

Special Process: Heat Treat System Assessment

Facility Name: Curtis Thermal Processing
 Address: 10911 N 2nd Street
 Machesney Park IL 61115

Phone Number:	815 282 1433	Type(s) of Thermal Processing at this Facility:	
Fax Number:		Process Table A - Ferrous	
		Carburizing	
Number of Heat Treat Employees at this Facility: 14		Carbonitriding	
		Carbon Correction	
Captive Heat Treater (Y/N):	N	Neutral Hardening	X
		Quench & Temper	X
Commercial Heat Treater (Y/N):	Y	Austempering / Martempering	
		Tempering	X
Date of Assessment:	16-Aug-2011	Precipitation Hardening / Aging	
Date of Previous Assessment:	26-Aug-2010		

	Process Table B - Ferrous	
	Nitriding (Gas)	
	Ferritic-Nitrocarburizing (Gas or Salt)	
	Process Table C - Aluminum	
	Aluminum Heat Treatment	
	Process Table D - Ferrous	
	Induction Heat Treating	
	Process Table E	
	Annealing	
	Normalizing	
	Stress-Relieving	

Current Quality Certification(s): ISO 9001-2008, A2LA

Date of Re-assessment (if necessary):

Personnel Contacted:			
Name:	Title:	Phone:	Email:
Matt Heystek	Quality Manager	815 282 1433	matt.heystek@curtistherm.com

Auditors/Assessors:			
Name:	Company:	Phone:	Email:
Matt Heystek	CTP		

Number of "Not Satisfactory" Findings:
0

Number of "Needs Immediate Action" Findings:
0

Number of "Fail" Findings in the Job Audit(s):

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Question Number	Question	Requirements and Guidance	Objective Evidence	Assessment			
				N/A	Satisfactory	Not Satisfactory	Needs Immediate Action
Section 1 - Management Responsibility & Quality Planning							
1.1	Is there a dedicated and qualified heat treat person on-site?	To ensure readily available expertise, there shall be a dedicated and qualified heat treat person on site. This individual shall be a full-time employee and the position shall be reflected in the organization chart. A job description shall exist identifying the qualifications for the position including metallurgical and heat treat knowledge. The qualifications shall include a minimum of 5 years experience in heat treat operations or a combination of a minimum of 5 years of formal metallurgical education and heat treat experience.	Plant Manager: BS Metallurgical Engineering + 11 yrs heat treat experience Position listed on Org Chart		X		
1.2	Does the heat treater perform advanced quality planning?	The organization shall incorporate a documented advance quality planning procedure. A feasibility study shall be performed and internally approved for each part. Similar parts can be grouped into part families for this effort as defined by the organization. After the part approval process is approved by the customer, no process changes are allowed unless approved by the customer. The heat treater shall contact the customer when clarification of process changes is required. This clarification of process changes shall be documented.	Feasibility reviewed for each new part as they come in or requests for quote are received. Customer part files created based on review and the files are initialed and dated by the reviewer. PPAP performed upon request.		X		
1.3	Are heat treat FMEA's up to date and reflecting current processing?	The organization shall incorporate the use of a documented Failure Mode and Effects Analysis (FMEA) procedure and ensure the FMEA's are updated to reflect current part quality status. The FMEA shall be written for each part or part family or they may be process-specific and written for each process. In any case, they shall address all process steps from part receipt to part shipment and all key heat treat process parameters as defined by the organization. A cross-functional team shall be used in the development of the FMEA. All special characteristics, as defined by the organization and its customers, shall be identified, defined, and addressed in the FMEA.	Procedure QP-31; PFMEA's are process specific unless a part-specific PFMEA is requested by the customer. Reviewed annually at a min. Cross functional team includes operator.		X		

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1.4	Are heat treat process control plans up to date and reflecting current processing?	<p>The organization shall incorporate the use of a documented Control Plan procedure and ensure the Control Plans are updated to reflect current controls.</p> <p>The Control Plans shall be written for each part or part family or they may be process-specific and written for each process. In any case, they shall address all process steps from part receipt to part shipment and identify all equipment used and all key heat treat process parameters as defined by the organization.</p> <p>A cross-functional team, including a production operator, shall be used in the development of Control Plans, which shall be consistent with all associated documentation such as work instructions, shop travelers, and FMEA's. All special characteristics, as defined by the organization and its customers, shall be identified, defined, and addressed in the Control Plans.</p> <p>Sample sizes and frequencies for evaluation of process and product characteristics shall also be addressed consistent with the minimum requirements listed in the Process Tables, Sections 3.0 and 4.0.</p>	<p style="color: blue;">Procedure QP-31; Control Plans are process-specific unless a part-specific Control Plan is requested by the customer. Annual review.</p>	N/A	X		

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1.5	Are all heat treat related and referenced specifications current and available? For example: SAE, AIAG, ASTM, General Motors, Ford, and DaimlerChrysler.	To ensure all customer requirements are both understood and satisfied, the organization shall have all related heat treat and customer referenced standards and specifications available for use and a method to ensure that they are current. Such standards and specifications include, but are not limited to, those relevant documents published by SAE, AIAG, ASTM, General Motors, Ford, and DaimlerChrysler. The organization shall have a process to ensure the timely review, distribution, and implementation of all customer and industry engineering standards / specifications and changes based on customer-required schedule. Timely review should be as soon as possible and shall not exceed two working weeks. The organization shall document this process of review and implementation, and it shall address how customer and industry documents are obtained, how they are maintained within the organization, how the current status is established, and how the relevant information is cascaded to the shop floor within the two-week period. The organization shall identify who is responsible for performing these tasks.	All engineering standards maintained by Quality Manager per work instruction WI-01. Standards are checked monthly for new revisions. New requirements flowed down to shop floor via shop order changes and memos within 2 weeks of receipt.		X		
1.6	Is there a written process specification for all active processes?	The heat treater shall have written process specifications for all active processes and identify all steps of the process including relevant operating parameters. Examples of operating parameters include process temperatures, cycle times, load rates, atmosphere or gas flow settings, belt speeds, quench agitation speeds, etc. Such parameters shall not only be defined, they shall have operating tolerances as defined by the organization in order to maintain process control. All active processes should have a written process specification. These process specifications may take the form of work instructions, job card, computer-based recipes, or other similar documents.	Shop Orders contain part specific parameters that flow down from a computerized Part File. This file is created and controlled by Engineering. Control Plans and department work instructions list tolerances. Reference Work instruction OP-04 and P-95.		X		

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1.7	Has a valid product capability study been performed initially and after process equipment has been relocated, or had a major rebuild?	To demonstrate each process is capable of yielding acceptable product the organization shall perform product capability studies for the initial validation of each process, after relocation of any process equipment, & after a major rebuild of any equipment. The organization shall define what constitutes a major rebuild. Initial product capability studies shall be conducted for all heat treat processes per furnace line defined in scope of work & in accordance with customer requirements. A furnace line may include a combination of equipment that is integrated in the performance of a heat treatment process, e.g., hardening, quenching, and tempering. Capability study techniques shall be appropriate for the heat treat product characteristics, e.g., tensile strength, case depth, hardness. Any specific customer requirements shall be met, in the absence of customer requirements, the organization shall establish acceptable ranges for measures of capability. An action plan shall exist to address the steps to followed in case capability indices fall outside customer requirements or established ranges.	Initial capability studies performed on both furnaces using hardness and tensile strength after tempering.		X		
1.8	Does the heat treater collect and analyze data over time, and react to this data?	The analysis of products and processes over time can yield vital information for defect prevention efforts. The organization shall have a system to collect, analyze, and react to product or process data over time. Methods of analysis shall include ongoing trend or historical data analysis of product or process parameters. The organization shall determine which parameters to include in such analysis.	Historical hardness data for each part is analyzed. Tempering temperatures are determined from this data. Hardness capability studies are performed for each furnace on an annual basis. Computerized trend charts for critical furnace parameters are automatically logged and reviewed daily by management.		X		

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1.9	Is management reviewing the heat treat monitoring system every 24 hours?	Management shall review the furnace monitoring systems at intervals not to exceed 24 hours. The heat treat monitoring system includes but is not limited to temperature strip charts, atmosphere strip charts, computer data logs, furnace and operator logs, etc. The management review shall include efforts to detect out-of-control conditions or alarm conditions. The process of reviewing the furnace data shall be documented and this requirement also applies to computerized data.	Plant Manager at CTP and Engineering manager at Commercial Steel Treating review trend charts daily.		X		
1.10	Are internal assessments being completed on an annual basis, at a minimum, using AIAG HTSA?	The organization shall conduct internal assessments on an annual basis, at a minimum, using the AIAG HTSA.	conducted annually by qualified auditors per Quality Procedure 12. The audit is included in the Schedule of Audits (Work Instruction 12.01). Job audits, also required by CQI-9, are included in the schedule and are a component of our layered auditing. Self assessments sent		x		
1.11	Is there a system in place to authorize reprocessing and is it documented?	The quality management system shall include a documented process for reprocessing that shall include authorization from a designated individual. The reprocessing procedure shall describe product characteristics for which reprocessing is allowed as well as those characteristics for which reprocessing is not permissible. Any reprocessing activity shall require a new processing control sheet issued by qualified technical personnel denoting the necessary heat treat modifications. Records shall clearly indicate when and how any material has been reprocessed. The Quality Manager or a designee shall authorize the release of reprocessed product.	Reprocessing is governed by Quality Procedure 13. Specific reprocessing instructions are identified and controlled by Quality Manager or designated personnel		X		
1.12	Does the Quality Department review, address, and document customer and internal concerns?	The quality management system shall include a process for documenting, reviewing, and addressing customer concerns and any other concerns internal to the organization. A disciplined problem-solving approach shall be used.	Reprocessing is governed by Quality Procedure 13. Specific reprocessing instructions are identified and controlled by Quality Manager or designated personnel		X		

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1.13	Is there a continual improvement plan applicable to each process defined in the scope of the assessment?	The heat treater shall define a process for continual improvement for each heat treat process identified in the scope of the HTSA. The process shall be designed to bring about continual improvement in quality and productivity. Identified actions shall be prioritized and shall include timing (estimated completion dates). The organization shall show evidence of program effectiveness.	CTP continual Improvement Plan covers three items: 1) Reducing gap times; 2) Reduce Non-conforming product; 3) Increase timeliness of PM task completion		X		
1.14	Does the Quality Manager or designee authorize the disposition of material from quarantine status?	The Quality Manager is responsible for authorizing and documenting appropriate personnel to disposition quarantine material.	Disposition of material is authorized by the Quality Manager or his designee per the requirements of Quality Procedure 13.		X		
1.15	Are there procedures or work instructions available to the heat treat personnel that define the heat treating process?	There shall be procedures or work instructions available to heat treat personnel covering the heat treating process. These procedures or work instructions shall include methods of addressing potential emergencies (such as power failure), equipment start-up, equipment shut-down, product segregation (See 2.8), product inspection, and general operating procedures. These procedures or work instructions shall be accessible to shop floor personnel.	Appropriate controlled documents in the form of Procedures, Work Instructions and Forms are stored in a binder in the furnace control room.		X		
1.16	Is management providing employee training for heat treating?	The organization shall provide employee training for all heat treating operations. All employees, including backup and temporary employees, shall be trained. Documented evidence shall be maintained showing the employees trained and the evidence shall include an assessment of the effectiveness of the training. Management shall define the qualification requirements for each function, and ongoing or follow-up training shall also be addressed.	Procedure #17 governs training. Records of training stored in a binder. Training matrices are found in forms 17.00.01 and Lab manual section 9.0.		X		

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1.17	Is there a responsibility matrix to ensure that all key management and supervisory functions are performed by qualified personnel?	The organization shall maintain a responsibility matrix identifying all key management and supervisory functions and the qualified personnel who may perform such functions. It shall identify both primary and secondary (backup) personnel for the key functions (as defined by the organization). This matrix shall be readily available to management at all times.	Quality Form QC-16.		X		
1.18	Is there a preventive maintenance program? Is maintenance data being utilized to form a predictive maintenance program?	The organization shall have a documented preventive maintenance program for key process equipment (as identified by the organization). The program shall be a closed-loop process that tracks maintenance efforts from request to completion to assessment of effectiveness. Equipment operators shall have the opportunity to report problems, and problems shall also be handled in a closed-loop manner. Company data, e.g., downtime, quality rejects, first-time-through capability, recurring maintenance work orders, and operator-reported problems, shall be used to improve the preventive maintenance program. Furnaces and generators shall be scheduled for burn-out at frequencies determined by the organization (see Section 1 of the Process Tables). Maintenance data shall be collected and analyzed as part of a predictive maintenance program.	The Maintenance efforts for all key equipment are managed via a computerized MP-2 Maintenance Program. All work orders are reviewed and closed by the Maintenance Supervisor. Reference documents MN-08 and MN-14. Furnaces and Generators are burned out quarterly or as needed per PM task #00011. All open and closed maintenance tasks reviewed by plant manager weekly.		X		
1.19	Has the Heat Treater developed a critical spare part list and are the parts available to minimize production disruptions?	The heat treater shall develop and maintain a critical spare parts list and shall ensure the availability of such parts to minimize production disruptions.	An electronic critical spare parts list was developed by the Engineering Manager and is maintained and executed by the Purchasing Manager.		X		

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Section 2 - Floor and Material Handling Responsibility							
2.1	Does the facility ensure that the data entered in the receiving system matches the information on the customer's shipping documents?	It is critical that all customer requirements and lot identification be adequately transferred to internal heat treat documents. The facility shall ensure that the data entered in the receiving system match the information on the customer's shipping documents. Documented processes and evidence of compliance shall exist, e.g., shop travelers, work orders, etc. Sometimes the material received does not precisely correspond to customer shipping documents. The facility shall have a detailed process in place to resolve receiving discrepancies. The requirements stated above also apply to captive heat treat departments. This process refers to receiving and shipping the parts in and out of the heat treat department.	All lot information is entered into the computer order entry system. Material grades and heat treating instructions are compared against computer part file in database. Discrepancies are passed to engineering for review and resolution. A proper flow down of customer requirements to our shop order is ensured by conducting multiple job audits throughout the year		X		
2.2	Is product clearly identified and staged throughout the heat treat process?	Procedures for part and container identification help to avoid incorrect processing or mixing of lots. Appropriate location and staging within the facility also help to ensure that orders are not shipped until all required operations are performed. Customer product shall be clearly identified and staged throughout the heat treat process. Non-heat treated, in-process, and finished product shall be properly segregated and identified. All material shall be staged in a dedicated and clearly defined area.	Staging locations within the plant have signs. Each container has a CTP tag attached to it for ID.		X		
2.3	Is lot traceability and integrity maintained throughout all processes?	Out-going lot(s) shall be traceable to the incoming lot(s). The discipline of precisely identifying lots and linking all pertinent information to them enhances the ability to do root cause analysis and continual improvement.	Lot identification is linked to a CTP shop order number, which is unique for each order. All information is stored in the computer system.		X		

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2.4	Are procedures adequate to prevent movement of non-conforming product into the production system?	The control of suspect or non-conforming product is necessary to prevent inadvertent shipment or contamination of other lots. Procedures shall be adequate to prevent movement of non-conforming product into the production system. Procedures shall exist addressing proper disposition, product identification, and tracking of material flow in and out of the hold area. A non-conforming hold area shall be clearly designated to maintain segregation of such material.	Non- conforming product is placed in quarantine area with red "Hold" tag. NCM system is used for disposition of quarantined parts per Procedure #13. Computer system will not print test report or delivery receipt unless all requirements are met.		X		
2.5	Is there a system to identify trap points in the entire heat treat process to reduce risk of mixed parts (inappropriate, non-heat treated, or improperly heat treated parts)?	Heat-treating furnaces and other processing equipment contain areas that have a risk of trapping or holding parts. Such trapping of parts can lead to damage, improperly processed parts or lot mixing/contamination. A system shall exist to identify trap points in the entire heat treat process to reduce risk of mixed parts (inappropriate, non-heat treated, or improperly heat treated parts). The heat treater shall have documented procedures to identify and monitor trap points for each process/equipment. Monitoring of potential trap points shall occur for every part changeover.	Layered audits of each furnace line are conducted approximately 12 times per year (Form P-79). Review and signoffs are on each tub tag. Tracking of sort data from customers.		X		
2.6	Are containers free of inappropriate material?	Containers handling customer product shall be free of inappropriate material. After emptying and before re-using containers, containers shall be inspected to ensure that all parts and inappropriate material have been removed. The source of inappropriate material shall be identified and addressed. This is to ensure that no nonconforming heat treated parts or inappropriate material contaminate the finished lot.	All tubs are inspected and Operators sign off each container tag. When mixed parts are identified in green (incoming) material, a report is emailed to the customer describing the level of the mixture.		X		

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2.7	Is furnace loading specified, documented and controlled?	Furnace loading parameters shall be specified, documented, and controlled. Examples include feed rate, belt speed, number of parts per fixture, and load weight. Refer to Process Tables, Section 3.0, for frequency of checks.	Loading parameters are specified by engineering in part files. Parameters print out on shop orders and furnace schedules		X		
2.8	Are operators trained in material handling, containment action and product segregation in the event of an equipment emergency including power failure?	Unplanned or emergency downtime greatly raises the risk of improper processing. Operators shall be trained in material handling, containment action, and product segregation in the event of an equipment emergency including power failure. Training shall be documented. Work instructions specifically addressing potential types of equipment emergencies and failures shall be accessible to and understood by equipment operators. These instructions shall address containment actions related to all elements of the heat-treating process, e.g., loading, austenitizing, quenching, tempering.	Procedure #28 defines the various equipment emergencies and details the proper actions when these occur. Training is documented in Operator Training Matrix. P-62 fully governs the reaction to power failures		X		
2.9	Is the handling, storage and packaging adequate to preserve product quality?	Handling, storage, and packaging shall be adequate to preserve product quality. The heat treater's furnace loading system, in-process handling, and shipping process shall be assessed for risk of part damage or other quality concerns. Some equipment includes conveyors and other moving components that may not be able to handle all part configurations. Other practices such as stacking of overloaded containers can also increase the risk of part damage.	Equipment and material handling procedures are adequate.		X		

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2.10	Are plant cleanliness, housekeeping, environmental and working conditions conducive to control and improved quality?	Plant cleanliness, housekeeping, environmental, and working conditions shall be conducive to controlling and improving quality. The heat treater should evaluate such conditions and their effect on quality. A housekeeping policy shall be clearly defined and executed. The facility shall be reviewed for conditions that are detrimental to quality processing such as loose parts on floor, oil around quench tanks, inadequate plant lighting, smoke, etc.	Policy # 08 – Housekeeping and housekeeping audit form 12.01.04	X			
2.11	Are parts free from contaminants that would be detrimental to the heat treatment of the product?	Many heat-treated parts are subjected to surface finish or appearance operations such as plating or coating after heat treatment. Parts shall be free from contaminants that are detrimental to subsequent processes or the product. Pre-wash (if applicable) and post-wash parameters shall be monitored and documented. Oils and other contaminants or residues can be difficult to remove once subjected to the heat treatment process. Review the chemical supplier's recommendation for cleaning the system. Parts shall be free of rust, burrs, chips, detrimental amounts of drawing compound, cutting fluids, rust preventing oils, lubricants, etc., prior to heat treat. Note: Refer to the appropriate heat treater's requirements and specifications to determine acceptability. Refer to Process Table, Section 5.0, for frequency of checking washer solutions.	All parts are cleaned prior to heat treatment and between quench and temper utilizing hot water pre-washers and post-washers on each furnace line.	X			

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2.12	Is the quenching system monitored, documented, and controlled?	The quenching system shall be monitored, documented, and controlled. The temperature, agitation, level, concentration (if applicable), time in the quenchant, and additions shall be controlled to the heat treater's specifications. Refer to Process Tables, Sections 3.0 and 5.0, for frequency of checks. Computer-monitoring equipment, with alarms and alarm logs, satisfy the verification requirement. Quench delay tolerance and alarm is required for furnaces with integral quench tanks. Temper delay time shall be specified by the heat treater for parts that are quenched and tempered, e.g., carburizing, carbonitriding, neutral hardening, solution treating and aging.	Quench temperatures automatically controlled and checked every 2 hours. Quench levels monitored automatically with alarms. Quench agitation verified hourly.		X		
2.13	Is soluble oil or other rust preventive monitored and controlled if applicable?	Parts are often dipped in or sprayed with rust preventive solutions immediately after the heat treating process. Soluble oil solutions or other rust preventive solutions shall be monitored and controlled, if applicable. The heat treater shall have and maintain documented tolerances for the solutions. Refer to Process Tables, Section 5.0, for frequency of checks.	Organic Sealer applied to parts after temper. Concentrations are checked 2x weekly to the tolerances listed in Procedure.		X		
2.14	Are process control parameters monitored per frequencies specified in Process Tables?	Process control parameters shall be monitored per frequencies specified in Process Tables. Refer to Process Tables, Section 3.0. Computer monitoring equipment with alarms and alarm logs satisfy the verification requirement. A designated floor person shall verify the process parameters, e.g., by initialing a strip chart or data log. Management review is required per Question 1.9.	All furnaces have computer monitoring with alarms. Critical furnace parameters are recorded on the back of the Shop Order. Two hour checks are performed and recorded on form P-59		X		
2.15	Are In-Process / Final Test Frequencies performed as specified in Process Tables?	In-Process / Final Test Frequencies shall be performed as specified in Process Tables. Refer to Process Tables, Section 4.0.	Testing frequencies are identified on the Shop Order and they meet or exceed Process Table Requirements		X		

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2.16	Is product test equipment verified?	Product test equipment shall be verified. Test equipment shall be verified/calibrated per applicable customer-specific standard or per an applicable consensus standard such as those published by ASTM, DIN, EN, ISO, JIS, NIST, SAE etc. Verification/calibration results shall be internally reviewed, approved, and documented. Refer to Process Tables, Section 1.0, for frequency of checks.	All hardness testers are calibrated annually (at a minimum) and verified daily certified test blocks. Reports from outside services are reviewed and initialed by Metallurgical Engineer or Director of Metallurgy.	N/A	X		

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Section 3 - Equipment							
3.1	Do furnaces, generators, and quench systems have proper process control equipment?	The heat-treat furnaces, generators, and quench systems shall have proper process controls and related equipment. Examples include temperature, carbon potential/dew point, gas flows, quench monitoring system including agitation, temperature control and quenching oil analysis, etc. as listed in the applicable Process Tables, Section 1.0.	All furnace lines and generators have proper process controls.		X		
3.2	Are process equipment calibrations and/or verification certified, posted, and current?	The calibration and certification of the process equipment shall be checked at regular specified intervals. Refer to the applicable Process Tables, Sections 1.0 and 2.0, for equipment calibration or certification time tables.	Furnace instrument calibrations performed quarterly by outside service		X		
3.3	Are thermocouples & protection tubes checked or replaced per Process Tables?	The thermocouples and protection tubes shall be checked or replaced in compliance to a preventive maintenance schedule. Refer to the applicable Process Tables, Section 2.0.	Thermocouples are checked monthly and replaced every 3 months.		X		
3.4	Are temperature uniformity surveys performed per requirements in Process Tables?	Temperature uniformity surveys shall be conducted per the requirements in the applicable Process Tables, Section 2.0. The frequency reductions allowed in AMS 2750D are not allowed under this document. Certain furnace designs, e.g., rotary retorts preclude direct temperature profiles. Alternate test methods per AMS 2750D 3.5.15 are acceptable for furnaces where temperature uniformity studies are not possible.	3 point temperature uniformity surveys performed annually or after furnace rebuild		X		
3.5	Is the variation of the furnace controlled thermocouple from set point within the requirements in the Process Table?	The variation between the furnace-control thermocouple and the set point temperature shall be within the limits defined in the applicable Process Tables, Section 2.0. This does not apply to the first zone of a multi-zone continuous furnace.	All control thermocouples in last zones of continuous furnaces are within specified tolerances, which are listed in the control plan.		X		
3.6	Are the process & equipment alarm checks being tested quarterly or after any repair or rebuild?	The heat treater shall have a list of heat treat process and equipment alarms. These alarms shall be independently tested quarterly at a minimum, and after any repair or rebuild. These checks shall be documented.	Furnace interlock and alarm verification performed quarterly. Results recorded on logsheets in PM system		X		

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3.7	Are generators and furnace atmospheres continuously monitored, automatically controlled, and documented?	<p>Generator and furnace atmosphere carbon potential/dew point shall be continuously monitored, automatically controlled, and documented. This requirement is specific to Process Table 1, Sections 1.0 and 3.0, for carburizing, carbonitriding, and neutral hardening. Continuous monitoring and automatic control of the carbon potential/dew point is required for all generators and atmosphere furnaces except rotary retort and shaker furnaces that preclude in situ control and monitoring. For rotary retort and shaker furnaces, the method described in AMS 2750D 3.5.15.2 "Property Surveys" shall be used to ensure adequate control of the furnace atmosphere. If generators are not used, the flow rates of the supplied atmosphere gases shall be monitored and controlled. The assessor shall verify the effectiveness of the atmosphere control system per customer requirements, the heat treater's control plan, and internal procedures.</p> <p>The atmosphere control system shall maintain the atmosphere dew point/carbon potential set point within the parameters specified in the control plan or internal procedures. The heat treater shall have a back-up method of checking the carbon potential/dew point. Examples are dew point, electrical wire resistance, gas analysis, shim stock, carbon bar, etc. The automatic and continuous atmosphere control system shall consist of sensors such as oxygen probes or on-line Infrared (IR) gas analysis. See Process Table A, Sect. 3.0 for verification frequencies.</p>	<p>Oxygen probes are the fundamental method for controlling atmosphere and carbon potential. Effectiveness is verified daily with a portable 3-gas analyzer.</p>	N/A	X		

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3.8	When the back-up verification check of the atmosphere does not agree or correlate within pre-established limits with the primary control method (carbon potential/dew point reading), is correlation of the carbon-bearing atmosphere to the primary control method re-established?	<p>This issue is specific to Process Table 1, carburizing, carbonitriding, and neutral hardening. When the back-up verification check of the atmosphere does not agree or correlate within pre-established limits with the primary control method (carbon potential/dew point reading), the heat treater shall resolve the out-of-limit discrepancy. The back-up atmosphere monitoring system reading and the automatically controlled atmosphere dew point/carbon potential reading shall be maintained within the correlation limits specified in the control plan or internal procedures. These range tolerances vary with the specific heat treat process and the equipment used. The heat treater shall make appropriate technical adjustments and corrections and then re-establish/demonstrate the correlation of the actual atmosphere carbon potential/dew point reading to the primary control and back-up atmosphere reading. The range tolerances for correlation between the two readings shall be in the control plan or internal procedures. The back-up carbon potential/dew point reading shall be established using one or more of the following methods:</p> <ul style="list-style-type: none"> • Carbon bar or slug • Shim stock • 3-gas analyzer • Dew point • Hot wire resistance 	Maintenance and Lab personnel resolve all atmosphere problems. 3-gas analyzer is used by the Lab for correlation.		X		

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Question Number	Question	Requirements and Guidance	Objective Evidence	Assessment			
				N/A	Satisfactory	Not Satisfactory	Needs Immediate Action
3.9	Are all ammonia lines equipped with quick disconnects or a three valve fail safe vent system?	<p>All ammonia lines to furnaces shall be equipped with quick disconnects or a three-valve fail-safe vent system. Normal valves may allow ammonia to leak through even when they are closed. This can be undesirable and detrimental in heat treat processes not specifying/requiring ammonia.</p> <ul style="list-style-type: none"> • A quick disconnect shall be present in any ammonia line going to a furnace. This line shall be disconnected after carbonitriding (or any other process using ammonia) before another heat treating operation not specifying/using ammonia begins. • An alternative three-valve ammonia "fail-safe" vent system is permitted. See the definition "Three Valve Fail-Safe Vent" and diagram in the glossary. • Documentation shall show when ammonia lines are disconnected for non-ammonia bearing atmosphere processes. 	Ammonia is not used at CTP.	X			
3.10	For fasteners and small metal parts, is a minimum of 3 hours allocated for an oxidizing burn-out prior to processing product not requiring ammonia?	<p>This is applicable to fasteners and small metal parts. The heat treater shall perform a minimum 3 hours oxidizing burn-out prior to processing product not requiring ammonia as an addition. Ammonia pick-up can be undesirable in parts and heat treat processes not specifying/requiring ammonia as an addition. Log book, data logger, or other records shall document the actual oxidizing burn-out time and that sufficient time has been allocated to remove ammonia from the furnace prior to processing parts in heat treat processes not specifying ammonia.</p>	Ammonia is not used at CTP.	X			
3.11	Do all atmosphere furnaces and generators have flow scopes or flow meters for all gases?	<p>All atmosphere furnaces and generators (output trim/adjustment gas) shall have flow scopes or flow meters for all gases. Flow scopes and meters shall be periodically serviced per the heat treater's preventive maintenance program. Cleaning and proper re-assembly procedures shall be documented.</p>	All furnaces and generators have flow scopes for each gas line that is connected including endothermic gas, natural gas, and air. Flow scope servicing described in PM task.		X		

Special Process: Heat Treat System Assessment							
Question Number	Question	Requirements and Guidance	Objective Evidence	Assessment			
				N/A	Satisfactory	Not Satisfactory	Needs Immediate Action
3.12	For threaded fasteners, are all continuous belt furnaces equipped with sight glass inspection ports and infrared pyrometers at discharge end of the hardening furnace?	Infrared temperature pyrometers are required at the exit end of continuous belt furnaces running threaded fasteners to monitor for under temperature parts. The temperature alarm shall be within 28C (50F) of the furnace set point temperature. Results shall be strip charted or continuously data logged. Infrared (IR) units shall be calibrated annually at a minimum and certified. All sight glasses shall be cleaned per the preventive maintenance schedule.	IR pyrometer system has data logger, reviewed daily. IR instruments are calibrated annually. Sight glasses are cleaned daily.		X		
3.13	Is salt chemistry in the austenitizing salt bath monitored?	Applicable to ferritic-nitrocarburizing, austempering, and neutral hardening in salt. The heat treater shall check the salt chemistry in the austenitizing salt bath, or part decarburization, daily. Refer to the applicable Process Tables, Section 3.0, for frequency of checks.	Salt baths are not used at CTP.	X			
3.14	Is the quenching medium analyzed?	The heat treater shall periodically have the quenching medium analyzed for specific quenching characteristics, e.g., cooling curve, water content, salt concentration, as specified in the applicable Process Tables, Section 5.0. <ul style="list-style-type: none"> • The quench media characteristic tolerances shall be specified by the quench medium supplier or the heat treater. • Analysis shall be reviewed for conformance by the heat treater. This review shall be documented. 	Cooling curves are run quarterly on continuous belt furnaces.		X		

Special Process: Heat Treat System Assessment							
Question Number	Question	Requirements and Guidance	Objective Evidence	Assessment			
				N/A	Satisfactory	Not Satisfactory	Needs Immediate Action
FOR INDUCTION HEAT TREATING							
3.15	Is the positioning of each part being controlled?	A method to detect proper part position, such as the use of proximity switches, optical sensors, mechanical probes, etc., is required for each part.		x			
3.16	Does the heat treater control the energy or power for each part?	The heat treater shall control the energy or power for each part. • A signature monitor for each machine is preferred. A signature monitor gives the energy unit (voltage, kilowatt, etc.) vs. time or distance (for scanning systems). • An energy monitor or equivalent is acceptable if approved by the authorized customer representative.		x			
3.17	Does the supplier have a coil management system? Coil refers to the heating coil and the quench plenum.	The heat treater shall have a coil management system. Coil refers to the heating coil and the quench plenum. • Spare coils for each part shall be available on-site. • Coils shall conform to the approved original design. • Engineering change approval from the customer is required whenever the coil design is changed.		x			
3.18	Is quench system automatic?	The quench system shall be an automatic operation. No manual quenching is allowed unless specifically approved by the authorized customer representative. Quenching shall be automatically initiated and controlled.		x			
3.19	Does each lot of parts have first piece set-up?	The heat treater shall perform first piece set-up for each lot of parts		x			

Section 4 - Job Audit

Job Identity: _____
Customer: _____
Shop Order Number: _____
Part Number: _____
Part Description: _____
Material: _____
Heat Treat Requirements: _____

Question #	Job Audit Question	Related HTSA Question #	Customer or Internal Requirement	Job (Shop) Order or Reference Documentation Requirement	Actual Condition (Objective Evidence)	Pass / Fail / N/A
4.1	Are contract review, advance quality planning, FMEA, control plans, etc., performed by qualified individuals?	1.2 1.3 1.4 1.17		N/A		
4.2	Does the heat treat facility have the customer specifications for the part?	1.5		N/A		
4.3	Is a shop traveler created to meet customer requirements?	1.6 2.1				
4.4	Is material identification (part numbers, lot numbers, heat numbers, contract numbers, etc.) maintained throughout the heat treat process?	2.2 2.3 2.4				
4.5	Is there documented evidence of Receiving Inspection?	2.1				
4.6	Are the Loading / Racking requirements identified?	1.6 2.7 2.9				
4.7	Is the proper recipe or process specification (cycle times, temperature, atmosphere, etc.) used? Refer to Process Tables, Section 3.0, for specific parameters. List parameters that were verified in this audit in the spaces provided below.	1.5 1.6 2.1 2.14 2.15				

Section 4 - Job Audit

Job Identity: _____
Customer: _____
Shop Order Number: _____
Part Number: _____
Part Description: _____
Material: _____
Heat Treat Requirements: _____

Question #	Job Audit Question	Related HTSA Question #	Customer or Internal Requirement	Job (Shop) Order or Reference Documentation Requirement	Actual Condition (Objective Evidence)	Pass / Fail / N/A
4.8	What are the product inspection requirements?	2.15				
4.8.1	Requirement: (1)					
	Test Method:					
	Test frequency or quantity:					
	Selection of samples:					
	Specification:					
4.8.2	Requirement: (2)					
	Test Method:					
	Test frequency or quantity:					
	Selection of samples:					
	Specification:					
4.8.3	Requirement: (3)					
	Test Method:					
	Test frequency or quantity:					
	Selection of samples:					
	Specification:					
4.8.4	Requirement: (4)					
	Test Method:					
	Test frequency or quantity:					

Section 4 - Job Audit

Job Identity: _____
Customer: _____
Shop Order Number: _____
Part Number: _____
Part Description: _____
Material: _____
Heat Treat Requirements: _____

Question #	Job Audit Question	Related HTSA Question #	Customer or Internal Requirement	Job (Shop) Order or Reference Documentation Requirement	Actual Condition (Objective Evidence)	Pass / Fail / N/A
	Selection of samples:					
	Specification:					

Section 4 - Job Audit

Job Identity: _____
Customer: _____
Shop Order Number: _____
Part Number: _____
Part Description: _____
Material: _____
Heat Treat Requirements: _____

Question #	Job Audit Question	Related HTSA Question #	Customer or Internal Requirement	Job (Shop) Order or Reference Documentation Requirement	Actual Condition (Objective Evidence)	Pass / Fail / N/A
Operator or Inspector Responsibilities						
4.9	Were appropriate process steps signed off?	1.4 2.2 2.3 2.14				
4.10	Were all inspection steps, as documented in the control plan performed?	1.2 1.4				
4.11	Were steps/operations performed that were not documented in the control plan?	1.2 1.4 1.6				
4.12	If additional steps were performed, were they authorized?	1.2 1.4 1.6 1.11 1.17				
4.13	Does the governing specification allow reprocessing or rework?	1.11				
4.14	If the order was certified, did the certification accurately reflect the process performed?	2.14 2.15				
4.15	Was the certification signed by an authorized individual?	1.17				
4.16	Are the parts and containers free of inappropriate objects or contamination?	2.6 2.11				

Section 4 - Job Audit

Job Identity: _____
Customer: _____
Shop Order Number: _____
Part Number: _____
Part Description: _____
Material: _____
Heat Treat Requirements: _____

Question #	Job Audit Question	Related HTSA Question #	Customer or Internal Requirement	Job (Shop) Order or Reference Documentation Requirement	Actual Condition (Objective Evidence)	Pass / Fail / N/A
	Packaging Requirements					
4.17	Are packaging requirements identified?	2.9				
4.18	Are parts packaged to minimize mixed parts (for example, parts packed over height of container)?	2.9				
	Shipping Requirements					
4.19	Were the parts properly identified?	2.3 2.9				
4.20	Were the containers properly labeled?	2.3 2.9				

**PROCESS TABLE A - Carburizing / Carbonitriding / Carbon Correction / Neutral Hardening /
 Austempering / Martempering / Tempering / Precipitation Hardening - Aging**

All requirements given below are subordinate to customer specific requirements.

The customer may have additional requirements, e.g., inspection testing, greater frequencies, etc. When performing the job audit, the auditor shall verify heat treater is conforming to the customer's requirements.

* Continuous furnace frequencies are per lot (work order) or as specified, whichever is more frequent.
 ** Does not apply to furnaces operating below 760C (1400F).
 ---- indicate "not applicable".

Item #	Related HTSA Question #	Category/Process Steps	Batch Furnace	Continuous Furnace *	Generators
1.0 PROCESS AND TEST EQUIPMENT REQUIREMENTS					
A1.1	3.1 3.7	All furnaces, generators and quench systems shall have temperature indicating instruments.	Yes	Yes	Yes
A1.2	3.1 3.7	Continuous strip charts and/or data loggers are required for temperature and carbon monitoring unit, e.g., dew point, oxygen probe, IR gas analyzer, etc.	Yes	Yes	Yes
A1.3	1.18	A program for furnace and generator burnout is required (applies to carbon bearing atmospheres).	Yes	Yes	Yes
A1.4	3.2	Furnace weigh scales shall be verified quarterly and calibrated annually at a minimum.	Yes	Yes	----
A1.5	3.2	Dew pointers, 3-gas analyzers, spectrometers, and carbon IR combustion analyzers (shim stock analysis), used to verify carbon potential in furnaces, shall be calibrated annually at a minimum.	----	----	----
A1.6	3.2	Verification of calibration of spectrometers, and carbon IR combustion analyzers, shall be checked daily or prior to use.	----	----	----
A1.7	3.2	Verification of calibration of 3-gas analyzers with zero gas and span gas shall be performed weekly at a minimum.	----	----	----
A1.8	3.2	Oxygen probe controllers shall be calibrated quarterly at a minimum.	Yes	Yes	Yes
A1.9	2.16	All hardness test equipment (for each scale used) shall be calibrated semi-annually minimum, and verified daily minimum per the applicable ASTM standard.	----	----	----
A1.10	2.16	Files shall be verified daily (or prior to use) with provers per SAE J864.	----	----	----
A1.11	3.2	Refractometers (typically used to check polymer quenchant and washer solutions) shall be verified daily (with distilled water) and calibrated annually (per manufacturer's requirements) at a minimum.	----	----	----

**PROCESS TABLE A - Carburizing / Carbonitriding / Carbon Correction / Neutral Hardening /
 Austempering / Martempering / Tempering / Precipitation Hardening - Aging**

All requirements given below are subordinate to customer specific requirements.

The customer may have additional requirements, e.g., inspection testing, greater frequencies, etc. When performing the job audit, the auditor shall verify heat treater is conforming to the customer's requirements.

* Continuous furnace frequencies are per lot (work order) or as specified, whichever is more frequent.
 ** Does not apply to furnaces operating below 760C (1400F).
 ----- indicate "not applicable".

Item #	Related HTSA Question #	Category/Process Steps	Batch Furnace	Continuous Furnace *	Generators
2.0		PYROMETRY			
A2.1	3.2 3.3	Thermocouples and calibration of thermocouples shall conform to AMS 2750D.	Yes	Yes	Yes
A2.2	3.2 3.3	Instrument Calibration per AMS 2750D shall be quarterly at a minimum. Frequency reductions per AMS 2750D are not allowed.	Yes	Yes	Yes
A2.3	3.2 3.3	CQI-9 requires a comparative check of the control temperature sensor (CTS) in the Qualified Work Zone to a (1) calibrated test temperature sensor (CTTS) or, (2) resident thermocouple (R-T/C). (1) The CTS shall be within an operating temperature range of +/- 5C (or +/-10F) of the CTTS. This check shall be performed monthly. (2) Within the operating temperature range the difference between the CTS and R-T/C readings shall be no more than +/- 1C (or +/-2F) as determined at the time of the most recent temperature uniformity survey. This check shall be performed weekly. Any actions to correct a failing reading or validate a test result shall be documented. Additionally, Type K and N thermocouples shall be checked monthly for equipment operating at or above 760C (1400F) and changed annually at a minimum. Type K and N thermocouples shall be checked quarterly for equipment operating below 760C (1400F) and changed every two years at a minimum. Type R and S thermocouples shall be checked monthly for equipment operating at or above 760C (1400F) and changed every two years at a minimum. Protection Tubes shall be visually checked at the same frequency as thermocouples.	Yes	Yes	Yes
A2.4	3.4	Temperature Uniformity Survey (TUS): refer to AMS 2750D for procedures. TUS frequency shall be annual and after major rebuild. Temperature uniformity tolerance for hardening furnaces shall be +/- 14 C (or +/- 25 F). Temperature uniformity tolerance for tempering furnaces shall be +/- 11 C (or +/- 20 F). Minimum and maximum temperature ranges shall be tested per AMS 2750D. Exception: If the operating range of the Qualified Work Zone is equal to or less than 85 C (153 F) then only one temperature is required to be tested. The temperature shall be within the operating range of the Qualified Work Zone. Frequency reductions per AMS 2750D are not allowed.	Yes	Yes - In Qualified Work Zone	-----
A2.5	3.5	Recorded temperature(s) for austenizing processes shall be controlled within +/- 9C (or +/- 15F) of the set point as evidenced by continuous recording pyrometers. Furnace temperature shall be controlled with soak times starting at the lower tolerance limit (as defined above).	Yes	Yes - In Qualified Work Zone	-----

**PROCESS TABLE A - Carburizing / Carbonitriding / Carbon Correction / Neutral Hardening /
 Austempering / Martempering / Tempering / Precipitation Hardening - Aging**

All requirements given below are subordinate to customer specific requirements.

The customer may have additional requirements, e.g., inspection testing, greater frequencies, etc. When performing the job audit, the auditor shall verify heat treater is conforming to the customer's requirements.

* Continuous furnace frequencies are per lot (work order) or as specified, whichever is more frequent.
 ** Does not apply to furnaces operating below 760C (1400F).
 ----- indicate "not applicable".

Item #	Related HTSA Question #	Category/Process Steps	Batch Furnace	Continuous Furnace *	Generators
A2.6	3.5	Recorded temperature(s) for tempering and precipitation hardening processes shall be controlled within +/- 6C (or +/- 10F) of the set point as evidenced by continuous recording pyrometers. Furnace temperature shall be controlled with soak times starting at the lower tolerance limit (as defined above).	Yes	Yes - In Qualified Work Zone	-----
A2.7	3.2	Infrared pyrometers shall be calibrated to a black body furnace annually.			-----

**PROCESS TABLE A - Carburizing / Carbonitriding / Carbon Correction / Neutral Hardening /
 Austempering / Martempering / Tempering / Precipitation Hardening - Aging**

All requirements given below are subordinate to customer specific requirements.

The customer may have additional requirements, e.g., inspection testing, greater frequencies, etc. When performing the job audit, the auditor shall verify heat treater is conforming to the customer's requirements.

* Continuous furnace frequencies are per lot (work order) or as specified, whichever is more frequent.
 ** Does not apply to furnaces operating below 760C (1400F).
 ----- indicate "not applicable".

Item #	Related HTSA Question #	Category/Process Steps	Batch Furnace	Continuous Furnace *	Generators
3.0 PROCESS MONITOR FREQUENCIES					
A3.1	1.4 2.14	Monitor primary temperature control instrument(s).	Each batch or continuous recording with sign-off every 2 hours. Alarm systems satisfy the sign-off requirement.	Each lot or continuous recording with sign-off every 2 hours. Alarm systems satisfy the sign-off requirement	Each Shift
A3.2	1.4 2.14 3.7	Monitor generator atmospheres.	-----	-----	Continuous
A3.3	1.4 2.14 3.7	Monitor primary furnace atmosphere control(s)**.	Continuous recording with sign-off every 2 hours. Alarm systems satisfy the sign-off requirement.	Continuous recording with sign-off every 2 hours. Alarm systems satisfy the sign-off requirement	-----
A3.4	1.4 2.14 3.7	Verify primary atmosphere control method by back-up method**.	Daily	Daily	Daily
A3.5	1.4 2.14 3.13	For austenizing salt baths: Salt chemistry (soluble oxides) or decarburization on the parts shall be checked daily.	Daily	Daily	-----
A3.6	1.4 2.12	Quench Media Process Parameters			
		- Temperature	Each batch or continuous recording with sign-off every 2 hours. Alarm systems satisfy the sign-off requirement.	Each lot or continuous recording with sign-off every 2 hours. Alarm systems satisfy the sign-off requirement.	-----
		- Quench Level	Daily	Daily	-----
		- Agitation	- Daily visual check is required. - Monitor each load in the absence of an alarm system.	- Daily visual check is required. - Monitor every 2 hours in the absence of an alarm system.	-----
A3.7	1.4 2.14	Monitor time in furnace, cycle time or belt speed.	Each batch	Twice/shift & after any change in the belt speed.	-----
A3.8	1.4 2.7	Monitor load size or fixturing or loading rate as applicable.	Each batch	Twice/shift & after any change in loading rate.	-----
A3.9	1.4 2.12	Quench Delay Time - Alarm system shall be based on the time that the load exits the furnace to the time the load is at the bottom of the quench tank.	Each batch	Each basket for pusher-type continuous furnaces. Not applicable for belt furnaces.	-----

PROCESS TABLE A - Carburizing / Carbonitriding / Carbon Correction / Neutral Hardening / Austempering / Martempering / Tempering / Precipitation Hardening - Aging

All requirements given below are subordinate to customer specific requirements.

The customer may have additional requirements, e.g., inspection testing, greater frequencies, etc. When performing the job audit, the auditor shall verify heat treater is conforming to the customer's requirements.

* Continuous furnace frequencies are per lot (work order) or as specified, whichever is more frequent.
** Does not apply to furnaces operating below 760C (1400F).
----- indicate "not applicable".

Item #	Related HTSA Question #	Category/Process Steps	Batch Furnace	Continuous Furnace *	Generators
4.0		IN-PROCESS/FINAL TEST FREQUENCIES			
A4.1	1.4 2.15	Microstructure	Daily per furnace	Daily per furnace	----
A4.2	1.4 2.15	Surface hardness	Each batch	Every 2 hours minimum	----
A4.3	1.4 2.15	Core hardness (when specified)	Each batch	Every 4 hours	----
A4.4	1.4 2.15	Case depth (when specified)	Each batch	Every 4 hours	----
5.0		QUENCHANT AND SOLUTION TEST FREQUENCIES			
A5.1	2.12 3.14	Polymer Quench Media			
		- Concentration	Daily	Daily	----
		- Quenchability Check; e.g., cooling curve, viscosity, or titration	Every six months	Every six months	----
A5.2	2.12 3.14	Water Quench Media			
		- Suspended solids	Every six months	Every six months	----
A5.3	2.12 3.14	Salt Quench Media			
		- Analysis & Contaminants	Every six months	Every six months	----
A5.4	2.12 3.14	Brine or Caustic Quench Media			
		- Concentration and/or Specific Gravity.	Daily	Daily	----
		- Suspended solids	Every six months	Every six months	----
A5.5	2.12 3.14	Oil Quench Media			
		- Water content, suspended solids, viscosity, cooling curve, total acid, and flash point.	Quarterly	Quarterly	----
A5.6	2.13	Rust Preventive - Soluble Oil			
		- Concentration	2x / week	2x / week	----
A5.7	2.11	Washers			
		- Concentration of cleaner	Daily	Daily	----
		- Temperature of solution (required if temperature is specified to be above ambient temperature).	Each shift	Each shift	----

PROCESS TABLE B - Nitriding (Gas) and Ferritic-Nitrocarburizing (Gas or Salt)

Item #	Related HTSA Question #	Category/Process Steps	Batch Furnace	Continuous Furnace*	Generators	Salt Bath
1.0						
PROCESS AND TEST EQUIPMENT REQUIREMENTS						
B1.1	3.1 3.7	All furnaces, generators and quench systems shall have temperature indicating instruments.	Yes	Yes	Yes	Yes
B1.2	3.1 3.7	Continuous strip charts and/or data loggers are required for temperature and carbon monitoring unit, e.g., dew point, oxygen probe, IR gas analyzer, etc.	Yes	Yes	Yes	Yes - For temperature only
B1.3	1.18	A program for furnace and generator burnout is required. Not required for retort gas nitriding.	Yes	Yes	Yes	----
B1.4	3.12 3.13	For austenitizing salt baths: Salt chemistry (soluble oxides) or decarburization on the parts shall be checked daily.	----	----	----	Yes
B1.5	3.2	Furnace weigh scales shall be verified quarterly and calibrated annually at a minimum.	Yes	Yes	----	----
B1.6	3.2	Dew pointers and gas analyzers, used to verify proper atmosphere in furnaces, shall be calibrated annually at a minimum.	----	----	----	----
B1.7	2.16	All hardness test equipment (for each scale used) shall be calibrated semi-annually minimum, and verified daily minimum per the applicable ASTM standard.	----	----	----	----
B1.8	2.16	Files shall be verified daily (or prior to use) with provers per SAE J864.	----	----	----	----
B1.9	3.2	Refractometers (typically used to check polymer quenchants and washer solutions) shall be verified daily (with distilled water) and calibrated annually (per manufacturer's requirements) at a minimum.	----	----	----	----

All requirements given below are subordinate to customer specific requirements.

The customer may have additional requirements, e.g., inspection testing, greater frequencies, etc. When performing the job audit, the auditor shall verify heat treater is conforming to the customer's requirements.

* Continuous furnace frequencies are per lot (work order) or as specified, whichever is more frequent.
 ---- indicate "not applicable".

PROCESS TABLE B - Nitriding (Gas) and Ferritic-Nitrocarburizing (Gas or Salt)

All requirements given below are subordinate to customer specific requirements. The customer may have additional requirements, e.g., inspection testing, greater frequencies, etc. When performing the job audit, the auditor shall verify heat treater is conforming to the customer's requirements. * Continuous furnace frequencies are per lot (work order) or as specified, whichever is more frequent. ----- indicate "not applicable".						
Item #	Related HTSA Question #	Category/Process Steps	Batch Furnace	Continuous Furnace*	Generators	Salt Bath
2.0		PYROMETRY				
B2.1	3.2 3.3	Thermocouples and calibration of thermocouples shall conform to AMS 2750D.	Yes	Yes	Yes	Yes
B2.2	3.2 3.3	Instrument Calibration per AMS 2750D shall be quarterly at a minimum. Frequency reductions per AMS 2750D are not allowed.	Yes	Yes	Yes	Yes
B2.3	3.2 3.3	CQI-9 requires a comparative check of the control temperature sensor (CTS) in the Qualified Work Zone to a (1) calibrated test temperature sensor (CTTS) or, (2) resident thermocouple (R-T/C). (1) The CTS shall be +/- 5C (or +/- 10F) of a CTTS at the operating temperature range; this checked shall be performed monthly. (2) The relationship between the CTS and R-T/C at the operating temperature range shall be within +/- 1C (or +/- 2F) of their relationship determined at the time of the most recent temperature uniformity survey; this checked shall be performed weekly. Any actions to correct a failing reading or validate a test result shall be documented. Additionally, Type K and N thermocouples shall be checked monthly for equipment operating at or above 760C (1400F) and changed annually at a minimum. Type K and N thermocouples shall be checked quarterly for equipment operating below 760C (1400F) and changed every two years at a minimum. Type R and S thermocouples shall be checked monthly for equipment operating at or above 760C (1400F) and changed every two years at a minimum. Protection Tubes shall be visually checked at same frequency as thermocouples.	Yes	Yes	Yes	Yes

PROCESS TABLE B - Nitriding (Gas) and Ferritic-Nitrocarburizing (Gas or Salt)

<p>All requirements given below are subordinate to customer specific requirements.</p> <p>The customer may have additional requirements, e.g., inspection testing, greater frequencies, etc. When performing the job audit, the auditor shall verify heat treater is conforming to the customer's requirements.</p> <p>* Continuous furnace frequencies are per lot (work order) or as specified, whichever is more frequent. ----- indicate "not applicable".</p>						
Item #	Related HTSA Question #	Category/Process Steps	Batch Furnace	Continuous Furnace*	Generators	Salt Bath
B2.4	3.4	<p>Temperature Uniformity Survey (TUS): refer to AMS 2750D for procedures. TUS frequency shall be annual and after major rebuild.</p> <p>Temperature uniformity tolerance shall be +/- 9 C (15 F).</p> <p>Minimum and maximum temperature ranges shall be tested per AMS 2750D. Exception: If the operating range of the Qualified Work Zone is equal to or less than 85 C (153 F) then only one temperature is required to be tested. The temperature shall be within the operating range of the Qualified Work Zone.</p> <p>Frequency reductions per AMS 2750D are not allowed.</p>	Yes	Yes - In Qualified Work Zone	-----	Yes
B2.5	3.5	Recorded temperature(s) shall be controlled within +/- 9C (or +/- 15F) of the set point as evidenced by continuous recording pyrometers. Furnace temperature shall be controlled with soak times starting at the lower tolerance limit (as defined above).	Yes	Yes - In Qualified Work Zone	-----	Yes
B2.6	3.2	Infrared pyrometers shall be calibrated to a black body furnace annually .				

PROCESS TABLE B - Nitriding (Gas) and Ferritic-Nitrocarburizing (Gas or Salt)

Item #	Related HTSA Question #	Category/Process Steps	Batch Furnace	Continuous Furnace*	Generators	Salt Bath
3.0						
PROCESS MONITOR FREQUENCIES						
B3.1	1.4 2.14	Monitor primary temperature control instrument(s).	Each batch or continuous recording with sign-off every 2 hours. Alarm systems satisfy the sign-off requirement	Each lot or continuous recording with sign-off every 2 hours. Alarm systems satisfy the sign-off requirement	Each Shift	Every 2 hours & after any change
B3.2	1.4 2.14 3.7	Monitor generator atmospheres, if applicable.	----	----	Continuous	----
B3.3	1.4 2.14 3.7	Monitor primary furnace atmosphere control(s).	Each batch (rotary furnaces only) or continuous recording with sign-off every 2 hours. Alarm systems satisfy the sign-off requirement	Continuous recording with sign-off every 2 hours. Alarm systems satisfy the sign-off requirement	----	Daily
B3.4	1.4 3.7	Dissociation of ammonia shall be checked in gas nitriding.	Each batch and every 4 hours minimum	Every 4 hours	Daily	N/A
B3.5	1.4 3.7	Gas ratios for ferritic nitrocarburizing shall be checked.	Each batch	Every 2 hours minimum		
B3.6	1.4 2.14 3.13	Check salt chemistry (soluble oxides) in salt baths used for austenitizing, or decarburization on the parts.	----	----	----	Daily

All requirements given below are subordinate to customer specific requirements.

The customer may have additional requirements, e.g., inspection testing, greater frequencies, etc. When performing the job audit, the auditor shall verify heat treater is conforming to the customer's requirements.

* Continuous furnace frequencies are per lot (work order) or as specified, whichever is more frequent.
 ---- indicate "not applicable".

PROCESS TABLE B - Nitriding (Gas) and Ferritic-Nitrocarburizing (Gas or Salt)

All requirements given below are subordinate to customer specific requirements.						
The customer may have additional requirements, e.g., inspection testing, greater frequencies, etc. When performing the job audit, the auditor shall verify heat treat is conforming to the customer's requirements.						
* Continuous furnace frequencies are per lot (work order) or as specified, whichever is more frequent. ----- indicate "not applicable".						
Item #	Related HTSA Question #	Category/Process Steps	Batch Furnace	Continuous Furnace*	Generators	Salt Bath
B3.7	1.4 2.12	Quench Media Process Parameters				
		- Temperature	Each batch or continuous recording with sign-off every 2 hours. Alarm systems satisfy the sign-off requirement.	Each lot or continuous recording with sign-off every 2 hours. Alarm systems satisfy the sign-off requirement.	-----	Each batch or continuous recording with sign-off every 2 hours. Alarm systems satisfy the sign-off requirement.
		- Quench Level	Daily	Daily	-----	Daily
		- Agitation	- Daily - Monitor each load in the absence of an alarm system.	- Daily - Monitor every 2 hours in the absence of an alarm system.	-----	Daily
B3.8	1.4 2.14	Monitor time in furnace, cycle time or belt speed.	Each batch	Twice/shift & after any change in the belt speed.	-----	Each batch
B3.9	1.4 2.7	Monitor load size or fixturing or loading rate as applicable.	Each batch	Twice/shift & after any change in loading rate.	-----	Each batch
B3.10	1.4 2.12	Quench Delay Time if applicable - Alarm system shall be based on the time that the load exits the furnace to the time the load is at the bottom of the quench tank.	Each batch	Each basket if applicable.	-----	Each batch
4.0		IN-PROCESS/FINAL TEST FREQUENCIES				
B4.1	1.4 2.15	Microstructure	Daily per furnace	Daily per furnace	-----	Daily per furnace
B4.2	1.4 2.15	Surface hardness	Each batch	Every 2 hours minimum	-----	Each batch
B4.3	1.4 2.15	Core hardness (when specified)	Each batch	Every 4 hours	-----	Each batch
B4.4	1.4 2.15	Case depth (when specified)	Each batch	Every 4 hours	-----	Each batch

PROCESS TABLE B - Nitriding (Gas) and Ferritic-Nitrocarburizing (Gas or Salt)

Item #	Related HTSA Question #	Category/Process Steps	Batch Furnace	Continuous Furnace*	Generators	Salt Bath
5.0		QUENCHANT AND SOLUTION TEST FREQUENCIES				
		Quench Media Controls If Applicable				
B5.1	2.12 3.14	Polymer Quench Media				
		- Concentration	Daily	Daily	----	----
		- Quenchability Check; e.g., cooling curve, viscosity, or titration.	Every six months	Every six months	----	----
B5.2	2.12 3.14	Water Quench Media				
		- Suspended solids	Every six months	Every six months	----	----
B5.3	2.12 3.14	Salt Quench Media				
		- Analysis & Contaminants	Every six months	Every six months	----	Every six months
B5.4	2.12 3.14	Brine or Caustic Quench Media				
		- Concentration and/or Specific Gravity	Daily	Daily	----	----
		- Suspended solids	Every six months	Every six months	----	----
B5.5	2.12 3.14	Oil Quench Media				
		- Water content, suspended solids, viscosity, cooling curve, total acid, and flash point.	Quarterly	Quarterly	----	----
B5.6	2.13	Rust Preventive - Soluble Oil				
		- Concentration	2x / week	2x / week	----	2x / week
B5.7	2.11	Washers				
		- Concentration of cleaner	Daily	Daily	----	Daily
		- Temperature of solution (required if temperature is specified to be above ambient temperature).	Each shift	Each shift	----	Each shift

All requirements given below are subordinate to customer specific requirements.

The customer may have additional requirements, e.g., inspection testing, greater frequencies, etc. When performing the job audit, the auditor shall verify heat treater is conforming to the customer's requirements.

* Continuous furnace frequencies are per lot (work order) or as specified, whichever is more frequent.
 ---- indicate "not applicable".

PROCESS TABLE C - Aluminum Heat Treating

<p>All requirements given below are subordinate to customer specific requirements.</p> <p>The customer may have additional requirements, e.g., inspection testing, greater frequencies, etc. When performing the job audit, the auditor shall verify heat treater is conforming to the customer's requirements.</p> <p>*Continuous furnace frequencies are per lot (work order) or as specified, whichever is more frequent. ----- indicate "not applicable".</p>					
Item #	Related HTSA Question #	Category/Process Steps	Batch Solution Treating and Aging Furnaces	Continuous Solution Treating and Aging Furnaces	Annealing Furnace
1.0		PROCESS AND TEST EQUIPMENT REQUIREMENTS			
C1.1	3.1 3.7	All furnaces and quench systems shall have temperature indicating instruments.	Yes	Yes	Yes
C1.2	3.1 3.7	Continuous strip charts and/or data loggers are required for temperature sensors.	Yes	Yes	Yes
C1.3	2.16	All hardness test equipment (for each scale used) shall be calibrated semi-annually minimum, and verified daily minimum per the applicable ASTM standard.	-----	-----	-----
C1.4	3.2	Furnace weigh scales shall be verified quarterly and calibrated annually at a minimum.	Yes	Yes	Yes
C1.5	3.2	Refractometers (typically used to check polymer quenchants and washer solutions) shall be verified daily (with distilled water) and calibrated annually (per manufacturer's requirements) at a minimum.	-----	-----	-----

PROCESS TABLE C - Aluminum Heat Treating

All requirements given below are subordinate to customer specific requirements.					
The customer may have additional requirements, e.g., inspection testing, greater frequencies, etc. When performing the job audit, the auditor shall verify heat treater is conforming to the customer's requirements.					
*Continuous furnace frequencies are per lot (work order) or as specified, whichever is more frequent. ----- indicate "not applicable".					
Item #	Related HTSA Question #	Category/Process Steps	Batch Solution Treating and Aging Furnaces	Continuous Solution Treating and Aging Furnaces	Annealing Furnace
2.0		PYROMETRY			
C2.1	3.2 3.3	Thermocouples and calibration of thermocouples shall conform to AMS 2750D.	Yes	Yes	Yes
C2.2	3.2 3.3	Instrument Calibration per AMS 2750D shall be quarterly at a minimum. Frequency reductions per AMS 2750D are not allowed.	Yes	Yes	Yes
C2.3	3.2 3.3	CQI-9 requires a comparative check of the control temperature sensor (CTS) in the Qualified Work Zone to a (1) calibrated test temperature sensor (CTTS) or, (2) resident thermocouple (R-T/C). (1) The CTS shall be +/- 5C (or +/- 10F) of a CTTS at the operating temperature range; this checked shall be performed monthly. (2) The relationship between the CTS and R-T/C at the operating temperature range shall be within +/- 1C (or +/- 2F) of their relationship determined at the time of the last temperature uniformity survey; this checked shall be performed weekly. Any actions to correct a failing reading or validate a test result shall be documented. Additionally, Type K and N thermocouples shall be checked monthly for equipment operating at or above 760C (1400F) and changed annually at a minimum. Type K and N thermocouples shall be checked quarterly for equipment operating below 760C (1400F) and changed every two years at a minimum. Type R and S thermocouples shall be checked monthly for equipment operating at or above 760C (1400F) and changed bi-annually every two years at a minimum. Protection Tubes shall be visually checked at same frequency as thermocouples.	Yes	Yes	Yes

PROCESS TABLE C - Aluminum Heat Treating

<p>All requirements given below are subordinate to customer specific requirements.</p> <p>The customer may have additional requirements, e.g., inspection testing, greater frequencies, etc. When performing the job audit, the auditor shall verify heat treater is conforming to the customer's requirements.</p> <p>*Continuous furnace frequencies are per lot (work order) or as specified, whichever is more frequent. ----- indicate "not applicable".</p>					
Item #	Related HTSA Question #	Category/Process Steps	Batch Solution Treating and Aging Furnaces	Continuous Solution Treating and Aging Furnaces	Annealing Furnace
C2.4	3.4	<p>Temperature Uniformity Survey (TUS): refer to AMS 2750D for procedures. TUS frequency shall be quarterly and after major rebuild.</p> <p>Temperature uniformity tolerance for solution treating and aging furnaces shall be +/- 6 C (or +/- 10 F). Temperature uniformity tolerance for annealing furnaces shall be +/- 14 C (or +/- 25 F).</p> <p>Minimum and maximum temperature ranges shall be tested per AMS 2750D. Exception: If the operating range of the Qualified Work Zone is equal to or less than 85 C (153 F) then only one temperature is required to be tested. The temperature shall be within the operating range of the Qualified Work Zone.</p> <p>Frequency reductions per AMS 2750D are not allowed.</p>	Yes	Yes - In Qualified Work Zone	Yes
C2.5	3.5	Recorded temperature(s) shall be controlled within +/- 6C (or +/- 10F) of the set point as evidenced by continuous recording pyrometers. Furnace temperature shall be controlled with soak times starting at the lower tolerance limit (as defined above).	Yes	Yes - In Qualified Work Zone	-----
C2.6	3.5	Recorded temperature(s) shall be controlled within +/- 9C (or +/- 15F) of the set point as evidenced by continuous recording pyrometers. Furnace temperature shall be controlled with soak times starting at the lower tolerance limit (as defined above).	-----	-----	Yes
C2.7	3.2	Infrared pyrometers shall be calibrated to a black body furnace annually.			

PROCESS TABLE C - Aluminum Heat Treating

Item #	Related HTSA Question #	Category/Process Steps	Batch Solution Treating and Aging Furnaces	Continuous Solution Treating and Aging Furnaces	Annealing Furnace
3.0					
PROCESS MONITOR FREQUENCIES					
C3.1	1.4 2.14	Monitor primary temperature control instrument(s).	Each batch or continuous recording with sign-off every 2 hours. Alarm systems satisfy the sign-off requirement.	Each lot or continuous recording with sign-off every 2 hours. Alarm systems satisfy the sign-off requirement.	Each batch or continuous recording with sign-off every 2 hours. Alarm systems satisfy the sign-off requirement.
C3.2	1.4 2.12	Quench Media Process Parameters - Heat treater shall specify temperature range based on product form and material. Temperature shall be monitored as noted.	Each batch or continuous recording with sign-off every 2 hours. Alarm systems satisfy the sign-off requirement.	Each lot or continuous recording with sign-off every 2 hours. Alarm systems satisfy the sign-off requirement.	-----
		- Quench Level	Daily	Daily	-----
		- Agitation	- Daily visual check is required. - Monitor each load in the absence of an alarm system.	- Daily visual check is required. - Monitor every 2 hours in the absence of an alarm system.	-----
C3.3	1.4 2.14	Monitor process cycle time	Each batch	Twice/shift & after any change in the indexing speed.	Each batch
C3.4	1.4 2.7	Monitor load size or fixturing as applicable.	Each batch	Twice/shift & after any change in loading rate.	Each batch
C3.5	1.4 2.12	Quench Delay Time - Quench delay time shall be based on the time that the load exits the furnace to the time the load is at the bottom of the quench tank.	Each batch	Each load	-----
4.0					
IN-PROCESS/FINAL TEST FREQUENCIES					
C4.1	1.4 2.15	Hardness or tensile testing (post aging).	Each batch	Every 4 hours	Each batch or every 4 hours for continuous furnaces
5.0					
QUENCHANT AND SOLUTION TEST FREQUENCIES					
C5.1	2.12 3.14	Polymer Quench Media			
		- Concentration	Daily	Daily	-----
		- Suspended solids	Every six months	Every six months	-----
		- Quenchability Check; e.g., cooling curve, viscosity, or titration.	Every six months	Every six months	-----
C5.2	2.12 3.14	Water Quench Media			
		- Suspended solids	Every six months	Every six months	-----
C5.3	2.11	Washers			
		- Concentration of cleaner	Daily	Daily	Daily
		- Temperature of solution (required if temperature is specified to be above ambient temperature).	Each shift	Each shift	Each shift

All requirements given below are subordinate to customer specific requirements.

The customer may have additional requirements, e.g., inspection testing, greater frequencies, etc. When performing the job audit, the auditor shall verify heat treater is conforming to the customer's requirements.

*Continuous furnace frequencies are per lot (work order) or as specified, whichever is more frequent.
 ----- indicate "not applicable".

PROCESS TABLE D - Induction Heat Treating

<p>All requirements given below are subordinate to customer specific requirements.</p> <p>The customer may have additional requirements, e.g., inspection testing, greater frequencies, etc. When performing the job audit, the auditor shall verify heat treater is conforming to the customer's requirements.</p> <p>----- indicate "not applicable".</p>			
Item #	Related HTSA Question #	Category/Process Steps	Per Coil
1.0		PROCESS AND TEST EQUIPMENT REQUIREMENTS	
D1.1	---	Per customer requirement	
D1.2	2.16	All hardness test equipment (for each scale used) shall be calibrated semi-annually minimum, and verified daily minimum per the applicable ASTM standard.	-----
D1.3	2.16	Files shall be verified daily (or prior to use) with provers per SAE J864.	-----
D1.4	3.2	Refractometers (typically used to check polymer quenchants and washer solutions) shall be verified each shift (with distilled water) and calibrated annually (per manufacturer's requirements) at a minimum.	-----

PROCESS TABLE D - Induction Heat Treating

<p>All requirements given below are subordinate to customer specific requirements.</p> <p>The customer may have additional requirements, e.g., inspection testing, greater frequencies, etc. When performing the job audit, the auditor shall verify heat treater is conforming to the customer's requirements.</p> <p>----- indicate "not applicable".</p>			
Item #	Related HTSA Question #	Category/Process Steps	Per Coil
2.0		PYROMETRY	
D2.1	3.2	Infrared pyrometers shall be calibrated to a black body furnace annually.	-----
3.0		PROCESS MONITORING FREQUENCIES	
<p>All process parameters shall be checked the beginning of every shift, tool change, or any equipment repair. In absence of process parameter alarms, also check process parameters at end of shift or lot (whichever is the greater frequency).</p>			
D3.1	1.4 2.12	Quench Media Process Parameters	
		- Temperature	Alarm system for high and low temperature is required.
		- Quench Level	Daily
		- Quench Pressure and Flow	- Quench pressure and flow may be checked at manifold. Quench flow shall be checked visually at each coil. - In the absence of an alarm system, monitor every 2 hours or after any change.
D3.2	1.4 2.14	Monitor cycle time	Check cycle time at start up and after any process change.
D3.3	1.4 2.14 3.16	Monitor: 1) Volts or Amps, and 2) Kilowatts Use of an energy monitor or signature monitor satisfies 1) and 2).	- This requirement applies to each power supply (not per coil). - In the absence of an alarm system, monitor every 2 hours or after any change.

PROCESS TABLE D - Induction Heat Treating

All requirements given below are subordinate to customer specific requirements.			
The customer may have additional requirements, e.g., inspection testing, greater frequencies, etc. When performing the job audit, the auditor shall verify heat treater is conforming to the customer's requirements. ----- indicate "not applicable".			
Item #	Related HTSA Question #	Category/Process Steps	Per Coil
4.0		IN-PROCESS/FINAL TEST FREQUENCIES	Production Setup or Coil Change - Per Coil (1st Piece Inspection)
D4.4	1.4 2.15	Induction pattern length	1 part at start-up, end of production run, and every 4 hours minimum, and 1 part pre and 1 part post tool change, equipment repair, station alarm (shutdown, malfunction, etc.)
D4.5	1.4 2.15	Total or Effective Case depth	1 part at start-up, end of production run, and 1 part per 8 hours minimum, and 1 part pre and 1 part post tool change, equipment repair, station alarm (shutdown, malfunction, etc.)
D4.6	1.4 2.15	Surface hardness	1 part at start-up, end of production run, and every 4 hours minimum, and 1 part pre and 1 part post tool change, equipment repair, station alarm (shutdown, malfunction, etc.)
D4.7	1.4 2.15	Core hardness (when specified)	1 part at start-up, end of production run, and every 4 hours minimum, and 1 part pre and 1 part post tool change, equipment repair, station alarm (shutdown, malfunction, etc.)
D4.8	1.4 2.15	Microstructure	1 part at start-up, and 1 part pre and 1 part post tool change, equipment repair, station alarm (shutdown, malfunction, etc.)

PROCESS TABLE D - Induction Heat Treating

<p>All requirements given below are subordinate to customer specific requirements.</p> <p>The customer may have additional requirements, e.g., inspection testing, greater frequencies, etc. When performing the job audit, the auditor shall verify heat treater is conforming to the customer's requirements.</p> <p>----- indicate "not applicable".</p>			
Item #	Related HTSA Question #	Category/Process Steps	Per Coil
5.0		QUENCHANT AND SOLUTION TEST FREQUENCIES	
		Quench Media Controls If Applicable	
D5.1	2.12 3.14	Polymer Quench Media	
		- Concentration	Once per day
		- Quenchability Check; e.g., cooling curve, viscosity, or titration	Monthly
D5.2	2.12 3.14	Water Quench Media	
		- Suspended solids	Quarterly
D5.3	2.12 3.14	Brine or Caustic Quench Media	
		- Concentration and/or Specific Gravity	Monthly
		- Suspended solids	Quarterly
D5.4	2.13	Rust Preventive - Soluble Oil	
		- Concentration	2x / week
D5.5	2.11	Washers	
		- Concentration of cleaner	Daily
		- Temperature of solution (required if temperature is specified to be above ambient temperature).	Each shift

PROCESS TABLE E - Annealing / Normalizing / Stress-Relieving

All requirements given below are subordinate to customer specific requirements.

The customer may have additional requirements, e.g., inspection testing, greater frequencies, etc. When performing the job audit, the auditor shall verify heat treater is conforming to the customer's requirements.

* Continuous furnace frequencies are per lot (work order) or as specified, whichever is more frequent.
** Does not apply to furnaces operating below 760C (1400F).
---- indicate "not applicable".

Item #	Related HTSA Question #	Category/Process Steps	Batch Furnace	Continuous Furnace *	Generators
1.0		PROCESS AND TEST EQUIPMENT REQUIREMENTS			
E1.1	3.1 3.7	All furnaces, generators and quench systems (where applicable) shall have temperature indicating instruments.	Yes	Yes	Yes
E1.2	3.1 3.7	Continuous strip charts and/or data loggers are required for temperature and carbon monitoring unit, e.g., dew point, oxygen probe, IR gas analyzer, etc.	Yes	Yes	Yes
E1.3	3.2	Furnace weigh scales shall be verified quarterly and calibrated annually at a minimum.	Yes	Yes	----
E1.4	3.2	Dew pointers, 3-gas analyzers, spectrometers, and carbon IR combustion analyzers (shim stock analysis), used to verify carbon potential in furnaces, shall be calibrated annually at a minimum. This is applicable when used in controlling carbon-bearing atmospheres.	----	----	----
E1.5	3.2	Verification of calibration of spectrometers, and carbon IR combustion analyzers, shall be checked daily or prior to use. This is applicable when used in controlling carbon-bearing atmospheres.	----	----	----
E1.6	3.2	Verification of calibration of 3-gas analyzers with zero gas and span gas shall be performed weekly at a minimum. This is applicable when used in controlling carbon-bearing atmospheres.	----	----	----
E1.7	3.2	Oxygen probe controllers shall be calibrated quarterly at a minimum. This is applicable when used in controlling carbon-bearing atmospheres.	Yes	Yes	Yes
E1.8	2.16	All hardness test equipment (for each scale used) shall be calibrated semi-annually minimum, and verified daily minimum per the applicable ASTM standard.	----	----	----

PROCESS TABLE E - Annealing / Normalizing / Stress-Relieving

All requirements given below are subordinate to customer specific requirements.					
The customer may have additional requirements, e.g., inspection testing, greater frequencies, etc. When performing the job audit, the auditor shall verify heat treater is conforming to the customer's requirements.					
* Continuous furnace frequencies are per lot (work order) or as specified, whichever is more frequent.					
** Does not apply to furnaces operating below 760C (1400F).					
---- indicate "not applicable".					
Item #	Related HTSA Question #	Category/Process Steps	Batch Furnace	Continuous Furnace *	Generators
2.0		PYROMETRY			
E2.1	3.2 3.3	Thermocouples and calibration of thermocouples shall conform to AMS 2750D.	Yes	Yes	Yes
E2.2	3.2 3.3	Instrument Calibration per AMS 2750D shall be quarterly at a minimum. Frequency reductions per AMS 2750D are not allowed.	Yes	Yes	Yes
E2.3	3.2 3.3	CQI-9 requires a comparative check of the control temperature sensor (CTS) in the Qualified Work Zone to a (1) calibrated test temperature sensor (CTTS) or, (2) resident thermocouple (R-T/C). (1) The CTS shall be +/- 5C (or +/- 10F) of a CTTS at the operating temperature range; this checked shall be performed monthly. (2) The relationship between the CTS and R-T/C at the operating temperature range shall be within +/- 1C (or +/- 2F) of their relationship determined at the time of the most recent temperature uniformity survey; this checked shall be performed weekly. Any actions to correct a failing reading or validate a test result shall be documented. Additionally, Type K and N thermocouples shall be checked monthly for equipment operating at or above 760C (1400F) and changed annually at a minimum. Type K and N thermocouples shall be checked quarterly for equipment operating below 760C (1400F) and changed every two years at a minimum. Type R and S thermocouples shall be checked monthly for equipment operating at or above 760C (1400F) and changed bi-annually every two years at a minimum. Protection Tubes shall be visually checked at same frequency as thermocouples.	Yes	Yes	Yes

PROCESS TABLE E - Annealing / Normalizing / Stress-Relieving

<p>All requirements given below are subordinate to customer specific requirements.</p> <p>The customer may have additional requirements, e.g., inspection testing, greater frequencies, etc. When performing the job audit, the auditor shall verify heat treater is conforming to the customer's requirements.</p> <p>* Continuous furnace frequencies are per lot (work order) or as specified, whichever is more frequent.</p> <p>** Does not apply to furnaces operating below 760C (1400F).</p> <p>---- indicate "not applicable".</p>					
Item #	Related HTSA Question #	Category/Process Steps	Batch Furnace	Continuous Furnace *	Generators
E2.4	3.4	<p>Temperature Uniformity Survey (TUS): refer to AMS 2750D for procedures. TUS frequency shall be annual and after major rebuild.</p> <p>Temperature uniformity tolerance for hardening furnaces shall be +/- 14 C (or +/- 25 F). Temperature uniformity tolerance for tempering furnaces shall be +/- 11 C (or +/- 20 F).</p> <p>Minimum and maximum temperature ranges shall be tested per AMS 2750D. Exception: If the operating range of the Qualified Work Zone is equal to or less than 85 C (153 F) then only one temperature is required to be tested. The temperature shall be within the operating range of the Qualified Work Zone.</p> <p>Frequency reductions per AMS 2750D are not allowed.</p>	Yes	Yes - In Qualified Work Zone	----
E2.5	3.5	<p>Recorded temperature(s) shall be controlled within +/- 9C (or +/- 15F) of the set point as evidenced by continuous recording pyrometers. Furnace temperature shall be controlled with soak times starting at the lower tolerance limit (as defined above).</p>	Yes	Yes - In Qualified Work Zone	----

PROCESS TABLE E - Annealing / Normalizing / Stress-Relieving

All requirements given below are subordinate to customer specific requirements.					
The customer may have additional requirements, e.g., inspection testing, greater frequencies, etc. When performing the job audit, the auditor shall verify heat treater is conforming to the customer's requirements.					
* Continuous furnace frequencies are per lot (work order) or as specified, whichever is more frequent.					
** Does not apply to furnaces operating below 760C (1400F).					
---- indicate "not applicable".					
Item #	Related HTSA Question #	Category/Process Steps	Batch Furnace	Continuous Furnace *	Generators
3.0		PROCESS MONITOR FREQUENCIES			
E3.1	1.4 2.14	Monitor primary temperature control instrument(s).	Each batch or continuous recording with sign-off every 2 hours. Alarm systems satisfy the sign-off requirement.	Each lot or continuous recording with sign-off every 2 hours. Alarm systems satisfy the sign-off requirement.	Each Shift
E3.2	1.4 2.14 3.7	Monitor generator atmospheres	----	----	Continuous
E3.3	1.4 2.14 3.7	Monitor primary furnace atmosphere control(s)**.	Continuous recording with sign-off every 2 hours. Alarm systems satisfy the sign-off requirement.	Continuous recording with sign-off every 2 hours. Alarm systems satisfy the sign-off requirement.	----
E3.4	1.4 2.14 3.7	Verify primary atmosphere control method by back-up method**.	Daily	Daily	Daily
E3.5	1.4 2.14 3.13	For salt baths: check salt chemistry (soluble oxides) in salt baths or decarburization on the parts.	Daily	Daily	----
E3.6	1.4 2.14	Monitor time in furnace, cycle time or belt speed.	Each batch	Twice/shift & after any change in the belt speed.	----
E3.7	1.4 2.7	Monitor load size or fixturing or loading rate as applicable.	Each batch	Twice/shift & after any change in loading rate.	----
4.0		IN-PROCESS/FINAL TEST FREQUENCIES			
E4.1	1.4 2.15	Microstructure (when specified)	Daily per furnace	Daily per furnace	----
E4.2	1.4 2.15	Surface hardness (when specified)	Each batch	Every 2 hours minimum	----
E4.3	1.4 2.15	Core hardness (when specified)	Each batch	Every 4 hours	----
5.0		SOLUTION TEST FREQUENCIES			
E5.1	2.13	Rust Preventive - Soluble Oil			
		- Concentration	2x / week	2x / week	----
E5.2	2.11	Washers			
		- Concentration of cleaner	Daily	Daily	----
		- Temperature of solution (required if temperature is specified to be above ambient temperature).	Each shift	Each shift	----