SAE The Engineering Society For Advancing Mobility Land Sea Air and Space®
INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE STANDARD

SAE AS7102 REV A

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Submitted for recognition as an American National Standard

NATIONAL AEROSPACE AND DEFENSE CONTRACTORS ACCREDITATION PROGRAM REQUIREMENTS FOR HEAT TREATING

1. SCOPE:

This Aerospace Standard (AS) establishes the requirements for Heat Treating Accreditation by the National Aerospace and Defense Contractors Accreditation Program (NADCAP). These requirements may be supplemented by additional requirements specified by the NADCAP Heat Treating Task Group. Using the audit checklist (AC7102) will ensure that accredited heat treat suppliers meet all of the requirements in this standard and all applicable supplementary standards.

All instructions, procedures, tests and inspection records, etc., referenced herein shall be in writing; distribution of instructions and procedures (including all revisions) shall be recorded and controlled.

The NADCAP Heat Treating Task Group recognizes SAE AS7004, SAE AS7106, and SAE AS7107 as equivalent to the systems questions of this document as noted in the NADCAP Auditor Handbook.

2. REFERENCES:

2.1 Applicable Documents:

The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order.

2.1.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

AS7001	National Aerospace and Defense Contractors Accreditation Program (NADCAP) - Program Description
AS7002	National Aerospace and Defense Contractors Accreditation Program (NADCAP) - Rules for Implementation
AS7003	National Aerospace and Defense Contractors Accreditation Program (NADCAP) - Program Operation
AS7101	NADCAP - Requirements for Accreditation of Materials Test Laboratories
AS7102/1	NADCAP Requirements for Heat Treating Accreditation Programs - Brazing Requirements
AMS 2750	Pyrometry
AMS 2801	Heat Treatment, Titanium Alloy Parts
AMS 3025	Polyalkylene Glycol Heat Treat Quenchant
ARP1820	Chord Method of Evaluating Surface Microstructural Characteristics
ARP1962	Certification of Heat Treating Personnel

2.1.2 PRI Publications:

Available from the Performance Review Institute, 163 Thornhill Road, Warrendale, PA 15086-7527.

AC7101/3	NADCAP - Material Test Laboratories, Mechanical Testing
AC7101/4	NADCAP - Material Test Laboratories, Metallography and Microhardness
AC7101/5	NADCAP - Material Test Laboratories, Hardness
AC7101/7	NADCAP - Material Test Laboratories, Mechanical Test Specimens
AC7102	NADCAP - Audit Criteria for Heat Treating
AC7102/1	NADCAP - Audit Criteria for Heat Treating - Brazing

2.2 Definitions

2.2.1 Instruction: A written document describing the specifics of "How-to" accomplish a given task.

2.2.2 Procedure: A written document that ensures reproducibility by describing the specific process or service to be performed.

2.2.3 Interpolation: Estimation of a value between two known values to account for the uncertainty applicable to the temperature read that is dependent on the scale division spacing, the width of the indicator point, and the operator's skill in discerning the ratio of the widths of the spaces between the indicator and the two nearest scale markings.

3. GENERAL QUALITY SYSTEM:

3.1 Quality Policy:

3.1.1 There shall be a clear system in place regarding management's establishment of a comprehensive quality policy.

3.1.2 The quality policy shall be reviewed, at least annually by the president or other top location managers and actions shall be taken to correct any nonconformances.

3.2 Organization:

3.2.1 A formal organization chart shall exist that defines the organizations within the company, the responsibility and authority of the quality organization, and its relationship with other organizations within the company.

3.2.2 The quality organization shall be functioning and without longstanding vacancies.

3.2.3 Employees shall perform their jobs in conformance with applicable procedures.

3.3 Quality System:

3.3.1 Documentation shall support that all details of the quality system are thoroughly implemented and that customer requirements are met.

3.3.2 Procedures and other instructions shall conform to a system of revision control.

3.4 Document Control:

3.4.1 There shall be a documented system to control standards, specifications, engineering drawings, and all documentation pertinent to quality.

3.4.2 Applicable ASTM, MIL, AMS and customer specification revisions shall be on file.

3.5 Communications:

3.5.1 There shall be procedures that specify ongoing communications between management and employees including solicitation, review, and acknowledgement of employee suggestions and comments.

3.6 Contract Review:

3.6.1 Procedures shall exist for review of shippers, purchase orders, and contracts by all affected organizations.

3.6.2 Records shall support that review of inquiries, requests for quotations, purchase orders, and contracts are accomplished in accordance with customers requirements.

3.6.3 The review shall assure that all quality and technical requirements are defined and documented.

3.7 Internal Procedure Planning:

3.7.1 There shall be a system of procedure planning.

3.7.2 Procedures in use on the floor shall conform to the system and to contract requirements.

3.8 Purchasing - Supplier Selection:

3.8.1 Procedures shall provide for the selection of suppliers on the basis of their ability to meet requirements.

3.8.2 The recorded history of in-plant and/or source inspection and testing of supplier performance and supplier corrective action data shall be included in supplier selection decisions.

3.9 Purchasing - Incoming QA:

3.9.1 Procedures shall afford the purchaser the right to verify, at source or delivery, the quality of purchased products and services.

3.9.2 Documents shall support that verifications are performed in accordance with established frequency.

3.9.3 Results of verifications shall be used in a program to preclude nonconforming purchases.

3.9.4 Nonconforming purchases shall be withheld.

3.10 Product Identification and Traceability:

3.10.1 Procedures shall provide for identification of parts and inspection and test/inspection samples (traceable to applicable drawings, specifications, or other documents) during all stages of processing and delivery.

3.10.2 An examination of in-process parts shall indicate conformance to the procedure.

3.11 Stamp and Signature Control:

3.11.1 There shall be procedure for stamp/signature control that provides for control of issuance of stamps and authorization of signatures.

3.11.2 Records shall be maintained showing stamps issued, date of issue, and to whom issued.

3.11.3 Appropriate actions shall be included in the stamp/signature control procedure covering lost, mutilated, or worn stamps, reassigned stamps, and removal of stamp or signature authority.

3.12 Control of Nonconforming Product:

3.12.1 There shall be procedures to control identification, documentation, evaluation, segregation and disposition of nonconforming product, including notification of the internal organizations and the purchaser.

3.12.2 Documents shall support that nonconforming product is handled in accordance with the procedures.

3.12.3 There shall be a procedure for timely notification to customer of nonconforming product that has been shipped.

3.13 Corrective Action:

3.13.1 Procedures shall be established and maintained requiring the determination of the cause of all nonconformances and the corrective action needed to prevent recurrence.

3.13.2 Records shall demonstrate that corrective actions are implemented and their effects evaluated. The evaluations shall include determination of the necessity for any additional action.

3.13.3 The supplier shall periodically analyze the history of nonconforming parts, the cause of each nonconformance, and the corrective actions to determine that the goal of reducing the frequency of nonconformances is being achieved.

3.14 Delivery and Service:

3.14.1 There shall be a procedure that provides for the protection of parts after final inspection and during shipment that includes customer requirements.

3.14.2 Parts, awaiting shipment, shall exhibit protection in accordance with the procedure.

3.14.3 Shipping documents shall conform to the requirements of the purchase order or contract.

3.15 Customer Service and Satisfaction:

3.15.1 Procedures shall be established to periodically monitor customer satisfaction (e.g., a quality rating or frequency of defects) and to communicate this information internally to all affected organizations.

3.15.2 Records shall support that the procedure is being followed.

3.15.3 There shall be a procedure to ensure that customers are informed of all discrepancies (e.g., out-of-tolerance or out-of-control conditions).

3.15.4 Records shall support that all rework is authorized when required by the customer.

3.16 Statistical Methods - Process Integrity:

3.16.1 Procedures shall identify the following:

a. The key parameters (e.g., time, temperature, heating rate, cooling rate, heating environment) that affect final product quality
b. Statistical determination of their capability (e.g., Cp, Cpk)

3.16.2 The determination of which process parameters affect final product quality shall be based on analysis of production or experimental test results.

3.16.3 The statistical distribution of each key process parameter shall be determined and corrective action shall be taken when observations indicate an out-of-control condition.

3.16.4 Analysis of this data shall indicate continuous improvement.

3.17 Statistical Methods - Process Control:

3.17.1 There shall be a documented system of statistical monitoring of key heat treat parameters.

3.17.2 There shall be documented reactions to out-of-control conditions that were statistically identified.

3.17.3 There shall be evidence of improved process variable performance over time.

3.17.4 The goal of the quality system shall be continuous improvement by reduction of the variation of heat treat parameters (e.g, time, temperature).

3.18 Data Analysis:

3.18.1 Test results that are suitable for statistical analysis shall be utilized in a process of continuous improvement.

3.19 Internal Quality Audits:

3.19.1 Procedures shall require periodic internal audits that systematically evaluate compliance with all specifications, standards, and procedures.

3.19.2 The results of internal audits shall be reviewed and acted upon by management.

3.19.3 Internal audits of the quality system, processes, and/or product shall be carried out by personnel other than those having direct responsibility for the work being performed.

3.19.4 There shall be documented evidence of compliance to the procedure, and the audits shall be completed in a timely fashion.

4. PROCESS PLANNING AND CONTROL:

4.1 Process Planning:

4.1.1 Procedures shall require review of purchase orders to assess the supplier's ability to conform to requirements.

4.1.2 Procedures shall ensure that the customer requirements are included on job orders entering the production system.

4.1.3 Records shall indicate that the procedure is followed.

4.2 Quality Planning:

4.2.1 Procedures shall require incorporation of quality requirements in the planning of each job before processing.

4.2.2 The quality requirements shall be evident on job travelers.

4.3 Job Documentation:

4.3.1 Procedures shall require that documentation/travelers detailing each operation accompany each job.

4.3.1.1 Procedures shall require traceability from the documentation to the parts (e.g., by part number).

4.3.1.2 In-process documentation shall include process status, inspection status, engineering change notices, and all other relevant information.

4.4 Change Control:

4.4.1 Procedures shall specify a system of controlling revision of travelers and processing of quality documents.

4.4.2 Records shall indicate that the procedure is followed.

4.4.3 When customer approved fixed processes are in place, process changes shall be made only after approval by the cognizant customer organization.

4.5 Specification Changes:

4.5.1 Procedures shall require that new, revised, and amended specifications be integrated into the production system promptly upon receipt.

4.5.2 Records shall indicate that the procedure is followed and that old specifications are used only when specified.

4.6 Process Control:

4.6.1 Procedures shall assure that parts are processed in conformance with the process instructions on the traveler.

4.6.2 Procedures shall require a method of recording actual process data for comparison to instructions on the traveler.

4.6.3 Records shall indicate that the procedures are followed.

4.7 Automated Processes and Recordings:

4.7.1 Where automated heat treating processes and/or record-keeping are used, there shall be a system in effect to assure the integrity of the process and records.

4.7.2 Procedures shall include a method of ensuring that electronic/magnetic programs can not be altered without authorization.

4.7.3 Procedures shall include a method of ensuring that electronic/magnetic records can not be altered.

4.7.4 When required by customer, back-ups of electronic/magnetic programs shall be stored at a separate location.

4.8 Furnace Malfunctions/Cycle Interruptions:

4.8.1 Procedures shall specify the actions to be taken when furnace malfunctions occur and/or when furnace cycles are interrupted.

4.8.2 These procedures shall meet customer requirements (e.g., fixed processes versus non-fixed processes).

4.8.3 Records shall indicate that the procedure is followed.

5. PERSONNEL:

5.1 Personnel performing heat treating and associated quality and test functions shall be trained and approved for the specific function(s) in accordance with ARP1962 or equivalent.

5.2 Training:

5.2.1 There shall be training procedures that assure personnel performing heat treating and associated quality training and test functions are competent to perform assigned tasks.

5.2.2 Records shall indicate that training is scheduled and attended in accordance with procedures.

5.3 Evaluation of Personnel:

5.3.1 Procedures shall require periodic evaluation to ensure that approved personnel maintain proficiency in their assigned tasks.

5.3.2 Records shall indicate that evaluations are made and the results reviewed with employees.

5.3.3 The results of evaluations shall be used in a program of continuous improvement of personnel.

6. MATERIAL HANDLING AND PROTECTION:

6.1 Receiving Procedure:

6.1.1 Procedures shall require receiving to count and inspect incoming material when quantities are specified and counting or weighing is required.

6.1.2 Records shall indicate that procedures are followed.

6.1.3 Count and quality discrepancies shall immediately be brought to the customer's attention.

6.1.4 Procedures shall ensure that incoming customer documents remain traceable to those specific jobs throughout processing.

6.2 Corrosion and Mechanical Damage Protection:

6.2.1 Procedures shall ensure handling, packaging, and corrosion protection of parts.

6.2.2 Records shall indicate that the procedure is followed.

6.3 Lot Integrity:

6.3.1 Procedures shall specify how lots and sub-lots of identical parts are to be identified to preclude their mixing and to ensure lot integrity.

6.3.2 Travelers, or other documentation, both completed and in-process, shall demonstrate that the procedures are followed.

6.4 Housekeeping:

6.4.1 Procedures shall specify plant cleanliness standards and assign responsibility for housekeeping.

6.4.2 The company's facilities shall be clean, uncluttered, well lighted, and defined.

6.5 Space Control:

6.5.1 There shall be a plan of functional areas specifying locations for defective and staged material.

6.5.2 The locations shall be marked to conform with the plan.

6.6 Titanium Cleaning and Handling:

6.6.1 Procedures for cleaning titanium surfaces shall preclude using halogenated substances, unless permitted by the customer.

6.6.2 Procedures shall require that finished parts be handled with clean, white gloves, unless otherwise allowed by the customer.

6.6.3 The above procedures shall be followed.

6.7 Plating and Cleaning:

6.7.1 There shall be a documented system for controlling the following:

a. Chemical composition
b. Current density of baths
c. Temperature of baths
d. Agitation of baths
e. Etch rate

6.7.2 Procedures shall specify methods and frequency of periodic tests of the following:

a. Thickness of plating
b. Adhesion of plating
c. Porosity of plating

6.7.3 Records shall indicate that the procedures are followed.

6.8 Refrigeration:

6.8.1 For aluminum alloys, procedures shall cover cooling requirements after quench.

6.8.1.1 Procedures shall specify time/temperature limits for retention of -AQ temper or retarding of aging.

6.8.1.2 Records shall indicate that procedures are followed.

6.8.2 For steels, procedures shall cover sub-zero cooling.

6.8.2.1 Procedures shall specify time/temperature limits for sub-zero treatments.

6.8.2.2 Records shall indicate that procedures are followed.

7. TEST & INSPECTION:

7.1 Survey for Hardness Testing:

The NADCAP Heat Treating accreditation program utilizes the NADCAP Materials Testing Laboratories Audit Criteria referenced herein with the following exceptions:

a. External Round Robin Programs are not required
b. The requirements of AC7101/1 are not applicable to heat treaters.

7.1.1 If the supplier performs hardness testing, PRI AC7101/5 shall apply. Accreditation by NADCAP to SAE AS7101 shall satisfy this requirement. In addition to the requirements contained in PRI AC7101/5 the requirements in 7.1.2 through 7.1.4.1 herein shall be satisfied.

7.1.2 The following items shall be verified during the audit:

a. Anvils shall be free of indentations
b. Test blocks shall be available covering the ranges of hardness values recorded
c. Logs or records shall be up-to-date and complete
d. Test blocks shall not have indentations on both sides
e. Test block indentations shall not be too close together
f. Daily test samples shall have three or more indentations
g. Test blocks shall have indentations greater than the number of daily readings
h. Penetrators shall be free of chips or other damage
i. Periodic calibration records shall be current and complete

7.1.3 Procedures shall address items a. through i. above.

7.1.4 The hardness testers shall be a part of a program of gage repeatability and reproducibility studies (e.g., internal round robin).

7.1.4.1 The shop paper shall show the actual values measured (e.g., conversion from other scale or tests [tensile]).

7.2 Metallography/Microhardness:

7.2.1 If the supplier performs metallography/microhardness testing, PRI AC7101/4 shall apply. Accreditation by NADCAP to SAE AS7101 shall satisfy this requirement. In addition to the requirements contained in PRI AC7101/4 the requirements in 7.2.2 through 7.2.2.4 shall be satisfied.

7.2.2 Surface Contamination Testing of Alloy Steel:

7.2.2.1 Testing procedures shall conform to specifications.

7.2.2.2 Testing procedures shall cover the following:

a. Partial decarburization test for steel < 220 ksi
b. Partial decarburization test for steel ≥ 220 ksi
c. Intergranular oxidation test
d. Tests for total decarburization, carburization, and nitriding

7.2.2.3 Test records shall be current and complete.

a. For steels ≥ 220 ksi, the chord method shall be in accordance with ARP1820.
b. Severity shall be used as the accept/reject criteria.

7.2.2.4 Testing frequencies shall conform to specifications.

7.2.3 Titanium:

7.2.3.1 If AMS 2801 or MIL-H-81200 is required, there shall be a system in place to control test coupons and their use.

7.2.3.2 Documentation shall support that the test coupons are used in accordance with procedures.

7.3 Mechanical Testing

7.3.1 If the supplier performs mechanical testing, SAE AS7101/3 shall apply. Accreditation to SAE AS7101 shall satisfy this requirement.

7.4 Nonconventional and Engineering Tests:

7.4.1 Nonconventional and engineering tests shall conform to customer requirements.

7.5 Preparation of Mechanical Test Specimens:

7.5.1 If the supplier prepares mechanical test specimens, SAE AS7101/7 shall apply. Accreditation to SAE AS7101 shall satisfy this requirement.

7.6 Conductivity Testing:

7.6.1 Calibration:

7.6.1.1 There shall be a procedure for periodic calibration of conductivity testing devices.

7.6.1.2 Standard calibration blocks shall be properly maintained and protected from damage.

7.6.1.3 Standard calibration blocks shall be a primary standard with values assigned in accordance with ASTM B 193, or with values assigned by an independent agency using standards traceable to National Institute of Standards and Technology (NIST).

7.6.1.4 Records shall demonstrate conformance to the calibration procedures.

7.6.2 Applicability and Location of Test:

7.6.2.1 There shall be documentation (sketch or description) to specify the location of the test on each part.

7.6.2.2 Conductivity readings shall be taken on a flat surface of greater diameter than the conductivity probe.

7.6.2.3 There shall be evidence that tests are performed in accordance with requirements.

7.7 Periodic Maintenance of Testing Equipment:

7.7.1 Procedures shall require maintenance at a specified frequency by qualified personnel (employees or vendors) in accordance with specifications.

7.7.2 There shall be records that indicate that maintenance is performed in accordance with procedures and appropriate standards.

7.8 Test Materials and Specimens:

7.8.1 There shall be a procedure that specifies control and identification of test materials and specimens, as well as when and where they are to be used.

7.8.2 Records shall indicate that test coupons are used in accordance with procedures.

7.8.3 Procedures shall specify the periodic review of test results as part of a continuing program to improve product quality.

7.9 Dimensional Testing:

7.9.1 Calibration:

7.9.1.1 There shall be a procedure for periodic calibration of dimensional measurement tools.

7.9.1.2 Standards, gage blocks, and other devices used for calibration shall be maintained and protected from damage.

7.9.1.3 The standard used for calibration shall have values traceable to NIST.

7.9.1.4 Records shall demonstrate that calibrations conform to the procedure.

7.9.2 Applicability and Location of Test:

7.9.2.1 Procedures shall specify when and where measurements are to be made on the parts and specimens.

7.9.2.2 Records shall indicate that measurements are performed as specified.

7.10 Sampling Plans:

7.10.1 When sampling for inspection or testing is permitted and a sampling plan is not specified, selection of statistically significant (95% confidence that 99% of the parts are acceptable, e.g., MIL-STD-412, MIL-STD-105, AQL 1.0) samples shall conform to the following:

a. There shall be a procedure that includes the number of parts in the lot and the number in the sample for the specific test or inspection.
b. Procedures shall specify the frequency and method of sampling.
c. Reduced sampling shall be justified.

7.10.2 Records shall demonstrate that samples are taken in accordance with the specified sampling plan.

7.11 Acceptance/Rejection Standards:

7.11.1 Acceptance/rejection criteria shall exist in the event that these criteria are not specified by the customer.

7.11.2 Records shall indicate that acceptances are based on the criteria.

7.12 Test Reports and Records:

7.12.1 Test results shall be recorded on, or traceable to, the paper (traveler) that accompanied the parts through processing. (This does not apply to tests made for manufacturing convenience, e.g., as-quenched hardness test to determine tempering temperature.)

7.12.2 For hardness and conductivity tests, records and reports shall include the results of each test or the range of results.

7.12.3 For other tests, the results of each test and the average shall be reported.

7.12.4 Procedures shall specify periodic review of test results as part of a continuing program to improve product quality.

8. FURNACE CONTROL AND MAINTENANCE:

8.1 Furnace Document Control:

8.1.1 Operating Instructions:

8.1.1.1 Current operating manuals or instructions shall be available to furnace operators, maintenance personnel, and other personnel requiring the information.

8.1.2 Heating Times:

8.1.2.1 Procedures shall specify the method for determining heat-up time or start of soaking time and cooling rate.

8.1.2.2 Records on the furnace chart or log shall indicate that the procedure is followed.

8.1.2.3 When metal temperature is specified, records shall demonstrate that the metal was at temperature for the specified time.

8.1.3 Maintenance:

8.1.3.1 All components of each furnace requiring maintenance or inspection shall be maintained or inspected in accordance with a schedule.

8.1.3.2 Records shall indicate that maintenance has been performed in accordance with the schedule.

8.1.3.3 Maintenance schedules shall be prepared with preventative maintenance as a goal and shall be based on prior maintenance records.

8.2 Furnace Condition:

8.2.1 External Furnace Condition - For each furnace, where practical:

8.2.1.1 Doors, fans, etc. shall be free of evidence of leaking atmosphere.

8.2.1.2 On compressed air actuators, lubricator sets shall operate smoothly.

8.2.1.3 All safety interlocks, flame curtains, burn offs, and other safety items shall be operational.

8.2.1.4 The furnace over temperature shall be checked periodically.

8.2.1.5 Circulation fans shall run smoothly and shall be in good operating condition with fan belts properly adjusted.

8.2.1.6 The coolant flow to circulation fans shall conform to specifications.

8.2.1.7 If gear drives are used, the gear teeth, drive trains, and sprockets shall be checked for abnormal conditions.

8.2.1.8 All plumbing, conduit, and functional apparatus shall be clearly marked and/or color coded.

8.2.2 Internal Furnace Components - For each furnace where practical:

8.2.2.1 The composition and condition of the internal furnace components (e.g., refractory, metals, insulation, heating elements and element insulators) shall prevent detrimental affects to the parts/material being heat treated.

8.3 Control of Heating Environment:

8.3.1 Procedures shall specify how atmosphere from each generator/blender is to be controlled.

8.3.2 Procedures shall specify how atmospheres are to be controlled and monitored to ensure conformance to requirements.

8.3.3 Records shall indicate that the procedure is followed.

8.3.4 Metering:

8.3.4.1 Flowmeters shall be operational and appropriate for the gas and flow rates.

8.3.4.2 Maintenance schedules shall include periodic checks of floats in flowmeters to ensure that they are free and functioning.

8.3.4.3 Safety shut-off valves and nitrogen purges shall be operational.

8.3.5 Purging:

8.3.5.1 When atmosphere is changed, the furnace shall be purged in accordance with a procedure (based on tests or good practice) that assures elimination of effects of the previous atmosphere.

8.3.5.2 The procedure for a purge of a nitriding atmosphere shall include a requirement for ammonia cut-off and purge.

8.3.5.3 Records on the furnace chart or log shall indicate that the procedure is followed.

8.3.6 Salt Baths:

8.3.6.1 Each salt bath shall be tested periodically in accordance with the applicable heat treatment specification.

8.3.6.2 The salt bath test shall assure conformance to corrosion, carburization, decarburization, nitriding, and intergranular attack requirements.

8.3.6.3 Records shall indicate that the procedure is followed.

8.3.7 Aluminum Alloys:

8.3.7.1 There shall be a procedure that specifies that racks, fixtures, etc. shall be free from entrapped quenchant.

8.3.7.2 Furnaces shall be designed and operating such that products of combustion do not enter solution heat treating furnaces for finished parts.

8.3.7.3 There shall be a procedure that includes the use of protective compounds when required.

8.3.7.4 Records shall indicate that the procedure is followed.

8.4 Carbon Control - Steels:

8.4.1 Procedures shall specify a system of maintenance and calibration of carbon controls and indicators.

8.4.2 Records shall indicate that the calibrations are performed as required by the procedures and applicable specifications.

8.4.3 The accuracy of the carbon control system shall be confirmed by the results of tests required by heat treatment specifications.

8.5 Quench Systems:

8.5.1 Quench mechanisms shall be operational and capable of meeting maximum quench delay provisions of specifications.

8.5.2 Quenchant Control:

8.5.2.1 Procedures shall specify how quenchant temperature is to be controlled.

8.5.2.2 All required mechanical equipment shall be operational.