Special Process: Heat Treat System Assessment

Facility Name: State Heat Treating Company			
Address: 520 32nd ST SE, Grand Rapids, MI. 49548			
Phone Number: 616.243.0178		Fax Number: 616.243.6337	
Date of Assessment:	10.09.2024	Date of Previous Assessment:	10.09.2023
Internal (Captive) Heat Treater (Y/N):	N	Commercial Heat Treater (Y/N):	Y

Type(s) of Thermal Processing at this Facility:

Process Table A		**Process Table D**	
Carburizing	YES	Induction Heat Treating	NO
Carbonitriding	YES	**Process Table E**	
Carbon Restoration	NO	Annealing	YES
Neutral Hardening (Quench and Temper)	YES	Normalizing	YES
Austempering / Martempering	NO	Stress-Relieving	YES
Tempering	YES	**Process Table F**	
Precipitation Hardening / Aging	AGING ONLY	Low Pressure Processing (Carburizing / Carbonitriding / Neutral Hardening)	NO
Process Table B		**Process Table G**	
Nitriding (Gas)	NO	Sinter Hardening	NO
Ferritic-Nitrocarburizing (Gas or Salt)	NO	**Process Table H**	
Process Table C		Ion Nitriding	NO
Aluminum Heat Treatment	YES	**Process Table I**	
		Hot Stamping	NO

Current Quality Certification(s): ISO-9001:2015

Date of Re-assessment (if necessary): 01-22-2025

Personnel Contacted:

Name:	**Title:**	**Phone:**	**Email:**
NATE LEASK	PLANT MANAGER	616.719.9473	nleask@garichards.com
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Auditors/Assessors:

Name:	**Company:**	**Phone:**	**Email:**
ARI DITTA	STATE HEAT TREATING	616.514.9204	aditta@garichards.com

Number of "Not Satisfactory" Findings: 0

Number of "Needs Immediate Action" Findings: 0

Number of "Fail" Findings in the Job Audit(s): 0

Section 1 - Management Responsibility and Quality Planning

Please describe Objective Evidence for each Requirement

1.1 Is there a dedicated and qualified heat treat person on-site?

To ensure readily available expertise the following requirements shall be met.

Requirements	Objective Evidence	Assessment			
		N/A	Satisfactory	Not Satisfactory	Needs Immediate Action
There shall be a dedicated and qualified full-time heat treat person on site.	JD-009 (Quality Technician) require education and five years of heat treat experience.		X		
The position shall be reflected in the organization chart.	WI-5-001-A Organization Chart		X		
A job description shall exist identifying the qualifications for the positions including appropriate metallurgical and heat treat knowledge for the individuals.	JD-009 (Quality Technician) require education and five years of heat treat experience.		X		
Evidence shall be available regarding the qualifications with a minimum of 5 years experience in heat treat operations or as a combination of a minimum of 5 years of formal metallurgical education and heat treat experience.	JD-009 (Quality Technician) require education and five years of heat treat experience.		X		

Comments:

1.2 Does the heat treater perform advanced quality planning?

The organization shall incorporate a documented advance quality planning process. A structured system for such process with the APQP elements is recommended, samples are available in the AIAG APQP manual or other equivalent national automotive industry standards. Similar parts can be grouped into part families for this effort as defined by the organization.

Requirements	Objective Evidence	Assessment			
		N/A	Satisfactory	Not Satisfactory	Needs Immediate Action
There shall be documented advance quality planning procedure available.	See WI-7-001 Product Process and Realization. APQP required fields are utilized in the ERP software.		X		
Feasibility studies shall be performed and internally approved for each part or group of similar parts.	Every part receives its own process with all changes and modifications recorded in the Part Master File.		X		
There shall be a documented system for process changes with approval by the customer.	Every new part is reviewed and processed per a family FMEA and control plan.		X		

Comments:

1.3 Are heat treat FMEAs up to date and reflecting current processing?

Failure Mode and Effects Analysis (FMEA) for processes (PFMEA) is mandatory for the prevention of product/process failure modes and final product concerns. Examples of appropriate methods and standards include SAE J1739, AIAG & VDA FMEA Handbook.

Requirements	Objective Evidence	Assessment			
		N/A	Satisfactory	Not Satisfactory	Needs Immediate Action
There shall be a documented Failure Mode and Effects Analysis (FMEA) procedure with the present FMEAs updated and reflecting the current part quality status.	FMEAs are done for families of parts and processes.		x		
FMEAs shall address all process steps from part receipt to part shipment and all the key heat treat process parameters as defined by the organization.	FMEAs are done for families of parts and processes and mimic the BOM.		x		
All special characteristics, as defined by the organization and its customers, shall be identified, defined, and addressed in the FMEA.	Each plan is reviewed yearly with all changes recorded on the FMEA located in their respective parts families.		x		
A cross-functional team shall be used in the development of the FMEA and shall be consistent with all associated documentation such as Control Plans, work instructions and shop travelers.	Each plan is reviewed yearly with all changes recorded on the FMEA located in their respective parts families.		x		

Comments:

1.4 Are heat treat process control plans up to date and reflecting current processing?

Reference automotive industry Control Plan guidelines. The Control Plan may be specific for each part or part family or it can be process specific and written for each process. In any case it describes required controls and actions for each process step as well as periodic requirements to assure process is in control.

Requirements	Objective Evidence	Assessment			
		N/A	Satisfactory	Not Satisfactory	Needs Immediate Action

The organization shall incorporate the use of a documented Control Plan reflecting the current process.	Control Plans are done for families of parts and processes.		x		
Control Plans 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.	Control Plan are done for families of parts and processes and mimic the BOM.		x		
A cross-functional team shall be used in the development of the Control Plan and shall be consistent with all associated documentation such as FMEAs, work instructions and shop travelers.	Each plan is reviewed yearly with all changes recorded on the Control Plan located in their respective parts families.		x		
All special characteristics as defined by the organization or its customers shall be identified, defined, and addressed in the applicable control plan.	Each plan is reviewed yearly with all changes recorded on the Control Plan located in their respective parts families.		x		
Sample sizes and frequencies for evaluation of process and product characteristics shall be addressed and shall be consistent with the minimum requirements listed in the applicable Process Table.	Internal standard work instructions define the sample sizes and frequencies per the applicable process tables.		x		
Comments:					

1.5 Are all heat treat related and referenced specifications current and available?

A document control system is pertinent for the handling and internal distribution of received customer specifications and to keep up to date with national or global standards related or close to heat treat processes.

		Assessment			
Requirements	**Objective Evidence**	**N/A**	**Satisfactory**	**Not Satisfactory**	**Needs Immediate Action**
The organization shall have a procedure and process to ensure the timely review, distribution and implementation of all customer and industry engineering standards/specifications and changes based on customer-required schedule.	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.		x		
The organization shall have all related heat treat and customer referenced standards and specifications available for use, like but not limited to SAE, AIAG, ASTM, ISO, EN, JIS, General Motors, Ford, and FCA.	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. All specifications are purchased as needed and electronically filed in a rational hierarchical manner.		x		
The procedure shall include a 2-week distribution limit for cascading newly received and reviewed documents.	Should any changes be needed, the ERP will be updated to reflect any requested changes.		x		
Comments:					

1.6 Is there a documented system to create process specifications for all active processes?

A documented system for creating process specifications is necessary for operating the heat treat process within the desired, requested process parameters to reach the final product specifications. Examples of process parameters include process temperatures, cycle times, load rates, atmosphere or gas flow settings, belt speeds, quench agitation speeds, etc.

		Assessment			
Requirements	**Objective Evidence**	**N/A**	**Satisfactory**	**Not Satisfactory**	**Needs Immediate Action**
Authorization shall be defined to a responsible person (see 1.1) for establishing process specification for the heat treatment of the products with the available equipment.	Quality Technician is responsible for establishing process specification.		x		
The heat treater shall have written process specifications for all active processes and identify all steps of the process including relevant process parameters.	All written process specs and BOM is listed in ERP Master Parts File; and all revisions are recorded in the change history.		x		
Parameters shall have operating tolerances as defined by the organization in order to maintain process control.	Process Variables are reviewed annually and listed on the control panel next to each furnace.		x		
Process specifications shall be available in the form of work instructions, job card, computer-based recipes, or other similar documents.	Several levels of standard work instructions exist in the QMS to define the process specifications.		x		
All process specification changes shall be reviewed to the extent necessary to ensure continued conformity with customer requirements for process changes.	All written process specs and BOM is listed in ERP Master Parts File; and all revisions are recorded in the change history.		x		

All process specification changes shall be documented to include the date the process specification change was implemented and the person(s) approving the change.	All written process specs and BOM is listed in ERP Master Parts File; and all revisions are recorded in the change history.		x		
Comments:					

1.7 Has the heat treat process been validated initially and after process equipment has been relocated, or had a major rebuild or modification?

To demonstrate each heat treat process is capable of yielding acceptable product, the organization shall perform process validation as part of the initial validation of each process, after relocation of any process equipment or heat treat location change, and after a major rebuild of any equipment. Each process line may include a combination of equipment that is integrated in the performance of a heat treat process, e.g.

		Assessment			
Requirements	**Objective Evidence**	**N/A**	**Satisfactory**	**Not Satisfactory**	**Needs Immediate Action**
The organization shall define what constitutes a major rebuild or modification that may impact product characteristics.	Modifications or rebuilds that affect atmosphere are subject to new capabilitiy studies to validate both the process variables and also the process specifications.		x		
Process validation shall be performed on full production load, or production run, with production intended fixturing and load configuration.	Lab results tell us if we are in control of each process based on the specifcations required from each part.		x		
An action plan shall exist if process control parameters or any of the product characteristics fall outside of the control tolerance limits or the heat treater does not conform to the respective Process Table.	There is standard work that defines the handling of non-conforming material. P-8-002 Control of Nonconforming Product		x		
The heat treater shall demonstrate that all parts in the heat treat process (heat treat batch or production run) will meet customer specifications. Samples for these tests shall be selected that best represent the entire production load population. • An acceptable guideline for test sample locations is to use those loading locations	We perform capability studies on each furnace line for each process family that is associated with that line. We also do capability studies at level 2 inpections. Operators will also do capability studies if they run out of room on work orders.		x		
Comments:					

1.8 Does the heat treater collect and analyze data over time, and react to this data?

The analysis of product characteristics (e.g. tensile strength) and processes parameters (e.g. temperature) over time can yield vital information for defect prevention efforts. Examples include but are not limited to product property trend charts, scrap trends, and variation in process parameter recordings.

		Assessment			
Requirements	**Objective Evidence**	**N/A**	**Satisfactory**	**Not Satisfactory**	**Needs Immediate Action**
The organization shall have a system to collect, analyze, and react to product or process data over time.	Ongoing data collection is done on significant parameters for each process family.		x		
Methods of analysis shall include ongoing trend or historical data analysis of product characteristics or process parameters.	Certs are maintained with hardness results as well as case depth analysis. We are also working on SPC for case depth analysis.		x		
The organization shall determine which parameters are included in such analysis.	Certs are maintained with hardness results as well as case depth analysis. We are also working on SPC for case depth analysis.		x		
Comments:					

1.9 Is the heat treat monitoring system reviewed by Qualified Personnel?

This review is intended to be a second level review in addition to those performed by the heat treat operators. This review would be performed by qualified personnel as defined per question 1.17. 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.

		Assessment			
Requirements	**Objective Evidence**	**N/A**	**Satisfactory**	**Not Satisfactory**	**Needs Immediate Action**
Qualified Personnel shall review the furnace monitoring systems at intervals not to exceed 24 hours.	All equipment with electronic data collection is reviewed daily via computer and furnace monitoring software.		x		
The process of reviewing the furnace data shall be documented. This requirement also applies to computerized data.	Process is documented daily via Furnace Trend Sign Off Log Sheet WI-7-003-CC.		x		

This second level review shall include detection and reaction to out of control conditions or alarms. This reaction shall be documented.	Action is required on LPA results that are lower than acceptable tolerances.		x		
Comments:					

1.10	**Are internal assessments being completed on an annual basis, at a minimum, using AIAG HTSA?**				
The internal assessment includes a completed job audit and process table for each applicable process.					
		Assessment			
Requirements	**Objective Evidence**	**N/A**	**Satisfactory**	**Not Satisfactory**	**Needs Immediate Action**
The organization shall conduct internal assessments on an annual basis, at a minimum, using the current revision of the AIAG HTSA.	The Heat Treat Process Assessment is reviewed and updated yearly per this CQI-9.		x		
Comments:					

1.11	**Does the heat treater have a documented procedure for the rework/reprocessing of parts?**				
Rework/Reprocessing of heat treated components can have a significant impact on the performance of the component. Reworking/Reprocessing in some cases is an acceptable practice. A rework/reprocessing procedure is key to identifying the rework/reprocessing practice. To be approved for rework/reprocessing, either on a case by case basis or pre-approved in the PPAP, the heat treater shall meet the following.					
		Assessment			
Requirements	**Objective Evidence**	**N/A**	**Satisfactory**	**Not Satisfactory**	**Needs Immediate Action**
Any change or addition to the rework/reprocessing procedure shall require notification and approval in accordance with the AIAG PPAP process. Any rework/reprocessing not previously approved and identified in the rework/reprocessing procedure is not allowed.	Any part processed that does not meet the customers spec is placed on hold and reviewed by authorized people. A rework instruction is required for reprocessing. All reworked parts are final inspected byplant manager or quality. All rework instructions and results are documented on a new work order and recorded. See WI-8-002 Controlling Nonconforming.		x		
The OEM shall be notified by the Tier 1 supplier prior to rework/reprocessing product utilizing an unapproved process. If not Tier 1, the customer shall be notified.	All re-work affecting results or changing based on revision levels is documented via WI-7-003-P Material Deviation-Suspect Material Notification and also ERP change log.		x		
The rework/reprocessing procedure shall be referenced in the heat treater's PPAP approved PFMEA and process control plan.	Process Flow indicates that parts not meeting results are placed on hold for disposition. Re-work steps for re-tempering are added to the Control Plan and PFMEA.		x		
The rework/reprocessing procedure shall include the following: • A description of product characteristics for which rework/reprocessing is allowed and those characteristics for which rework/reprocessing is not permissible. • A requirement that all rework/reprocessing activity have a new process control sheet issued	All rework instructions and results are documented on a new work order and recorded. See WI-8-002 Controlling Nonconforming.		x		
Comments:					

1.12	**Does the Quality Department review, address, and document customer and internal concerns?**				
		Assessment			
Requirements	**Objective Evidence**	**N/A**	**Satisfactory**	**Not Satisfactory**	**Needs Immediate Action**
The quality management system shall include a process for documenting, reviewing, and addressing customer concerns and any other concerns internal to the organization.	All internal and external problems are put in the Customer Complaint Log and dealt with through our internal review process.		x		
A disciplined problem-solving approach shall be used.	See WI-8-001-B Observation-NC-OFI (or customer form).		x		
Comments:					

1.13	**Does the organization have a Continual Improvement Plan (CIP)?**
Continual improvement is an ongoing effort in the organization to improve processes, services, or products. These efforts may seek incremental improvement over time or breakthrough improvement all at once. A CIP identifies specific continual improvement items, responsibilities and estimated completion dates. Downtime reports, scrap reports, preventive maintenance reports, energy consumption, use of medias, etc., may be used	

		Assessment			
Requirements	**Objective Evidence**	**N/A**	**Satisfactory**	**Not Satisfactory**	**Needs Immediate Action**
The organization shall have continual improvement plan(s).	Reviewed at annual management review meeting.		x		
The CIP shall have specific action items, identify responsibilities and target completion dates for each action item.	Any major Continual Improvement project will be controlled by Work Instruction WI-8-004 Continual Improvement.		x		
The organization shall show evidence of program execution.	Shown through Continous Improvement Log WI-8-004		x		
Comments:					

1.14 Does the organization have a documented procedure for the control of nonconforming material?

This practice is the responsibility of the manufacturers' quality management organization and their included personnel. The procedure should best describe the complete process with the handling of nonconforming or suspect products, beginning with detection and the authorization/obligation to quarantine these products up to the final decision and disposition in quarantine status.

		Assessment			
Requirements	**Objective Evidence**	**N/A**	**Satisfactory**	**Not Satisfactory**	**Needs Immediate Action**
The documented procedure shall specify the responsibilities for handling segregation and disposition of suspect or non-conforming products.	Quality manger and plant manager are authorized to release "ON HOLD" product and will document this on the new rework work order or a Material Deviation report.		x		
The organization shall keep records showing evidence of process being followed.	See WI-8-002 Controlling Nonconforming.		x		
Comments:					

1.15 Are there procedures or work instructions available to the heat treat personnel that define the heat treating process?

		Assessment			
Requirements	**Objective Evidence**	**N/A**	**Satisfactory**	**Not Satisfactory**	**Needs Immediate Action**
There shall be procedures or work instructions available to all employees involved in heat treating and inspection of heat treated product.	All elements of our process flow have written procedures and are part of all employees training. These are located in Level 4 of the QMS.		x		
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.	WI-7-003 Production outlines the product procedures as well as the manufacturing process map.		x		
Comments:					

1.16 Is management providing employee training for heat treating?

		Assessment			
Requirements	**Objective Evidence**	**N/A**	**Satisfactory**	**Not Satisfactory**	**Needs Immediate Action**
The organization shall provide employee training (including follow up and ongoing training) for all heat treating and inspection operations, including backup and temporary employees.	WI-6-001-F Employee Qualification - Level 5, and WI-6-001-O Operator Training Matrix - Level 5		x		
Management shall define the qualification requirements for each function.	WI-6-001-F Employee Qualification - Level 5		x		
Documented evidence of training and training effectiveness shall be maintained.	Testing is indivdual funciton based (forklift, Rockwell hardness, Level 1 inspect test, Level 2 inspect test, etc…) and stored in each employee's HR training folder.		x		
Operators shall be trained in material handling, containment action, and product segregation in the event of an equipment emergency including power failure.	Trained with WI-7-003 Production and P-8-002 Control of Nonconforming Product		x		
Comments:					

1.17 Are all key management and supervisory functions (in regards to Heat Treatment) performed by qualified personnel?

Key management and supervisory functions, in regards to heat treatment, are critical to ensure both process stability and product quality. This can be accomplished in several different ways. Some examples to consider are a responsibility matrix, the organizational chart, job descriptions, or incorporation into other similar system documentation.

Requirements	Objective Evidence	Assessment			
		N/A	Satisfactory	Not Satisfactory	Needs Immediate Action
The organization shall define and document, key management and supervisory functions in regards to heat treatment.	WI-6-001-Q Key Management Responsibility Matrix		x		
This documentation shall clearly identify both primary and secondary (backup) personnel.	WI-6-001-Q Key Management Responsibility Matrix		x		
This information shall be readily available to appropriate personnel.	WI-6-001-Q Key Management Responsibility Matrix		x		
Comments:					

1.18 Is there a preventive maintenance program? Is maintenance data being utilized to form a predictive maintenance program?

Preventive maintenance is essential to ensure equipment, machines and tools are kept in appropriate condition for the manufacturing of products at desired quality and capacity levels. The organization shall comply with the following requirements.

Requirements	Objective Evidence	Assessment			
		N/A	Satisfactory	Not Satisfactory	Needs Immediate Action
The organization shall have a documented preventive maintenance program for all heat treat process equipment.	A full and complete preventive maintenance program (MaintiMizer) is written and used.		x		
The program shall be a closed-loop process that tracks maintenance efforts from request to completion to assessment of effectiveness.	All maintenance work orders maintained within program (MaintiMizer).		x		
Equipment operators shall have the opportunity to report problems, and the problems shall be handled in a closed-loop manner.	Operators may submit maintenance requests directly to maintenance to be managed in MaintiMizer.		x		
The 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 maintenance program.	See Maintenance Work Instructions MI-005.		x		
Maintenance data shall be collected and analyzed as part of the defined predictive	Handled in Management Review		x		
Comments:					

1.19 Has the Heat Treater developed a critical spare part list and are the parts available to minimize production disruptions?

The critical spare parts list and available inventory is typically comprised of long lead time components such as (but not limited to) burners, fans, rolls, belts and other alloy parts. Availability of spare parts may be maintained on-site or off-site (for example, consignment) as identified by the heat treater.

Requirements	Objective Evidence	Assessment			
		N/A	Satisfactory	Not Satisfactory	Needs Immediate Action
The heat treater shall develop and maintain a critical spare parts list.	All critical parts are listed and purchased from approved suppliers only. See WI-7-002-B Approved Vendor List.		x		
The heat treater shall ensure the availability of critical spare parts to minimize production disruptions.	Critical Parts in Inventory MI-003.		x		
Comments:					

1.20 Is material from different heat lots which may preclude achieving the specified metallurgical properties prevented from being processed together?

Batch to batch variation may have an adverse effect on metallurgical properties. This variation may require that batches be processed separately.

Requirements	Objective Evidence	Assessment			
		N/A	Satisfactory	Not Satisfactory	Needs Immediate Action
Where appropriate, the heat treater shall have a material product flow management system to prevent the processing of mixed batches.	All orders are run separately and lot controlled. Each Purchase Order receives a new Work Order per part number and lot segregation is enforced. APQP is performed to ensure proper recipes, Work Orders are created to ensure proper recipes and cycle per part are used, and scheduling is performed to run parts requiring similar atmosphere in efficient orders, but not mixed.		x		
Comments:					

Section 2 - Floor and Material Handling Responsibility

Please describe Objective Evidence for each Requirement

2.1 Does the heat treat responsible organization ensure that customer data entered in the process tracking system matches the customer order?

It is critical that all customer requirements and lot identification be adequately transferred to internal heat treat documents. This also applies to captive heat treaters and their internal material flow.

		Assessment			
Requirements	**Objective Evidence**	**N/A**	**Satisfactory**	**Not Satisfactory**	**Needs Immediate Action**
The heat treater shall establish a documented product tracking system (e.g. shop travelers, work orders, etc.) which supports the heat treatment with relevant product and process information.	All incoming product is reviewed for accuracy at receiving. All information provided is verified with our process and recorded on the customers' document. See WI-7-001-C and WI-7-001-D. See SHP-003 (WO) and SHP-013 (Receipt of CSP).		x		
The heat treat organization shall establish a system to detect and resolve discrepancies on received products and corresponding customer information.	Any discrepancies are documented and customer is notified of discrepancy.		x		

Comments:

2.2 Is product clearly identified and staged throughout the heat treat process?

Product identification, process status and location of products with their process status are important to prevent incorrect processing or mixing of lots.

		Assessment			
Requirements	**Objective Evidence**	**N/A**	**Satisfactory**	**Not Satisfactory**	**Needs Immediate Action**
There shall be a procedure for part and container identification to avoid incorrect processing or mixing of lots.	All work in the facility is identified by a work order and all product is audited for work orders, CSP, load tags, and basket markings via Weekly Plant Audit WI-7-003-V.		x		
Non-heat treated, in-process, and finished product shall be properly segregated in clearly identified locations.	All product is staged in set areas waiting for processing. During processing it is identified by load tags and with the work order and the furnace log. All finished product is in a "done ready to ship" area with all parts identified with the work order. See WI-7-003-A Work order/data sheet guide lines.WI-7-003-B - customer supplied product tags.		x		

Comments:

2.3 Is lot traceability and integrity maintained throughout all processes?

		Assessment			
Requirements	**Objective Evidence**	**N/A**	**Satisfactory**	**Not Satisfactory**	**Needs Immediate Action**
Lot traceability shall be maintained throughout the entire process.	All lots have their own work order. All work orders are kept separate during processing and remain so during shipment back to the customer. See WI-7-003-B CSP, WI-7-003-A. Customer PO=>Incoming Paperwork=>CSP=>Work Order=>Shipper=>Invoice		x		

Comments:

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.

		Assessment			
Requirements	**Objective Evidence**	**N/A**	**Satisfactory**	**Not Satisfactory**	**Needs Immediate Action**
Procedures shall exist addressing proper disposition, product identification, and tracking of material flow in and out of the hold area.	Product shall be logged in the Customer Complaint Log via WI-8-003. See Controlling of Non-conforming WI-8-002 and use the Material Deviation Suspect form for the customer if applicable with WI-7-003-P.		x		
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". All product in the hold area shall be logged using WI-8-002-A - Hold Area Log. Hold area log is audited weekly via WI-7-003-T Dock Audit.		x		
Comments:					

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 (including but not limited to baskets, conveyors, chutes, etc.) 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.

		Assessment			
Requirements	**Objective Evidence**	**N/A**	**Satisfactory**	**Not Satisfactory**	**Needs Immediate Action**
The heat treater shall have procedures to identify and monitor trap points for each process/equipment.	The preventative maintenance program generates a work order for a review of each lines operation for frequent furnace review to identify trap points bi-annually.		x		
Monitoring of potential trap points shall occur for every lot changeover.	Monitoring trap points in the Operator Work Instructions OI-037 and discipline to monitoring trap points.		x		
Comments:					

2.6 Are containers free of inappropriate material or free of heat treated parts mixed with non-heat treated parts?

The purpose of the requirement is to reduce the risk of contaminating the finished lot with nonconforming parts or inappropriate material. Containers used for the transport of parts to be heat treated are often used for the same material after completion of the heat treat process. It is critical that the finished lot is not contaminated with non-heat treated parts or other inappropriate material remaining in the container.

		Assessment			
Requirements	**Objective Evidence**	**N/A**	**Satisfactory**	**Not Satisfactory**	**Needs Immediate Action**
There shall be a procedure that addresses the inspection of containers used for transporting non-heat treated and heat treated parts.	Each container is removed from the loading area and looked at prior to returning to the finished parts area. Any foreign material is removed. Small parts in boxes with folding edges are loaded into plastic bags lining the container to prevent parts mixing from being stuck anywhere within the container.		x		
The procedure shall include the inspection of containers after emptying and immediately before re-using to ensure that all parts and inappropriate material have been removed.	See OI-037		x		
The source of inappropriate material shall be identified and addressed.	A weekly Dock Audit is conducted via WI-7-003-T to review in-process containers in the plants. Anything found to be out of compliance is added to the customer complaint log and following via internal corrective action.		x		
Comments:					

2.7	Is furnace loading specified, documented and controlled?

Requirements	Objective Evidence	Assessment			
		N/A	Satisfactory	Not Satisfactory	Needs Immediate Action
Furnace loading parameters shall be specified, documented, and controlled (including but not limited to the following examples: feed rate, belt speed, number of parts per fixture, load weight, etc.).	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 via the Layered Process Audit WI-7-003-C. Also controlled by the load heigh gages by the furance. See WI-7-003 Production.		x		

Comments:

2.8	Is there a procedure for material handling, containment action, and product segregation in the event of an equipment emergency including power failure?

Unplanned or emergency downtime greatly increases the risk of improper processing.

Requirements	Objective Evidence	Assessment			
		N/A	Satisfactory	Not Satisfactory	Needs Immediate Action
There shall be a procedure for material handling, containment action, and product segregation in the event of an equipment emergency including power failure.	See OI-037: Operator Intructions for non-conforming instructions.		x		
The procedure 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 W-I8-002 Controlling Non-conforming.		x		
The procedure shall define when this emergency plan is to be implemented.	See W-I8-002 Controlling Non-conforming.		x		

Comments:

2.9	Is the handling, storage and packaging adequate to preserve product quality?

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.

Requirements	Objective Evidence	Assessment			
		N/A	Satisfactory	Not Satisfactory	Needs Immediate Action
Handling, storage, and packaging shall be adequate to preserve product quality.	Each process that is assessed to potentially damage a part during loading, processing, unloading and transport has special processing for hand load, hand unload, special racking instructions, and / or special shipping instructions.		x		
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.	See WI-7-001 Product Process and Realization. See also WI-6-002-A Condition of Facility See also WI-7-003-T Dock Audit		x		

Comments:

2.10	Are plant cleanliness, housekeeping, environmental, and working conditions conducive to control and improve quality?

	Assessment

Requirements	Objective Evidence	N/A	Satisfactory	Not Satisfactory	Needs Immediate Action
Plant cleanliness, housekeeping, environmental, and working conditions shall be conducive to controlling and improving quality.	A plant survey is done by an internal auditor monthly to evaluate the plant for building maintenance, lighting, cleanliness, and organization using Condition of facility form see WI-6-002 A		x		
A housekeeping policy shall be clearly defined and executed.	Employee Training Phase One.		x		
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.	This is a management responsibility see WI-6-002 Infrastructure.		x		
Comments:					

2.11 Are parts free from contaminants that would be detrimental to the heat treatment process?

Oils, coatings and other contaminants or residues may adversely affect the heat treatment process or subsequent processes. Pre/Post wash or other methods of contamination removal may be required by customer or mandatory for process function.

		Assessment			
Requirements	**Objective Evidence**	**N/A**	**Satisfactory**	**Not Satisfactory**	**Needs Immediate Action**
If applicable, cleaning parameters shall be monitored and documented.	Any part with detrimental amounts of oils or drawing compounds are prewashed and all product is post washed prior to temper.		x		
The frequency for checking the cleaning parameters shall conform to applicable Process Table, Section 5.0	All washers are on a preventive maintenance program and checked daily. All washer concentrations are verified by the soap supplier quarterly or as needed. There is a daily PM for checking furnace washer solution.		x		
Comments:					

2.12 Is the quenching system monitored, documented, and controlled?

Refer to Process Tables, Sections 3.0 and 5.0, for details and frequency of checks.

		Assessment			
Requirements	**Objective Evidence**	**N/A**	**Satisfactory**	**Not Satisfactory**	**Needs Immediate Action**
The quenching system shall be monitored, documented, and controlled. (Computer-monitoring equipment, with alarms and alarm logs, satisfy the verification requirement.)	There is a daily PM for checking the quench system in our furnance level checks.		x		
Quench delay time with alarm is required. Not applicable for belt, shaker, or pusher furnaces where parts free-fall into the quench.	The temperature, agitation speed, time in the quench are all automatically controlled. All furnaces have high temp alarms. WI-7-001 Product Process and Realization for specification.		x		
Temper delay time shall be specified by the heat treater for parts that are quenched and tempered (e.g. carburizing, carbonitriding, neutral hardening, induction hardening).	Temper delay time specified on neutral harden and case harden control plans.		x		
Comments:					

2.13 Are soluble oil or other rust preventive solutions monitored and controlled if applicable?

Parts are often dipped in or sprayed with rust preventive solutions immediately after the heat treating process. Refer to Process Tables, Section 5.0, for frequency of checks.

		Assessment			
Requirements	**Objective Evidence**	**N/A**	**Satisfactory**	**Not Satisfactory**	**Needs Immediate Action**

Soluble oil solutions or other rust preventive solutions shall be monitored and controlled, if applicable.	The rust prevention is controlled by new additions of product and by supplier once every 6 months.		x		
The heat treater shall have and maintain documented tolerances for the solutions.	Product is pre-titrated by the supplier prior to being added into our tank. PM system contains tolerances for solutions as well as supplier data sheets.		x		
Comments:					

2.14	**Are process control parameters monitored per frequencies specified in Process Tables?**				
Refer to Process Tables, Section 3.0.					
		Assessment			
Requirements	**Objective Evidence**	**N/A**	**Satisfactory**	**Not Satisfactory**	**Needs Immediate Action**
Process control parameters shall be monitored per frequencies specified in Process Tables.	All required process control parameters are continuously recorded and signed off by the operator at shift change at least every 8 hours. This is recorded on furnace log sheets.		x		
A designated floor person shall verify the process parameters, e.g. by initialing a strip chart or data log. (Computer monitoring equipment with alarms and alarm logs satisfy the verification requirement.)	Temperature is continuously monitored and logged using the furnace monitoring software and sign off log sheet WI-7-003-CC.		x		
Comments:					

2.15	**Are In-Process/Final Test Frequencies performed as specified in Process Tables?**				
		Assessment			
Requirements	**Objective Evidence**	**N/A**	**Satisfactory**	**Not Satisfactory**	**Needs Immediate Action**
In-Process/Final Test Frequencies shall be performed as specified in Process Tables.	Yes, there is an inspection sampling plan at every work station which matches or surpasses section 4 table. This is also found in the lab.		x		
Any exceptions to test frequencies specified in the process tables shall be approved by the Customer in writing.	All test frequency deviations are customer spec driven.		x		
Comments:					

2.16	**Is product test equipment calibrated and verified?**				
Refer to Process Tables, Section 1.0, for frequency of checks.					
		Assessment			
Requirements	**Objective Evidence**	**N/A**	**Satisfactory**	**Not Satisfactory**	**Needs Immediate Action**
Test equipment shall be calibrated and verified per applicable customer-specific standards or per an applicable consensus standard such as those published by ASTM, DIN, EN, ISO, JIS, NIST, SAE etc.	An outside service performs the calibrations on all test equipment quaterly. See lab scope WI-6-001-R Lab Scope.		x		
Calibration and verification results shall be internally reviewed, approved, and documented.	All test equipment is verified internally on a daily basis. See WI-7-001 E, G, I . Also WI-6-002-B.		x		
Comments:					

Section 3 - Equipment

Please describe Objective Evidence for each Requirement

3.1	**Do furnaces, generators, and quench systems have proper process control equipment?**

Examples include temperature, carbon potential, dew point, gas flows, quench monitoring system including agitation, temperature control, etc., as listed in the applicable Process Tables, Section 1.0

		Assessment			
Requirements	**Objective Evidence**	**N/A**	**Satisfactory**	**Not Satisfactory**	**Needs Immediate Action**
The heat-treat equipment including furnaces, generators, and quench systems shall have proper process controls.	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. All temperature and carbon controllers are monitored through our software.		x		
Comments:					

3.2	**Are process equipment calibrations, verifications and certifications current?**

Refer to the applicable Process Tables, Sections 1.0 and 2.0, for equipment calibration, verification and certification frequencies.

		Assessment			
Requirements	**Objective Evidence**	**N/A**	**Satisfactory**	**Not Satisfactory**	**Needs Immediate Action**
The calibrations, verifications and certifications of the process equipment shall be performed at regular intervals as specified in the applicable Process Table(s).	All calibrations are posted at/on the control or equipment being certified.		x		
Non-contact thermometry devices shall be calibrated as specified in the applicable Process Tables.	All calibrations are posted at/on the control or equipment being certified		x		
A documented offset procedure as defined in Section P3.2.3 shall exist.	MI-008 Offset Procedure now exists.		x		
The documented offset procedure shall indicate who has the authority to approve the use of offsets and how this approval is documented.	MI-008 Offset Procedure now exists.		x		
Offset or bias applied for the instrumentation calibration adjustment shall comply with P3.2.3.	MI-008 Offset Procedure now exists.		x		
Calibration labels shall meet the requirements established in Section P3.2.5.1.	All labels contain calibration company, date completed, next due date, and tech initials.		x		
Calibration reports shall meet the requirements established in Section P3.2.5.2.	Reports given by third party as required and saved electronically.		x		
Comments:					

3.3	**Are thermocouples and protection tubes checked or replaced per Process Tables?**

The accuracy of thermocouples is essential for good temperature control, the collection of accurate process data and the protection of furnace equipment.

		Assessment			
Requirements	**Objective Evidence**	**N/A**	**Satisfactory**	**Not Satisfactory**	**Needs Immediate Action**
Thermocouples shall be calibrated before first use, within the temperature range in which they will be used and meet the accuracy requirements of the Section P3.1 Tables.	All thermocouples are changed out per our PM program semiannually. We also run third party SAT on a quarterly basis to verify the thermocouples.		x		
Control, monitoring and recording thermocouples shall be SAT checked as per the applicable Process Table(s) and Section P3.3.	We run third party SAT on a quarterly basis to verify the thermocouples.		x		
The insertion depth of Type K and Type E test thermocouples shall be documented when the thermocouple is reused as per Section P3.1.3.3.	Depth is recorded on SAT calibration certs via insertion tube: they are protected and a determined length.		x		
System Accuracy Test records shall meet the requirements established in Section P3.3.5.	Our third party testing company provides the reports according to the requirements.		x		
Protection tubes shall be checked or replaced in compliance to a documented preventive maintenance schedule.	All thermocouples are changed out per our PM program semiannually. All protection tubes are evaluated at the same time.		x		

Comments:

3.4	Are temperature uniformity surveys performed per requirements in Process Tables?					
			Assessment			
	Requirements	**Objective Evidence**	**N/A**	**Satisfactory**	**Not Satisfactory**	**Needs Immediate Action**
	Temperature uniformity surveys shall be conducted per the requirements in the applicable Process Tables, Section 2.0.	TUS surveys are preformed per requirements of CQI-9 or more frequently.		x		
	Actions that alter the temperature uniformity characteristics of a furnace shall be documented per section P3.4.1.2.	Any variances are logged in the maintenance program.		x		
	If used, alternate temperature uniformity test methods shall meet the requirements of Section P3.4.8.	N/A		x		
	The upper temperature tolerance shall not be exceeded at any time. Exceptions may exist in systems where multiple process temperatures exist in a single process cycle per section P 3.4.5.1.	We keep the upper range according to the tolerance or according to customer specification: whichever is tighest.		x		
	The organization's internal process specification shall define suitable soak time at temperature requirements for pass/fail determination as per Section P3.4.5.1.	Soak time is dependent on load size surveyed as well as weight capacity of the furnace.		x		
	Temperature uniformity survey reporting shall meet the requirements established in Section P3.4.7.	All reporting requirements are met.		x		
Comments:						

3.5	Is the variation of the furnace control thermocouple from set point within the requirements in the Process Table?					
			Assessment			
	Requirements	**Objective Evidence**	**N/A**	**Satisfactory**	**Not Satisfactory**	**Needs Immediate Action**
	The variation between the furnace control thermocouple value and the set point temperature shall be within the limits defined in the applicable Process Tables, Section 2.0.	Set point and control are within +/- 2.0 F		x		
Comments:						

3.6	Are the process and equipment alarm checks being tested quarterly or after any repair or rebuild?					
			Assessment			
	Requirements	**Objective Evidence**	**N/A**	**Satisfactory**	**Not Satisfactory**	**Needs Immediate Action**
	The heat treater shall have a list of alarms that, if not properly working, may have a high probability of producing non-conforming product.	Process alarms exist per the maintenance PM program and listings and are maintained and checked accordingly.		x		
	The listed alarms shall be checked quarterly at a minimum or after any repair or rebuild.	This is built into our PM program.		x		
	Other alarms, including but not limited to safety-related, shall be checked per the heat treater's requirement.	This is built into our PM program.		x		
	These alarm checks shall be documented.	This is built into our PM program.		x		
Comments:						

3.7	Are generators and furnace atmospheres continuously monitored, automatically controlled, and documented?					
For furnaces that preclude in-situ control and monitoring, use the method described in Section 3.4.5 "Property Surveys".						
			Assessment			
	Requirements	**Objective Evidence**	**N/A**	**Satisfactory**	**Not Satisfactory**	**Needs Immediate Action**
	Generator and furnace atmosphere carbon potential/dew point shall be continuously monitored, automatically controlled, and documented.	All furnaces are automatically controlled and recorded. The carbon controllers are verified by dew point daily.		x		
	The recorded furnace carbon potential shall be controlled within ±0.05 of the set point.	The carbon controllers are verified by dew point daily.		x		

The recorded dew point shall be controlled within acceptable limits as specified in the control plan or internal procedures.	The generators are monitored continuously and recorded as well as dewpoint checks.		x		
If generators are not used, the flow rates of the supplied atmosphere gases shall be monitored and controlled.		x			
The automatic and continuous atmosphere control system shall consist of sensors such as oxygen probes or on-line infrared (IR) gas analysis.	There are sensors for carbon potential in the environment as a direct result of air and natural gas flow.		x		
The heat treater shall also have a back-up method of checking carbon potential/dew point.	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.		x		
Back up method verification frequencies shall be conducted according to the applicable process tables.	Daily PM's for dewpoint are required and logged and management continuously monitors the software to gage primary against the back up method.		x		
Comments:					

3.8	**When the back-up verification check of the atmosphere does not correlate within pre-established limits with the primary control method (carbon potential/dew point reading), is correlation of the**					
			Assessment			
Requirements		**Objective Evidence**	**N/A**	**Satisfactory**	**Not Satisfactory**	**Needs Immediate Action**
The back-up atmosphere monitoring system reading and the primary control method atmosphere dew point/carbon potential reading shall be maintained within the correlation limits specified in the control plan or internal procedures.		The data collection program will show the correlation between the two readings on the maintenance work order and the controller output.		x		
The back-up carbon potential/dew point reading shall be established using one of more of the following methods:		We use the Dew Point check method.		x		
When a discrepancy has been detected, the correlation shall be re-established between the back-up and primary method and documented.		Daily PM's for dewpoint are required and logged and management continuously monitors the software to gage primary against the back up method. Anytime a correlation is not accurate, an adjustment is made and documented within the maintenance program.		x		
The range tolerances for correlation between the two readings shall be in the control plan or internal procedures.		Process variable tables for each piece of equipment define the tolerance and requirement of all readings.		x		
Comments:						

3.9	**Are all ammonia lines equipped with a fail-safe method to prevent the inadvertent introduction of ammonia into the furnace?**					
			Assessment			
Requirements		**Objective Evidence**	**N/A**	**Satisfactory**	**Not Satisfactory**	**Needs Immediate Action**
One of the following fail-safe methods shall be used to prevent inadvertent introduction of ammonia into the furnace. • A quick disconnect or physical separation of the lines		All equipment with ammonia available have quick disconnects installed and used.		x		
The disconnecting of ammonia atmosphere from non-ammonia bearing atmosphere shall be documented.		The furnace log sheet will show the addition or removal of the line.		x		
Comments:						

3.10	**Is there a minimum of 3 hour purge of the furnace atmosphere when switching from an ammonia bearing atmosphere to a non-ammonia bearing?**
Ammonia pick-up can be undesirable in parts and heat treat processes not specifying/requiring ammonia as an addition.	
	Assessment

Requirements	Objective Evidence	N/A	Satisfactory	Not Satisfactory	Needs Immediate Action
The heat treater shall perform a minimum 3 hours purge prior to processing product not requiring ammonia as an addition.	Procedure OI-008 instructs the operator to have the ammonia off for 3 hrs prior to running any neutral harding work.		x		
Any reduction of the 3 hour purge shall require conclusive test data of the atmosphere to show no significant amount of residual ammonia is present in the furnace atmosphere.	Procedure OI-008 instructs the operator with what to do.		x		
Log book, data logger, or other records shall document the actual purge time and that sufficient time has been allocated to remove ammonia from the furnace prior to processing	Log sheet records when ammonia is shut off.		x		
Comments:					

3.11	Do all atmosphere furnaces and generators have flow scopes or flow meters for all gases?				
			Assessment		
Requirements	**Objective Evidence**	**N/A**	**Satisfactory**	**Not Satisfactory**	**Needs Immediate Action**
All atmosphere furnaces and generators (output trim/adjustment gas) shall have flow scopes or flow meters for all gases.	All furnaces and generators have flow scopes for all gases.		x		
Flow scopes and meters shall be periodically serviced per the heat treater's preventive maintenance program.	A PM is in place for inspection and servicing of flow scopes.		x		
Cleaning and proper re-assembly procedures shall be documented.	A PM is in place for inspection and servicing of flow scopes.		x		
Comments:					

3.12	Is there a fail-safe system at the front of continuous belt furnaces for austenitizing to prevent non-uniform loading of parts?				
			Assessment		
Requirements	**Objective Evidence**	**N/A**	**Satisfactory**	**Not Satisfactory**	**Needs Immediate Action**
Sight glass inspection ports shall exist for the visual evaluation of load distribution.	All process load requirments on the work order and verified on the log sheet. We do not have sight glass inspection ports.		x		
Sight glass inspection ports shall be cleaned per the preventive maintenance schedule.		x			
There shall be a fail-safe system implemented on continuous belt furnaces to prevent non uniform loading of the parts.	We do not have have continuous belt furnaces. Only continuous basket-pushing furnaces.	x			
In the absence of a fail-safe system, a non-contact thermometry device shall be employed with the following requirements met: • A non-contact thermometry device shall be aimed at the center of product mass from the discharge end of the furnace (i.e. bulk head portal) in order to acquire part temperature immediately prior to quenching. • A non-contact thermometry device temperature alarm shall be -28°C	We have thermocouples in every zone of the furnaces, including those immediately prior to the quench. All zones are continuously monitored via data collection programs.		x		
Comments:					

3.13	Is salt chemistry in the austenitizing salt bath monitored?				
This is applicable to salt bath heat treating processes listed in Process Tables A and B.					
			Assessment		
Requirements	**Objective Evidence**	**N/A**	**Satisfactory**	**Not Satisfactory**	**Needs Immediate Action**
The heat treater shall check the salt chemistry in the austenitizing salt bath, or part decarburization.	We do not have a salt-bath austemper type of process.	x			

The heat treater shall conform to the frequency of checks defined in the applicable Process Table Sections 3.	We do not have a salt-bath austemper type of process.	x			
Comments:					

3.14	**Is the quenching medium analyzed?**				
		Assessment			
Requirements	**Objective Evidence**	**N/A**	**Satisfactory**	**Not Satisfactory**	**Needs Immediate Action**
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	All furnaces have the quenchant checked by an outside lab 4 times per year.		x		
The quench medium characteristic tolerances shall be specified by the quench medium supplier or the heat treater.	PM and documentation are logged.		x		
Test results shall be reviewed for conformance and documented by the heat treater.	PM and documentation are logged.		x		
Comments:					

FOR INDUCTION HEAT TREATING

3.15	**Is the positioning of each part being controlled?**				
		Assessment			
Requirements	**Objective Evidence**	**N/A**	**Satisfactory**	**Not Satisfactory**	**Needs Immediate Action**
There shall be a method to ensure proper part position such as the use of proximity switches, optical sensors or mechanical Poka-Yoke system		x			
Comments:					

3.16	**Does the heat treater control the energy or power for each part?**				
		Assessment			
Requirements	**Objective Evidence**	**N/A**	**Satisfactory**	**Not Satisfactory**	**Needs Immediate Action**
The heat treater shall control the energy or power for each part.		X			
Signature monitor or energy monitor shall be used to monitor energy or power to the part and record all out of control events		X			
Any alternative method shall be approved by the Customer.		X			
Comments:					

3.17	**Does the supplier have a coil management system?**				
Coil refers to the heating coil and the quench plenum.					
		Assessment			
Requirements	**Objective Evidence**	**N/A**	**Satisfactory**	**Not Satisfactory**	**Needs Immediate Action**
The heat treater shall have a coil management system.		X			
Spare coils for each part shall be available on-site.		X			
Coils shall conform to the customer approved design.		X			
Comments:					

3.18	**Is quench system automatic?**	
		Assessment

Requirements	Objective Evidence	N/A	Satisfactory	Not Satisfactory	Needs Immediate Action
The quench system shall be automatically initiated and controlled.		X			
Comments:					

3.19	**Is there a procedure that addresses maintenance of the inductor and quench spray nozzle(s)**				
		Assessment			
Requirements	**Objective Evidence**	**N/A**	**Satisfactory**	**Not Satisfactory**	**Needs Immediate Action**
There shall be a procedure that includes regular inspection and cleaning of the inductor and quench spray nozzle(s).		X			
Comments:					

3.20	**Is there a procedure to purge the air pockets from the quench lines?**				
After downtime of the induction heating system, air pockets may form in the quench lines. These air pockets will cause interrupted quenching at start-up. Factors such as quench line diameter, length, geometry, etc., should be considered when establishing the time limit of the downtime.					
		Assessment			
Requirements	**Objective Evidence**	**N/A**	**Satisfactory**	**Not Satisfactory**	**Needs Immediate Action**
There shall be a procedure to purge the quench lines after downtime.		X			
The Heat treater shall establish the time limit (of the downtime) when this procedure is to be followed.		X			
Comments:					

Section 4 - Job Audit

Job Identity: CARBURIZE & HARDEN, TEMPER, & BLAST
Customer: *********
Shop Order Number: 459243
Part Number: *********
Part Description: ROCKER ARM - CH,T,GB
Material: AMS 6274
Heat Treat Requirements: RC 58-62 CASE DEPTH .035"-.045" CORE RC 25-45

Question #	Job Audit Question	Related HTSA Question #	Customer or Internal Requirement	Job (Shop) Order or Reference Documentation Requirement	Actual Condition (Objective Evidence)	Pass / Fail / NA
4.1	Does the heat treat facility have the customer specifications for the part?	1.5	Customer Requirement	Stated on customer prints: verified on incoming paperwork.	Master Part list and incoming paperwork verification.	Pass
4.2	Is material identification (part numbers, lot numbers, heat numbers, contract numbers, etc.) maintained throughout the heat treat process?	2.2 2.3 2.4	Internal Requirement	Product is identified by customer part and by the incoming paperwork to produce the work order and tagged with an inhouse order number.	An inhouse order number is assigned and attached to the container. This number is listed on the work order. Load markers are used in the furnace and noted on work order. The work order stays with the parts during the entire process.	Pass
4.3	Are the Loading/Racking requirements identified?	1.6 2.7 2.9	Internal Requirement	Work order 459243 lists "RACK" (special way they are hand racked into a basket)	459243	Pass
4.4	Is the proper recipe or process specification (cycle times, temperature, atmosphere, etc.) used? Refer to Process Tables, Section 3.0, for specific parameters.	1.5 1.6 2.1 2.14 2.15	Carburize & Harden, Wash, Temper, See Mount File (Lab), Blast/3 Min.	Work order 459243 lists both the process steps and also the recipe at the bottom.	Work order provided upon request.	Pass
4.5	What are the product inspection requirements per the Control Plan?	2.15	RC 58-62, Case Depth .035"-.045", Core RC 25-45	Inspection Sampling Plan WI-7-001-R		Pass
4.5.1	Requirement: (1)		Surface Hardness as Quenched	Work order 459243	Work order provided upon request.	Pass
	Test Method:		Rockwell C			Pass
	Test frequency or quantity:		Every load of batch.	2 pieces required and checked per load. (1 load)	459243	Pass
	Selection of samples:		Random			Pass
	Specification:		RC 58-62			Pass
4.5.2	Requirement: (2)		Case Depth as Quenched	Work order 459243	Work order provided upon request.	Pass
	Test Method:		Section 1 piece per load, Mounted etched and mircohardness testing			Pass
	Test frequency or quantity:		1 piece per load.	1 piece required and checked per load.	459243	Pass
	Selection of samples:		Random			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 / NA
	Specification:		Case Depth .035"-.045"		Effective case depth is .039" EFF, Surface hardness was RC 59,60, Core Hardness was RC 45. All meeting spec.	Pass
4.5.3	Requirement: (3)		Surface Hardness after Temper	Work order459243	Work order upon request.	Pass
	Test Method:		Rockwell C			Pass
	Test frequency or quantity:		Every load of batch.	2 pieces required and checked per load. (1 load)	459243	Pass
	Selection of samples:		Random			Pass
	Specification:		RC 58-62			Pass
4.5.4	Requirement: (4)		Effective Case Depth	Work order 459243	Work order upon request.	Pass
	Test Method:		Section 1 piece per load, mount, polish, measure effective case depth by checking microhardness at intervals of .005" into depth of the part	Work order 459243, Mount #B8-4-24	Effective case depth is .039" EFF, Surface hardness was RC 59,60, Core Hardness was RC 45. All meeting spec.	Pass
	Test frequency or quantity:		1 piece per load.	1 piece required and checked per load.		Pass
	Selection of samples:		Random			Pass
	Specification:		Case Depth .035"-.045" EFF			Pass
	Operator or Inspector Responsibilities					
4.6	Were appropriate process steps signed off?	1.4 2.2 2.3 2.14	Internal Requirement	Work Order 459243	Yes; work order upon request	Pass
4.7	Were all inspection steps, as documented in the control plan performed?	1.2 1.4	Internal Requirement	Work Order 459243	Yes; work order upon request	Pass
4.8	Were steps/operations performed that were not documented in the control plan?	1.2 1.4 1.6			No	Pass
4.9	If additional steps were performed, were they authorized?	1.2 1.4 1.6 1.11 1.17			N/A	N/A
4.10	Does the governing specification allow reprocessing or rework?	1.11		N/A	No	Pass
4.11	If the order was certified, did the certification accurately reflect the process performed?	2.14 2.15			N/A	N/A
4.12	Was the certification signed by an authorized individual?	1.17			N/A	N/A
4.13	Are the parts and containers free of inappropriate objects or contamination?	2.6 2.11		Visual inspection and random process audits including trap points	Yes	Pass
	Packaging Requirements					

Question #	Job Audit Question	Related HTSA Question #	Customer or Internal Requirement	Job (Shop) Order or Reference Documentation Requirement	Actual Condition (Objective Evidence)	Pass / Fail / NA
4.14	Are packaging requirements identified?	2.9		Work order 459243	2 Pans on 1 Skid	Pass
4.15	Are parts packaged to minimize mixed parts (for example, parts packed over height of container)?	2.9		N/A	Work Order 459243	Pass
	Shipping Requirements					
4.16	Were the parts properly identified?	2.3 2.9		Shipping/Receiving personnel compares shipper to work order after job is complete (prior to shipment).	Yes - Work order 459243 compared to shipper 284190	Pass
4.17	Were the containers properly labeled?	2.3 2.9	Internal Requirement	Incoming parts are weighed up and confirmed against the incoming paperwork, Assigned an inhouse order # which is listed on weight receipt and transferred to work order and all containers labeled with that order #.	Work order 459243	Pass

PROCESS TABLE A – Carburizing / Carbonitriding / Carbon Restoration / 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. When performing the job audit, the auditor shall verify heat treater is conforming to the Customer's requirements.

Continuous furnace frequencies for item numbers A4.2, A4.3, and A4.4 are per lot (work order) or as specified, whichever is more frequent.

OK - Complies to requirement
NOK - Does not comply to requirement (Explain noncompliance in 'Related HTSA Question #')
NA - Requirement not applicable

Item #	Related HTSA Question #	Category/Process Steps	
1.0		**PROCESS AND TEST EQUIPMENT REQUIREMENTS**	**OK / NOK / NA**
A1.1	3.1 3.7	Recording instruments are required for temperature controlling devices and protective atmosphere monitoring unit, e.g. dew point, oxygen probe, or other atmosphere controlling devices.	OK
A1.2	1.18	A program for furnace, generator, and oxygen probe burnout is required (applies to carbon bearing atmospheres).	OK
A1.3	3.2	Furnace loading weigh scales shall be verified quarterly and calibrated annually at a minimum.	NA
A1.4	3.2	Dew pointers, gas analyzers, spectrometers, and carbon IR combustion analyzers (shim stock/foil analysis), used to verify carbon potential in furnaces, shall be calibrated annually at a minimum.	OK
A1.5	3.2	Verification of spectrometers and carbon IR combustion analyzers (shim stock/foil analysis) shall be performed daily or prior to use.	NA
A1.6	3.2	Verification of gas analyzers with zero gas and span gas when used as the back-up verification shall be performed weekly at a minimum. When used for primary control of the carbon-bearing atmospheres, verification shall be daily.	NA
A1.7	3.2	Atmosphere controllers shall be calibrated quarterly (single-point or multi-point calibration). A six month calibration interval is allowed if multi-point calibration is utilized.	OK
A1.8	2.16 3.2	Laboratory and Test equipment used for product and process testing shall be calibrated annually at a minimum, per the applicable national standard (e.g. ASTM, EN, JIS) or approved equivalent standard, and verified per internal procedure if not specified in the applicable standard.	OK
A1.9	2.16	Files for testing hardness shall be verified per the Customer requirement.	OK
A1.10	3.2	Refractometers typically used to check polymer quenchants and washer solutions shall be verified prior to use with distilled water.	NA
2.0		**PYROMETRY**	**OK / NOK / NA**
A2.1	3.2 3.3	Thermocouples and calibration of thermocouples shall conform to Section P3.1.	OK
A2.2	3.2 3.3	Calibration of instrumentation shall conform to Section P3.2.	OK
A2.3	3.2 3.3	System Accuracy Test (SAT) for all control, monitoring, and recording thermocouples shall conform to Section P3.3.	OK
A2.4	3.4	Temperature Uniformity Survey (TUS) shall be performed annually and after major rebuild per Section P3.4. Temperature uniformity tolerance for austentizing furnaces shall be +/- 15°C (or +/- 25°F). Temperature uniformity tolerance for tempering and precipitation hardening furnaces shall be +/- 10°C (or +/- 20°F).	OK

Item #	Related HTSA Question #	Category/Process Steps				
A2.5	3.5	Temperature(s) for austentizing processes shall be controlled within +/- 10°C (or +/- 15°F) of the set point as evidenced by recording instruments. Furnace temperature shall be controlled with soak times starting at the lower tolerance limit (as defined above). **For Continuous Furnaces, this requirement applies to the Qualified Work Zone.**				OK
A2.6	3.5	Temperature(s) for tempering and precipitation hardening processes shall be controlled within +/- 5°C (or +/- 10°F) of the set point as evidenced by recording instruments. Furnace temperature shall be controlled with soak times starting at the lower tolerance limit (as defined above). **For Continuous Furnaces, this requirement applies to the Qualified Work Zone.**				OK
A2.7	3.2	Non-contact thermometry devices used for temperature monitoring (e.g. infrared pyrometer, thermal imaging camera) shall be calibrated annually at a minimum in the temperature range to be used utilizing a blackbody device or per the manufacturer's recommended procedure.				NA
3.0		**PROCESS MONITORING PARAMETERS**	**REQUIREMENTS / FREQUENCY**			**OK / NOK / NA**
			Batch (Chamber) Furnace	**Continuous Furnace**	**Atmosphere Generation**	
A3.1	1.4 1.6 2.14	Monitor primary temperature control instrument(s).	Continuous recording with alarm system set per limits in A2.5 and A2.6. In absence of alarm system, sign-off every 2 hours and at the end of the cycle, or each cycle for processes under 2 hours satisfies this requirement.	Continuous recording with alarm system set per limits in A2.5 and A2.6. In absence of alarm system, sign-off every 2 hours and at the end of the cycle, or each cycle for processes under 2 hours satisfies this requirement.	Generators shall be continuously monitored and recorded. Sign-off required for each shift for generators. An alarm system will satisfy the sign-off requirement.	OK
A3.2	1.4 2.14 3.7 3.11	Monitor atmosphere generation as applicable.			Generators shall be continuously monitored and recorded. Other systems, such as nitrogen-methanol systems, may either be continuously monitored and alarmed, or sign-off every 2 hours.	OK
A3.3	1.4 1.6 2.14 3.7	Monitor primary furnace atmosphere control(s).	Continuous recording with alarm system. In absence of alarm system, sign-off every 2 hours and at the end of the cycle, or each cycle for processes under 2 hours satisfies this requirement.	Continuous recording with alarm system. In absence of alarm system, sign-off every 2 hours and at the end of the cycle, or each cycle for processes under 2 hours satisfies this requirement.		OK
A3.4	1.4 2.14 3.7 3.8	Verify primary atmosphere control method by back-up method.	Daily	Daily	Daily	OK
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		NA

Item #	Related HTSA Question #	Category/Process Steps				
A3.6	1.4 2.14	Monitor time in furnace, cycle time, or belt speed.	Each batch or furnace load.	Sign-off twice/shift and after any change in the belt speed. Alarm systems (if set per acceptable limits) or continuous recording satisfy this requirement.		OK
A3.7	1.4 2.7	Monitor load size, fixturing, or loading rate as applicable.	Each batch or furnace load.	Sign-off twice/shift and after any change in loading rate. Alarm systems (if set per acceptable limits) or continuous recording satisfy this requirement.		OK
A3.8	1.4 2.12	**Quench Media Process Parameters - Liquid**				
		Temperature	Continuous recording with sign-off every 2 hours and at the end of the cycle, or each cycle for processes under 2 hours. Alarm systems (if set per acceptable limits) satisfy the sign-off requirement.	Continuous recording with sign-off every 2 hours and at the end of the cycle, or each cycle for processes under 2 hours. Alarm systems (if set per acceptable limits) satisfy the sign-off requirement.		OK
		Quench Level	Continuous monitor with alarm or daily verification.			OK
		Agitation	Daily visual check, or monitor the agitation during the quenching operation with alarm systems set at acceptable limits.			OK
A3.9	1.4 2.12	**Quench Media Process Parameters - Gas**				
		Pressure in the quench cell.	Monitor each load. Alarm system is required.			OK
		Fan speed or power.	Monitor each load. Alarm system is required.			OK
		Cooling water temperature and flow rate.	Monitor each load. Alarm system is required.			OK
A3.10	1.4 2.12	Quench Delay Time	Each batch or furnace load.	Each basket for pusher-type continuous furnaces where the loaded basket is quenched. Not applicable for belt, shaker, or pusher furnaces where parts free-fall into the quench.		OK
A3.11	1.4 2.12	Temper Delay Time - The maximum delay time between quenching and tempering shall be specified on the control plan and monitored.	Each batch or furnace load.	Each load.		OK

Item #	Related HTSA Question #	Category/Process Steps				
4.0		**IN-PROCESS/FINAL TEST PARAMETERS**	**REQUIREMENTS / FREQUENCY**			**OK / NOK / NA**
			Batch (Chamber) Furnace	**Continuous Furnace**	**Atmosphere Generation**	
A4.1	1.4 2.15	Microstructure shall be checked at a low magnification of 100X and a high magnification of 400X or above. Microstructure visual references shall be available.	Daily per furnace unless specified by Customer to be checked with greater frequency, e.g. each batch.	Daily per furnace unless specified by Customer to be checked with greater frequency, e.g. each load.		OK
A4.2	1.4 2.15	Surface hardness (when specified).	Each batch or furnace load.	Each lot or every 2 hours.		OK
A4.3	1.4 2.15	Core hardness (when specified).	Each batch or furnace load.	Each lot or every 4 hours.		OK
A4.4	1.4 2.15	Case Depth (when specified).	Each batch or furnace load.	Each lot or every 4 hours.		OK
5.0		**QUENCHANT AND SOLUTION TEST PARAMETERS**	**REQUIREMENTS / FREQUENCY**			**OK / NOK / NA**
			Batch (Chamber) Furnace	**Continuous Furnace**	**Atmosphere Generation**	
A5.1	2.12 3.14	**Polymer Quench Media**				
		Concentration	Daily	Daily		NA
		Cooling Curve Analysis	Every six months (complete replacement of the quench media and cleaning of the quench tank within six months satisfies this requirement).	Every six months (complete replacement of the quench media and cleaning of the quench tank within six months satisfies this requirement).		NA
A5.2	2.12 3.14	**Water Quench Media**				
		Suspended solids	Every six months (complete replacement of the quench media and cleaning of the quench tank within six months satisfies this requirement).	Every six months (complete replacement of the quench media and cleaning of the quench tank within six months satisfies this requirement).		OK
A5.3	2.12 3.14	**Salt Quench Media**				
		Analysis and Contaminants	Every six months.	Every six months.		NA
A5.4	2.12 3.14	**Brine or Caustic Quench Media**				
		Concentration and/or Specific Gravity	Daily	Daily		OK
		Suspended solids	Every six months (complete replacement of the quench media and cleaning of the quench tank within six months satisfies this requirement).	Every six months (complete replacement of the quench media and cleaning of the quench tank within six months satisfies this requirement).		OK

Item #	Related HTSA Question #	Category/Process Steps				
A5.5	2.12 3.14	**Oil Quench Media**				
		Water content, suspended solids, viscosity, cooling curve, maximum cooling rate, total acid, and flash point.	Every six months.	Every six months.		OK
A5.6	2.13	**Rust Preventive - Soluble Oil**				
		Concentration	2x/week	2x/week		OK
A5.7	2.11	**Cleaning Solution**				
		Concentration of cleaner	Daily	Daily		OK
		Temperature of solution (required if temperature is specified to be above ambient temperature).	Each shift.	Each shift.		OK

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. When performing the job audit, the auditor shall verify heat treater is conforming to the Customer's requirements.

Continuous furnace frequencies for item numbers B4.2, B4.3, B4.4, and B4.5 are per lot (work order) or as specified, whichever is more frequent.

OK - Complies to requirement
NOK - Does not comply to requirement (Explain noncompliance in 'Related HTSA Question #')
NA - Requirement not applicable

Item #	Related HTSA Question #	Category/Process Steps	
1.0		**PROCESS AND TEST EQUIPMENT REQUIREMENTS**	**OK / NOK / NA**
B1.1	3.1 3.7	Recording instruments are required for temperature controlling devices and protective atmosphere monitoring unit, e.g. dew point, oxygen probe, or other atmosphere controlling devices.	N/A
B1.2	1.18	A program for furnace and generator burnout is required. Not required for retort gas nitriding.	N/A
B1.3	3.2	Furnace weigh scales shall be verified quarterly and calibrated annually at a minimum.	N/A
B1.4	3.2	Gas analyzers, used to verify proper atmosphere in furnaces, shall be calibrated annually at a minimum.	N/A
B1.5	2.16	Laboratory and Test equipment used for product and process testing shall be calibrated annually at a minimum, per the applicable national standard (e.g. ASTM, EN, JIS) or approved equivalent standard, and verified per internal procedure if not specified in the applicable standard.	N/A
B1.6	2.16	Files for testing hardness shall be verified per the Customer requirement.	N/A
B1.7	3.2	Refractometers typically used to check polymer quenchants and washer solutions shall be verified prior to use with distilled water.	N/A
2.0		**PYROMETRY**	**OK / NOK / NA**
B2.1	3.2 3.3	Thermocouples and calibration of thermocouples shall conform to Section P3.1.	N/A
B2.2	3.2 3.3	Calibration of instrumentation shall conform to Section P3.2.	N/A
B2.3	3.2 3.3	System Accuracy Test (SAT) for all control, monitoring, and recording thermocouples shall conform to Section P3.3.	N/A
B2.4	3.4	Temperature Uniformity Survey (TUS) shall be performed annually and after major rebuild per Section P3.4. Temperature uniformity tolerance shall be +/- 10°C (15°F).	N/A
B2.5	3.5	Process temperature(s) shall be controlled within +/- 10°C (or +/- 15°F) of the set point as evidenced by recording instruments. Furnace temperature shall be controlled with soak times starting at the lower tolerance limit (as defined above). **For Continuous Furnaces, this requirement applies to the Qualified Work Zone.**	N/A

3.0		**PROCESS MONITORING PARAMETERS**	**REQUIREMENTS / FREQUENCY**				**OK / NOK / NA**
			Batch (Chamber) Furnace	**Continuous Furnace**	**Salt Bath**	**Atmosphere Generation**	
B3.1	1.4 2.14	Monitor primary temperature control instrument(s).	Continuous recording with alarm system set per limits in B2.5. In absence of alarm system, sign-off every 2 hours and at the end of the cycle, or each cycle for processes under 2 hours satisfies this requirement.	Continuous recording with alarm system set per limits in B2.5. In absence of alarm system, sign-off every 2 hours and at the end of the cycle, or each cycle for processes under 2 hours satisfies this requirement.	Continuous recording with alarm system set per limits in B2.5. In absence of alarm system, sign-off every 2 hours and at the end of the cycle, or each cycle for processes under 2 hours satisfies this requirement.	Generators shall be continuously monitored and recorded. Sign-off required for each shift for generators. An alarm system will satisfy the sign-off requirement.	N/A

Item #	Related HTSA Question #	Category/Process Steps					
B3.2	1.4 2.14 3.7 3.11	Monitor generator atmospheres, if applicable.				Generators shall be continuously monitored and recorded. Other systems, such as nitrogen-methanol systems, may either be continuously monitored and alarmed, or sign-off every 2 hours.	N/A
B3.3	1.4 2.14 3.7 3.8	Monitor primary furnace atmosphere control(s).	Each furnace load or continuous recording with sign-off every 2 hours and at the end of the cycle, or each cycle for processes under 2 hours. Alarm systems satisfy the sign-off requirement.	Continuous recording with alarms set per acceptable limits. In absence of alarm system, sign-off every 2 hours and at the end of the cycle, or each cycle for processes under 2 hours satisfies this requirement.			N/A
B3.4	1.4 3.7	Monitor dissociation of ammonia for gas nitriding.	Document with sign-off each furnace load and every 4 hours minimum and after any change. Automatic controls/ alarm systems satisfy the sign-off requirement.				N/A
B3.5	1.4 3.7 3.11	Monitor gas ratios for ferritic nitrocarburizing.	Document with sign-off each furnace load and every 4 hours minimum and after any change. Automatic controls/ alarm systems satisfy the sign-off requirement.	Document with sign-off each furnace load or every 4 hours minimum and after any change. Automatic controls/alarm systems satisfy the sign-off requirement.			N/A
B3.6	1.4 2.14 3.13	Check salt chemistry.			Daily		N/A
B3.7	1.4 2.14	Check nitriding salt aeration.			Daily		N/A
B3.8	1.4 2.14	Monitor cycle time in furnace/salt bath.	Each batch or furnace load.	Each batch or furnace load.	Each batch or furnace load.		N/A
B3.9	1.4 2.7	Monitor load size/fixturing.	Each batch or furnace load.	Each batch or furnace load.	Each batch or furnace load.		N/A
		Quench Media Process Parameters					N/A

Item #	Related HTSA Question #	Category/Process Steps					
B3.10	1.4 2.12	Temperature	Each furnace load or continuous recording with sign-off every 2 hours and at the end of the cycle, or each cycle for processes under 2 hours. Alarm systems satisfy the sign-off requirement.	Each furnace load or continuous recording with sign-off every 2 hours and at the end of the cycle, or each cycle for processes under 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.		N/A
		Quench Level	Continuous monitor with alarm or daily verification.	Continuous monitor with alarm or daily verification.	Daily		N/A
		Agitation/Aeration	Daily visual check, or monitor the agitation during the quenching operation with alarm systems set at acceptable limits.	Daily visual check, or monitor the agitation during the quenching operation with alarm systems set at acceptable limits.	Daily		N/A
4.0		**IN-PROCESS/FINAL TEST PARAMETERS**	**REQUIREMENTS / FREQUENCY**				**OK / NOK / NA**
			Batch (Chamber) Furnace	**Continuous Furnace**	**Salt Bath**	**Atmosphere Generation**	
B4.1	1.4 2.15	Microstructure shall be checked at a low magnification of 100X and a high magnification of 400X or above. Microstructure visual references shall be available.	Daily per furnace unless specified by Customer to be checked with greater frequency, e.g. each furnace batch.	Daily per furnace unless specified by Customer to be checked with greater frequency, e.g. each furnace load.	Daily per furnace unless specified by Customer to be checked with greater frequency, e.g. each batch.		N/A
B4.2	1.4 2.15	Surface hardness (when specified)	Each batch or furnace load.	Each lot or every 2 hours.	Each batch or furnace load.		N/A
B4.3	1.4 2.15	Core hardness (when specified)	Each batch or furnace load.	Each lot or every 4 hours.	Each batch or furnace load.		N/A
B4.4	1.4 2.15	Case depth (when specified)	Each batch or furnace load.	Each lot or every 4 hours.	Each batch or furnace load.		N/A
B4.5	1.4 2.15	White layer/compound zone (when specified)	Each batch or furnace load.	Each lot or every 4 hours.	Each batch or furnace load.		N/A
5.0		**QUENCHANT AND SOLUTION TEST PARAMETERS**	**REQUIREMENTS / FREQUENCY**				**OK / NOK / NA**
			Batch (Chamber) Furnace	**Continuous Furnace**	**Salt Bath**	**Atmosphere Generation**	
B5.1	2.12 3.14	**Quench Media Controls (if applicable)**					N/A
		Polymer Quench Media					N/A
		Concentration	Daily	Daily	Daily		N/A
		Contamination	Every six months (complete replacement of the quench media and cleaning of the quench tank within six months satisfies this requirement).	Every six months (complete replacement of the quench media and cleaning of the quench tank within six months satisfies this requirement).	Every six months (complete replacement of the quench media and cleaning of the quench tank within six months satisfies this requirement).		N/A
		Water Quench Media					N/A

Item #	Related HTSA Question #	Category/Process Steps					
B5.2	2.12 3.14	Suspended solids	Every six months (complete replacement of the quench media and cleaning of the quench tank within six months satisfies this requirement).	Every six months (complete replacement of the quench media and cleaning of the quench tank within six months satisfies this requirement).	Every six months (complete replacement of the quench media and cleaning of the quench tank within six months satisfies this requirement).		N/A
B5.3	2.12 3.14	**Salt Quench Media**					N/A
		Analysis and Contaminants	Every six months.	Every six months.	Every six months.		N/A
B5.4	2.12 3.14	**Oil Quench Media**					N/A
		Water content, suspended solids, viscosity, total acid, and flash point.	Every six months.	Every six months.	Every six months.		N/A
B5.5	2.13	**Rust Preventive - Soluble Oil**					N/A
		Concentration	2x/week	2x/week	2x/week		N/A
B5.6	2.11	**Cleaning Solution**					N/A
		Concentration of cleaner	Daily	Daily	Daily		N/A
		Temperature of solution (required if temperature is specified to be above ambient temperature).	Each shift.	Each shift.	Each shift.		N/A

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. When performing the job audit, the auditor shall verify heat treater is conforming to the Customer's requirements.

Continuous furnace frequencies for item numbers C4.1 are per lot (work order) or as specified, whichever is more frequent.

OK - Complies to requirement
NOK - Does not comply to requirement (Explain noncompliance in 'Related HTSA Question #')
NA - Requirement not applicable

Item #	Related HTSA Question #	Category/Process Steps	
1.0		**PROCESS AND TEST EQUIPMENT REQUIREMENTS**	**OK / NOK / NA**
C1.1	3.1	Recording instruments are required for temperature controlling devices and protective atmosphere monitoring unit, e.g. dew point, oxygen probe, or other atmosphere controlling devices.	OK
C1.2	2.16	Laboratory and Test equipment used for product and process testing shall be calibrated annually at a minimum, per the applicable national standard (e.g. ASTM, EN, JIS) or approved equivalent standard, and verified per internal procedure if not specified in the applicable standard.	OK
C1.3	3.2	Furnace weigh scales shall be verified quarterly and calibrated annually at a minimum.	OK
C1.4	3.2	Refractometers typically used to check polymer quenchants and washer solutions shall be verified prior to use with distilled water.	OK
2.0		**PYROMETRY**	**OK / NOK / NA**
C2.1	3.2 3.3	Thermocouples and calibration of thermocouples shall conform to Section P3.1.	OK
C2.2	3.2 3.3	Calibration of Instrumentation shall conform to Section P3.2.	OK
C2.3	3.2 3.3	System Accuracy Test (SAT) for all control, monitoring, and recording thermocouples shall conform to Section P3.3	OK
C2.4	3.4	Temperature Uniformity Survey (TUS) frequency shall be quarterly and after major rebuild per Section P3.4. Temperature Uniformity tolerance for solution and aging furnaces shall be +/- 5°C (+/- 10°F). Temperature Uniformity tolerance for annealing furnaces shall be +/- 15°C (+/- 25°F). Minimum and maximum temperature of the operating range shall be tested. Exception: If the operating range of the Qualified Work Zone is equal to or less than 85°C (155°F) then only one temperature is required to be tested. The test temperature shall be within the operating range of the Qualified Work Zone.	OK
C2.5	3.5	**For Solution Treating and Aging:** Process temperature(s) shall be controlled within +/- 5°C (or +/- 10°F) of the set point as evidenced by recording instruments. Furnace temperature shall be controlled with soak times starting at the lower tolerance limit (as defined above). **For Continuous Furnaces, this requirement applies to the Qualified Work Zone.**	OK
C2.6	3.5	**For Annealing Furnaces:** Process temperature(s) shall be controlled within +/- 10°C (or +/- 15°F) of the set point as evidenced by recording instruments. Furnace temperature shall be controlled with soak times starting at the lower tolerance limit (as defined above). **For Continuous Furnaces, this requirement applies to the Qualified Work Zone.**	OK

Item #	Related HTSA Question #	Category/Process Steps			
C2.7	3.2	Non-contact thermometry devices used for temperature monitoring (e.g. infrared pyrometer, thermal imaging camera) shall be calibrated annually at a minimum in the temperature range to be used utilizing a blackbody device or per the manufacturer's recommended procedure.			N/A
3.0		**PROCESS MONITORING PARAMETERS**	**REQUIREMENTS / FREQUENCY**		**OK / NOK / NA**
			Batch (Chamber) Furnace	**Continuous Furnace**	
C3.1	1.4 2.14	Monitor primary temperature control instrument(s).	Continuous recording with alarm system set per limits in C2.5 and C2.6. In absence of alarm system, sign-off every 2 hours and at the end of the cycle, or each cycle for processes under 2 hours satisfies this requirement.	Continuous recording with alarm system set per limits in C2.5 and C2.6. In absence of alarm system, sign-off every 2 hours and at the end of the cycle, or each cycle for processes under 2 hours satisfies this requirement.	N/A
C3.2	1.4 2.14	Monitor time in furnace, cycle time, or belt speed.	Each batch or furnace load.	Sign-off twice/shift and after any change in the belt speed. Alarm systems (if set per acceptable limits) or continuous recording satisfy this requirement.	N/A
C3.3	1.4 2.7	Monitor load size, fixturing, or loading rate as applicable.	Each batch or furnace load.	Sign-off twice/shift and after any change in loading rate. Alarm systems (if set per acceptable limits) or continuous recording satisfy this requirement.	N/A
C3.4	1.4 2.12	**Quench Media Process Parameters**			N/A
		Temperature	Continuous recording with alarm system set per acceptable limits. In absence of alarm system, sign-off every 2 hours and at the end of the cycle, or each cycle for processes under 2 hours satisfies this requirement.	Continuous recording with alarm system set per acceptable limits. In absence of alarm system, sign-off every 2 hours and at the end of the cycle, or each cycle for processes under 2 hours satisfies this requirement.	N/A
		Quench Media - Sprayed	Media Flow Rate and Pressure shall be monitored with alarm system set per acceptable limits. In absence of alarm system, sign-off every 2 hours and at the end of the cycle, or each cycle for processes under 2 hours satisfies this requirement. Nozzle pattern (number and direction) are to be defined, verified, and logged.		N/A
		Quench Media - Forced Air	Media Flow Rate shall be monitored with alarm system set per acceptable limits. In absence of alarm system, sign-off every 2 hours and at the end of the cycle, or each cycle for processes under 2 hours satisfies this requirement. Distribution pattern is to be defined, verified, and logged.		N/A
		Quench Media - Submerged	Continuous monitor of level with alarm or daily verification.		N/A
		Agitation	Monitor the agitation during the quenching operation with alarm systems set at acceptable limits.		N/A

Item #	Related HTSA Question #	Category/Process Steps			
C3.5	1.4 2.12	Quench Delay Time - Quench delay time shall be based on the time that the furnace door starts to open to the time the load is: (a) at the bottom of the quench tank for immersion quench, (b) until Quench chamber door is closed and forced air is turned on for forced air quench, (c) until quench spray is applied to part(s), for spray quench.	Each batch or furnace load.	Each basket/coil strip for pusher type or roller hearth continuous furnaces. Not applicable for furnaces where parts free fall into the quench.	N/A
4.0		**IN-PROCESS/FINAL TEST PARAMETERS**	**REQUIREMENTS / FREQUENCY**		**OK / NOK / NA**
			Batch (Chamber) Furnace	**Continuous Furnace**	
C4.1	1.4 2.15	Hardness, tensile test, or other destructive test per customer specification (when specified).	For hardness testing, each batch or furnace load. For other destructive testing methods, daily per furnace unless specified by Customer to be checked with greater frequency, e.g. each batch.	For hardness testing, every 4 hours. For other destructive testing methods, daily per furnace unless specified by Customer to be checked with greater frequency, e.g. each batch.	OK
5.0		**QUENCHANT AND SOLUTION TEST PARAMETERS**	**REQUIREMENTS / FREQUENCY**		**OK / NOK / NA**
			Batch (Chamber) Furnace	**Continuous Furnace**	
C5.1	2.12 3.14	**Polymer Quench Media**			OK
		Concentration	Daily	Daily	OK
		Cooling Curve Analysis	Every six months (complete replacement of the quench media and cleaning of the quench tank within six months satisfies this requirement).	Every six months (complete replacement of the quench media and cleaning of the quench tank within six months satisfies this requirement).	OK
C5.2	2.12 3.14	**Water Quench Media**			OK
		Suspended solids	Every six months (complete replacement of the quench media and cleaning of the quench tank within six months satisfies this requirement).	Every six months (complete replacement of the quench media and cleaning of the quench tank within six months satisfies this requirement).	OK
C5.3	2.11	**Cleaning Solution**			OK
		Concentration of cleaner	Daily	Daily	OK
		Temperature of solution (required if temperature is specified to be above ambient temperature).	Each shift.	Each shift.	OK

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. When performing the job audit, the auditor shall verify heat treater is conforming to the Customer's requirements.

OK - Complies to requirement
NOK - Does not comply to requirement (Explain noncompliance in 'Related HTSA Question #')
NA - Requirement not applicable

Item #	Related HTSA Question #	Category/Process Steps		
1.0		**PROCESS AND TEST EQUIPMENT REQUIREMENTS**		**OK / NOK / NA**
D1.1	2.16	Laboratory and Test equipment used for product and process testing shall be calibrated annually at a minimum, per the applicable national standard (e.g. ASTM, EN, JIS) or approved equivalent standard, and verified per internal procedure if not specified in the applicable standard.		N/A
D1.2	2.16	Files for testing hardness shall be verified per the Customer requirement.		N/A
D1.3	3.2	Refractometers typically used to check polymer quenchants and washer solutions shall be verified prior to use with distilled water.		N/A
2.0		**PYROMETRY**		**OK / NOK / NA**
D2.1	3.2 3.3	Thermocouples and calibration of thermocouples shall conform to Section P3.1.		N/A
D2.2	3.2 3.3	Calibration of instrumentation shall conform to Section P3.2.		N/A
D2.3	3.2	Non-contact thermometry devices used for temperature monitoring (e.g. infrared pyrometer, thermal imaging camera) shall be calibrated annually at a minimum in the temperature range to be used utilizing a blackbody device or per the manufacturer's recommended procedure.		N/A
3.0		**PROCESS MONITORING PARAMETERS**	**REQUIREMENTS / FREQUENCY**	**OK / NOK / NA**
All process parameters shall be checked at 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 2.14	Monitor cycle time.	Check cycle time at start of production, every 8 hours, and after any process change.	N/A
D3.2	1.4 2.14 3.16	Monitor energy/power.	An energy monitor or signature monitor is required and shall be equipped with alarms set at acceptable limits. This requirement applies to each power supply (not per coil).	N/A
D3.3	1.4 3.12	Monitor part temperature (when specified). Note: This does not replace the requirement for energy or signature monitors.	Check at start of production, every 4 hours, and after any process change. 100% of parts monitored and alarmed set to limits specified in the control plan satisfies this requirement.	N/A

Item #	Related HTSA Question #	Category/Process Steps		
D3.4	1.4 2.12	Quench Temperature	Alarm system for high and low temperature is required.	N/A
		Quench Media Level	Continuous monitor with alarm or daily verification.	N/A
		Quench Pressure and Flow	Alarm system for quench pressure and flow rate for high and low limits is required. In the absence of an alarm, the quench pressure and flow shall be checked at start of production run and every 8 hours.	N/A
D3.5	1.4 2.12	Temper Delay Time - The maximum delay time between quenching and tempering shall be specified on the control plan and monitored.	Each batch.	N/A
4.0		**IN-PROCESS/FINAL TEST PARAMETERS**	**REQUIREMENTS / FREQUENCY (PER COIL)**	**OK / NOK / NA**
D4.1	1.4 2.15	Induction pattern	1 part at start of production run, end of production run, and every 4 hours minimum, and 1 part pre- and 1 part post- tool change, equipment repair, station alarm (shutdown greater than 4 hours, malfunction, etc.).	N/A
D4.2	1.4 2.15	Total or Effective Case depth	1 part at start of production run, 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 greater than 4 hours, malfunction, etc.).	N/A
D4.3	1.4 2.15	Surface hardness	1 part at start of production run, end of production run, and every 4 hours minimum, and 1 part pre- and 1 part post- tool change, equipment repair, station alarm (shutdown greater than 4 hours, malfunction, etc.).	N/A
D4.4	1.4 2.15	Core hardness (when specified)	1 part at start of production run, end of production run, and every 8 hours minimum, and 1 part pre- and 1 part post- tool change, equipment repair, station alarm (shutdown greater than 4 hours, malfunction, etc.).	N/A
D4.5	1.4 2.15	Microstructure shall be checked at a low magnification of 100X and a high magnification of 400X or above. Microstructure visual references shall be available.	1 part at start of production run, 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 greater than 4 hours, malfunction, etc.).	N/A

Item #	Related HTSA Question #	Category/Process Steps		
5.0		**QUENCHANT AND SOLUTION TEST PARAMETERS**	**REQUIREMENTS / FREQUENCY**	**OK / NOK / NA**
D5.1	2.12 3.14	**Polymer Quench Media**		N/A
		Concentration	Daily	N/A
		Cooling Curve Analysis	Every six months (complete replacement of the quench media and cleaning of the quench tank within six months satisfies this requirement).	N/A
D5.2	2.12 3.14	**Water Quench Media**		N/A
		Suspended solids	Every six months (complete replacement of the quench media and cleaning of the quench tank within six months satisfies this requirement).	N/A
D5.3	2.12 3.14	**Brine or Caustic Quench Media**		N/A
		Concentration and/or Specific Gravity	Daily	N/A
		Suspended solids	Every six months (complete replacement of the quench media and cleaning of the quench tank within six months satisfies this requirement).	N/A
D5.4	2.13	**Rust Preventive - Soluble Oil**		N/A
		Concentration	2x/week	N/A
D5.5	2.11	**Cleaning Solution**		N/A
		Concentration of cleaner	Daily	N/A
		Temperature of solution (required if temperature is specified to be above ambient temperature).	Each shift.	N/A

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. When performing the job audit, the auditor shall verify heat treater is conforming to the Customer's requirements.

Continuous furnace frequencies for item numbers E4.2 and E4.3 are per lot (work order) or as specified, whichever is more frequent.

OK - Complies to requirement
NOK - Does not comply to requirement (Explain noncompliance in 'Related HTSA Question #')
NA - Requirement not applicable

Item #	Related HTSA Question #	Category/Process Steps	
1.0		**PROCESS AND TEST EQUIPMENT REQUIREMENTS**	**OK / NOK / NA**
E1.1	3.1 3.7	Recording instruments are required for temperature controlling devices and protective atmosphere monitoring unit, e.g. dew point, oxygen probe, or other atmosphere controlling devices.	OK
E1.2	1.18	A program for furnace, generator, and oxygen probe burnout is required (applies to carbon bearing atmospheres).	OK
E1.3	3.2	Furnace weigh scales shall be verified quarterly and calibrated annually at a minimum.	OK
E1.4	3.2	Dew pointers, 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.	OK
E1.5	3.2	Verification of spectrometers and carbon IR combustion analyzers (shim stock/foil analysis) shall be performed daily or prior to use.	OK
E1.6	3.2	Verification of gas analyzers with zero gas and span gas when used as the back-up verification shall be performed weekly at a minimum. When used for primary control of the carbon-bearing atmospheres, verification shall be daily.	OK
E1.7	3.2	Atmosphere controllers shall be calibrated quarterly (single-point or multi-point calibration). A six month calibration interval is allowed if multi-point calibration is utilized.	OK
E1.8	2.16 3.2	Laboratory and Test equipment used for product and process testing shall be calibrated annually at a minimum, per the applicable national standard (e.g. ASTM, EN, JIS) or approved equivalent standard, and verified per internal procedure if not specified in the applicable standard.	OK
E1.9	3.2	Refractometers typically used to check polymer quenchants and washer solutions shall be verified prior to use with distilled water.	OK
2.0		**PYROMETRY**	**OK / NOK / NA**
E2.1	3.2 3.3	Thermocouples and calibration of thermocouples shall conform to Section P3.1.	OK
E2.2	3.2 3.3	Calibration of instrumentation shall conform to Section P3.2.	OK
E2.3	3.2 3.3	System Accuracy Test (SAT) for all control, monitoring, and recording thermocouples shall conform to Section P3.3.	OK
E2.4	3.4	Temperature Uniformity Survey (TUS) shall be performed annually and after major rebuild per Section P3.4. Temperature uniformity tolerance for furnaces operating at or above 680°C (1250°F) shall be +/- 15°C (or +/- 25°F). Temperature uniformity tolerance for furnaces operating below 680°C (1250°F) shall be +/- 10°C (or +/- 20°F).	OK

Item #	Related HTSA Question #	Category/Process Steps			
E2.5	3.5	**For processes at or above 680°C (1250°F)**: Process temperature(s) shall be controlled within +/- 10°C (or +/- 15°F) of the set point as evidenced by recording instruments. Furnace temperature shall be controlled with soak times starting at the lower tolerance limit (as defined above). **For Continuous Furnaces, this requirement applies to the Qualified Work Zone.**			OK
E2.6	3.5	**For processes below 680°C (1250°F):** Process temperature(s) shall be controlled within +/- 5°C (or +/- 10°F) of the set point as evidenced by continuous recording instruments. Furnace temperature shall be controlled with soak times starting at the lower tolerance limit (as defined above). **For Continuous Furnaces, this requirement applies to the Qualified Work Zone.**			OK
3.0		**PROCESS MONITORING PARAMETERS**	**REQUIREMENTS / FREQUENCY**		**OK / NOK / NA**
			Batch (Chamber) Furnace	**Continuous Furnace**	**Atmosphere Generation**
E3.1	1.4 2.14	Monitor primary temperature control instrument(s).	Continuous recording with alarm system set per limits in E2.5 and E2.6 In absence of alarm system, sign-off every 2 hours and at the end of the cycle, or each cycle for processes under 2 hours satisfies this requirement.	Continuous recording with alarm system set per limits in E2.5 and E2.6. In absence of alarm system, sign-off every 2 hours and at the end of the cycle, or each cycle for processes under 2 hours satisfies this requirement.	Generators shall be continuously monitored and recorded. Sign-off required for each shift for generators. An alarm system will satisfy the sign-off requirement.	OK
E3.2	1.4 2.14 3.7	Monitor generator atmospheres.			Generators shall be continuously monitored and recorded. Other systems, such as nitrogen-methanol systems, may either be continuously monitored and alarmed, or sign-off every 2 hours.	OK
E3.3	1.4 2.14 3.7	Monitor primary furnace atmosphere control(s).	Continuous recording with alarms set per acceptable limits. In absence of alarm system, sign-off every 2 hours and at the end of the cycle, or each cycle for processes under 2 hours satisfies this requirement.	Continuous recording with alarms set per acceptable limits. In absence of alarm system, sign-off every 2 hours and at the end of the cycle, or each cycle for processes under 2 hours satisfies this requirement.		OK
E3.4	1.4 2.14 3.7 3.8	Verify primary atmosphere control method by back-up method.	Daily	Daily	Daily	OK

Item #	Related HTSA Question #	Category/Process Steps				
E3.5	1.4 2.14	Monitor time in furnace, cycle time, or belt speed.	Each batch or furnace load.	Sign-off twice/shift and after any change in the belt speed. Alarm systems (if set per acceptable limits) or continuous recording satisfy this requirement.		OK
E3.6	1.4 2.7	Monitor load size, fixturing, or loading rate as applicable.	Each batch or furnace load.	Sign-off twice/shift and after any change in loading rate.		OK
E3.7	2.14	Monitor cooling rate (start temp, end temp, °F/min), as applicable	Each batch or furnace load	Once per shift		OK
4.0		**IN-PROCESS/FINAL TEST PARAMETERS**	**REQUIREMENTS / FREQUENCY**			**OK / NOK / NA**
			Batch (Chamber) Furnace	**Continuous Furnace**	**Atmosphere Generation**	
E4.1	1.4 2.15	Microstructure shall be checked at a low magnification of 100X and a high magnification of 400X or above (when specified). Microstructure visual references shall be available.	Daily per furnace unless specified by Customer to be checked with greater frequency, e.g. each batch.	Daily per furnace unless specified by Customer to be checked with greater frequency, e.g. each batch.		OK
E4.2	1.4 2.15	Surface hardness (when specified).	Each batch or furnace load.	Each lot or every 4 hours.		OK
E4.3	1.4 2.15	Core hardness (when specified).	Each batch or furnace load.	Each lot or every 4 hours.		OK
5.0		**SOLUTION TEST PARAMETERS**	**REQUIREMENTS / FREQUENCY**			**OK / NOK / NA**
			Batch (Chamber) Furnace	**Continuous Furnace**	**Atmosphere Generation**	
E5.1	2.13	**Rust Preventive - Soluble Oil**				OK
		Concentration	2x/week	2x/week		OK
E5.2	2.11	**Cleaning Solution**				OK
		Concentration of cleaner	Daily	Daily		OK
		Temperature of solution (required if temperature is specified to be above ambient temperature).	Each shift.	Each shift.		OK

PROCESS TABLE F – Low Pressure Processing (Carburizing / Carbonitriding / Neutral Hardening)

All requirements given below are subordinate to customer specific requirements.

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

OK - Complies to requirement
NOK - Does not comply to requirement (Explain noncompliance in 'Related HTSA Question #')
NA - Requirement not applicable

Item #	Related HTSA Question #	Category/Process Steps	
1.0		**PROCESS AND TEST EQUIPMENT REQUIREMENTS**	**OK / NOK / NA**
F1.1	3.1	All gaseous quench systems shall have pressure indicators and fan operation indicators.	N/A
F1.2	3.1 3.17	Recording instruments are required for temperature controlling devices and protective atmosphere monitoring unit, e.g. dew point, oxygen probe, or other atmosphere controlling devices.	N/A
F1.3	3.2	Flow controllers for atmosphere delivery shall be calibrated annually or verified annually against a calibrated master. The master used for verification shall be calibrated at a minimum annually per applicable ASTM, NIST, ISO, or other national equivalent standard.	N/A
F1.4	3.2	Verification of spectrometers and carbon IR combustion analyzers (shim stock/foil analysis) shall be performed daily or prior to use.	N/A
F1.5	3.2	Vacuum monitoring devices shall be calibrated annually or verified annually against a calibrated master. The master used for verification shall be calibrated at a minimum annually per applicable ASTM, NIST, ISO, or other national equivalent standard.	N/A
F1.6	2.16	Laboratory and Test equipment used for product and process testing shall be calibrated annually at a minimum, per the applicable national standard (e.g. ASTM, EN, JIS) or approved equivalent standard, and verified per internal procedure if not specified in the applicable standard.	N/A
F1.7	2.16	Files for testing hardness shall be verified per the Customer requirement.	N/A
F1.8	3.2	Refractometers typically used to check polymer quenchants and washer solutions shall be verified prior to use with distilled water.	N/A
2.0		**PYROMETRY**	**OK / NOK / NA**
F2.1	3.2 3.3	Thermocouples and calibration of thermocouples shall conform to Section P3.1.	N/A
F2.2	3.2 3.3	Calibration of instrumentation shall conform to Section P3.2.	N/A
F2.3	3.2 3.3	System Accuracy Test (SAT) for all control, monitoring, and recording thermocouples shall conform to Section P3.3.	N/A
F2.4	3.4	Temperature Uniformity Survey (TUS) shall be performed annually and after major rebuild per Section P3.4. Temperature uniformity tolerance for hardening and tempering furnaces shall be +/- 10°C or +/- 20°F.	N/A
F2.5	3.5	Temperature(s) for austentizing processes shall be controlled within +/- 10°C (or +/- 15°F) of the set point as evidenced by recording instruments.	N/A

Item #	Related HTSA Question #	Category/Process Steps		
F2.6	3.5	Temperature(s) for tempering and precipitation hardening processes shall be controlled within +/- 5°C (or +/- 10°F) of the set point as evidenced by recording instruments.		N/A
3.0		**PROCESS MONITORING PARAMETERS**	**REQUIREMENTS / FREQUENCY**	**OK / NOK / NA**
F3.1	1.4 2.14	Monitor primary temperature control instrument(s).	Continuous recording with alarm system set per limits in F2.5. In absence of alarm system, sign-off every 2 hours and at the end of the cycle, or each cycle for processes under 2 hours satisfies this requirement.	N/A
F3.2	1.4 2.14	Monitor pressure and flow in the carburizing/ carbonitriding process.	Continuous recording with alarm system. In absence of alarm system, sign-off every 2 hours and at the end of the cycle, or each cycle for processes under 2 hours satisfies this requirement.	N/A
F3.3	1.4 2.14 3.7 3.8	Verify primary atmosphere control method by back-up method.	Daily, per qualified work zone (chamber).	N/A
F3.4	1.2 2.7	Calculate part surface area.	Prior to production (during APQP phase), the surface area of the parts shall be calculated and documented for each load configuration.	N/A
F3.5	1.4 2.12	**Quench Media Process Parameters – Liquid**		N/A
		Quench Delay Time	Each batch or furnace load.	N/A
		Temperature	Continuous recording with sign-off every 2 hours and at the end of the cycle, or each cycle for processes under 2 hours. Alarm systems (if set per acceptable limits) satisfy the sign-off requirement.	N/A
		Quench Level	Daily check or alarm system is required.	N/A
		Agitation	Daily check or alarm system is required. Acceptable methods for checking agitation are using flow sensors, current sensors, or pressure differential sensors.	N/A
F3.6	1.4 2.12	**Quench Media Process Parameters - Gas**		N/A
		Quench Delay Time	Monitor each load. Alarm system is required.	N/A
		Pressure in the quench cell	Monitor each load. Alarm system is required.	N/A
		Fan speed or power	Monitor each load. Alarm system is required.	N/A
		Cooling water temperature and flow rate	Monitor each load. Alarm system is required.	N/A
F3.7	1.4 2.12	Temper Delay Time - The maximum delay time between quenching and tempering shall be controlled per the control plan.	Each batch or furnace load.	N/A
4.0		**IN-PROCESS/FINAL TEST PARAMETERS**	**REQUIREMENTS / FREQUENCY**	**OK / NOK / NA**
F4.1	1.4 2.15	Microstructure shall be checked at a low magnification of 100X and a high magnification of 400X or above. Microstructure visual references shall be available.	Daily per furnace (must rotate cells) or any time one of the process parameters is out of specification.	N/A

Item #	Related HTSA Question #	Category/Process Steps		
F4.2	1.4 2.15	Surface hardness	Each batch or furnace load.	N/A
F4.3	1.4 2.15	Core hardness (when specified)	Daily per furnace (must rotate cells) or any time one of the process parameters is out of specification.	N/A
F4.4	1.4 2.15	Case depth (when specified)	Daily per furnace (must rotate cells) or any time one of the process parameters is out of specification.	N/A
5.0		**QUENCHANT AND SOLUTION TEST PARAMETERS**	**REQUIREMENTS / FREQUENCY**	**OK / NOK / NA**
F5.1	2.12 3.14	**Polymer Quench Solution**		N/A
		Concentration	Daily	N/A
		Quenchability Check cooling curve, viscosity, or titration.	Every six months (complete replacement of the quench media and cleaning of the quench tank within six months satisfies this requirement).	N/A
F5.2	2.12	**Oil Quenching**		N/A
		Water content, suspended solids, viscosity, cooling curve, total acid, and flash point.	Every six months.	N/A
F5.3	2.13	**Rust Preventative Solution – Soluble Oil**		N/A
		Concentration	2x/week	N/A
F5.4	2.11	**Cleaning Solution**		N/A
		Concentration	Daily	N/A
		Temperature of solution (required if temperature is specified to be above ambient temperature).	Each shift.	N/A

PROCESS TABLE G – Sinter Hardening

All requirements given below are subordinate to customer specific requirements.

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

Continuous furnace frequencies for item numbers G4.2, G4.3, G4.4, and G4.5 are per lot (work order) or as specified, whichever is more frequent.

OK - Complies to requirement
NOK - Does not comply to requirement (Explain noncompliance in 'Related HTSA Question #')
NA - Requirement not applicable

Item #	Related HTSA Question #	Category/Process Steps	
1.0		**PROCESS AND TEST EQUIPMENT REQUIREMENTS**	**OK / NOK / NA**
G1.1	3.1 3.7	Recording instruments are required for temperature controlling devices and protective atmosphere monitoring unit, e.g. dew point, oxygen probe, or other atmosphere controlling devices.	N/A
G1.2	3.1	Atmosphere flow meters/indicators are required.	N/A
G1.3	1.18	A program for furnace, generator, and oxygen probe burnout is required (applies to carbon bearing atmospheres).	N/A
G1.4	3.2	Dew pointers, gas analyzers, spectrometers, and carbon IR combustion analyzers (shim stock/foil analysis), used to verify carbon potential in furnaces, shall be calibrated annually at a minimum.	N/A
G1.5	3.2	Verification of spectrometers and carbon IR combustion analyzers (shim stock/foil analysis) shall be performed daily or prior to use.	N/A
G1.6	3.2	Verification of gas analyzers with zero gas and span gas when used as the back-up verification shall be performed weekly at a minimum. When used for primary control of the carbon-bearing atmospheres, verification shall be daily.	N/A
G1.7	3.2	Atmosphere controllers shall be calibrated quarterly (single-point or multi-point calibration). A six month calibration interval is allowed if multi-point calibration is utilized.	N/A
G1.8	2.16 3.2	Laboratory and Test equipment used for product and process testing shall be calibrated annually at a minimum, per the applicable national standard (e.g. ASTM, EN, JIS) or approved equivalent standard, and verified per internal procedure if not specified in the applicable standard.	N/A
2.0		**PYROMETRY**	**OK / NOK / NA**
G2.1	3.2 3.3	Thermocouples and calibration of thermocouples shall conform to Section P3.1.	N/A
G2.2	3.2 3.3	Calibration of instrumentation shall conform to Section P3.2.	N/A
G2.3	3.2 3.3	System Accuracy Test (SAT) for all control, monitoring, and recording thermocouples shall conform to Section P3.3.	N/A
G2.4	3.4	Temperature Uniformity Survey (TUS) shall be performed annually and after major rebuild per Section P3.4. Temperature uniformity tolerance for sinter hardening furnaces shall be +/- 15°C (or +/- 25°F). Temperature uniformity tolerance for tempering furnaces shall be +/- 10°C (or +/- 20°F).	N/A
G2.5	3.5	**For processes at or above 1000°C (1830°F):** Process temperature(s) shall be controlled within +/- 20°C (+/- 35°F) of the set point as evidenced by recording instruments. Furnace temperature shall be controlled with soak times starting at the lower tolerance limit (as defined above). **For Continuous Furnaces, this requirement applies to the Qualified Work Zone.**	N/A

Item #	Related HTSA Question #	Category/Process Steps				
G2.6	4.5	**For processes less than 1000°C (1830°F):** Process temperature(s) shall be controlled within +/- 10°C (or +/- 15°F) of the set point as evidenced by recording instruments. Furnace temperature shall be controlled with soak times starting at the lower tolerance limit (as defined above). **For Continuous Furnaces, this requirement applies to the Qualified Work Zone.**				N/A
3.0		**PROCESS MONITORING PARAMETERS**	**REQUIREMENTS / FREQUENCY**			**OK / NOK / NA**
			Batch (Chamber) Furnace	**Continuous Furnace**	**Atmosphere Generation**	
G3.1	1.4 1.6 2.14	Monitor primary temperature control instrument(s).	Continuous recording with alarm system set per limits in G2.5 and G2.6. In absence of alarm system, sign-off every 2 hours and at the end of the cycle or each cycle for processes under 2 hours satisfies this requirement.	Continuous recording with alarm system set per limits in G2.5 and G2.6. In absence of alarm system, sign-off every 2 hours and at the end of the cycle or each cycle for processes under 2 hours satisfies this requirement.	Generators shall be continuously monitored and recorded. Sign-off required for each shift for generators. An alarm system will satisfy the sign-off requirement.	N/A
G3.2	1.4 2.14 3.7 3.11	Monitor generator atmospheres.			Generators shall be continuously monitored and recorded. Other systems, such as nitrogen-methanol systems, may either be continuously monitored and alarmed, or sign-off every 2 hours.	N/A
G3.3	1.4 1.6 2.14 3.7	Monitor primary furnace atmosphere control(s).	Continuous recording with alarm system. In absence of alarm system, sign-off every 2 hours and at the end of the cycle, or each cycle for processes under 2 hours satisfies this requirement.	Continuous recording with alarm system. In absence of alarm system, sign-off every 2 hours and at the end of the cycle, or each cycle for processes under 2 hours satisfies this requirement.		N/A
G3.4	1.4 2.14 3.7 3.8	Verify primary atmosphere control method by back-up method.	Daily	Daily	Daily	N/A
G3.5	1.4 2.14	Monitor time in furnace, cycle time, or belt speed.	Each batch or furnace load.	Sign-off twice/shift and after any change in the belt speed.		N/A
G3.6	1.4 2.7	Monitor load size, fixturing, or loading rate as applicable.	Each batch or furnace load.	Sign-off twice/shift and after any change in loading rate.		N/A
G3.7	1.4 2.12	Quench Delay Time - Quench delay time shall be based on the time that the furnace door starts to open to the time the load is at the bottom of the quench tank (oil) or the start of the gas pressure quenching (gas quench).	Each batch or furnace load.	Not applicable for belt furnaces.		N/A

Item #	Related HTSA Question #	Category/Process Steps				
G3.8	1.4 2.12	**Quench Media Process Parameters - Oil**				N/A
		Temperature of water exchange system for quench chamber (does not apply to convection systems).	One of the three options is required. (1) Record temperature per batch or 2x per shift, whichever is more frequent. (2) Continuously record temperature and sign-off per batch or 2x per shift, whichever is more frequent. (3) Alarm system on temperature controller.	One of the three options is required. (1) Record temperature 2x per shift, or after any change. (2) Continuously record temperature and sign-off 2x per shift, or after any change. (3) Alarm system on temperature controller.		N/A
		Agitation (Fan/Blower Speed)	Alarm system is required to ensure proper operation of the fans. If fan speed is variable, then verify fan speed every 8 hours, or after any change.	Alarm system is required to ensure proper operation of the fans. If fan speed is variable, then verify fan speed every 8 hours, or after any change.		N/A
G3.9	1.4 2.12	**Quench Media Process Parameters - Gas**				N/A
		Pressure in quench vestibule.	Monitor each load. Alarm system is required.			N/A
		Fan speed or power.	Monitor each load. Alarm system is required.			N/A
		Cooling water temperature and flow rate.	Monitor each load. Alarm system is required.			N/A
4.0		**IN-PROCESS/FINAL TEST PARAMETERS**	**REQUIREMENTS / FREQUENCY**			**OK / NOK / NA**
			Batch (Chamber) Furnace	**Continuous Furnace**	**Atmosphere Generation**	
G4.1	1.4 2.15	Microstructure shall be checked at a low magnification of 100X and a high magnification of 400X or above. Microstructure visual references shall be available.	Daily per furnace unless specified by Customer to be checked with greater frequency, e.g. each batch.	Daily per furnace unless specified by Customer to be checked with greater frequency, e.g. each load.		N/A
G4.2	1.4 2.15	Mechanical Testing (when specified).	Each batch or furnace load.	Each lot or every 4 hours.		N/A
G4.3	1.4 2.15	Apparent hardness.	Each batch or furnace load.	Each lot or every 4 hours.		N/A
G4.4	1.4 2.14	Particle hardness (when specified).	Each batch or furnace load.	Each lot or every 4 hours.		N/A
G4.5	1.4 2.15	Core hardness (when specified).	Each batch or furnace load.	Each lot or every 4 hours.		N/A

PROCESS TABLE H – Ion Nitriding

All requirements given below are subordinate to customer specific requirements.

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

Please note that the corresponding process of Gas Nitriding is covered in Process Table "B" and Plasma Ion Nitriding is covered in Process Table "H".

OK - Complies to requirement
NOK - Does not comply to requirement (Explain noncompliance in 'Related HTSA Question #')
NA - Requirement not applicable

Item #	Related HTSA Question #	Category/Process Steps	
1.0		**PROCESS AND TEST EQUIPMENT REQUIREMENTS**	**OK / NOK / NA**
H1.1	3.1 3.7	Recording instruments are required for temperature controlling devices and protective atmosphere monitoring unit, e.g. dew point, oxygen probe, or other atmosphere controlling devices.	N/A
H1.2	1.18	Vessel is to be free of contamination that may affect the process.	N/A
H1.3	3.2	Vacuum monitoring devices shall be calibrated annually or verified annually against a calibrated master. The master used for verification shall be calibrated at a minimum annually per applicable ASTM, NIST, ISO, or other national equivalent standard.	N/A
H1.4	3.2 3.11	Gas ratio controllers for atmosphere delivery shall be calibrated annually or verified annually against a calibrated master. Alternatively, using a Pre-mixed gas of Certified Composition satisfies this requirement. The master used for verification shall be calibrated at a minimum annually per applicable ASTM, NIST, ISO, or other national equivalent standard.	N/A
H1.5	3.1	Pre-Mixed Gases shall have a Certificate of Ratio of Gas Mixture and Gas Purity with each shipment.	N/A
H1.6	2.16	Laboratory and Test equipment used for product and process testing shall be calibrated annually at a minimum, per the applicable national standard (e.g. ASTM, EN, JIS) or approved equivalent standard, and verified per internal procedure if not specified in the applicable standard.	N/A
H1.7	2.16	Files for testing hardness, if used, shall be verified per the Customer requirement.	N/A
H1.8	1.4 2.11	The vessel shall achieve a leak up rate of 90 microns Hg per hour or less and shall be verified weekly.	N/A
2.0		**PYROMETRY**	**OK / NOK / NA**
H2.1	3.2	Thermocouples and calibration of thermocouples shall conform to Section P3.1.	N/A
H2.2	3.2	Calibration of instrumentation shall conform to Section P3.2.	N/A
H2.3	3.2	Protection Tubes for thermocouples in the vessels, if used, shall be visually checked for each batch.	N/A
H2.4	3.4	Systems Accuracy Test (SAT) and Temperature Uniformity Survey (TUS) are not required. In lieu of SAT and TUS, temperature ranges shall be established during preproduction testing using multiple thermocouples representing the work zone and confirmed using a property survey and documented in the Control Plan for each part.	N/A

Item #	Related HTSA Question #	Category/Process Steps		
H2.5	3.5	Process temperature(s) shall be controlled with thermocouples in the load for each batch placed as practical to represent the extremes of the load (minimum and maximum temperatures) as evidenced by recording instruments.		N/A
H2.6	3.2	Non-contact thermometry devices used for temperature monitoring (e.g. infrared pyrometer, thermal imaging camera) shall be calibrated annually at a minimum in the temperature range to be used utilizing a blackbody device or per the manufacturer's recommended procedure.		N/A
3.0		**PROCESS MONITORING PARAMETERS**	**REQUIREMENTS / FREQUENCY**	**OK / NOK / NA**
H3.1	1.4 2.11	Vessel evacuation to 75 microns Hg or less is required prior to initiating the cycle.	Each batch.	N/A
H3.2	1.4 2.14	Monitor temperature control instrument(s).	Continuous recording with alarm system set per limits per the control plan. In absence of alarm system, sign-off every 2 hours or each batch for processes under 2 hours satisfies this requirement.	N/A
H3.3	1.4 2.14 3.7	Monitor vessel vacuum and pressure control(s).	Continuous recording with alarm system set per limits per the control plan. In absence of alarm system, sign-off every 2 hours or each batch for processes under 2 hours satisfies this requirement.	N/A
H3.4	1.4 2.14	Verify Process Gas Mixture settings.	Each batch.	N/A
H3.5	1.4 2.14	Monitor time in furnace, cycle time.	Each batch.	N/A
H3.6	1.4 2.14	Monitor load size and fixturing as applicable.	Each batch.	N/A
4.0		**IN-PROCESS/FINAL TEST PARAMETERS**	**REQUIREMENTS / FREQUENCY**	**OK / NOK / NA**
H4.1	1.4 2.15	Microstructure shall be checked at a low magnification of 100X and a high magnification of 400X or above. Microstructure visual references shall be available.	Each batch.	N/A
H4.2	1.4 2.15	Surface hardness	Each batch.	N/A
H4.3	1.4 2.15	Core hardness (when specified)	Each batch.	N/A
H4.4	1.4 2.15	Case depth (when specified)	Each batch.	N/A
H4.5	1.4 2.15	White Layer/Compound Zone (when specified)	Each batch.	N/A
5.0		**SOLUTION TEST PARAMETERS**	**REQUIREMENTS / FREQUENCY**	**OK / NOK / NA**
H5.1	2.13	**Rust Preventive - Soluble Oil**		N/A
		Concentration	2x/week	N/A
H5.2	2.11	**Cleaning Solution**		N/A
		Concentration of cleaner.	Daily	N/A
		Temperature of solution (required if temperature is specified to be above ambient temperature).	Each shift.	N/A

PROCESS TABLE I – Hot Stamping

"Hot Stamping" is also known as dry contact press hardening, high strength metal sheet hardening, press hardening, or die press quenching. This process first austenitizes and then simultaneously quenches and forms a part. Quenching is achieved by direct contact with a die that is internally cooled with a suitable medium. The die is used in conjunction with a high tonnage press and relatively short heat treat cycles are used.

All requirements given below are subordinate to customer specific requirements.

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

OK - Complies to requirement
NOK - Does not comply to requirement (Explain noncompliance in 'Related HTSA Question #)
NA - Requirement not applicable

Item #	Related HTSA Question #	Category/Process Steps	
1.0		**PROCESS AND TEST EQUIPMENT REQUIREMENTS**	**OK / NOK / NA**
I1.1	3.1 3.7	Recording instruments are required for temperature controlling devices and protective atmosphere monitoring unit, e.g. dew point, oxygen probe, or other atmosphere controlling devices.	N/A
I1.2	3.2	To avoid double layer loading, furnace loading device and control elements shall be verified and maintained per maintenance plan.	N/A
I1.3	3.2	Dew pointers, gas analyzers, spectrometers, and carbon IR combustion analyzers (shim stock/foil analysis), used to verify protective atmosphere in furnaces, shall be calibrated annually at a minimum.	N/A
I1.4	3.2	Oxygen probe controllers shall be calibrated quarterly (single-point or multi-point calibration). A six month calibration interval is allowed if multi-point calibration is utilized.	N/A
I1.5	3.2	Verification of spectrometers and carbon IR combustion analyzers (shim stock/foil analysis) shall be performed daily or prior to use.	N/A
I1.6	3.2	Verification of gas analyzers with zero gas and span gas when used as the back-up verification shall be performed weekly at a minimum. When used for primary control of the carbon-bearing atmospheres, verification shall be daily.	N/A
I1.7	2.16	Laboratory and Test equipment used for product and process testing shall be calibrated annually at a minimum, per the applicable national standard (e.g. ASTM, EN, JIS) or approved equivalent standard, and verified per internal procedure if not specified in the applicable standard.	N/A
2.0		**PYROMETRY**	**OK / NOK / NA**
I2.1	3.2 3.3	Thermocouples and calibration of thermocouples shall conform to Section P3.1.	N/A
I2.2	3.2 3.3	Calibration of instrumentation shall conform to Section P3.2.	N/A
I2.3	3.2 3.3	System Accuracy Test (SAT) for all control, monitoring, and recording thermocouples shall conform to Section P3.3.	N/A
I2.4	3.4	Temperature Uniformity Survey (TUS) shall be performed annually and after major rebuild per Section P3.4 Temperature uniformity tolerance for hardening furnaces shall be +/- 15°C (or +/- 25°F).	N/A
I2.5	3.5	Process temperature(s) shall be controlled within +/- 10°C (or +/- 15°F) of the set point as evidenced by recording instruments. Furnace temperature shall be controlled with soak times starting at the lower tolerance limit (as defined above). **For Continuous Furnaces, this requirement applies to the Qualified Work Zone.**	N/A
I2.6	3.2	Non-contact thermometry devices used for temperature monitoring (e.g. infrared pyrometer, thermal imaging camera) shall be calibrated annually at a minimum in the temperature range to be used utilizing a blackbody device or per the manufacturer's recommended procedure.	N/A

Item #	Related HTSA Question #	Category/Process Steps					
3.0		**PROCESS MONITORING PARAMETERS**	**REQUIREMENTS / FREQUENCY**				**OK / NOK / NA**
			BOX Type Furnace (Single-Chamber)	**BOX Type Furnace (Multi-Chamber)**	**Continuous Furnace**	**Atmosphere Generation**	
I3.1	1.4 2.14	Monitor primary temperature control instrument(s).	Continuous recording with alarm system set per limits in I2.5. In absence of alarm system, sign-off every 2 hours satisfies this requirement.	For each chamber, continuous recording with alarm system set per limits in I2.5. In absence of alarm system, sign-off every 2 hours for each chamber satisfies this requirement.	Continuous recording with alarm system set per limits in I2.5. In absence of alarm system, sign-off every 2 hours satisfies this requirement.	Generators shall be continuously monitored and recorded. Sign-off required for each shift for generators. An alarm system will satisfy the sign-off requirement.	N/A
I3.2	1.4 2.14 3.7	Monitor atmosphere generation as applicable.				Dried air or nitrogen-systems may either be continuously monitored and alarmed, or sign-off every 2 hours.	N/A
I3.3	1.4 2.14 3.7	Monitor primary furnace atmosphere control(s), as applicable	Continuous recording with alarm system. In absence of alarm system, sign-off every 2 hours satisfies this requirement.	For each chamber, continuous recording with alarm system. In absence of alarm system, sign-off every 2 hours for each chamber satisfies this requirement.	Continuous recording with alarm system. In absence of alarm system, sign-off every 2 hours satisfies this requirement.		N/A
I3.4	1.4 2.14	Monitor time in furnace.	System monitoring of time in furnace (ex. Robot, PLC, etc.). Alarm for times outside of process window.	For each chamber, system monitoring of time in furnace (ex. Robot, PLC, etc.). Alarm for times outside of process window.	System monitoring of time in furnace (ex. Roller speed). Alarm for times outside of process window.		N/A
I3.5		Press cycle parameter (e.g. dwell time, tonnage)	System monitoring of applicable press cycle parameters. There shall be an alarm for conditions outside of process window.				N/A
		Quench Process Parameters					N/A
I3.6	1.4 2.12	Monitor part temperature in die.	System to monitor part temperature in the die and immediately prior to quenching (infrared, thermal camera, or other suitable non-contact thermometry device).				N/A
I3.7	1.4 2.12	Temperature of die cooling system.	Continuous recording. Alarm for temperature control systems are required.				N/A
I3.8	1.4 2.12	Cooling system flow control.	Monitoring of die cooling system flow. Alarm for flow control systems are required.				N/A
I3.9	1.4 2.12	Supplemental Cooling Water - Temperature	Continuous recording. Alarm for temperature control systems are required.				N/A
I3.10	1.4 2.12	Supplemental Cooling Water – Flow Rate	Monitoring of quenchant system flow. Alarm for flow control systems are required.				N/A

Item #	Related HTSA Question #	Category/Process Steps					
4.0		**IN-PROCESS/ FINAL TEST PARAMETERS**	**REQUIREMENTS / FREQUENCY**				**OK / NOK / NA**
			BOX Type Furnace (Single-Chamber)	**BOX Type Furnace (Multi-Chamber)**	**Continuous Furnace**	**Atmosphere Generation**	
I4.1	1.4 2.15	Microstructure shall be checked at a low magnification of 100X and a high magnification of 400X or above. Microstructure visual references shall be available.	Daily per furnace.	Daily per furnace (chamber). May rotate chambers but minimum each chamber per week.	Daily per furnace.		N/A
I4.2	1.4 2.15	Decarburization (for bare steel only).	Daily per furnace.	Daily per furnace (chamber). May rotate chambers but minimum each chamber per week.	Daily per furnace.		N/A
I4.3	1.4 2.15	Coating Thickness, Layer Evaluation (for coated material).	Daily per furnace.	Daily per furnace (chamber). May rotate chambers but minimum each chamber per week.	Daily per furnace.		N/A
I4.4	1.4 2.15	Hardness	At start up (per cavity) and every 4 hours minimum (per cavity).	At start up (per cavity) and every 4 hours minimum (per cavity). May rotate chambers but minimum each chamber every 48 hours.	At start up (per cavity) and every 4 hours minimum (per cavity).		N/A
I4.5	1.4 2.15	Mechanical (Tensile, Yield, % Elongation) - when specified.	As required by Customer.	As required by Customer.	As required by Customer.		N/A
5.0		**PRESS AND QUENCH TEST PARAMETERS**	**REQUIREMENTS / FREQUENCY**				**OK / NOK / NA**
			BOX Type Furnace (Single-Chamber)	**BOX Type Furnace (Multi-Chamber)**	**Continuous Furnace**	**Atmosphere Generation**	
		Press and Quenching					N/A
I5.1	2.15 3.14	Die - Segment Wear managed to maintain desired properties.	Per maintenance and equipment plan.				N/A
I5.2	2.15 3.14	Cooling System check. Cooling media contamination. Cleaning/maintenance of cooling system and cooling channels in the die.	Per maintenance and equipment plan (tubes, channels, filters etc.).				N/A