# LASER CUTTING QUALITY STANDARD

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**AMERICAN MANUFACTURING COMPLIANCE AUTHORITY (AMCA)**
**QUALITY STANDARDS FOR LASER CUTTING OPERATIONS**
**Revision 2.1 – 2025**

## 1. Purpose and Scope

These standards establish minimum quality, safety, and performance requirements for industrial laser-cutting operations within facilities governed by the American Manufacturing Compliance Authority (AMCA). They apply to $CO_2$, fiber, and Nd:YAG laser systems used for cutting metals, plastics, composites, and other approved materials. All manufacturers, subcontractors, and certified operators must adhere to these standards to ensure consistency, precision, and safety.

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## 2. Definitions

- **Laser Cutting:** A thermal machining process that uses a concentrated laser beam to cut or engrave material.
- **Kerf Width:** The width of material removed during the cutting process.
- **Heat-Affected Zone (HAZ):** Area where material properties are altered by heat but not melted.
- **Cut Quality Class (CQC):** AMCA grading scale evaluating accuracy, finish, and structural integrity (CQC-A, CQC-B, CQC-C).
- **Workpiece:** Any material or component subject to laser cutting.

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## 3. Equipment Requirements

3.1 **System Accuracy**

- Equipment must maintain a positional accuracy of **±0.05 mm** or better across the full cutting envelope.
- Repeatability shall be no greater than **±0.02 mm**.

3.2 **Laser Power Stability**

- Power output must remain stable within **±2%** of the programmed setting during continuous operation.
- All systems must include automatic power monitoring and error logging.

3.3 **Maintenance & Calibration**

- Machines must undergo full calibration every **1,000 operating hours** or quarterly, whichever occurs first.
- Optics must be cleaned according to manufacturer guidelines and inspected at least weekly.
- All maintenance activities must be documented and retained for a minimum of **three years**.

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## 4. Material and Workpiece Requirements

4.1 **Material Condition**

- Workpieces must be free of contaminants, oils, excessive surface corrosion, and coatings that could release hazardous fumes when cut.
- Material flatness must meet manufacturer tolerances to avoid defocusing and dimensional deviation.

4.2 **Traceability**

- Each workpiece batch must be traceable to its material certification, including grade, thickness, and supplier of origin.

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## 5. Cutting Process Standards

5.1 **Operational Setup**

- Operators must verify focus height, assist-gas type, and pressure before initiating production runs.
- Test cuts must be performed when switching materials, thicknesses, or cutting parameters.
- Fixtures and supports shall be inspected to ensure minimal vibration and secure clamping.

5.2 **Assist Gases**

- Oxygen, nitrogen, and air may be used according to the material specification.
- Gas purity must be at least **99.5%** for nitrogen cutting and **99.0%** for oxygen cutting.
- Pressure regulators and delivery lines must be leak-tested monthly.

5.3 **Programming and Nesting**

- Cutting programs shall be produced using validated CAM software approved by AMCA.
- Nesting must optimize material usage while ensuring minimum edge-to-edge spacing based on material thickness.

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## 6. Quality Requirements

6.1 **Dimensional Tolerance**

- Unless otherwise specified on engineering drawings, default dimensional tolerance for laser-cut parts is **±0.1 mm**.
- For CQC-A components, the tolerance tightens to **±0.05 mm**.

6.2 **Edge Quality**

- Edges must be free of excessive burrs, major striations, or re-solidified slag.
- Acceptable burr height:
  - CQC-A: **≤0.03 mm**
  - CQC-B: **≤0.10 mm**
  - CQC-C: **≤0.20 mm**

6.3 **Heat-Affected Zone (HAZ)**

- HAZ must not exceed **0.5 mm** for carbon steel and **0.3 mm** for stainless steel unless otherwise required by the application.
- No warpage greater than **0.25 mm per 300 mm** of cut length is permitted.

6.4 **Kerf Consistency**

- Kerf width variation shall not exceed **±10%** of the programmed kerf for the production batch.

6.5 **Surface Finish**

- Surface discoloration is acceptable only in non-cosmetic, non-precision applications.
- Cosmetic components must show uniform coloration and minimal laser oxidation.

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## 7. Inspection and Testing

7.1 **In-Process Inspection**

- First-article inspection required at the start of each shift and after parameter changes.
- At least **5%** of production parts (or one piece per batch, whichever is greater) must be inspected for dimensional accuracy.

7.2 **Final Inspection**

- Visual inspection for edge quality, warpage, and contamination is mandatory.
- Dimensional inspection must use calibrated equipment (CMM, calipers, gauges).

7.3 **Non-Conforming Material (NCM)**

- Non-conforming parts must be segregated, tagged, and recorded in the NCM log.
- Rework must follow documented procedures and undergo full re-inspection.

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## 8. Safety Requirements

8.1 **Laser Safety Controls**

- All systems must comply with ANSI Z136.1 and AMCA Laser Safety Protocol LSP-4.
- Safety interlocks may not be bypassed except by authorized maintenance personnel.

8.2 **Personal Protective Equipment (PPE)**

- Appropriate laser-rated eyewear must be worn when operating or servicing open-beam systems.
- Operators must use heat-resistant gloves when handling freshly cut parts.

8.3 **Ventilation and Fume Extraction**

- Laser systems must be connected to approved fume extraction units capable of meeting local air quality standards.
- Filters must be replaced per manufacturer guidelines and inspected monthly.

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## 9. Documentation and Records

- Cutting parameter sheets, material certifications, inspection reports, and maintenance logs must be retained for **a minimum of five years**.
- All digital records must be backed up in accordance with AMCA Data Integrity Standard DIS-2.

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## 10. Personnel Requirements

10.1 **Training**

- Operators must complete AMCA-certified training covering machine operation, safety, material handling, and quality inspection.
- Recertification is required every **two years**.

10.2 **Competency Verification**

- Facilities must maintain a competency matrix documenting operator qualifications and authorized operation levels.

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## 11. Continuous Improvement

- Facilities shall analyze scrap rates, rework levels, and machine downtime quarterly.

- Preventive actions must be documented and reviewed during AMCA audits.

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## 12. Compliance

Failure to meet these standards may result in corrective action requests, suspension of certification, or additional penalties as determined by AMCA Enforcement Policy EP-1.



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