

## INCONEL 686 (UNS N06686)

# A Procurement-Focused White Paper for Corrosion-Resistant Fasteners and Chemical Processing Service

### In this document

- What to specify (ASTM/ASME/DIN), what to verify (chemistry limits, condition, traceability).
- How to buy corrosion-resistant alloy 686 fasteners without surprises (galling risk, marking, documentation, substitutions).
- Where INCONEL 686 fits in chemical processing and pollution-control duty (mixed acids, chlorides, localized corrosion).
- A receiving-inspection checklist procurement can use with QA and maintenance teams.

**Intended audience:** Procurement, supply chain, and sourcing teams supporting engineering, maintenance, and reliability organizations.

**Prepared by:** Nickel Systems (materials and fastener supply).

Disclaimer: This document is informational. Final material selection, design allowables, code compliance, and sour-service suitability must be validated by the responsible engineer and applicable specifications. "INCONEL" is a trademark of the Special Metals group of companies.

# Executive summary

INCONEL alloy 686 (UNS N06686 / W.Nr. 2.4606) is a single-phase, austenitic nickel-chromium-molybdenum-tungsten alloy designed for outstanding resistance to aggressive corrosion in severe environments. High nickel and molybdenum support performance in reducing media; high chromium improves resistance to oxidizing media; and molybdenum plus tungsten improve resistance to localized corrosion such as pitting and crevice corrosion. Low carbon helps maintain corrosion resistance in weld heat-affected zones by minimizing grain boundary precipitation. [1]

## Procurement quick sheet

Procurement quick sheet	
<b>UNS / Trade name</b>	UNS N06686 (INCONEL is a Special Metals trademark)
<b>What it is</b>	Single-phase Ni-Cr-Mo-W corrosion-resistant alloy; low Fe and low C are tightly controlled for corrosion performance and weld HAZ resistance. [1]
<b>Where it fits</b>	Severe chemical processing and pollution-control service; corrosion-critical fasteners, welded assemblies, and components exposed to mixed oxidizing/reducing media. [1]
<b>Typical service driver</b>	Mixed acids, chloride/halide exposure, crevice conditions, and weld integrity requirements where localized corrosion dominates risk. [1]
<b>Key risks to manage</b>	Wrong product-form spec; missing heat/lot traceability; unapproved substitutions; uncontrolled assembly/lubrication leading to galling in fasteners.

# 1. What procurement should specify (and why)

Most field issues with high-performance nickel alloys are procurement-controllable: wrong specification, wrong condition, missing traceability, or an unapproved substitution. Start every RFQ by pinning down the UNS number, the governing product-form specification(s), and any code or sour-service requirements (ASME, NACE, customer standards). **[1]**

## Core identification

- **UNS:** N06686 (often sold as INCONEL alloy 686 or Alloy 686). **[1]**
- **Trademark:** “INCONEL” is a trademark of the Special Metals group of companies; specify the trademarked grade only if required by your program. **[1]**

## Common product-form specifications (from manufacturer guidance)

Product form (common)	Typical standards / specs to cite in RFQ	Procurement notes
<b>Rod / Bar / Wire / Forging stock</b>	ASTM B462; ASTM B564 / ASME SB564; ASTM B574 / ASME SB574; DIN 17752 / 17753 / 17754 (as applicable). <b>[1]</b>	Common fastener/machined-part stock. Confirm condition (typically annealed) and require heat/lot traceability.
<b>Plate / Sheet / Strip</b>	ASTM B575 / ASME SB575; ASTM B906 / ASME SB906; DIN 17750 (as applicable). <b>[1]</b>	For formed parts, liners, and welded fabrications. Match form/spec to code and require certification language that matches the drawing.
<b>Pipe / Tube</b>	ASTM B163 / ASME SB163; ASTM B619 / ASME SB619; ASTM B622 / ASME SB622; ASTM B626 (as applicable). <b>[1]</b>	Select seamless vs. welded based on service/code. Match to fittings/joining method; require testing per the governing spec.
<b>Fasteners (bolts, nuts, studs, screws)</b>	ASTM F467/F467M and ASTM F468/F468M (where used for nickel-alloy fasteners) plus customer drawing/AMS requirements as applicable.	Define thread class, marking, traceability, and approved anti-galling lubricant/coating. No “equivalents” without written approval.
<b>Welding products</b>	AWS A5.14 ERNiCrMo-14; AWS A5.11 ENiCrMo-14 (often marketed as 686CPT).	Use overmatching filler where weld corrosion drives risk. Require filler certs/lot traceability.
<b>All forms (sour-service / corrosion guidance)</b>	NACE MR0175 / ISO 15156 (alloy 686 is noted as approved for oil and gas service in manufacturer guidance). <b>[1]</b>	Include NACE/ISO language only when required; confirm any project limits with engineering.

Procurement tip: if purchases fall under ASME code, request the ASME “SB” versions where applicable (e.g., ASTM B575 vs. ASME SB575). Also specify required certification language, testing, and marking rules from the governing drawing or customer specification.

## 2. Chemistry, condition, and documentation to control

Chemistry is the identity. For alloy 686, low carbon and tightly controlled iron help preserve corrosion resistance—especially in weld heat-affected zones. [1]

### Limiting chemical composition (wt %)

Element	Limit
Nickel (Ni)	Balance
Chromium (Cr)	19.0 - 23.0
Molybdenum (Mo)	15.0 - 17.0
Tungsten (W)	3.0 - 4.4
Titanium (Ti)	0.02 - 0.25
Iron (Fe)	1.0 max
Carbon (C)	0.01 max
Manganese (Mn)	0.75 max
Silicon (Si)	0.08 max
Phosphorus (P)	0.04 max
Sulfur (S)	0.02 max

### Typical condition / heat treatment

Manufacturer guidance indicates alloy 686 is normally annealed at 2150–2200°F (1180–1200°C) with rapid cooling, and it is readily weldable without post-weld heat treatment to restore corrosion resistance. [1]

### Documentation package to request on every PO line

- **Mill test report (MTR)** with heat number, full chemistry against limits, and mechanical properties for the ordered form. [1]
- **Traceability:** heat/lot on packaging and on parts where feasible; positive material identification (PMI) plan for critical items.
- **Code and service declarations:** ASME “SB” spec compliance when applicable; NACE MR0175 language if required; country of melt/source if specified.
- **Change control:** written notification and approval for any substitution, size/condition changes, or split heats/lots.

## 3. Buying INCONEL 686 fasteners: what matters most

Alloy 686 is often selected when fasteners must survive severe corrosive exposure (mixed acids, chlorides, crevice conditions) where other alloys can pit, crevice, or suffer corrosion margin loss. Because nickel-base alloys are prone to galling, fastener procurement should treat lubrication/coatings and assembly controls as part of the specification—not as an afterthought. [1][3]

### Specify these items explicitly on the RFQ/PO

- **Fastener standard:** specify the governing fastener standard and program requirements (e.g., ASTM F467/F468 where applicable, plus customer drawing/AMS notes).
- **Material identity:** UNS N06686 with chemistry limits; require MTR and (when critical) PMI on incoming lots. [1]
- **Form and condition:** bar/rod stock to the correct spec; confirm annealed condition per manufacturer guidance when required. [1]
- **Threads and fit:** thread series and class of fit, surface finish, and any rolled-vs-cut requirements; define “no recut after coating” if applicable.
- **Anti-galling controls:** specify an approved lubricant/anti-seize or coating/plating system and define installation/torque controls.
- **Marking & traceability:** part/head marking (as feasible), package label marking, and certificate cross-reference to heat/lot.

### Practical anti-galling guidance (procurement-level)

Nickel-base alloys can gall during assembly—especially under high preload, high friction, or poor surface condition. Procurement can reduce risk by requiring controlled lubrication/coatings and by ensuring the installation method matches the lubricant assumptions used to set torque and preload. Industry guidance for nickel-alloy fasteners emphasizes specifying lubrication/coatings and managing assembly practices to prevent seizure. [3]

When silver plating is used (common in certain aerospace practices), it can act as both a corrosion deterrent and a dry lubricant; treat plating as a controlled process requirement with certification and compatibility checks for your service environment. [4]

### When NOT to use alloy 686

- Often over-specified: general atmospheric service, mild aqueous corrosion, or high-temperature oxidation duty where other alloys are standard—unless chemical exposure is the dominant driver.
- Substitution risk: do not allow “equivalent” substitutions (e.g., 625, C-276, alloy 22) without engineering review; corrosion ranking depends on environment and localized-corrosion margin. [1]

## 4. Chemical processing: where alloy 686 earns its keep

Manufacturer guidance describes INCONEL alloy 686 as used for resistance to aggressive media in chemical processing, pollution control, pulp and paper manufacture, and waste management. [1]

Its chemistry targets both reducing and oxidizing acids, including mixed-acid solutions, while maintaining resistance to localized corrosion (pitting/crevice) that can dominate real plant failures. [1]

### Typical procurement-relevant application drivers

- **Mixed acid service:** environments where oxidizers, chlorides/halides, and reducing acids can appear together (startup/shutdown, upset conditions). [1]
- **Crevice and deposit conditions:** gasketed joints, flanges, threaded connections, and under-deposit regions where crevice corrosion initiates. [1]
- **Pollution-control exposure:** flue-gas desulfurization (FGD) outlet-duct and related condensate/acid mixtures (manufacturer testing discusses simulated FGD environments). [1]
- **Weld integrity:** need to preserve corrosion resistance in welded joints; manufacturer guidance notes no post-weld heat treatment is required to restore corrosion resistance. [1]

### Codes, sour-service, and approvals to call out

- Allowable design stresses for ASME Section VIII service are referenced in manufacturer guidance via ASME Section II, Part D (Table 1B) and Code Case information. [1]
- For ASME fabrication, alloy 686 is classified as a P-No. 43 material (manufacturer guidance). [1]
- Alloy 686 is noted as approved under NACE MR0175 for oil and gas service (manufacturer guidance); procurement should include compliance language only when required by the project standard. [1]

## 5. Receiving inspection and RFQ checklist

Use this checklist to align procurement, QA, and maintenance on what “good” looks like for alloy 686 fasteners and product forms. Tailor it to your governing standards and criticality.

### Receiving inspection (typical for corrosion-critical items)

Check	What to verify	Procurement/QA notes
<b>Identity</b>	UNS N06686 on MTR; heat number matches packaging/markings; perform PMI on sample parts/stock for critical items.	Most common field failure cause is inadvertent substitution—treat identity as a first-order control.
<b>Chemistry limits</b>	Chemistry within limiting ranges (Cr, Mo, W, Ti, Fe, C, etc.) per MTR. <b>[1]</b>	Low carbon and low iron are intentional; confirm they are met on every lot. <b>[1]</b>
<b>Product-form spec</b>	Ordered ASTM/ASME/DIN spec on cert matches PO (e.g., B575/SB575 for plate; applicable fastener spec for bolts/nuts).	Do not accept “equivalent” specs without engineering approval; specs can differ in testing/requirements.
<b>Condition</b>	Annealed/solution condition as required; for welded fabrications confirm no unnecessary PWHT requirement is imposed.	Manufacturer notes normal anneal 2150–2200°F with rapid cooling. <b>[1]</b>
<b>Dimensions &amp; threads</b>	Thread class, length, tolerances, surface finish; gaging results.	Dimensional escapes can create installation damage and drive galling risk or leaks at joints.
<b>Surface / lubrication</b>	Approved coating or lubricant present when specified; no flaking/contamination; compatibility with service.	Galling control should be specified in advance; verify the installed condition matches torque assumptions. <b>[3][4]</b>
<b>Traceability retention</b>	Lot/heat traceability maintained through kitting and into installation records.	Critical for audits, warranty, and failure analysis; define record retention expectations.

### RFQ line-item template (copy/paste)

**Material:** INCONEL alloy 686, UNS N06686 (W.Nr. 2.4606).

**Product form/spec:** \_\_\_\_\_ (e.g., ASTM B575 / ASME SB575 for plate; applicable fastener spec for bolts/nuts).

**Condition:** \_\_\_\_\_ (e.g., annealed/solution condition; per manufacturer guidance).

**Size & tolerances:** \_\_\_\_\_ (include thread class for fasteners).

**Surface / anti-galling:** \_\_\_\_\_ (approved lubricant or coating; torque/assembly requirements if applicable).

**Certifications required:** MTR with heat/lot, full chemistry + mechanicals; NACE MR0175 statement if required; PMI plan; country of origin if required.

**Traceability:** Heat/lot maintained through packaging and marking; no substitutions without written approval.

### References

- [1] Special Metals, “INCONEL® alloy 686” Technical Bulletin (Publication SMC-024) – composition, specifications, heat treatment, corrosion performance, and code/NACE notes. (PDF)

- [2] Nickel Systems, “Inconel 686” material page and technical data – procurement cross-reference and key properties.
- [3] ASM Orange Coast (Special Metals content), “Nickel-Base Alloys for High Performance Fasteners” – galling guidance and mitigation.
- [4] NASA, “Fastener Design Manual” (NASA RP-1228 / NTRS 19900009424) – discussion of platings/lubricants and assembly considerations.
- [5] Special Metals Welding Products, references to INCO-WELD 686CPT / NiCrMo-14 filler metals (catalog/selector references) – welding product identification.