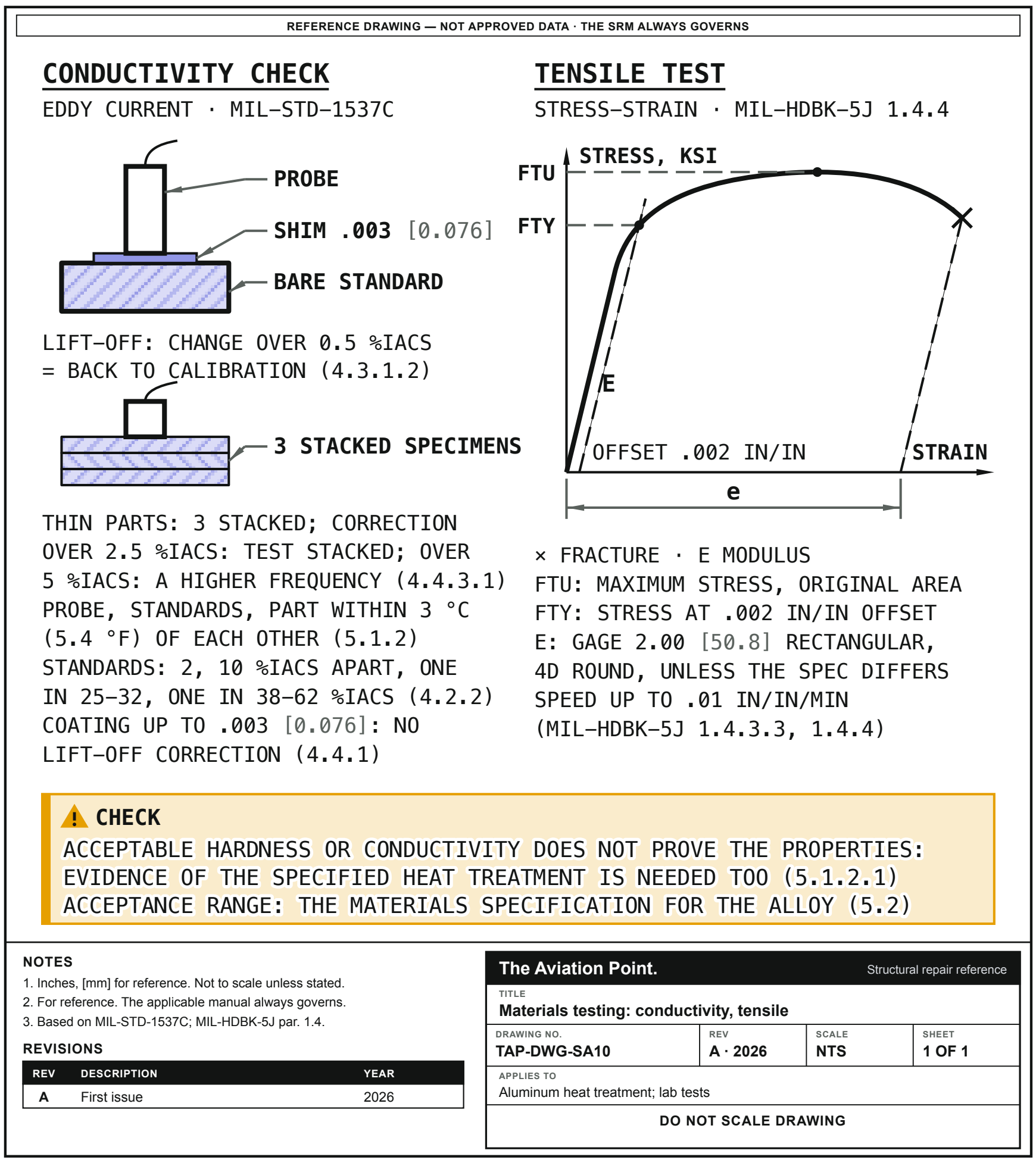
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Testing of Materials: Hardness, Conductivity, Tensile, Fatigue and Impact

Rockwell · Brinell · conductivity %IACS · tensile, fatigue and impact in the lab

1 Identification



Conductivity after MIL-STD-1537C pars. 4.2 to 5.2; tensile terms after MIL-HDBK-5J pars. 1.4.3 and 1.4.4. Acceptance values come from the materials specification.

The tests at a glance

Test	What it measures	Where	Source
Rockwell hardness	Depth of indentation: a minor load seats a steel ball or a diamond cone, then the major load is applied. Superficial Rockwell, with light loads, for thin sections and small parts	Shop or lab	AC 43.13-1B par. 4-17
Brinell hardness	Load divided by the area of the impression left by a 10 mm ball	Lab, or a part that will not return to service	AC 43.13-1B par. 4-18
Vickers, Knoop (micro)	Diamond pyramid; microhardness with loads up to 1 kg	Lab: plating, foil, wire, case depth, decarburization	AC 43.13-1B pars. 4-19, 4-20
Electrical conductivity	Conductivity in %IACS (percent of the International Annealed Copper Standard) by eddy current; with hardness it verifies aluminum heat treatment	Shop or lab	MIL-STD-1537C foreword, par. 1.1
Tensile	Stress-strain curve: modulus, yield at 0.2 % offset, ultimate, elongation, reduction of area	Lab	MIL-HDBK-5J par. 1.4.4
Fatigue	Cycles to failure at a stress (or strain) amplitude and ratio R, plotted as S-N curves	Lab	MIL-HDBK-5J par. 1.4.9
Impact	Energy absorbed in breaking a notched bar	Lab	ASTM E23

Educational reference only, not approved data. Always consult the applicable SRM, AMM, or AC 43.13-1B and your certifying authority.

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2 Allowable damage

Typical Brinell hardness of aluminum alloys

Alloy	O (annealed)	Hardened temper, HB
1100	23	H18: 44
3003	28	H16: 47
2014	45	T6: 135
2024	47	T4: 120
2025	—	T6: 110
5052	47	H36: 73
6061	30	T4: 65 · T6: 95
6151	—	T6: 100
7075	—	T6: 135
7079	—	T6: 135
Castings	—	195-T6: 75 · 220-T4: 75 · C355-T6: 80 · A356-T6: 70

Conductivity check of aluminum heat treatment

Item	Requirement
Instrument	Direct reading wherever possible; an indirect one needs at least three certified standards within ±10 %IACS of the value, one above and one below
Sensitivity, accuracy	0.5 %IACS clearly distinguishable; ±1.0 %IACS or better through non-conductive coatings at least 0.003 in (0.076 mm) thick
Instrument standards	At least two, certified to ±0.85 %IACS, at least 10 %IACS apart: one in 25 to 32, one in 38 to 62 %IACS
Standardize	Warm-up about 20 min (solid state 5 min); every 15 min in continuous use
Lift-off	0.003 in (0.076 mm) shim on a bare standard: difference not over 0.5 %IACS, or the instrument goes back to calibration
Calibration	Every 120 days or on objective evidence; never over 12 months
Surface	Clean; 150 RHR (165 RMS) maximum; a non-conductive coating up to 0.003 in (0.076 mm) needs no lift-off correction
Edges	Minimum edge distance by the user's tests or the instrument maker's specification
Temperature	Probe, standards and part within 3 °C (5.4 °F) of each other
Hardness first	Hardness of the first part of the lot, to ASTM E10 or E18
Doubtful reading	Recheck the standards, then test hardness before any disposition
Clad and Alclad	Clad only with documented correlation; Alclad at 50 to 75 kHz, and over 0.091 in (2.3 mm) the cladding is spot-faced off one part per lot for a correction factor
Thin parts	Down to 40 % under the minimum thickness: three stacked specimens. Correction over 2.5 %IACS: test stacked; over 5 %IACS: use a higher frequency
Acceptance range	—
What it proves	Acceptable hardness or conductivity does not guarantee mechanical properties: evidence of the specified heat treatment is needed as well
Personnel	Indirect-reading instruments: level II to NAS 410

3 Repair

1. Alloy, temper, spec range.
2. Clean surface, coatings ≤ 0.003 in.
3. Standardize, check lift-off.
4. Hardness on the first part.
5. Read %IACS, 3 °C of the standards.
6. Disposition and record.

Key points

- **Know the alloy first:** a test confirms, it does not identify.
- **Hardness pits:** not on sealing, fatigue-critical or bearing areas.
- **Conductivity + hardness** together define a temper.
- **Acceptance:** the material specification, never this sheet.

MAIN SOURCES · AC 43.13-1B CHG 1, Acceptable Methods, Techniques, and Practices: Aircraft Inspection and Repair · MIL-STD-1537C, Electrical Conductivity Test for Verification of Heat Treatment of Aluminum Alloys, Eddy Current Method · MIL-HDBK-5J, Metallic Materials and Elements for Aerospace Vehicle Structures · TO 1-1A-1 / NAVAIR 01-1A-1, General Manual for Structural Repair · 29 CFR 1910.133, Eye and face protection · Test standards named by number

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