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Superseded by PRI AC7116/4

National Aerospace and Defense Contractors Accreditation Program
Requirements for Laser Beam Machining (LBM)

RATIONALE

AS7116/4A is being cancelled and superseded by PRI AC7116/4. The requirements in the document have not changed.

CANCELLATION NOTICE

This document has been declared "CANCELLED" as of July 2008 and has been superseded by AC7116/4. By this action, this document will remain listed in the Numerical Section of the Aerospace Standards Index noting that it is superseded by AC7116/4.

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1. SCOPE:

This Aerospace Standard (AS) is to be used to supplement AS7116. In addition to the requirements contained in AS7116, the requirements contained herein shall apply to suppliers seeking NADCAP accreditation for laser beam machining (LBM). The LBM requirements contained herein address the drilling, cutting and marking LBM process methods.

2. REFERENCES:

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15086-0001.

- AS7101/4 National Aerospace and Defense Contractors Accreditation Program (NADCAP) – Requirements for Material Testing Laboratories – Metallography and Microhardness
- AS7108 National Aerospace and Defense Contractors Accreditation Program (NADCAP) – Audit Criteria for Chemical Processing
- AS7116 National Aerospace and Defense Contractors Accreditation Program (NADCAP) – Requirements for Nonconventional Machining.

2.2 PRI Documents:

Available from Performance Review Institute, 161 Thornhill Road, Warrendale, PA 15086-7527.

- AC7116/4 National Aerospace and Defense Contractors Accreditation Program (NADCAP) – Audit Criteria for Laser Beam Machining (LBM)

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2.3 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428

ASTM E3 Methods of Preparation of Metallographic Specimens

2.4 Applicable customer specifications shall be available at the facility.

3. EQUIPMENT:

3.1 Maintenance:

3.1.1 A laser maintenance plan shall exist and include the following, where applicable:

- a. High voltage power supply
- b. Optical to mechanical alignment
- c. Laser cooling equipment
- d. Filter replacement schedule
- e. Verification of pulse format
- f. Flash lamp replacement schedule

3.2 Laser Power Output Monitoring:

3.2.1 A plan shall exist that meets customer requirements for checking laser output power using calibrated power meters that are external to the laser cavity.

3.2.2 The plan shall require an annual calibration of laser power meters.

3.3 Laser Alignment:

3.3.1 A laser alignment plan shall exist that addresses the alignment after a machine crash or after an optical element has been changed.

4. WORK INSTRUCTION REQUIREMENTS:

4.1 Laser Equipment:

4.1.1 The workstation instructions shall list the laser machine model or machine number.

4.2 Tooling and Support Material:

4.2.1 Fixtures/Tooling:

4.2.1.1 The tool fixture shall be listed by tool number and/or description when no tool number is available.

4.2.1.2 Any additional tools and production aids shall be listed by tool number and/or description when no tool number is available.

4.2.2 Tooling Acceptance:

4.2.2.1 If tooling control is used for acceptance of parts, there shall be a plan to periodically check tooling.

4.3 Laser Parameter Requirements:

4.3.1 The laser workstation instructions shall list values or ranges for the following laser parameters, where applicable:

- a. Pulse format (i.e. pulse width, duty cycle)
- b. Repetition rate
- c. Laser power output or voltage
- d. Aperture
- e. Number of shots
- f. Part program name or schedule ID or number
- g. Traverse speed (laser cutting and laser marking only)
- h. Spot wobble (laser marking only)

4.3.2 Where laser machines have switches or controls for parameters that are not listed in Paragraph 4.3.1, the workstation instructions shall list values or limits for the additional parameters.

4.4 General Laser Requirements:

4.4.1 The workstation instructions shall describe the following, as applicable:

- a. Nozzle gas type
- b. Nozzle gas pressure or nozzle gas line pressure
- c. Lens focal length
- d. Nozzle orifice size (laser cutting only)

5. QUALITY PLANS:

5.1 Procedure:

5.1.1 There shall be a quality plan for each laser operation and part processed that includes the following, as applicable:

- a. Dimensions to be checked
- b. Method of control (i.e., fixture, part program)
- c. Method of inspection
- d. Frequency of inspection
- e. Visual examination to detect burrs
- f. Visual comparison of surface finish
- g. Airflow
- h. Metallurgical checks and frequency

5.2 Quality Plan Approval:

5.2.1 The quality plan shall be approved in accordance with customer requirements.

5.2.2 The customer shall approve the use of any sampling plans.

5.3 Gages:

5.3.1 For those dimensions measured at the laser operation, the quality plan shall list the gage by a drawing, gage number, or standard gage description.

6. ANCILLARY PROCESSES:

6.1 Part Cleaning:

6.1.1 Part cleaning shall be performed on processed parts either in-house or by an outside source.

6.1.1.1 If conducted in-house, one of the following shall apply:

- a. NADCAP accredited to SAE AS7108, proceed to Paragraph 6.2
- b. Not accredited to SAE AS7108, only de-ionized or tap water used, proceed to Paragraph 6.2
- c. Not accredited to SAE AS7108, cleaning solutions used, Paragraphs 6.1.2 through 6.1.10 shall be addressed

6.1.1.2 If conducted by an outside source, proceed to Paragraph 6.2.

6.1.2 Workstation instructions shall be available at the cleaning workstation.

6.1.3 If required, workstation instructions shall be approved in accordance with customer requirements.

6.1.4 If required, cleaning solutions shall be approved by the purchaser.

6.1.5 The following controls shall be calibrated, if applicable:

- a. Temperature gage
- b. Timer

6.1.6 The cleaning tank agitator shall be functioning, if applicable.

6.1.7 The maximum tank time shall be posted or listed in the workstation instructions, if applicable.

6.1.8 The rinse tank cleanliness and check interval shall be defined, if applicable.

6.1.9 There shall be a solution concentration testing and makeup procedure, if applicable.

6.1.10 The cleaning operator shall receive required supplier training.

6.2 Airflow:

- 6.2.1 Airflow inspection shall be conducted by an approved source, either in-house or by an outside source, as required by the customer.
 - 6.2.1.1 If conducted in-house, Paragraphs 6.2.2 through 6.2.10 shall be addressed.
 - 6.2.1.2 If conducted by an outside source, proceed to Paragraph 6.3.
 - 6.2.2 Workstation instructions shall be available at the airflow workstation.
 - 6.2.3 Workstation instructions shall be approved in accordance with customer requirements.
 - 6.2.4 The airflow stand shall be calibrated.
 - 6.2.5 A working master part shall be used per customer requirements.
 - 6.2.6 The airflow stand/system shall be corrected to the customers required barometric pressure and humidity conditions, if applicable.
 - 6.2.6.1 All fixtures, manufacturing aids, gaskets, and seals identified in the workstation instructions shall be the same items used at the workstation.
 - 6.2.7 The parts shall be clean and free of dirt and contamination prior to airflow.
 - 6.2.8 A procedure shall be in place to check for leaks.
 - 6.2.9 The airflow operator shall receive required supplier training.
- ## 6.3 Anti-Splatter:
- 6.3.1 Beam blocking and/or anti-splatter materials or chemicals shall be approved by the customer, if required.
 - 6.3.2 There shall be a procedure that prohibits the use of a copper or copper alloy as the beam block material.

7. LABORATORY ANALYSIS:

7.1 Inspection:

- 7.1.1 There shall be a laboratory analysis that shows conformance to applicable drawing notes and/or related specifications.
- 7.1.2 The samples used to demonstration conformance shall meet the following:
 - a. Machined using the same LBM process parameters used in production
 - b. Same material and heat treat condition as production parts, if applicable

7.2 Periodic Metallurgical Evaluation:

7.2.1 Periodic testing shall be performed to verify compliance to the customer's metallurgical requirements.

7.2.2 Metallographic testing on processed parts shall be conducted by an approved source, either in-house or by an outside source, if required by the customer.

7.2.2.1 If conducted in-house, one of the following shall apply:

- a. NADCAP accredited to SAE AS7101/4, proceed to Paragraph 8
- b. Initially approved by NADCAP subscribing customer, Paragraphs 7.2.3 through 7.2.9 shall be addressed

7.2.2.2 If conducted by an outside source, one of the following shall apply:

- a. NADCAP accredited to SAE AS7101/4, proceed to Paragraph 8
- b. Initially approved by NADCAP subscribing customer, proceed to Paragraph 8

7.2.3 Calibration:

7.2.3.1 The laboratory equipment calibration procedure shall be documented and referenced in the quality manual.

7.2.3.2 Calibration records shall be maintained.

7.2.3.3 Filar (fixed reticle) eyepieces used for dimensional measurement shall be calibrated against stage micrometers.

7.2.4 Training:

7.2.4.1 The quality manual shall require documented training of laboratory personnel.

7.2.4.2 The training shall include general and specific aspects of the examination to be performed, elements of preparation and interpretation of specimens and annual Round Robin comparisons for personnel who evaluate microstructure.

7.2.4.3 The laboratory shall employ a degreed metallurgist or equivalent that approves standards, procedures and approved non-degree laboratory personnel.

7.2.4.4 Criteria for equivalency shall be established by the quality manual.

7.2.5 Written Procedures:

7.2.5.1 Written procedures for preparation of metallographic specimens shall be available.

7.2.5.2 ASTM E3 shall be used as a reference in procedures for preparation of metallographic specimens.