and toughness. The design included:
  - **Snap-fit features** reinforced with living hinges,
  - **overmolded TPE sealing ring** to achieve water resistance,
  - and **internal ribs** to distribute stress.
- **Manufacturing Notes:** The material was dried thoroughly before molding to avoid voids and brittleness. Higher mold temperatures and controlled cooling were used to ensure dimensional stability and prevent warpage.
- **Result:** Field trials showed no cracking or water ingress after months of submersion. The part withstood repeated assembly/disassembly cycles without loss of snap-fit strength.



# Custom Manufacturing

## to Empower Your NPD Success!

Metal, Plastic & Silicone Integration Service



### Case Study 3: Glass-Filled Polypropylene Floater for Ocean Buoys

- **Challenge:** A buoy manufacturer needed a lightweight floater capable of handling **constant wave impact** and **full-time ocean exposure**. HDPE prototypes had worked but lacked sufficient stiffness under load.
- **Solution:** A **20% glass-filled PP-C** was selected to provide the necessary **stiffness** and **saltwater resistance**, while still being cost-effective. The floater design featured:
  - **Hollow interior with internal lattice ribs** for weight reduction,
  - **rounded fillets** to reduce stress concentration,
  - and **vent holes** to ease molding and prevent vacuum collapse.
- **Manufacturing Notes:** The mold design incorporated a textured surface for improved grip and reduced glare. Flow analysis ensured even filling despite rib structures.
- **Result:** The buoy floaters maintained performance over multiple seasons at sea. Mechanical stiffness improved by over 30% compared to HDPE, while weight savings were preserved.

👉 These case studies demonstrate that **successful marine plastic products require more than just choosing a “tough” material** — they demand a holistic approach where **design, material properties, and molding processes** work together to achieve long-term reliability.

## X. Conclusion

Designing and producing reliable marine plastic components requires a holistic approach that begins with a clear understanding of the project’s environmental and mechanical demands. Material selection is central to success, with options such as ASA, PC+ABS, glass-filled polypropylene, or specialized UV-stabilized blends offering a balance of outdoor durability, saltwater resistance, and mechanical strength.

Equally important is applying sound design practices, including maintaining uniform wall thickness, adding sufficient draft angles, and incorporating ribs, fillets, and sealing features that enhance both manufacturability and durability.

The injection molding process must be carefully controlled, using corrosion-resistant tooling, optimized temperatures, and proper resin handling to achieve consistent quality and long service life. Post-molding considerations, such as corrosion-resistant fasteners, reliable gasket integration, and durable surface markings, ensure that assembled products withstand long-term use in harsh marine conditions.

# Custom Manufacturing to Empower Your NPD Success!

Metal, Plastic & Silicone Integration Service



Beyond design and processing, validation through testing—ranging from salt spray and UV weathering to immersion and mechanical fatigue trials—provides confidence that the part will perform reliably in real-world applications. By aligning design, materials, molding processes, and testing from the earliest stages, manufacturers can deliver marine plastic components that not only survive but excel in demanding ocean environments.

**Ready to bring your design to life with precision and speed?** Partner with a trusted Injection Molding expert to accelerate your product development. [GEMS-MFG](#) is the comprehensive solution provider here for you. As a one-stop custom manufacturer, we provide a wide range of services, including rapid prototyping, mold making, injection molding, CNC machining, die casting, and more.

Whether your requirements involve intricate prototypes or precision parts, GEMS-MFG is committed to delivering an efficient and cost-effective solution tailored to your needs. Contact us today [\[INFO@GEMS-MFG\]](mailto:INFO@GEMS-MFG) to explore our offerings and receive an instant quote. Your manufacturing goals are our priority.

## Custom Manufacturing Plastic, Silicone & Metal Solution Provider

- Mold Making
- Injection Molding
- CNC Machining
- Die Casting
- Value Added Services
- Product Assembly



View more