Special Process: Heat Treat System Assessment

Facility Name:	**American Metal Processing Company**
Address:	**22720 Nagel Street**
	Warren, Michigan 48089
Phone Number:	**586-757-7337**
Fax Number:	**586-757-8232**
Number of Heat Treat Employees at this Facility:	**16**
Internal (Captive) Heat Treater (Y/N):	**N**
Commercial Heat Treater (Y/N):	**Y**
Date of Assessment:	**April 10, 2019**
Date of Previous Assessment:	**April 10, 2018**

Type(s) of Thermal Processing at this Facility:

Process Table A - Ferrous	
Carburizing	**Yes**
Carbonitriding	**Yes**
Carbon Restoration	**No**
Neutral Hardening (Quench and Temper)	**Yes**
Austempering / Martempering	**No**
Tempering	**Yes**
Precipitation Hardening / Aging	**No**

Process Table B - Ferrous	
Nitriding (Gas)	**No**
Ferritic-Nitrocarburizing (Gas or Salt)	**No**

Process Table C - Aluminum	
Aluminum Heat Treatment	**No**

Process Table D - Ferrous	
Induction Heat Treating	**No**

Process Table E	
Annealing	**No**
Normalizing	**No**
Stress-Relieving	**No**

Process Table F	
Low Pressure Carburizing	**No**

Process Table G	
Sinter Hardening	**No**

Process Table G	
Ion Nitriding	**No**

Current Quality Certification(s):	**IATF 16949:2016, IATF Certificate Number 0284226, Certificate Number 5465; ISO 9001:2015, Certificate Number 5466**
Date of Re-assessment (if necessary):	

Personnel Contacted:

Name:	**Title:**	**Phone:**	**Email:**
George Baloi	**Quality Mgr**	**586-757-7337, x-107**	george@ampht.com

Internal Auditors/Assessors:

Name:	**Company:**	**Phone:**	**Email:**
Ryan Currier	**Plant Mgr**	**586-757-7337, x-111**	ryan@ampht.com
George Baloi	**AMP Metallurgist**	**586-757-7337, x-107**	george@ampht.com
Pawel Kuras	**AMP Shift Leader**	**586-757-7337, x-108 (Lab)**	employee@ampht.com

Number of "Not Satisfactory" Findings:	**0**
Number of "Needs Immediate Action" Findings:	**0**
Number of "Fail" Findings in the Job Audit(s):	**0**

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Question Number	Question	Requirements and Guidance	Objective Evidence	Assessment			
				N/A	Satisfactory	Not Satisfactory	Needs Immediate Action
Section 1 - Management Responsibility & Quality Planning							
1.1	Is there a dedicated and qualified heat treat person on-site?	To ensure readily available expertise, there shall be a dedicated and qualified heat treat person on site. This individual shall be a full-time employee and the position shall be reflected in the organization chart. A job description shall exist identifying the qualifications for the position including metallurgical and heat treat knowledge. The qualifications shall include a minimum of 5 years experience in heat treat operations or a combination of a minimum of 5 years of formal metallurgical education and heat treat experience.	Organizational Chart and Job Descriptions are part of the Quality Management System (QMS), and are available for viewing on AMP's Intranet. AMP has experienced operators and lab technicians, with a minimum of 5 years experience in heat treat operations, on each shift. Quality Manager/Metallurgist and Plant Manager have 10+ yrs experience in heat treat operations.		X		
1.2	Does the heat treater perform advanced quality planning?	The organization shall incorporate a documented advance quality planning procedure. A feasibility study shall be performed and internally approved for each part. Similar parts can be grouped into part families for this effort as defined by the organization. After the part approval process is approved by the customer, no process changes are allowed unless approved by the customer. The heat treater shall contact the customer when clarification of process changes is required. This clarification of process changes shall be documented.	APQP Planning and Team Feasibility Studies are done by a cross-functional team. In the case of a new part which is part of a family of parts, the Team Feasibility Study can be completed by only one of the Team Members. Process changes are electronically documented (recorded) in computer part file change logs.		X		
1.3	Are heat treat FMEAs up to date and reflecting current processing?	The organization shall incorporate the use of a documented Failure Mode and Effects Analysis (FMEA) procedure and ensure the FMEAs are updated to reflect current part quality status. The FMEA shall be written for each part or part family or they may be process-specific and written for each process. In any case, they shall address all process steps from part receipt to part shipment and all key heat treat process parameters as defined by the organization. A cross-functional team shall be used in the development of the FMEA. All special characteristics, as defined by the organization and its customers, shall be identified, defined, and addressed in the FMEA.	Process Failure Mode and Effects Analyses (PFMEAs) are process-specific (Carburizing, Carbonitriding, and Neutral Hardening). PFMEAs address each process step and heat treat process parameters. A cross-functional team, is used in the development of the PFMEAs, which are maintained and controlled by the Quality Department. All special characteristics, as defined by AMP and/or its customers, are identified, defined, and addressed in the PFMEA and in the specific part recipes.		X		
1.4	Are heat treat process control plans up to date and reflecting current processing?	The organization shall incorporate the use of a documented Control Plan procedure and ensure the Control Plans are updated to reflect current controls. The Control Plans shall be written for each part or part family or they may be process-specific and written for each process. In any case, they shall address all process steps from part receipt to part shipment and identify all equipment used and all key heat treat process parameters as defined by the organization. A cross-functional team, including a production operator, shall be used in the development of Control Plans, which shall be consistent with all associated documentation such as work instructions, shop travelers, and FMEAs. All special characteristics, as defined by the organization and its customers, shall be identified, defined, and addressed in the Control Plans. Sample sizes and frequencies for evaluation of process and product characteristics shall also be addressed consistent with the minimum requirements listed in the Process Tables, Sections 3.0 & 4.0.	Control Plans are process-specific (Generic Carburizing, Carbonitriding, and Neutral Hardening Control Plans are available). Control Plans address each process step and key heat treat process parameters as defined by AMP and/or its Customers. A cross-functional team, is used in the development of the Control Plans, which are consistent with all associated documentation, such as work instructions, shop travelers, and PFMEAs (which are also process-specific). All special characteristics, as defined by AMP and/or its customers, including Safety Items (Inverted Delta) are identified, defined, and addressed in the Control Plans and part-specific recipes. Sample sizes and frequencies for evaluation of process and product characteristics are addressed and are consistent with the minimum requirements listed in the Process Tables, Sections 3.0 and 4.0. The Control Plans are maintained and controlled by the Quality Department.		X		

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1.5	Are all heat treat related and referenced specifications current and available? For example: Industry and customer specific specifications such as SAE, AIAG, ASTM, ISO, EN, JIS, General Motors, Ford, and Chrysler.	To ensure all customer requirements are both understood and satisfied, the organization shall have all related heat treat and customer referenced standards and specifications available for use and a method to ensure that they are current. Such standards and specifications include, but are not limited to, those relevant documents published by SAE, AIAG, ASTM, ISO, EN, JIS, General Motors, Ford, and Chrysler. The organization shall have a process to ensure the timely review, distribution, and implementation of all customer and industry engineering standards / specifications and changes based on customer-required schedule. Timely review should be as soon as possible and shall not exceed two working weeks. The organization shall document this process of review and implementation, and it shall address how customer and industry documents are obtained, how they are maintained within the organization, how the current status is established, and how the relevant information is cascaded to the shop floor within the two-week period. The organization shall identify who is responsible for performing these tasks.	All related heat treat and customer-referenced standards and specifications are available for use and viewing via AMP's own Intranet. These standards and specifications are requested from the customers at the time of quotation of the parts, are scanned into the electronic database within one week, and are available for viewing or printing on the AMP Intranet. Updates to referenced standards and specifications are usually obtained from customers, reviewed at AMP Staff/Quality Meetings for possible impact on processes and implementation timetables, and then scanned into the electronic database within one week of receipt, for viewing availability on the AMP Intranet. The Quality Department is responsible for performing these tasks.		X		
1.6	Is there a written process specification for all active processes?	The heat treater shall have written process specifications for all active processes and identify all steps of the process including relevant operating parameters. Examples of operating parameters include process temperatures, cycle times, load rates, atmosphere or gas flow settings, belt speeds, quench agitation speeds, etc. Such parameters shall not only be defined, they shall have operating tolerances as defined by the organization in order to maintain process control. All active processes should have a written process specification. These process specifications may take the form of work instructions, job card, computer-based recipes, or other similar documents.	Computer-based recipes for each part number include all process parameters, including process steps, tolerances, specifications, cycle times, gas flows, and process temperatures.		X		
1.7	Has a valid process capability study been performed initially and after process equipment has been relocated, or had a major rebuild?	To demonstrate each process is capable of yielding acceptable product the organization shall perform process capability studies for the initial validation of each process, after relocation of any process equipment, & after a major rebuild of any equipment. The organization shall define what constitutes a major rebuild. Initial process capability studies shall be conducted for all heat treat processes per furnace line defined in scope of work & in accordance with customer requirements. A furnace line may include a combination of equipment that is integrated in the performance of a heat treatment process, e.g., hardening, quenching, and tempering. Capability study techniques shall be appropriate for the heat treat product characteristics, e.g., tensile strength, case depth, hardness. Any specific customer requirements shall be met. In the absence of customer requirements, the organization shall establish acceptable ranges for measures of capability. An action plan shall exist to address the steps to followed in case capability indices fall outside customer requirements or established ranges.	Capability Studies for Surface Hardness (if discrete Surface Hardness data is required) are automatically generated for each and every Work Order processed and can be readily accessed for each Work Order. These Capability Studies are available for Work Orders going back to July of 2001.		X		
1.8	Does the heat treater collect and analyze data over time, and react to this data?	The analysis of products and processes over time can yield vital information for defect prevention efforts. The organization shall have a system to collect, analyze, and react to product or process data over time. Methods of analysis shall include ongoing trend or historical data analysis of product or process parameters. The organization shall determine which parameters to include in such analysis.	Historical Surface Hardness data for each part (last 5 Work Orders processed) is displayed on each Work Order, including steel chemistry information (assumed or as supplied by Customer), Surface Hardness (Min & Max) out of Quench, Tempering Temperature, and Surface Hardness (Min & Max) out of Temper. Surface Hardness and Tempering Temperature historical data helps our associates to determine the best tempering temperature for current Work Order.		X		

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1.9	Is management reviewing the heat treat monitoring system every 24 hours?	Management shall review the furnace monitoring systems at intervals not to exceed 24 hours. The heat treat monitoring system includes but is not limited to temperature strip charts, atmosphere strip charts, computer data logs, furnace and operator logs, etc. The management review shall include efforts to detect out-of-control conditions or alarm conditions. The process of reviewing the furnace data shall be documented and this requirement also applies to computerized data.	AMP has installed and implemented a real-time heat treat monitoring system/data acquisition system on all hardener furnaces, temper furnaces, and generators. This is currently available for viewing at a dedicated computer & monitor in the Laboratory, at the Supervisor's Station out in the plant, Office area and by management on their home PCs. All of the selected process parameters (zone temperatures, etc) are viewable, in real time, at any computer monitor tied into the monitoring network at AMP, and by management at their home PCs.		X		
1.10	Are internal assessments being completed on an annual basis, at a minimum, using AIAG HTSA?	The organization shall conduct internal assessments on an annual basis, at a minimum, using the AIAG HTSA.	Internal heat-treat assessments are being performed on an annual basis, at a minimum, using the AIAG HTSA.		X		
1.11	Is the OEM customer notified when parts are reprocessed?	The OEM shall be notified when parts are reprocessed in the heat treat operation. It is preferred that the notification be on a case-by-case basis. However, it is understood that some reprocessing (such as but not limited to re-tempering operations) may be pre-approved during the APQP or PPAP phase. To be pre-approved for reprocessing, the heat treater shall meet the following requirements: • The heat treater shall submit for approval by the OEM customer the reprocessing procedure and this procedure shall be referenced in the heat treater's FMEA and process control plan • The procedure shall describe product characteristics for which reprocessing is permissible as well as those characteristics for which reprocessing is not permissible. • Any reprocessing activity shall require a new processing control sheet issued by qualified technical personnel denoting the necessary heat treat process modifications. • Records shall clearly indicate when and how any material has been reprocessed. • The Quality Manager or a designee shall authorize the release or reprocessed product.	The OEM customer is notified when parts are reprocessed in the heat treat operation, on a case-by-case basis. However, Retempering is normally not considered as reprocessing or rework, so customer notification for Retempering is a rare occurrence. A Quality Procedure for Reworking / Reprocessing is documented and in place, including special Yellow Rework Form, issued, filled out, and signed by designated qualified technical personnel. Complete record documentation is kept of each Rework and the Rework Information is tracked and translated into several different Metrics by AMP, primarily to confirm the continuous reduction in number of Reworks and the reduction in the percentage of Reworks against the total Work Orders processed.		X		
1.12	Does the Quality Department review, address, and document customer and internal concerns?	The quality management system shall include a process for documenting, reviewing, and addressing customer concerns and any other concerns internal to the organization. A disciplined problem-solving approach shall be used.	Internal and Customer concerns are reviewed and addressed in documented Staff/Quality Meetings, using disciplined problem-solving. The documented concerns are tracked in the Staff/Quality Meeting Minutes until the concerns are resolved and closed. Depending on the nature of the concern, the concerns may be written up formally on a DMR (Defective Material Report) form, which uses an 8-D format, for additional visibility.		X		
1.13	Is there a continual improvement plan applicable to each process defined in the scope of the assessment?	The heat treater shall define a process for continual improvement for each heat treat process identified in the scope of the HTSA. The process shall be designed to bring about continual improvement in quality and productivity. Identified actions shall be prioritized and shall include timing (estimated completion dates). The organization shall show evidence of program effectiveness.	Continual improvement plans focus on the highest occurring problems in Quality and Productivity, with quarterly reporting on the various metrics, including trend lines to gauge the effectiveness of the problem resolutions.		X		
1.14	Does the Quality Manager or designee authorize the disposition of material from quarantine status?	The Quality Manager is responsible for authorizing and documenting appropriate personnel to disposition quarantine material.	The Quality Manager is responsible for implementing the Quality Procedure for disposition of Quarantined Material, as addressed in the QMS.		X		

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1.15	Are there procedures or work instructions available to the heat treat personnel that define the heat treating process?	There shall be procedures or work instructions available to heat treat personnel covering the heat treating process. These procedures or work instructions shall include methods of addressing potential emergencies (such as power failure), equipment start-up, equipment shut-down, product segregation (See 2.8), product inspection, and general operating procedures. These procedures or work instructions shall be accessible to shop floor personnel.	Operational Procedures and/or Work Instructions and Forms are available for viewing and/or printing from any computer with access to the G-drive on the AMP Intranet.		X		
1.16	Is management providing employee training for heat treating?	The organization shall provide employee training for all heat treating operations. All employees, including backup and temporary employees, shall be trained. Documented evidence shall be maintained showing the employees trained and the evidence shall include an assessment of the effectiveness of the training. Management shall define the qualification requirements for each function, and ongoing or follow-up training shall also be addressed.	On-The-Job Material Handler and Heat-Treater training and qualification program is utilized. The AMP Training Matrix lists all personnel qualifications and training that was successfully completed, as well as any training still in process.		X		
1.17	Is there a responsibility matrix to ensure that all key management and supervisory functions are performed by qualified personnel?	The organization shall maintain a responsibility matrix identifying all key management and supervisory functions and the qualified personnel who may perform such functions. It shall identify both primary and secondary (backup) personnel for the key functions (as defined by the organization). This matrix shall be readily available to management at all times.	A Responsibility Matrix is part of the Quality Management System and is available for viewing and review on the AMP Intranet.		X		
1.18	Is there a preventive maintenance program for all heat treat equipment? Is maintenance data being utilized to form a predictive maintenance program?	The organization shall have a documented preventive maintenance program for all heat treat process equipment. The program shall be a closed-loop process that tracks maintenance efforts from request to completion to assessment of effectiveness. Equipment operators shall have the opportunity to report problems, and problems shall also be handled in a closed-loop manner. Company data, e.g., downtime, quality rejects, first-time-through capability, recurring maintenance work orders, and operator-reported problems, shall be used to improve the preventive maintenance program. Maintenance data shall be collected and analyzed as part of a predictive maintenance program.	A documented Maintenance Program (including forms and records) is in place for key process equipment. Every Employee has the opportunity to file an Incident Report, which is reviewed, analyzed, and documented in Quality & Staff Meetings. These Incident Reports are used to improve Maintenance Programs, training, process parameters, and APQP. Furnaces and generators are scheduled for burn-out at frequencies determined by the organization (see Section 1 of the Process Tables). Maintenance data is collected and analyzed as part of a predictive maintenance program.		X		
1.19	Has the Heat Treater developed a critical spare part list and are the parts available to minimize production disruptions?	The heat treater shall develop and maintain a critical spare parts list and shall ensure the availability of such parts to minimize production disruptions.	Computer list of critical spare parts has been developed and is maintained by the Operations Department.		X		
1.20	Is material from different steel mill heats or metals which may preclude achieving the specified metallurgical properties prevented from being processed together?	Different steel mill heats or metals which require different heat treat parameters, such as but not limited to, austenitizing, quenching, or tempering times and/or temperatures shall be processed separately in order to achieve specified metallurgical properties.	When different steel mill heats or metals are indicated on the incoming orders, and they are not separated, but indicate that they should be processed separately, the order is placed on hold and the Customer is contacted for the Customer's final disposition. The final disposition is noted/written on the incoming order, with the date and name of the authorizing Customer who provided the final disposition.		X		

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Question Number	Question	Requirements and Guidance	Objective Evidence	Assessment N/A	Satisfactory	Not Satisfactory	Needs Immediate Action
Section 2 - Floor and Material Handling Responsibility							
2.1	Does the facility ensure that the data entered in the receiving system matches the information on the customer's shipping documents?	It is critical that all customer requirements and lot identification be adequately transferred to internal heat treat documents. The facility shall ensure that the data entered in the receiving system match the information on the customer's shipping documents. Documented processes and evidence of compliance shall exist, e.g., shop travelers, work orders, etc. Sometimes the material received does not precisely correspond to customer shipping documents. The facility shall have a detailed process in place to resolve receiving discrepancies. The requirements stated above also apply to captive heat treat departments. This process refers to receiving and shipping the parts in and out of the heat treat department.	All steel chemistry, heat, and lot information, if supplied by the customer, is entered into computer order entry system (WORP) for each Work Order. Material grades and heat treating instructions are compared against information in computer part file in database. Discrepancies are passed to Quality and Operations for review and resolution, before the Work Order is created and/or processed.		X		
2.2	Is product clearly identified and staged throughout the heat treat process?	Procedures for part and container identification help to avoid incorrect processing or mixing of lots. Appropriate location and staging within the facility also help to ensure that orders are not shipped until all required operations are performed. Customer product shall be clearly identified and staged throughout the heat treat process. Non-heat treated, in-process, and finished product shall be properly segregated and identified. All material shall be staged in a dedicated and clearly defined area.	Staging locations within the plant are clearly identified with large signs. Each customer container has an AMP router tag attached to it, identifying the heat-treating process, tub ID, Net Weight, Date order was created, Work Order number, photo of part, customer name, part number, lot number, and number of containers in order. Cannot close WO/ship product until all steps are electronically signed off by the shift supervisor.		X		
2.3	Is lot traceability and integrity maintained throughout all processes?	Out-going lot(s) shall be traceable to the incoming lot(s). The discipline of precisely identifying lots and linking all pertinent information to them enhances the ability to do root cause analysis and continual improvement.	Lot identification is linked to the AMP Work Order number, which is unique for each order. All information is stored in AMP's WORP computer system database.		X		
2.4	Are procedures adequate to prevent movement of non-conforming product into the production system?	The control of suspect or non-conforming product is necessary to prevent inadvertent shipment or contamination of other lots. Procedures shall be adequate to prevent movement of non-conforming product into the production system. Procedures shall exist addressing proper disposition, product identification, and tracking of material flow in and out of the hold area. A non-conforming hold area shall be clearly designated to maintain segregation of such material.	Suspect or Non-Conforming Product is quarantined with a red "Hold" tag. A Non-Conforming Product Procedure is used for disposition of quarantined parts. The AMP Computer system will not print a Certification or a Shipper unless all process steps have been signed off.		X		
2.5	Is there a system to identify trap points in the entire heat treat process to reduce risk of mixed parts (inappropriate, non-heat treated, or improperly heat treated parts)?	Heat-treating furnaces and other processing equipment contain areas that have a risk of trapping or holding parts. Such trapping of parts can lead to damage, improperly processed parts or lot mixing/contamination. A system shall exist to identify trap points in the entire heat treat process to reduce risk of mixed parts (inappropriate, non-heat treated, or improperly heat treated parts). The heat treater shall have documented procedures to identify and monitor trap points for each process/equipment. Monitoring of potential trap points shall occur for every part changeover.	Alternating the processing of larger parts and smaller parts helps to minimize mixing and makes sorting easier if mixing does occur. Large gap times between orders also reduce the risk of mixed parts. Chasers are placed at the end of orders to "bump" or "force" material out of the furnace and these chasers also serve to signify the end of the current order of material in the furnace. Trap points in the heat treat process have been identified and action plans developed and implemented to monitor and minimize the potential impact of those trap points on product being processed.		X		
2.6	Are containers free of inappropriate material?	Containers handling customer product shall be free of inappropriate material. After emptying and before re-using containers, containers shall be inspected to ensure that all parts and inappropriate material have been removed. The source of inappropriate material shall be identified and addressed. This is to ensure that no nonconforming heat treated parts or inappropriate material contaminate the finished lot.	Customer containers are rotated and flipped over to loosen and remove possible trapped parts, in the dumping station. Each container is also visually inspected for foreign and trapped material. AMP's in-house processing containers (Roura hoppers) are free of seams that could trap inappropriate material. The relevant AMP documents are titled "Container Handling Process" and "Dropped Parts Policy".		X		

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2.7	Is furnace loading specified, documented, and controlled?	Furnace loading parameters shall be specified, documented, and controlled. Examples include feed rate, belt speed, number of parts per fixture, and load weight. Refer to Process Tables, Section 3.0, for frequency of checks.	Furnace loading parameters are specified in the electronic recipes, controlled by electronic feeders, and printed out on the hard copies of the Work Orders.		X		
2.8	Are operators trained in material handling, containment action, and product segregation in the event of an equipment emergency, including power failure?	Unplanned or emergency downtime greatly raises the risk of improper processing. Operators shall be trained in material handling, containment action, and product segregation in the event of an equipment emergency including power failure. Training shall be documented. Work instructions specifically addressing potential types of equipment emergencies and failures shall be accessible to and understood by equipment operators. These instructions shall address containment actions related to all elements of the heat-treating process, e.g., loading, austenitizing, quenching, tempering.	Work Instructions for emergency procedures are documented and available to each operator on the shop floor and in the computer database; The relevant document is titled "Contingency Plans". Training is documented in the Training Matrix.		X		
2.9	Is the handling, storage, and packaging adequate to preserve product quality?	Handling, storage, and packaging shall be adequate to preserve product quality. The heat treater's furnace loading system, in-process handling, and shipping process shall be assessed for risk of part damage or other quality concerns. Some equipment includes conveyors and other moving components that may not be able to handle all part configurations. Other practices such as stacking of overloaded containers can also increase the risk of part damage.	Equipment and material handling procedures are adequate to preserve product quality.		X		
2.10	Are plant cleanliness, housekeeping, environmental and working conditions conducive to control and improved quality?	Plant cleanliness, housekeeping, environmental, and working conditions shall be conducive to controlling and improving quality. The heat treater should evaluate such conditions and their effect on quality. A housekeeping policy shall be clearly defined and executed. The facility shall be reviewed for conditions that are detrimental to quality processing such as loose parts on floor, oil around quench tanks, inadequate plant lighting, smoke, etc.	Plant cleanliness and housekeeping is the responsibility of each and every Employee and, ultimately, each Shift Supervisor. The environmental and working conditions are evaluated regularly to ensure that they are conducive to maintaining Employee health and welfare, as well as conducive to control of product and improving quality of product. A Housekeeping Worksheet Guidelines (part of our Business Operating System) is available for double-checking conformance to expected plant conditions.		X		
2.11	Are parts free from contaminants that would be detrimental to the heat treatment of the product?	Many heat-treated parts are subjected to surface finish or appearance operations such as plating or coating after heat treatment. Parts shall be free from contaminants that are detrimental to subsequent processes or the product. Pre-wash (if applicable) and post-wash parameters shall be monitored and documented. Oils and other contaminants or residues can be difficult to remove once subjected to the heat treatment process. Review the chemical supplier's recommendation for cleaning the system. Parts shall be free of rust, burrs, chips, detrimental amounts of drawing compound, cutting fluids, rust preventing oils, lubricants, etc., prior to heat treat. Note: Refer to the appropriate heat treater's requirements and specifications to determine acceptability. Refer to Process Table, Section 5.0, for frequency of checking washer solutions.	Virtually all parts are pre-cleaned prior to heat treatment. All parts are washed between quench and temper.		X		

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2.12	Is the quenching system monitored, documented, and controlled?	The quenching system shall be monitored, documented, and controlled. The temperature, agitation, level, concentration (if applicable), time in the quenchant, and additions shall be controlled to the heat treater's specifications. Refer to Process Tables, Sections 3.0 and 5.0, for frequency of checks. Computer-monitoring equipment, with alarms and alarm logs, satisfy the verification requirement. Quench delay tolerance and alarm is required for furnaces with integral quench tanks. Temper delay time shall be specified by the heat treater for parts that are quenched and tempered, e.g., carburizing, carbonitriding, neutral hardening, solution treating and aging.	Quench temperatures are monitored, controlled, and checked daily by each shift supervisor, as are quench levels and agitation. Digital alarms are in place for temperature. Oil is checked for quenchability quarterly for our rotary furnaces, since oil levels are being replenished frequently because of dragout. Furnace logs are used to record the daily monitoring & checking activities that are not actively monitored by our Process Control and Electronic Monitoring/Data Acquisition System.		X		
2.13	Is soluble oil or other rust preventive monitored and controlled if applicable?	Parts are often dipped in or sprayed with rust preventive solutions immediately after the heat treating process. Soluble oil solutions or other rust preventive solutions shall be monitored and controlled, if applicable. The heat treater shall have and maintain documented tolerances for the solutions. Refer to Process Tables, Section 5.0, for frequency of checks.	AMP has infrequent requirements for off-line rust Inhibitors/rust preventive solutions. When required, solutions are made up with the required concentrations per manufacturer.		X		
2.14	Are process control parameters monitored per frequencies specified in Process Tables?	Process control parameters shall be monitored per frequencies specified in Process Tables. Refer to Process Tables, Section 3.0. Computer monitoring equipment with alarms and alarm logs satisfy the verification requirement. A designated floor person shall verify the process parameters, e.g., by initialing a strip chart or data log. Management review is required per Question 1.9.	Process control parameters are monitored in real time on several computers in the plant, as well as being recorded in the Data Acquisition System. Individual furnace process parameters / steps are signed off on each Work Order by operators. Final inspection and signoff of all parameters for each Work Order is done by the Shift Supervisor or Designee. Furnace logs are also used to record additional parameters not recorded on the Electronic Monitoring/Data Acquisition System.		X		
2.15	Are In-Process / Final Test Frequencies performed as specified in Process Tables?	In-Process / Final Test Frequencies shall be performed as specified in Process Tables. Refer to Process Tables, Section 4.0.	Testing frequencies meet or exceed specifications. See individual Work Order instructions and Work Orders for actual Test Frequencies for each order.		X		
2.16	Is product test equipment verified?	Product test equipment shall be verified. Test equipment shall be verified/calibrated per applicable customer-specific standard or per an applicable consensus standard such as those published by ASTM, DIN, EN, ISO, JIS, NIST, SAE etc. Verification/calibration results shall be internally reviewed, approved, and documented. Refer to Process Tables, Section 1.0, for frequency of checks.	All hardness testers are calibrated at least annually and are also verified at the beginning of each shift, using certified test blocks and certified diamonds, with the results reviewed, approved, and documented.		X		

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Section 3 - Equipment							
3.1	Do furnaces, generators, and quench systems have proper process control equipment?	The heat-treat equipment including furnaces, generators, and quench systems shall have proper process controls and related equipment. Examples include temperature, carbon potential/dew point, gas flows, quench monitoring system including agitation, temperature control, etc. as listed in the applicable Process Tables, Section 1.0.	All furnace lines, generators, and quench systems have proper Process Controls and are Monitored continuously via our Electronic Monitoring / Data Acquisition System. Agitation is not electronically monitored, but is monitored via Furnace Logs.		X		
3.2	Are process equipment calibrations and/or verification certified, posted, and current?	The calibration and certification of the process equipment shall be checked at regular specified intervals. Refer to the applicable Process Tables, Sections 1.0 and 2.0, for equipment calibration or certification time tables.	Yes, per Table A, section 1.0 and 2.0 specified frequencies.		X		
3.3	Are thermocouples & protection tubes checked or replaced per Process Tables?	The thermocouples and protection tubes shall be checked or replaced in compliance to a preventive maintenance schedule. Refer to the applicable Process Tables, Section 2.0.	Thermocouples are checked quarterly by an outside service, based on a preventive maintenance schedule.		X		
3.4	Are temperature uniformity surveys performed per requirements in Process Tables?	Temperature uniformity surveys shall be conducted per the requirements in the applicable Process Tables, Section 2.0. Certain furnace designs, e.g., rotary retorts & some continuous pusher furnaces preclude direct temperature profiles. Alternate test methods per Section 3.4.5 are acceptable for furnaces where temperature uniformity studies are not possible. TUS studies are not required for Ion Nitriding. Refer to Process Table H Item # H2.4 for specific requirements.	AMP's Rotary Furnaces: Temperature Uniformity Surveys (TUS) are conducted per the requirements in the applicable Process Tables, Section 2.0 , Year-long Property Studies are also being conducted, using high-volume / frequently-processed parts, on each furnace, using Standard Deviation and Mean of Surface Hardness results, to evaluate and analyze the performance and the effectiveness of the performance of each furnace. TUS is performed for tempering furnaces.		X		
3.5	Is the variation of the furnace controlled thermocouple from set point within the requirements in the Process Table?	The variation between the furnace control thermocouple value and the set point temperature shall be within the limits defined in the applicable Process Tables, Section 2.0. For Ion nitriding refer to Process Table H Item # H2.5 for specific requirements.	All control thermocouples in continuous furnaces are within specified tolerances, and are being verified continuously via our Electronic Monitoring System.		X		
3.6	Are the process & equipment alarm checks being tested for proper function?	The heat treater shall have a list of heat treat process and equipment alarms that, if not properly working, may have a high probability of producing non-conforming product. These alarms shall be checked quarterly at a minimum or after any repair or rebuild. Other alarms, including but not limited to safety-related, shall be checked per heat treater's requirement. These alarm checks shall be documented.	System alarms are checked for proper function monthly (and after any repair or rebuild) and documented in the Preventive Maintenance log.		X		

Special Process: Heat Treat System Assessment

Question Number	Question	Requirements and Guidance	Objective Evidence	Assessment			
				N/A	Satisfactory	Not Satisfactory	Needs Immediate Action
3.7	Are generators and furnace atmospheres continuously monitored, automatically controlled, and documented? NOTE: This requirement is specific to Process Tables A, B, E, F, and G; Sections 1.0 and 3.0.	Generator and furnace atmosphere carbon potential/dew point shall be continuously monitored, automatically controlled, and documented. Recorded carbon potential shall be controlled within +/- 0.05 of the set point. Recorded dew point shall be controlled within acceptable limits specified in the control plan or internal procedures. NOTE: For rotary retort and shaker furnaces that preclude in situ control and monitoring, the method described in Section 3.4.5 "Property Surveys" shall be used. If generators are not used, the flow rates of the supplied atmosphere gases shall be monitored and controlled. The automatic and continuous atmosphere control system shall consist of sensors such as oxygen probes or on-line Infrared (IR) gas analysis. The heat treater shall also have a back-up method of checking the carbon potential/dew point. Examples are dew point, electrical wire resistance, gas analysis, shim stock, carbon bar, etc. See Process Tables, Sect. 3.0 for verification frequencies of primary and back up method.	Rotary Furnaces: Generators and furnace atmospheres are monitored via dewpoints and gas flow rates, which are recorded at the start of each and every Work Order. A portable 3-Gas Analyzer is available for verifying the endo gas composition and a portable DP analyzer verifies the dewpoint, while furnace-mounted carbon probes provide real-time, continuous monitoring of the atmosphere in the furnace shell to the Electronic Monitoring System/Data Acquisition System.		X		
3.8	A back up verification of the atmosphere is required. 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 carbon-bearing atmosphere to the primary control method re-established? NOTE: This requirement is specific to Process Tables A, B, E, F, and G; Sections 1.0 and 3.0.	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), the heat treater shall resolve the out-of-limit discrepancy. The back-up atmosphere monitoring system reading and the automatically controlled atmosphere dew point/carbon potential reading shall be maintained within the correlation limits specified in the control plan or internal procedures. These range tolerances vary with the specific heat treat process and the equipment used. The heat treater shall make appropriate technical adjustments and then re-establish/demonstrate the correlation of the actual atmosphere carbon potential/dew point reading to the primary control and back-up atmosphere reading. The range tolerances for correlation between the two readings shall be in the control plan or internal procedures. The back-up carbon potential/dew point reading shall be established using one or more of the following methods: • Carbon bar, slug, or surface carbon of part • Shim stock • 3-gas analyzer • Dew point • Hot wire resistance	Shift Supervisors, Operations, and Lab Personnel resolve all atmosphere problems, using one or more of the primary control methods, including a portable 3-Gas Analyzer available for verification of the atmosphere and a portable DP analyzer (DP2000). Key associates are trained in the use of the 3-Gas Analyzer/DP Analyzer for use in checking atmosphere, allowing a backup/verification of the actual atmosphere Dewpoint readings.		X		
3.9	Are all ammonia lines equipped with a fail-safe method to prevent ammonia leaks into the furnace?	One of these fail-safe methods shall be used to prevent ammonia to leak into the furnace: • A quick disconnect or physical separation of the lines • Three-valve ammonia "fail-safe" vent system is permitted. See the definition “Three Valve Fail-Safe Vent” and diagram in the glossary. • 1 manual and 2 electrical magnetic valves in series The heat treater shall show evidence that ammonia lines were disconnected for non-ammonia bearing atmosphere processes.	All ammonia lines going to furnaces are equipped with quick disconnects.		X		

Special Process: Heat Treat System Assessment

Question Number	Question	Requirements and Guidance	Objective Evidence	Assessment			
				N/A	Satisfactory	Not Satisfactory	Needs Immediate Action
3.10	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. The heat treater shall perform a minimum 3 hour purge prior to processing product not requiring ammonia as an addition. Reduction of 3 hour purge requires conclusive test data of the atmosphere to show no significant amount of residual ammonia is present in the furnace atmosphere. 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 parts in heat treat processes not specifying ammonia.	A minimum 3-hour oxiding burn-out is performed prior to processing product not requiring ammonia as an addition. End times for previous process (and part processed) are recorded, as well as the start time for the next process (and the specific part processed). The Furnace Log also records the start and end times for the burn-out.		X		
3.11	Do all atmosphere furnaces and generators have flow scopes or flow meters for all gases?	All atmosphere furnaces and generators (output trim/adjustment gas) shall have flow scopes or flow meters for all gases. Flow scopes and meters shall be periodically serviced per the heat treater's preventive maintenance program. Cleaning and proper re-assembly procedures shall be documented.	All generators and furnaces have flow scopes for each gas line that is connected, including endothermic gas, natural gas, air and ammonia. Cleaning is documented in the Furnace Log.		X		
3.12	Is there a rigorous fail-safe at the front of the furnace to prevent non-uniform loading of parts? In absence of a rigorous fail-safe, are all continuous belt furnaces equipped with sight glass inspection ports and infrared temperature pyrometers at discharge end of the hardening furnace?	In absence of a rigorous fail-safe at the front of the furnace to prevent non-uniform loading of parts (this includes the combustion system maintenance/adjustments to ensure proper efficiencies and physical limitation for part loading), then the heat treater shall have an infrared temperature pyrometer at the exit end. The infrared temperature pyrometers are required at the exit end of continuous belt furnaces to monitor for under temperature parts. The temperature alarm shall be within 28°C (50°F) of the furnace set point temperature. Results shall be strip charted or continuously data logged. Infrared temperature pyrometers shall be calibrated annually at a minimum and certified. All sight glasses shall be cleaned per the preventive maintenance schedule.	AMP has computer-controlled feeder systems to ensure that parts are uniformly loaded into the furnaces.		X		
3.13	Is salt chemistry in the austenitizing salt bath monitored? Note: This is applicable to salt bath heat treating processes listed in Process Tables A & B.	The heat treater shall check the salt chemistry in the austenitizing salt bath, or part decarburization, daily. Refer to the applicable Process Tables, Section 3.0, for frequency of checks.		X			
3.14	Is the quenching medium analyzed?	The heat treater shall periodically have the quenching medium analyzed for specific quenching characteristics, e.g., cooling curve, water content, salt concentration, as specified in the applicable Process Tables, Section 5.0. This does not include Process Table G & H. • The quench media characteristic tolerances shall be specified by the quench medium supplier or the heat treater. • Analysis shall be reviewed for conformance by the heat treater. This review shall be documented.	The quenching media (oil) is analyzed quarterly, while the water quench media is analyzed every six months.		X		

Special Process: Heat Treat System Assessment

Question Number	Question	Requirements and Guidance	Objective Evidence	Assessment			
				N/A	Satisfactory	Not Satisfactory	Needs Immediate Action
FOR INDUCTION HEAT TREATING							
3.15	Is the positioning of each part being controlled?	A method to detect proper part position, such as the use of proximity switches, optical sensors, mechanical probes, etc., is required for each part.		X			
3.16	Does the heat treater control the energy or power for each part?	The heat treater shall control the energy or power for each part. • A signature monitor for each machine is preferred. A signature monitor gives the energy unit (voltage, kilowatt, etc.) vs. time or distance (for scanning systems). • An energy monitor or equivalent is acceptable if approved by the authorized customer representative.		X			
3.17	Does the supplier have a coil management system? Coil refers to the heating coil and the quench plenum.	The heat treater shall have a coil management system. Coil refers to the heating coil and the quench plenum. • Spare coils for each part shall be available on-site. • Coils shall conform to the approved original design. • Engineering change approval from the customer is required whenever the coil design is changed.		X			
3.18	Is quench system automatic?	The quench system shall be an automatic operation. No manual quenching is allowed unless specifically approved by the authorized customer representative. Quenching shall be automatically initiated and controlled.		X			
3.19	Does each lot of parts have first piece set-up?	The heat treater shall perform first piece set-up for each lot of parts.		X			
3.20	Is there a procedure that addresses maintenance of the inductor and quench spray nozzle(s) (for example, quench ring, quench shower)?	Procedure shall include regular inspection and cleaning of the inductor and quench spray nozzle(s).		X			
3.21	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. The Heat treater shall establish the time limit (of the downtime) when this procedure is to be followed. [Example: The quench lines shall be purged after induction heating system is down greater than 4 hours.] Factors such as quench line diameter, length, geometry, etc. shall be considered.		X			

Section 4 - Job Audit Carbonitriding (CN)

Job Identity:

Customer: Non-Disclosure
Shop Order Number: WO 68671
Part Number: Non-Disclosure
Part Description: Non-Disclosure
Material: Per Customer print/specification
Heat Treat Requirements: Carbonitrided & Temper

Question #	Job Audit Question	Related HTSA Question #	Customer or Internal Requirement	Job (Shop) Order or Reference Documentation Requirement	Actual Condition (Objective Evidence)	Pass / Fail / N/A
4.1	Are contract review, advance quality planning, FMEA, control plans, etc., performed by qualified individuals?	1.2 1.3 1.4 1.17	Internal and Customer	RFQ and Team Feasibility for each part. Generic PFMEA for each process. Control Plans for each part are integrated into electronic recipes. These are created and maintained by qualified individuals.	RFQ, Team Feasibility, APQP, PFMEA performed by designated and qualified individuals - electronic signoff of Team Feasibility for PN XXXX is evident in WORP.	Pass
4.2	Does the heat treat facility have the customer specifications for the part?	1.5	Internal and Customer	Material specifications and customer specifications and requirements are listed on customer drawings/specifications and transferred to the specific part recipe.	Copies of Customer Material Steel Certs are not supplied by Customer; Customer product specifications & Material are on Customer Spec (and PO), which is viewable on AMP WORP software, & are listed on Work Order/recipe.	Pass
4.3	Is a shop traveler created to meet customer requirements?	1.6 2.1	Internal	Work Order is created electronically, along with a hard copy for the Shop Floor.	Work Order in WORP, along with a hard copy on shop floor and AMP router tag.	Pass
4.4	Is material identification (part numbers, lot numbers, heat numbers, contract numbers, etc.) maintained throughout the heat treat process?	2.2 2.3 2.4	Internal and Customer	Lot #, Heat #, Material chemistry if available are on AMP WO. A part photo and customer PN are on AMP WO and Router Tags, WO # & # of tubs are on the magnetic tag.	Carbonitriding, Quench Media Oil, PN XXXX, part photo, PO#15368, Shipper 6382, Lot#6382, Material Chemistry not provided, & # of tubs are listed on WO. Carbonitriding, Quench Media Oil, WO#, PN, Customer, part photo, Lot #, and # of tubs are on the router tag. WO # & # of tubs are on the magnetic tag.	Pass
4.5	Is there documented evidence of Receiving Inspection?	2.1	Internal requirement to check part ID, tub ID, tub weight, and quantity at Receiving	AMP Receiving Inspection Procedure requires visual inspection of parts and customer container as received. AMP Quality Dept is notified if an apparent problem exists with parts or container, for disposition by the Quality Dept. If necessary, parts are placed on hold pending disposition.	Parts weighed in & part #, weight, container #, & general condition are recorded & compared to Customer paperwork before creation of Work Order. All info noted on the shipper and entered in WORP, shows blue for 2% weight tolerance.	Pass

Section 4 - Job Audit Carbonitriding (CN)

Job Identity:

Customer: Non-Disclosure
Shop Order Number: WO 68671
Part Number: Non-Disclosure
Part Description: Non-Disclosure
Material: Per Customer print/specification
Heat Treat Requirements: Carbonitrided & Temper

Question #	Job Audit Question	Related HTSA Question #	Customer or Internal Requirement	Job (Shop) Order or Reference Documentation Requirement	Actual Condition (Objective Evidence)	Pass / Fail / N/A
4.6	Are the Loading / Racking requirements identified?	1.6 2.7 2.9	Internal	Work Order / Recipe defines Feedrate Requirement of 1000 lbs/hr.	Feeding rate set at 1000#/hr on computerized feeder and loading timing (start/finish) was documented on WO.	Pass
4.7	Is the proper recipe or process specification (cycle times, temperature, atmosphere, etc.) used? Refer to Process Tables, Section 3.0, for specific parameters. List parameters that were verified in this audit in the spaces provided below.	1.5 1.6 2.1 2.14 2.15	Internal	Proper recipe is integrated when part number is entered into electronic (Worp) Work Order creation software during creation of shop Work Order. Recipe does not have provision for adding additional steps to current WO. A hard copy of the WO is being used.	Hard copy WO (shop traveler) was compared to the furnace setup and settings.	Pass
			Pre-Wash	Furnace TBD	Furnace #20 and 21	Pass
			Feedrate	1000#/hr	Actual: 996#/Hr on feeder	Pass
			Quench-Oil Temperature	Setpoint:160^{0}F	Actual:155^{0}F	Pass
			Cycle Time	Setpoint: 1:00 hours (60 Hz)	Actual: 1:00 hours (60 Hz)	Pass
			Austenitizing Temperature	Setpoint: 1580^{0}F	Actual: 1579^{0}F	Pass
			Post-Wash & Temper	Post-Wash & Temper TBD	Furnace #203	Pass
			Tempering Temperature	Setpoint: 300^{0}F	Actual: 300^{0}F	Pass
			Tempering Time	Setpoint 1 hour min	Actual: 74 min	Pass

Section 4 - Job Audit Carbonitriding (CN)

Job Identity:

Customer: Non-Disclosure
Shop Order Number: WO 68671
Part Number: Non-Disclosure
Part Description: Non-Disclosure
Material: Per Customer print/specification
Heat Treat Requirements: Carbonitrided & Temper

Question #	Job Audit Question	Related HTSA Question #	Customer or Internal Requirement	Job (Shop) Order or Reference Documentation Requirement	Actual Condition (Objective Evidence)	Pass / Fail / N/A
4.8	What are the product inspection requirements?	2.15				
4.8.1	Requirement:	**Surface Hardness as Quenched**				
	Test Method:	Surface Hardness Testing	Internal	ASTM E18. If specified, inspection photo defining sample preparation & location(s) for Surface Hardness testing.	Test results recorded in WORP and on hard copy of Work Order.	Pass
	Test frequency or quantity:		Internal	5 pcs/hr, min 10 pcs/order	5 pcs checked at audit, 20 pcs total	Pass
	Selection of samples:		Internal	Random during hourly check	Random during hourly check	Pass
	Specification:		Internal	No specification	Actual: HRB 86.2 - 102.5	Pass
4.8.2	Requirement:	**Surface Hardness as Tempered**				
	Test Method:	Surface Hardness Testing	Internal and Customer	ASTM E18. If specified, inspection photo defining sample preparation & location(s) for Surface Hardness testing.	Test results recorded in WORP and on hard copy of Work Order.	Pass
	Test frequency or quantity:		Internal	5 pcs/hr, min 10 pcs/order	5 pcs checked at audit, 15 pcs total	Pass
	Selection of samples:		Internal	Random during hourly check	Random during hourly check	Pass
	Specification:		Internal and Customer	HRB 84 - 110	Actual: HRB 85.6 - 95.6	Pass
4.8.4	Requirement:	**Total Case Depth Testing**				
	Test Method:	Total Case Depth Testing Standard	Internal	Per J423: Sectioning part, acid-etching, then visual measurement using Brinnel Scope scale.	Test results recorded in WORP and on hard copy of Work Order	Pass
	Test frequency or quantity:		Internal	1 pc/ hr, min 3 pcs/order	2 pcs checked at audit, 5 pcs total	Pass
	Selection of samples:		Internal	Random	Random	Pass
	Specification:		Internal and Customer	0.003" - 0.010"	Actual: 0.006" - 0.008"	Pass

Section 4 - Job Audit Carbonitriding (CN)

Job Identity:

Customer: Non-Disclosure
Shop Order Number: WO 68671
Part Number: Non-Disclosure
Part Description: Non-Disclosure
Material: Per Customer print/specification
Heat Treat Requirements: Carbonitrided & Temper

Question #	Job Audit Question	Related HTSA Question #	Customer or Internal Requirement	Job (Shop) Order or Reference Documentation Requirement	Actual Condition (Objective Evidence)	Pass / Fail / N/A
Operator or Inspector Responsibilities						
4.9	Were appropriate process steps signed off?	1.4 2.2 2.3 2.14	Internal	Work Order requirement for redundant signoffs.	Electronic signoff of process steps in WORP, as well as initialed on hard copy of the WO. CN and Temper in Worp and paper shop traveler at audit time.	Pass
4.10	Were all inspection steps, as documented in the control plan performed?	1.2 1.4	Internal	Most of the Control Plan (CP), including inspection criteria, is integrated into electronic recipe in Worp software; a Generic Control Plan has also been created to address other aspects of Control Plans.	Electronic recipe requires electronic & manual signoff of each step, with final review & signoff by Shift Leader (or authorized representative) or WO cannot be closed for shipping. All steps signed off at the end of the job.	Pass
4.11	Were steps/operations performed that were not documented in the control plan?	1.2 1.4 1.6	Internal	Additional washing step can be performed at Shift Leader's discretion, as allowed in AMP documentation.	No additional steps were performed.	Pass
4.12	If additional steps were performed, were they authorized?	1.2 1.4 1.6 1.11 1.17	Internal	Internal Requirement that certain (critical) additional steps can only be authorized by the Quality Department.	No additional steps were performed. If post-wash is performed, it is allowed per AMP documentation	Pass
4.13	Does the governing specification allow reprocessing or rework?	1.11	No specification	Rework of order requires Quality Department approval. Retempering is not considered rework.	Call customer for rework approval.	Pass
4.14	If the order was certified, did the certification accurately reflect the process performed?	2.14 2.15	Internal and Customer	Data on Certification and data on WO match; data is electronically generated.	Certification Data matched the data in the hard copy of the WO & the electronic copy of the WO.	Pass
4.15	Was the certification signed by an authorized individual?	1.17	Internal and Customer	Certification automatically acquires & applies Quality Manager's electronic signature.	Certification electronically signed by Quality Manager.	Pass
4.16	Are the parts and containers free of inappropriate objects or contamination?	2.6 2.11	Internal and Customer	AMP procedure requires visual inspection of parts & containers at Incoming and Outgoing.	Containers & parts were visually free of contaminants. Outgoing customer containers inspected during audit.	Pass

Section 4 - Job Audit Carbonitriding (CN)

Job Identity:

Customer: Non-Disclosure
Shop Order Number: WO 68671
Part Number: Non-Disclosure
Part Description: Non-Disclosure
Material: Per Customer print/specification
Heat Treat Requirements: Carbonitrided & Temper

Question #	Job Audit Question	Related HTSA Question #	Customer or Internal Requirement	Job (Shop) Order or Reference Documentation Requirement	Actual Condition (Objective Evidence)	Pass / Fail / N/A
	Packaging Requirements					
4.17	Are packaging requirements identified?	2.9	Internal	AMP requires that, upon completion of Heat-Treating & Sorting, parts are returned to Customer's original containers and weighed, weights recorded on Work Order.	Process Steps were signed off on electronic & paper copies of Work Order and each bin weighed out, with weights recorded. Shipping records and signed shipper in WORP.	Pass
4.18	Are parts packaged to minimize mixed parts (for example, parts packed over height of container)?	2.9	Internal	AMP attempts to package outgoing material as closely to incoming packaging as possible, by weight.	Parts were evenly distributed in the container and were not packed over the height of the 1 container.	Pass
	Shipping Requirements					
4.19	Were the parts properly identified?	2.3 2.9	Internal and Customer	WO creation requirement to identify parts & container with AMP Router Tags, linking container to parts to AMP Work Order to Customer PO/Shipper.	Work Order Router Tag, identifying the parts within the container, were attached to Customer containers.	Pass
4.20	Were the containers properly labeled?	2.3 2.9	Internal	WO creation requires labeling of Customer containers w/Router Tags.	Properly labeled AMP Router Tags were attached to customer container.	Pass

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

All requirements given below are subordinate to customer specific requirements.

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

Continuous furnace frequencies are per lot (work order) or as specified, whichever is more frequent.

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

Item #	Related HTSA	Category/Process Steps	
1.0		**PROCESS AND TEST EQUIPMENT REQUIREMENTS**	**OK / NOK / NA**
A1.1	3.1 3.7	All furnaces, generators and quench systems shall have temperature indicating instruments.	**OK**
A1.2	3.1 3.7	Continuous strip charts and/or data loggers are required for temperature and carbon monitoring unit, e.g., dew point, oxygen probe, IR gas analyzer, etc.	**OK**
A1.3	1.18	A program for furnace and generator burnout is required (applies to carbon bearing atmospheres).	**OK**
A1.4	3.2	Furnace weigh scales shall be verified quarterly and calibrated annually at a minimum.	**OK**
A1.5	3.2	Dew pointers, 3-gas analyzers, spectrometers, and carbon IR combustion analyzers (shim stock analysis), used to verify carbon potential in furnaces, shall be calibrated annually at a minimum.	**OK**
A1.6	3.2	Verification of calibration of spectrometers, and carbon IR combustion analyzers, shall be checked daily or prior to use.	**N/A**
A1.7	3.2	Verification of calibration of 3-gas analyzers with zero gas and span gas shall be performed weekly at a minimum.	**OK**
A1.8	3.2	Oxygen probe controllers shall be calibrated quarterly (single-point or multi-point calibration) or semi-annual (multi-point calibration only; single-point calibration not allowed).	**OK**
A1.9	2.16	All hardness test equipment (for each scale used) shall be calibrated annually minimum, and verified daily or prior to use, per the applicable ASTM standard, ISO standard, JIS standard, or approved standard.	**OK**

A1.10	2.16	Files for testing hardness shall be verified per the Customer requirement.	**OK**
A1.11	3.2	Refractometers (typically used to check polymer quenchants and washer solutions) shall be verified prior to use (with distilled water) and calibrated annually (per manufacturer's requirements) at a minimum.	**N/A**

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

Item #	Related HTSA Question #	Category/Process Steps	
2.0		**PROCESS AND TEST EQUIPMENT REQUIREMENTS**	**OK / NOK / NA**
A2.1	3.2 3.3	Thermocouples and calibration of thermocouples shall conform to Section 3.1	**OK**
A2.2	3.2 3.3	Pyrometry Instrumentation and Calibration of instrumentation shall conform to Section 3.2	**OK**
A2.3	3.2 3.3	CQI-9 requires a System Accuracy Test (SAT) check of all control thermocouples per Section 3.3. Also, any recording or monitoring thermocouple(s) more than 5 centimeters from the controlling thermocouple in the zone, for example thermocouples in continuous belt furnaces near the drop point to quench used for recording or monitoring the hardening temperature (this does not include the "over-temperature" thermocouples that are used to protect the furnace from overheating).	**OK**
A2.4	3.4	TUS shall be performed annually and after major rebuild per Section 3.4 Temperature uniformity tolerance for hardening furnaces shall be +/- 15°C (or +/- 25°F). Temperature uniformity tolerance for tempering furnaces shall be +/- 10°C (or +/- 20°F).	**OK**
A2.5	3.5	Recorded temperature(s) for austenitizing processes shall be controlled within +/- 10°C (or +/- 15°F) of the set point as evidenced by continuous recording pyrometers. Furnace temperature shall be controlled with soak times starting at the lower tolerance limit (as defined above). **For Continuous Furnaces, this requirement applies to the Qualified Work Zone.**	**OK**
A2.6	3.5	Recorded temperature(s) for tempering and precipitation hardening processes shall be controlled within +/- 5°C (or +/- 10°F) of the set point as evidenced by continuous recording pyrometers. Furnace temperature shall be controlled with soak times starting at the lower tolerance limit (as defined above). **For Continuous Furnaces, this requirement applies to the Qualified Work Zone.**	**OK**
A2.7	3.2	Infrared pyrometers shall be calibrated annually using proper calibration methods or an approved manufacturer's procedure.	**N/A**

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

Item #	Related HTSA Question #	Category/Process Steps				
3.0		**Temperature & Atmosphere Controls**	**Batch Furnace**	**Continuous Furnace**	**Atmosphere Generation**	**OK / NOK / NA**
A3.1	1.4 2.14	Monitor primary temperature control instrument(s).	Continuous recording with sign-off every 2 hours or each batch for processes under 2 hours. Alarm systems (if set per limits in A2.5 and A2.6) satisfy the sign-off requirement.	Continuous recording with sign-off every 2 hours or each lot for processes under 2 hours). Alarm systems (if set per limits in A2.5 and A2.6) satisfy the sign-off requirement	Sign-off required for each shift for generators.	**OK**
A3.2	1.4 2.14 3.7	Monitor atmosphere generation as applicable.			Generators shall be continuously monitored and alarmed. 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 2.14 3.7	Monitor primary furnace atmosphere control(s)	Continuous recording with sign-off every 2 hours or each batch 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 or each lot for processes under 2 hours). Alarm systems (if set per acceptable limits) satisfy the sign-off requirement		**OK**
A3.4	1.4 2.14 3.7 3.8	Verify primary furnace atmosphere control method by back-up method	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			**N/A**

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

Item #	Related HTSA Question #	Category/Process Steps				
		Quench Media Process Parameters	**Batch Furnace**	**Continuous Furnace**		**OK / NOK / NA**
A3.6	1.4 2.12	Temperature	Continuous recording with sign-off every 2 hours (or each batch 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 (or each lot 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**
A3.7	1.4 2.14	Monitor time in furnace, cycle time, or belt speed.	Each batch	Twice/shift & after any change in the belt speed.		**OK**
A3.8	1.4 2.7	Monitor load size or fixturing or loading rate, as applicable.	Each batch	Twice/shift & after any change in loading rate.		**OK**
A3.9	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.	Each batch	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.		**N/A**

A3.10	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	Each load		**OK**

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

Item #	Related HTSA	Category/Process Steps				
4.0		**IN-PROCESS / FINAL TEST FREQUENCIES**	**Batch Furnace**	**Continuous Furnace**		**OK / NOK / NA**
A4.1	1.4 2.15	Microstructure shall be checked at a minimum magnification of 100x and 400x, or above 400x. Microstructural 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**
A4.2	1.4 2.15	Surface hardness	Each batch	Every 2 hours		**OK**
A4.3	1.4 2.15	Core hardness (when specified)	Each batch	Every 4 hours		**OK**
A4.4	1.4 2.15	Case depth (when specified)	Each batch	Every 4 hours		**OK**
5.0		**QUENCHANT AND SOLUTION TEST FREQUENCIES**	**Batch Furnace**	**Continuous Furnace**		**OK / NOK / NA**
A5.1	2.12 3.14	**Polymer Quench Media**				**N/A**
		Concentration	Daily	Daily		
		Cooling Curve Analysis	Semi-annually	Semi-annually		
A5.2	2.12 3.14	**Water Quench Media**				
		Suspended solids	Semi-annually	Semi-annually		**OK**
A5.3	2.12 3.14	**Salt Quench Media**				**N/A**
		Analysis & Contaminants	Semi-annually	Semi-annually		
A5.4	2.12 3.14	**Brine or Caustic Quench Media**				**N/A**
		Concentration and/or Specific Gravity.	Daily	Daily		
		Suspended solids	Semi-annually	Semi-annually		
A5.5	2.12 3.14	**Oil Quench Media**				
		Water content, suspended solids, viscosity, cooling curve, total acid, and flash point.	Semi-Annually	Semi-Annually		**OK**
A5.6	2.13	**Rust Preventive - Soluble Oil**				
		Concentration	2x / week	2x / week		**OK**
A5.7	2.11	**Washers**				
		Concentration of cleaner	Daily	Daily		**OK**
		Temperature of solution (required if temperature is specified to be above ambient temperature).	Each shift	Each shift		**OK**