QUALITY INSPECTION TECHNICAL MANUAL
GENERAL THREAD INSPECTION METHODS

Cross-Type Measurement, Gauge Management, SPC & Mechanical Testing

Document No.:	KFP-QIM-THD-008
Revision:	F
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Classification:	Internal Technical Document
Scope:	Universal inspection methods applicable across all thread types (M, UN, pipe, MJ, self-tapping, trapezoidal). Gauge calibration system, CMM protocols, three-wire method, SPC methodology, mechanical property testing, surface treatment verification. Master reference for all KFP-QIM-THD series manuals.

IATF 16949 | ISO 9001 | ISO 14001 Certified Facility

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Revision History

Rev.	Date	Description & Triggering Standards	Author	Approved
A	2005-06	Initial release. Established gauge calibration program per ISO/IEC 17025. Three-wire method master procedure. SPC methodology (Cpk ≥1.33 target). Mechanical testing per ISO 898-1:1999.	Quality Eng.	Quality Dir.
B	2009-03	Added CMM thread measurement protocol. Added surface treatment inspection (coating thickness, salt spray, adhesion). Expanded gauge management database.	Quality Eng.	Quality Dir.
C	2013-09	Updated to ISO 898-1:2013 and ISO 898-2:2012 for mechanical testing. Upgraded SPC target to Cpk ≥1.67. Added MSA (Measurement System Analysis) per AIAG MSA 4th edition.	Quality Eng.	Quality Dir.
D	2016-11	Added optical sorting validation protocol. Added profilometer surface roughness procedure. Enhanced gauge room environmental control (20±2°C).	Quality Eng.	Quality Dir.
E	2019-08	Added torque-angle testing per ISO 16047. Added hydrogen embrittlement testing per ISO 15330. Enhanced digital traceability system.	Quality Eng.	Quality Dir.
F	2026-03	Updated mechanical property references. Added: GR&R study requirements for all thread measurement methods, CMM software validation protocol, coating thickness measurement on thread flanks (vs. crest only), expanded H_2 embrittlement protocol for high-strength (>1050 MPa) fasteners, digital calibration certificate management.	Quality Eng.	Quality Dir.

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1. Scope

This manual defines the universal inspection methods, gauge management system, SPC methodology, and mechanical testing procedures used across all thread types at KeyFixPro. It is the master reference document for all KFP-QIM-THD series manuals (THD-001 through THD-007).

2. Normative References

Standard	Title / Scope
ISO/IEC 17025:2017	General requirements for competence of testing and calibration laboratories
ISO 1502:1996	Gauges and gauging for metric threads
ASME B1.2-1983 (R2001)	Gauges for Unified inch threads
ASME B1.3M-1992 (R2001)	Thread gauging systems (W, X, Y, Z)
ISO 16740:2005	General requirements for screw thread gauges
ISO 898-1:2013	Mechanical properties — Bolts (4th edition)
ISO 898-2:2012	Mechanical properties — Nuts (3rd edition)
ISO 3506-1:2009	Stainless steel fasteners — Mechanical properties
ISO 16047:2005	Torque/clamp force testing
ISO 15330:1999	H_2 embrittlement — Preloading test
ISO 4042:2022	Electroplated coatings on fasteners
ISO 9227:2017	Salt spray testing
ISO 2859-1:1999	AQL sampling plans
AIAG MSA (4th ed.)	Measurement System Analysis
AIAG SPC (2nd ed.)	Statistical Process Control

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3. Gauge Calibration System

3.1 Gauge Room Requirements

(a) Temperature: 20 ± 2°C (calibration) / 20 ± 1°C (referee measurements).

(b) Humidity: RH < 60%, no condensation.

(c) Cleanliness: no machining chips, oil, or dust on gauge surfaces.

(d) Vibration: gauge room isolated from production floor vibration.

3.2 Calibration Intervals

Gauge Type	Interval	Traceability	Action on Overdue
Thread GO ring/plug	6 months or 5,000 uses	NIM China / NIST via 17025 lab	Quarantine; re-inspect parts since last cal
Thread NO-GO ring/plug	6 months or 5,000 uses	Same	Same
Pipe thread gauges (L1/L3)	6 months	Same	Same
Micro-thread gauges (M1.6–M3)	3 months or 2,000 uses	Same (accelerated wear)	Same
Thread measuring wires	12 months	Certified to ±0.0005 mm	Replace set
Setting plugs/rings (master)	12 months	National metrology institute	Quarantine all working gauges calibrated against it
CMM (machine calibration)	12 months + daily artifact check	Laser interferometer calibration	Stop CMM use; emergency cal

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4. CMM Thread Measurement Protocol

4.1 Standard Parameters

Parameter	Setting
Scanning speed	3.0 mm/s max; 2.0 mm/s for P ≤ 0.5 mm
Points per revolution	120 min; 180 for fine-pitch (P ≤ 1.0 mm)
Axial coverage	3 helical revolutions min; 5 for FAI/PPAP; full travel for leadscrews
Stylus tip	R=0.5 mm std; R=0.3 mm for M1.6–M5 / #0–#6; R=0.25 mm for internal micro-threads
Probing force	≤0.1 N
Temperature	20 ± 1°C; part stabilized 2 hrs; CTE correction for non-steel
Alignment	3-point cylinder fit on unthreaded section
Software validation	Run NIST traceable thread artifact monthly; results within ±0.002 mm of certified values

4.2 GR&R Requirements (per AIAG MSA)

(a) All thread measurement methods (CMM, three-wire, gauge) require a Gauge R&R study per AIAG MSA 4th edition.

(b) Acceptance: %GR&R ≤10% of tolerance for critical characteristics; ≤30% for non-critical.

(c) Study design: 3 operators × 10 parts × 3 trials minimum.

(d) Frequency: at initial method validation + annually + after any equipment change.

5. SPC Methodology

5.1 Control Chart Selection

Data Type	Chart Type	Application	KFP Target
Variable (d_2, d, d_3)	X-R or X-S chart	Continuous measurement of thread dimensions	Cpk ≥ 1.67
Attribute (GO/NO-GO)	p-chart or np-chart	Pass/fail thread gauge results	$\bar{p}$ + 3σ = 0 defects target
Defect count	c-chart or u-chart	Number of thread defects per lot	Per control limits

5.2 Out-of-Control Response

Any SPC out-of-control signal (point beyond control limits, run of 7, trend of 7, 2-of-3 beyond 2σ) triggers:

(a) STOP production. Investigate root cause.

(b) Trace back to last in-control point. Re-inspect suspect parts.

(c) Document on SPC reaction plan form. Quality Engineer sign-off before restart.

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6. Mechanical Property Testing

6.1 Tensile and Proof Load (per ISO 898-1:2013 / SAE J429)

(a) Tensile test: full-size bolt test (wedge tensile per ISO 898-1 clause 9.2) or machined specimen.

(b) Proof load: bolt loaded to proof load value per property class, held 15 seconds, measured for permanent set.

(c) Frequency: per AQL sampling plan (ISO 2859-1) or per production control plan.

6.2 Hardness

(a) Core hardness: Rockwell (HRC for ≥20 HRC; HRB for softer) or Vickers.

(b) Surface hardness: for case-hardened parts (self-tapping screws), Vickers HV0.3.

(c) Frequency: 5 measurements per HT batch.

6.3 Torque Testing (per ISO 16047)

(a) Installation torque, prevailing torque, breakaway torque, stripping torque, torque-angle.

(b) Test machine: 0.5–500 N·m range, ±1% accuracy, data acquisition for torque-angle curve.

(c) Application: PPAP for all automotive projects; per customer spec for other industries.

6.4 Hydrogen Embrittlement Testing (per ISO 15330)

(a) Applicable to: all electroplated fasteners with tensile strength ≥1,050 MPa (property class 10.9, 12.9, SAE Grade 8).

(b) Method: incremental loading per ISO 15330, or 48-hr sustained load at 75% of proof load.

(c) Acceptance: no fracture after specified loading period.

(d) Frequency: every electroplating batch.

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7. Surface Treatment Verification

Test	Standard	Method	Frequency
Coating thickness	Per coating spec	XRF on thread FLANK (not crest only); or cross-section	Every plating batch; 5 pcs
Adhesion	ISO 2819 / ASTM B571	Bend test or tape test on coated thread	Every plating batch; 3 pcs
Salt spray resistance	ISO 9227	NSS test; Zn: 96h min; Zn-Ni: 720h min	Per coating qualification + annual
Baking verification	ISO 4042	Time/temp log: 190°C / 4h within 4h of plating	Every batch; oven recorder log
Thread function post-coat	ISO 1502 / ASME B1.2	GO/NO-GO gauge after coating	100% or per AQL
Torque coefficient (K-factor)	ISO 16047	Torque-tension test on coated bolt	Per customer spec; PPAP

> **IMPORTANT:** Coating thickness must be measured on the thread FLANK, not just the crest. XRF spot size must be small enough to target the flank surface. Crest-only measurement underestimates flank build-up, leading to GO gauge failures.

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Non-Conformance Handling and Disposition

Standard NC Procedure

Step	Action
1. Containment	STOP production. Segregate with RED tag. Quarantine. NCR Form KFP-NCR-001.
2. Scope	Trace to last good inspection. Re-inspect 100% of suspect window.
3. Root cause	8D/5-Why analysis. Common: tool wear, wrong setup, gauge error, material variation.
4. Disposition (MRB)	REWORK / USE-AS-IS (customer concession) / SCRAP.
5. Corrective action	Permanent fix; verify effectiveness over ≥3 production lots.
6. Customer notification	If NC product shipped: 24-hr notice + 8D per IATF 16949 §8.7.1.6.

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Records, Traceability & Documentation

Record	Doc ID	Retention	Storage
Material cert (EN 10204 3.1)	Per lot	15 yr (auto) / 10 yr	QMS + archive
OES report	KFP-MAT-OES-[lot]	= material cert	QMS
FAI report	KFP-FAI-[part]-[date]	Part life + 1 yr	QMS
SPC charts	Auto-generated	Current + 2 yr	SPC database
Gauge log	KFP-GAG-LOG-[line]	Current + 1 yr	QMS
CMM thread report	KFP-CMM-THD-[part]	Part life + 1 yr	QMS + PDF
Final inspection	KFP-FIN-[lot]-[date]	15 yr (auto)	QMS
NCR / 8D	KFP-NCR-[seq]	Part life + 3 yr	QMS
Gauge cal cert	KFP-CAL-[gauge ID]	+ 2 cal cycles	QMS
PPAP package	Per customer	Part life + 1 yr EOL	QMS + portal

Document Approval

Reviewed and approved by:

Role	Name	Signature	Date
Prepared by:	Quality Engineer		
Reviewed by:	Production Manager		
Approved by:	Quality Director		
Authorized by:	General Manager		

END OF DOCUMENT

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