

CNC MACHINING

CAPABILITY & DESIGN GUIDE

Precision milling, turning, Swiss machining and mill-turn solutions

3 / 4-Axis Milling Up to 1000 × 500 × 500 mm	5-Axis Milling Up to 650 × 650 × 300 mm
CNC Turning Up to Ø500 × 1500 mm	Swiss Machining Ø1-32 mm bar, up to 300 mm length

Prototype | Low-Volume Production | Production Machining

www.naitetech.com

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Machining Capabilities

Published service envelope for customer quoting and design reference

NAITE TECH provides precision CNC machining for prototypes, low-volume builds and production parts. The capability ranges below are intended as practical customer-facing service limits. Parts near a maximum envelope, or parts with unusual geometry, weight, fixturing or inspection requirements, are confirmed during engineering review before order release.

Process	Minimum Part	Maximum Workpiece*	General Tolerance	Precision Capability
3-Axis CNC Milling	5 × 5 × 5 mm	1000 × 500 × 500 mm	ISO 2768-1 m / c	±0.025 mm selected features
4-Axis CNC Milling	5 × 5 × 5 mm	1000 × 500 × 500 mm	ISO 2768-1 m / c	±0.025 mm selected features
5-Axis CNC Milling	5 × 5 × 5 mm	650 × 650 × 300 mm	ISO 2768-1 m / c	±0.025 mm selected features
CNC Turning	Approx. Ø2 mm	Ø500 × 1500 mm	ISO 2768-1 m / c	±0.010-0.025 mm selected diameters
Swiss CNC	Ø1 mm bar	Ø1-32 mm; L ≤300 mm	±0.020 mm typical	±0.010 mm common; ±0.005 mm by review
Mill-Turn / Live Tooling	Approx. Ø3 mm	Up to Ø300 × 800 mm	ISO 2768-1 m / c	±0.010-0.025 mm selected features

*Maximum workpiece size is not the same as machine travel. Workholding, tool access, rotary clearance, part weight, material condition and inspection access can reduce the usable envelope.

BEST-FIT APPLICATIONS

3-Axis Milling: Housings, plates, brackets, pockets, planar features and general prismatic parts.

4-Axis Milling: Indexed multi-face parts, radial holes, rotary features and reduced re-clamping.

5-Axis Milling: Complex contours, multi-face precision features, impellers and geometry requiring simultaneous tool orientation.

Turning / Swiss: Shafts, bushings, sleeves, pins, fittings, small precision components and long slender production parts.

Mill-Turn: Turned bodies with flats, cross holes, slots, pockets and features completed in fewer setups.

Capability principle

Quoted requirements on the accepted 2D drawing take priority over general values in this guide. 3D CAD defines nominal geometry; the drawing controls tolerances, GD&T, threads, surface finish and special process requirements.

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Tolerance & Precision Standards

Clear default rules for general dimensions and function-critical features

GENERAL TOLERANCES

Unless otherwise specified on the accepted engineering drawing:

- General metal machined parts: ISO 2768-1 class m for unspecified linear and angular dimensions.
- General plastic machined parts: ISO 2768-1 class c for unspecified linear and angular dimensions.
- Critical fits, GD&T, threads and surface requirements must be individually specified on the 2D drawing.
- Geometric tolerancing can be interpreted to ISO 1101 or ASME Y14.5 when specified by the customer.

PRECISION LEVELS

Level	Capability	Typical Use	Control
Standard	ISO 2768-1 m (metals) / c (plastics)	General prototypes and production parts	Standard dimensional inspection
Precision	± 0.025 mm (± 0.001 in) on specified features	Mating dimensions, bores, hole patterns, controlled datums	Enhanced inspection
High Precision	± 0.010 mm (± 0.0004 in) on selected measurable features	Bearing seats, critical diameters, precision assemblies	CMM / bore gauge / comparator as applicable
Special	Down to ± 0.005 mm (± 0.0002 in) on suitable selected features	Rigid turned, Swiss, reamed or specially finished features	Engineering approval + dedicated inspection

FEATURE-LEVEL GUIDANCE

Feature	Standard / Typical	Precision	Special
Milled linear dimensions	± 0.10 mm typical general	± 0.025 mm specified	± 0.010 mm by review
Turned diameters	± 0.05 mm typical general	± 0.010 - 0.025 mm	± 0.005 mm by review
Drilled holes	± 0.05 - 0.10 mm	Use reaming / boring / interpolation for fits	-
Interpolated / bored holes	± 0.05 mm	± 0.025 mm	± 0.010 mm by review
Reamed holes	Drawing-defined; H7 commonly practical	Fit-specific	Size/depth/material dependent

Tight tolerance rule

Tolerances of ± 0.010 mm and ± 0.005 mm are feature-specific capabilities, not whole-part default tolerances. They require stable geometry, an appropriate process sequence and a measurement method capable of verifying the requirement.

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Design for Manufacturability

Practical design rules that improve quality, cost and lead time

CORE CNC DESIGN GUIDELINES

Feature	Design Standard	Engineering Note
Minimum part size	5 × 5 × 5 mm for milling	Very small parts depend on workholding and handling.
Minimum feature	0.5 mm feasible; ≥1.0 mm preferred	Smaller features require micro tooling and reduce tool life.
Metal wall thickness	0.5 mm feasible; ≥0.8 mm recommended	Unsupported height and pocket depth strongly affect stability.
Plastic wall thickness	1.0 mm feasible; ≥1.5 mm recommended	Thermal expansion, creep and residual stress increase distortion risk.
Routine drilled hole	Ø1.0 mm and larger	Ø0.5 mm may be possible after depth/material review.
Hole depth	≤4D preferred; ≤6D common	>6D requires process review; deep-hole methods may be required.
Internal corner radius	R0.5 mm minimum recommended	Larger radii improve tool rigidity, finish and cycle time.
Thread size	M2 and larger standard	Smaller threads require tool-access and material review.
Cavity depth	Up to ~4× cavity width preferred	Deep/narrow pockets increase deflection, chatter and tool reach.
Engraving	≥0.5 mm line width; ≥2.5 mm character height	Use larger text for bead-blasted, anodized or coated parts.

TURNING / SWISS DESIGN GUIDELINES

- Length-to-diameter ratio ≤10:1 is preferred for conventional turning without special support.
- Long slender shafts may require tailstock support, steady rest, Swiss machining or multiple controlled operations.
- For precision diameters, keep critical features close to the supported workholding area when possible.
- Cross holes, flats and slots on turned parts can often be completed with live tooling / mill-turn to reduce setups.
- Avoid applying the tightest tolerance to long spans or thin-wall diameters unless functionally required.

Cost and accuracy

The most cost-effective drawings apply tight tolerances only to function-critical features, use standard hole/thread sizes, minimize deep narrow cavities, and allow generous internal radii wherever the design permits.

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Surface Finish, Edges & Materials

Machined surface standards and commonly supported materials

MACHINED SURFACE ROUGHNESS

Finish Level	Target Roughness	Application
As Machined	Ra 3.2 µm (125 µin)	General machined surfaces; consistent tool marks permitted.
Fine Machined	Ra 1.6 µm (63 µin)	Additional finishing passes and optimized cutting parameters.
Precision Machined	Ra 0.8 µm (32 µin)	Suitable for many sliding, sealing and precision turned surfaces.
Special Finish	Ra 0.4 µm (16 µin) on selected surfaces	May require grinding, polishing, lapping or specialized finishing.

EDGE CONDITION

- Non-functional sharp edges are deburred and lightly broken as standard practice.
- Typical non-critical edge break: approximately 0.2-0.5 mm unless otherwise specified.
- Functional sharp edges, sealing edges, knife edges and measurement datums must be marked KEEP SHARP / DO NOT BREAK EDGE on the drawing.
- Unspecified internal corners retain the natural cutter radius; an absolute sharp internal corner is not assumed.

COMMON MACHINABLE MATERIALS

Material Family	Common Options
Aluminum	6061-T6, 6063, 7075-T6, 2024, 5052, 6082
Stainless Steel	303, 304, 316 / 316L, 17-4PH, 15-5PH
Carbon / Alloy Steel	1018, 1045, 1215, 4140, 4340
Tool Steel	D2, A2, O1, H13, S7
Copper Alloys	Brass, copper, bronze and selected specialty alloys
Titanium / Magnesium	Common machinable grades subject to material condition and geometry
Engineering Plastics	POM / Delrin, ABS, Nylon, PC, PMMA, PTFE, PEEK, PVC, UHMW-PE, PP

Material availability depends on grade, temper/heat treatment, stock size, certification and order quantity. For plastics, temperature, moisture absorption and residual stress are considered when tight dimensional requirements apply.

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Surface Finishing Options

Cosmetic, corrosion-resistant and wear-resistant post-machining processes

Finish	Typical Materials	Key Consideration
As machined	Most metals & plastics	Fastest option; retains controlled machining marks.
Bead blasting	Aluminum, stainless steel, many metals	Uniform matte appearance; protect precision fits and sealing surfaces as required.
Anodizing Type II	Aluminum	Clear, black and colors; cosmetic and corrosion protection.
Hard anodizing Type III	Aluminum	Higher wear resistance; coating thickness must be considered on fits.
Passivation	Stainless steel	Improves corrosion resistance after machining and cleaning.
Black oxide	Carbon / alloy steel	Dark conversion finish; commonly combined with oil or seal.
Electroless nickel	Metals	Uniform thickness with good corrosion and wear performance.
Zinc / nickel / chrome plating	Compatible metals	Appearance, corrosion protection or wear properties depending on specification.
Powder coating / painting	Metals	Wide color/texture range; coating build affects dimensions.
Brushing / polishing	Aluminum, stainless, brass and others	Cosmetic directional or reflective surface.
Laser marking / engraving	Many materials	Permanent identification, serialization and branding.

DIMENSIONS AFTER FINISHING

- Coatings add thickness and may alter hole, thread, slot and mating dimensions.
- Critical fits should state whether dimensions apply before or after anodizing, plating, paint, heat treatment or other secondary processes.
- Masking instructions must be shown on the drawing for threads, bearing seats, electrical contacts, sealing surfaces or cosmetic boundaries.
- Cosmetic requirements should define visible A/B/C surfaces or include an approved appearance standard when appearance is critical.

Finish and tolerance planning

For dimensionally critical coated parts, the drawing and quotation should define the inspection stage and whether final dimensions are controlled before or after the coating process.

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Quality Assurance & Inspection

Inspection methods selected to match part function, tolerance and documentation requirements

Inspection planning is matched to the drawing requirements and the risk level of each feature. Standard production inspection is supplemented with precision metrology when tight tolerances, complex GD&T or customer documentation require it.

Inspection Method	Typical Use	When Applied
Visual workmanship	Burrs, damage, contamination, cosmetic defects	Standard shipment inspection
Caliper / micrometer / height gauge	General dimensions, diameters, thicknesses and heights	Routine dimensional inspection
Pin, plug and thread gauges	Holes, fits and thread acceptance	Feature-specific production control
CMM inspection	Position, profile, datums and complex GD&T	Precision / complex parts
Optical measurement	Small profiles, Swiss parts and non-contact features	Small or delicate geometry
Surface roughness measurement	Specified Ra requirements	When surface finish is a controlled characteristic

AVAILABLE QUALITY DOCUMENTATION

Document	Purpose
Dimensional Inspection Report	Agreed critical dimensions or inspection characteristics
Full Dimensional Report	Ballooned drawing / all agreed drawing dimensions
First Article Inspection (FAI)	Initial verification before production release
CMM Report	GD&T and complex dimensional verification
Material Certificate	Material grade / heat / lot documentation when available or specified
Certificate of Conformity (CoC)	Confirmation that supplied parts meet agreed order requirements

Measurement rule

For ± 0.010 mm and ± 0.005 mm features, the measurement method, datum strategy, instrument resolution and inspection environment must be suitable for the specified tolerance. These details are confirmed during quotation when necessary.

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RFQ & Drawing Requirements

What to provide for accurate pricing, manufacturability review and faster order release

Input	What to Specify	Why It Matters
3D CAD model	STEP / STP preferred; native CAD when helpful	Defines nominal geometry and feature locations.
2D drawing	PDF with dimensions, tolerances, GD&T and notes	Controls critical requirements and inspection acceptance.
Material	Exact alloy / grade / temper / heat-treatment condition	Impacts machinability, distortion, tool wear and material sourcing.
Quantity	Prototype quantity and expected production volume	Determines process, fixture and inspection strategy.
Surface finish	Ra requirement and/or post-processing specification	Defines machining and secondary-process requirements.
Quality documents	FAI, CMM report, material certificate, CoC, etc.	Allows inspection scope to be included in price and lead time.
Delivery requirements	Destination and target date	Supports realistic scheduling and logistics planning.

STANDARD DRAWING NOTES

UNLESS OTHERWISE SPECIFIED, GENERAL LINEAR AND ANGULAR TOLERANCES: ISO 2768-1 m FOR METALS / c FOR PLASTICS.

DEBURR AND BREAK NON-CRITICAL SHARP EDGES 0.2-0.5 mm. DO NOT BREAK EDGES MARKED KEEP SHARP.

CRITICAL DIMENSIONS, THREADS, GD&T AND SURFACE FINISH SHALL FOLLOW THE 2D DRAWING.

AS-MACHINED SURFACE ROUGHNESS: Ra 3.2 µm UNLESS OTHERWISE SPECIFIED.

DIMENSIONS APPLY AFTER FINISHING ONLY WHERE EXPLICITLY STATED ON THE DRAWING.

CAPABILITY APPLICABILITY

This guide defines the standard NAITE TECH CNC machining service envelope used for customer communication and quotation. Not every combination of maximum size, material, geometry, surface finish and tight tolerance can be achieved simultaneously. Parts with near-limit dimensions, thin walls, deep cavities, deep holes, micro features, difficult materials, complex GD&T or special inspection requirements are reviewed before order confirmation.

The accepted quotation and engineering drawing define the final manufacturing and inspection requirements for each order.

READY TO REVIEW YOUR CNC PROJECT?

Send your 3D CAD, 2D drawing, material, quantity and finish requirements for engineering review and quotation.

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