

Special Process: Heat Treat System Assessment			
Facility Name: STATE HEAT TREATING			
Address: 520 32ND ST. SE. GRAND RAPIDS, MICHIGAN 49548			
Number	616-243-0178	Type(s) of Thermal Processing at this Facility:	
Fax Number:	616-243-6337	Process Table A - Ferrous	
Number of Heat Treat Employees at this		Carburizing	X
Captive Heat Treater (Y/N):		Carbonitriding	X
Commercial Heat Treater		Carbon Correction	X
Date of Assessment:		Neutral Hardening	X
Date of Previous Assessment:		Quench & Temper	X
20-Feb-2010		Austempering / Martempering	
23-Mar-2009		Tempering	X
		Precipitation Hardening / Aging	X
		Process Table B - Ferrous	
		Nitriding (Gas)	
		Ferritic-Nitrocarburizing (Gas or Salt)	
		Process Table C - Aluminum	
		Aluminum Heat Treatment	X
		Process Table D - Ferrous	
		Induction Heat Treating	X
		Process Table E	
		Annealing	X
		Normalizing	X
		Stress-Relieving	X
Current Quality Certification(s):	ISO 9001:2008 REGISTRATION ENDING 02/19/2013		
Date of Re-assessment (if necessary):	02/19/2013		

Personnel Contacted:			
Name:	Title:	Phone:	Email:
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CHARLES TUTTLE	PRODUCTION SUPERVISOR	616-243-0178	charlie@stateheattreating.com
Auditors/Assessors:			
Name:	Company:	Phone:	Email:
PAUL VON EITZEN	G.A RICHARDS CO.	616-243-2800	paulvoneitzen@garichards.com
CHARLES TUTTLE	STATE HEAT TREATING	616-243-0178	charlie@stateheattreating.com
Number of "Not Satisfactory" Findings:			
0			
Number of "Needs Immediate Action" Findings:			
0			
Number of "Fail" Findings in the Job Audit(s):			
0			

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Number	Question	Requirements and Guidance	Objective Evidence	Assessment			
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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.	The owner Sue Boll has a BA in Chemistry & Paul Meengs has worked in the heat treat industry for 35+ years. Charles Tuttle, the plant supervisor has 12 years of heat treat experience.		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.	Every new part is reviewed and processed per a generic FEMA and CONTROL plan. Every part receives its own process with all changes and modifications recorded. See work instructions 7-10-102 Quality Planning, 7-20-603 Changes to requirements.		X		

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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.	FMEA's are done for families of parts and process's. Each plan is reviewed yearly with all changes recorded on the FMEA. See attached sample FMEA.		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. 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. 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. 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>Control plans are done for part/process families. Each plan is reviewed yearly with all changes recorded on the control plan. See attached copy of Control plan.</p>		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 specifications used for any given process will be indicated on the control plan and will be updated along with the review of the plan at its yearly review. All customer specifications will be reviewed at receipt and will not be controlled. Print revisions, if provided, will be recorded on our internal process and verified at order entry. See 4-23-104 PSD Management.		X		

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1.6	Is there a written process specification for all active processes?	<p>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.</p> <p>All active processes should have a written process specification.</p> <p>These process specifications may take the form of work instructions, job card, computer-based recipes, or other similar documents.</p>	<p>Each part is entered into a computer data base and has its own individual process. Along with the process is all routing and process parameters and any special instructions. Process Variables specific to each piece of equipment is posted at the control panel for operator review. See 7-10-102 Quality planning.</p>		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.	We do capability studies on each furnace line for each process family that is associated with that line. The data is taken from the lab checks of the product that is processed in that piece of equipment. See sample at g-data-WinWord-capability studies.		X		

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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.	Ongoing data collection is done on significant parameters for each process family. Each job that does not meet the requirements is recorded on a Problem Analysis and reviewed at ISO management meetings. See 8-50-301 Problem Analysis, 8-30-304 Work in process rejection.		X		
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.	All equipment with electronic data collection is reviewed daily via computer.		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.	All process elements of the ISO program are audited once per year by our internal auditor. Any item not dealt with in the ISO program will be reviewed on a yearly basis and updated as needed.		X		

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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.	Any part processed that does not meet the customers spec is placed on hold and reviewed by 1 of 2 persons authorized to place a rework instruction for reprocessing. All reworked parts are final inspected by shipping and receiving personnel and all rework instructions and results are documented on a new work order and recorded. See 8-30-303 Control of reworked product, 8-30-302 Disposition of nonconforming.		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.	Our top 40 customers are surveyed yearly and all results from the surveys tallied and added to the Management Review Meetings. All internal problems are put on a Problem Analysis and dealt with through our internal review process. See 8-21-601 Customer satisfaction.		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.	The review of the Control Plan and FEMA will show what is being done to improve quality and will be shown by the rpn numbers going lower with given improvements. Any major Continual Improvement project will be controlled by Work Instruction 8-50-306 Continuous Improvement		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.	1 Of 2 persons are authorized to release "ON HOLD" product and will document this on the work order or a Material Deviation report. See 8-30-303 Control of reworked product.		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.	All elements of our process flow have written procedures and are part of all employees training. We have these instructions available for review to all operators.		X		

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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.	Training starts from day 1 and is ongoing and fully documented. Each employee has an ongoing Employee Qualification on file with new levels added as required. See 6-20-402 Qualifying Employees.		X		
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.	An organizational chart is posted at the time clock listing the reporting structure of the company. In addition each persons job description lists their responsibility's, who they report to and their authority when dealing with rejects. See 5-00-401 Organization charts and 5-00-402 Job descriptions.		X		

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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.	A full and complete preventive maintenance program (Maintimizer) is written and used. The PM assignments are reviewed monthly with changes and modifications documented. All maintenance purchasing and inventory is maintained within this program. All critical parts are listed and purchased from approved suppliers only. See 7-40-502 Approved suppliers and 7-40-503 Purchase order & review.		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.	See 1.18		X		

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2.1	Does the facility ensure that the data entered in the receiving system matches the information on the customer's shipping documents?	<p>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.</p> <p>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.</p> <p>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.</p>	<p>All incoming product is reviewed for accuracy at receiving. All information provided is verified with our process and recorded on the customers document. Any discrepancies are documented and product is placed on hold pending a review by engineering. See 7-20-601 Products requirements review.</p>		X		
2.2	Is product clearly identified and staged throughout the heat treat process?	<p>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.</p>	<p>All product is staged in set areas waiting for processing. During process it is identified by load tags and with the work order. All finished product is in a "done ready to ship" area with all parts identified with the work order. See 7-50-202 Work order/data sheet.</p>		X		

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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.	All lots have their own work order. All work orders are kept separate during processing and will remain so during shipment back to the customer. See 7-50-205 Identification and traceability		X		
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.	All product that does not meet the customers specifications will be red tagged / and or rejected on the work order and placed in the "hold area" See 8-30-301 Identity / control nonconforming.		X		

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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.	The preventative maintenance program generates a work order for a review of each lines operation and identify additional areas for improvement.		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.	Each container is removed from the loading area and looked at prior to returning to the finished parts area. Any foreign material is removed.		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.	All process's have loading requirements documented on the work order. The operator logs the loading on the furnace log each order and at shift change. This is verified by shift supervisor and reviewed by management daily. See 7-50-203 Process validation.		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.	Our Work in Process rejection procedure covers all nonconforming situations and is part of all employees regular training. See 8-30-304 Work in process rejection.		X		

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2.9	Is the handling, storage and packaging adequate to preserve product quality?	<p>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.</p> <p>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.</p>	<p>Each process that is assessed to potentially damage a part during transport, loading, processing, unloading and transport has special processing for hand load, hand unload, special racking instructions, and / or special shipping instructions. See 7-50-207 Preservation of product.</p>		X		
2.10	Are plant cleanliness, housekeeping, environmental and working conditions conducive to control and improved quality?	<p>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.</p>	<p>A plant survey is done by an internal auditor monthly to evaluate the plant for building maintenance, lighting, cleanliness, and organization. This is one of the Management review measurables. See 6-30-205 Housekeeping.</p>		X		

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2.11	Are parts free from contaminants that would be detrimental to the heat treatment of the product?	<p>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.</p> <p>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.</p>	<p>Any part with detrimental amounts of oils or drawing compounds are prewashed and all product is post washed prior to temper. All washers are on a preventive maintenance program and checked and recorded 3 times per week. Additions are recorded and evaluated. We do not find any need for daily checks with the data showing no out of tolerance readings on a 3 day schedule. All washer concentrations are verified by the soap supplier quarterly or as needed.</p>		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.	The oil levels are checked manually every other day. All levels are recorded and documented on the pm request. The temperature, agitation speed, time in the quench are all automatically controlled. Quench delay timers and alarms are available on each furnace.		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.	The only analysis done on this product is to check for density. This will be performed by the supplier quarterly.		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 required process control parameters are continuously recorded and signed off by the operator at shift change at least every 8 hours. This is verified every 3 hours by the shift supervisor.		X		

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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.	Yes. See shop records. See 8-24-201 Work in process inspection and 8-24-301 Final inspection.	X			
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.	An outside service does the calibrations on all test equipment semi-annually. All test equipment is verified internally on a daily basis. See 7-60-301 Inspection measuring and testing equipment ID & Schedule and 7-60-305 Calibration records.	X			
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 equipment has automatic temperature controls, cycle timers, agitation control, carbon control, oil temperature and flow scopes for each zone. All controls are calibrated semi-annually.	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.	All calibrations are posted at/on the control or equipment being certified. All internal verifications are also posted at the equipment	X			

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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.	All thermocouples are changed out per our pm program semiannually. All protection tubes are evaluated at the same time.		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.	We use the ongoing capability studies to assure ourselves that the equipment can meet the requirements		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.	Data collection program shows the temperatures to be with-in the given range.		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.	All alarms are posted at each piece of equipment with a PM done quarterly to verify all alarms.		X		

Special Process: Heat Treat System Assessment							
Number	Question	Requirements and Guidance	Objective Evidence	Assessment			
				N/A	Satisfactory	Not Satisfactory	Needs Immediate Action
3.7	Are generators and furnace atmospheres continuously monitored, automatically controlled, and documented?	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. 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 systems 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.	All furnaces are automatically controlled and recorded. The carbon controllers are verified by dew point daily. The generators are monitored continuously and recorded.		X		

Special Process: Heat Treat System Assessment							
Number	Question	Requirements and Guidance	Objective Evidence	Assessment			
				N/A	Satisfactory	Not Satisfactory	Needs Immediate Action
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.</p> <p>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.</p> <p>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 	<p>All back-up checks are recorded on the data collection program and a maintenance work order will record the problem and the correction. The data collection program will show the correlation between the two readings.</p>		X		

Special Process: Heat Treat System Assessment							
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. 	All equipment with ammonia available have quick disconnects installed and used. The furnace log sheet will show the addition or removal of the line.		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>	Procedure OI-008 instructs the operator to have the ammonia off for 4 hrs prior to running any neutral harding work.		X		

Special Process: Heat Treat System Assessment							
Number	Question	Requirements and Guidance	Objective Evidence	Assessment			
				N/A	Satisfactory	Not Satisfactory	Needs Immediate Action
3.11	Do all atmosphere furnaces and generators have flow scopes or flow meters for all gases?	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.	All furnaces and generators have flow scopes for all gases.	X			
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.	n/a				
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.	n/a				
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. 	All furnaces have the quenchant checked by an outside lab 4 times per year.	X			
FOR INDUCTION HEAT TREATING							
3.15	Is the position 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.	Either a scanner with optical sensors or specific fixtures are used to assure that parts are properly located.	X			

Special Process: Heat Treat System Assessment							
Number	Question	Requirements and Guidance	Objective Evidence	Assessment			
				N/A	Satisfactory	Not Satisfactory	Needs Immediate Action
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. <ul style="list-style-type: none"> • 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. 	Each machine has a power setting control.		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. <ul style="list-style-type: none"> • 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. 	Each coil is ID'd and tied to the part with a set-up instruction.		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.	All equipment has automatic quench on and timers for duration.		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	Each job has a set-up instruction and first piece inspection.		X		

Section 4 - Job Audit

Job Identity:

Customer: Century Foundry
 Shop Order Number: 313025
 Part Number: 428632-01
 Part Description: Block
 Material: 356
 Heat Treat Requirements: BHN 75min

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	Incoming P.O	PASS
4.2	Does the heat treat facility have the customer specifications for the part?	1.5		N/A	Print	PASS
4.3	Is a shop traveler created to meet customer requirements?	1.6 2.1		313025		PASS
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		CSP#1522		PASS
4.5	Is there documented evidence of Receiving Inspection?	2.1			Highlighted	PASS
4.6	Are the Loading / Racking requirements identified?	1.6 2.7 2.9		313025	Hand Load	PASS
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		313025	Log Sheet	PASS
	TEMPERATURE		990 degrees F		SAME	
	QUENCH TYPE		Water			
	AGE TEMPERATURE		325 degrees F			

4.8	What are the product inspection requirements?	2.15	BHN 75 MIN	SAME	85-89	PASS
4.8.1	Requirement: (1)		Surf			
	Test Method:		BHN			
	Test frequency or quantity:		3 Per Order	SAME	85-89	PASS
	Selection of samples:		Random			
	Specification:		BHN 75 MIN			
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:					
	Selection of samples:					
	Specification:					
Operator or Inspector Responsibilities						
4.9	Were appropriate process steps signed off?	1.4 2.2 2.3 2.14		313025	YES	PASS
4.10	Were all inspection steps, as documented in the control plan performed?	1.2 1.4		313025	YES	PASS
4.11	Were steps/operations performed that were not documented in the control plan?	1.2 1.4 1.6			NO	PASS
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			NO	PASS
4.14	If the order was certified, did the certification accurately reflect the process performed?	2.14 2.15			NO	PASS
4.15	Was the certification signed by an authorized individual?	1.17			NO	PASS
4.16	Are the parts and containers free of inappropriate objects or contamination?	2.6 2.11		Visual	YES	PASS
Packaging Requirements						
4.17	Are packaging requirements identified?	2.9		313025	1 Box/Skid	PASS
4.18	Are parts packaged to minimize mixed parts (for example, parts packed over height of container)?	2.9		Visual	Yes	PASS
Shipping Requirements						
4.19	Were the parts properly identified?	2.3 2.9		Visual	Yes	PASS
4.20	Were the containers properly labeled?	2.3 2.9		Visual	Yes	PASS



Section 4 - Job Audit

Job Identity:

Customer: Leedy Manufacturing
 Shop Order Number: 312951
 Part Number: VEN-99
 Part Description: Wheel
 Material: Gray Iron
 Heat Treat Requirements: Surf Hardness RC45-50

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	YES	N/A	Incoming P.O	PASS
4.2	Does the heat treat facility have the customer specifications for the part?	1.5	YES	N/A	Print	PASS
4.3	Is a shop traveler created to meet customer requirements?	1.6 2.1	YES	312951		PASS
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	YES	CSP#1431		PASS
4.5	Is there documented evidence of Receiving Inspection?	2.1	YES	P.O. #101790	Highlighted	PASS
4.6	Are the Loading / Racking requirements identified?	1.6 2.7 2.9	YES	Rack		PASS
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	YES	312951	Furnace Log P64-4/09/10	PASS
	Furnace Temperature	4.7	1600 degrees F	} 312951	Furnace Log	PASS
	Quench Type	4.7	High Oil			
	Carbon	4.7	.45c			
	Draw Temperature	4.7	500 degrees F			

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	RC 45-50	II-069	RC 45, 46, 47	PASS
4.8.1	Requirement: (1)		As quenched			
	Test Method:		Rockwell "C"			
	Test frequency or quantity:		1pc 1st loos/Every 4hr	312951	RC 53, 54 X2	PASS
	Selection of samples:		Random			
	Specification:		RC 45-50			
4.8.2	Requirement: (2)		After temper	312951	RC 45,46, 47	PASS
	Test Method:		3 per order			
	Test frequency or quantity:					
	Selection of samples:					
	Specification:					
4.8.3	Requirement: (3)		Mount file			
	Test Method:		BHN	312951	BHN 444	PASS
	Test frequency or quantity:		1 per order			
	Selection of samples:		Random	D4-4-10		
	Specification:		BHN 415 min-mount			
4.8.4	Requirement: (4)		mount			
	Test Method:		knoop			
	Test frequency or quantity:		1 per order	D4-4-10	RC 50	PASS
	Selection of samples:		Random			
	Specification:					
Operator or Inspector Responsibilities						
4.9	Were appropriate process steps signed off?	1.4 2.2 2.3 2.14		312951	YES	PASS
4.10	Were all inspection steps, as documented in the control plan performed?	1.2 1.4		312951	YES	PASS
4.11	Were steps/operations performed that were not documented in the control plan?	1.2 1.4 1.6			NO	PASS

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
4.12	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			YES	PASS
4.14	If the order was certified, did the certification accurately reflect the process performed?	2.14 2.15		312951	YES	PASS
4.15	Was the certification signed by an authorized individual?	1.17		312951	YES	PASS
4.16	Are the parts and containers free of inappropriate objects or contamination?	2.6 2.11		Visual	YES	PASS
Packaging Requirements						
4.17	Are packaging requirements identified?	2.9		312951	3 crates	PASS
4.18	Are parts packaged to minimize mixed parts (for example, parts packed over height of container)?	2.9		Visual	Stacked neatly	PASS
Shipping Requirements						
4.19	Were the parts properly identified?	2.3 2.9		312951	YES	PASS
4.20	Were the containers properly labeled?	2.3 2.9		312951	YES	PASS

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 austenitizing 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 - Quenchability Check; e.g., cooling curve, viscosity, or titration	Daily Every six months	Daily 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. - Suspended solids	Daily Every six months	Daily 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 - Temperature of solution (required if temperature is specified to be above ambient temperature).	Daily Each shift	Daily Each shift	----- -----

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
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.	-----	-----	-----	-----

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)

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
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)

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
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

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
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)

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
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

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

<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
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	<p>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).</p> <p>(1) The CTS shall be +/- 5C (or +/- 10F) of a CTTS at the operating temperature range; this checked shall be performed monthly.</p> <p>(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.</p> <p>Any actions to correct a failing reading or validate a test result shall be documented.</p> <p>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.</p> <p>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.</p> <p>Protection Tubes shall be visually checked at same frequency as thermocouples.</p>	Yes	Yes	Yes

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
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

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
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 - Suspended solids - Quenchability Check; e.g., cooling curve, viscosity, or titration.	Daily Every six months Every six months	Daily 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 - Temperature of solution (required if temperature is specified to be above ambient temperature).	Daily Each shift	Daily Each shift	Daily Each shift

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

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
2.0		PYROMETRY	
D2.1	3.2	Infrared pyrometers shall be calibrated to a black body furnace annually.	-----
3.0		PROCESS MONITORING FREQUENCIES	
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).			
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

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
5.0		QUENCHANT AND SOLUTION TEST FREQUENCIES	
		Quench Media Controls If Applicable	
D5.1	2.12	Polymer Quench Media	
	3.14	- Concentration	Once per day
		- Quenchability Check; e.g., cooling curve, viscosity, or titration	Monthly
D5.2	2.12	Water Quench Media	
	3.14	- Suspended solids	Quarterly
D5.3	2.12	Brine or Caustic Quench Media	
	3.14	- 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

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
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	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	-----

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	----