



Automotive Industry Action Group

# CQI-9

## *Special Process: Heat Treat System Guideline*

FOR GM INTERNAL USE ONLY

# Special Process: Heat Treat System Assessment



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## APPROVAL STATUS

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## FOREWORD

Automotive Industry Action Group (AIAG) committees are made up of volunteers from member companies in the automotive industry. The work of preparing process audits is done by AIAG technical committees.

The main task of technical committees is to prepare Automotive Standards and System Requirements. Draft documents adopted by the technical committees are circulated to the Steering Committee for review and consensus approval. Publication of the documents requires approval by the Quality Steering Committee.

The Quality Steering Committee would like to acknowledge and thank the following individuals and their companies who have contributed time and effort to the development of this document.

# Special Process: Heat Treat System Assessment



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# Special Process: Heat Treat System Assessment



## 1.0 INTRODUCTION

### 1.1 General

The work of preparing *CQI 9: Special Process: Heat Treat System Assessment* (HTSA) was carried out through the AIAG Heat Treat Work Group. These heat treat requirements are complementary to customer and product standards.

The HTSA can be used to assess an organization's ability to meet the requirements in this assessment, as well as customer, regulatory, and the organization's own requirements. The HTSA can also be used between an organization and its suppliers.

In the HTSA, the word "shall" indicates a requirement. Where the term "such as" is used, any suggestions given are for guidance only.

### 1.2 Process Approach

The HTSA supports the automotive process approach as described in ISO/TS16949:2002.

### 1.3 Heat Treat System Assessment Goals

The goal of the HTSA is the development of a heat treat management system that provides for continual improvement, emphasizing defect prevention and the reduction of variation and waste in the supply chain.

The HTSA, coupled with an internationally recognized quality management system and applicable customer-specific requirements, defines the fundamental requirements for heat treat management systems.

The HTSA is intended to provide a common approach to a heat treat management system for automotive production and service part organizations.

### 1.4 Assessment Process

Ongoing assessments shall be conducted annually, unless otherwise specified by the customer, to re-examine the continuing compliance with the HTSA. Each assessment shall include a review of the organization's systems using the HTSA. Successive Job Audits (Section 4.0 of this document) shall sample parts from different automotive component manufacturers that require compliance to the HTSA document.

The assessment shall use the process approach to auditing as identified by the requirements of ISO/TS 16949:2002.

## 1.5 Assessor Qualifications

Assessors shall have the following specific experience to conduct the HEAT TREAT SYSTEM ASSESSMENT portion of the assessment:

- Be an experienced quality management system (QMS) internal auditor (e.g., ISO 9000:2000, ISO/TS 16949:2002)

## 1.6 Other Requirements

The organization shall keep records as evidence of compliance to the requirements identified in the HTSA, as well as all appropriate action plans to address any unsatisfactory ratings. These records shall be readily available for review by any customer requiring compliance to the requirements within this document.



# Special Process: Heat Treat System Assessment



## 2.0 SCOPE

### 2.1 General

This document specifies process requirements for an organization or its suppliers performing applicable heat treating, who need to

- demonstrate ability to consistently provide product that meets customer and applicable regulatory requirements, and
- enhance customer satisfaction through the effective application of the system, including processes for continual improvement of the system.

The Heat Treat System Assessment is applicable to sites where customer-specified parts for production and/or service are processed throughout the automotive supply chain.

### 2.2 Application

All requirements of the HTSA are generic and are intended to be applicable to all organizations performing the heat treat operations addressed in this document, regardless of type, size, and product.

Four Process Tables have been developed and the appropriate table(s) is to be referenced during the assessment. The Process Tables are specific to heat treat processes as noted below:

#### Process Table 1 – Ferrous

- Carburizing
- Carbonitriding
- Carbon Restoration or Correction
- Neutral Hardening (Quench and Temper)
- Austempering
- Martempering
- Tempering
- Precipitation Hardening – Aging

#### Process Table 2 – Ferrous

- Nitriding (Gas)
- Ferritic Nitrocarburizing (Gas or Salt)

#### Process Table 3 – Aluminum Heat Treating

#### Process Table 4 – Induction Heat Treating (Ferrous)

These Process Tables contain requirements for:

1. Process and Test Equipment
2. Pyrometry
3. Process Monitor Frequencies
4. In-Process/Final Test Frequencies
5. Quenchant and Solution Test Frequencies

The Process Tables specify the tolerances of process parameters and the frequencies for checking process control parameters and parts. The Requirements/Guidelines in the HTSA form will notify the assessor when to refer to the Process Tables.

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# Special Process: Heat Treat System Assessment



## **3.0 THE HEAT TREAT SYSTEM ASSESSMENT PROCEDURE**

1. Obtain current copy of *CQI-9 Special Process: Heat Treat System Assessment Guideline* from AIAG.
2. Identify all heat treat processes to which *CQI-9 Special Process: Heat Treat System Assessment Guideline* applies (see *CQI-9, 2.2*). Record these processes on the HTSA.
3. Complete the HTSA, determining the level of compliance. Sections 1-3 shall be completed first and independent of any job audits performed. A minimum of one job audit (Section 4) shall be performed during each assessment.
4. Address each “unsatisfactory” item and determine corrective action, including root cause analysis and implementation of the corresponding corrective action(s). Records of corrective action, including verification, shall be maintained.
5. Assessments shall be conducted annually unless otherwise specified by the customer.

**4.0 SPECIAL PROCESS: HEAT TREAT ASSESSMENT**

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## Instructions for completing the Cover Sheet

1. **Facility Name:** Name of the facility being assessed.  
One form shall be used for each facility. The facility may have several buildings or physical locations in the same general area. If there is a separate management team (Quality Manager and Metallurgist) or different management system, then these locations shall be considered as separate facilities.
2. **Address:** The street address of the facility being assessed; P.O Box numbers may be given as additional information.
3. **Phone Number:** The phone number of the facility.  
If there is no common phone number for the facility, the phone number of the Operations Manager or Quality Manager shall be used.
4. **Fax Number:** The fax number of the facility.
5. **Number of Heat Treat Employees at this Facility:** The number of employees, salaried and hourly, associated with the heat treat operation at this facility.
6. **Captive Heat Treater (Y/N):** Enter "Y" if this facility heat treats components for their own company. Enter "N" if the company does not heat treat any components for their own company.
7. **Commercial Heat Treater (Y/N):** Enter "Y" if this facility heat treats components for companies other than their own company. Enter "N" if this facility does not heat treat any components for other companies.
8. **Date of Assessment:** Enter the date(s) of the assessment. An alphanumeric format shall be used to avoid confusion with different numeric formats.  
Example: May 3 – 4, 2006
9. **Date of Previous Assessment:** List the date of the previous CQI-9 Special Process: Heat Treat System Assessment of this facility.
10. **Type(s) of Thermal Processing at this Facility:** Place a checkmark to designate all thermal process(es) performed at this facility. This information determines the appropriate Process Table that shall be used during the assessment. Processes not listed on the cover sheet are not part of the Heat Treat System Assessment.
11. **Current Quality Certification(s):** The heat treater shall list their current quality certifications, e.g., ISO/TS 16949:2002, ISO 9000:2002. Certifications may be from 3<sup>rd</sup> party sources or customer quality certifications. If customer quality certification is given, then the year of the last assessment by the customer shall also be given.



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12. **Date of Re-assessment (if necessary):** If “Not Satisfactory” findings were observed from the original assessment, then the heat treater shall address each item and determine correct action, including root cause analysis and implementation of the corresponding corrective action(s).

The date of the re-assessment shall be given here, and the appropriate Question(s) from Sections 1 – 4, in the original assessment, shall be modified to reflect that the evidence, relating to the implementation of the corrective action(s), has been observed. Also, the “Number of Not Satisfactory Findings” shall be modified as appropriate.

13. **Personnel Contacted:** List the name(s), title(s), phone number(s), and email address(es), if available, of the principal participants from the heat treater’s organization.
14. **Auditors/Assessors:** List the name(s), Company(ies), phone number(s) and email address(es), if available, of the auditor/assessor(s).
15. **Number of “Not Satisfactory” Findings:** Enter the number of “Not Satisfactory” findings observed during the assessment.

# Special Process: Heat Treat System Assessment



## Special Process: Heat Treat Process Assessment

Facility Name:			
Address			
Phone Number		<b>Type(s) of Thermal Processing at this Location:</b>	
Fax Number		<b>Process Table 1</b>	
		Carburizing	
Number of Heat Treat Employees at this Location:		Carbonitriding	
		Carbon Correction	
Captive Heat Treater (Y/N)		Neutral Hardening	
Commercial Heat Treater (Y/N)		Austempering / Martempering	
		Tempering	
Date of Evaluation:		Precipitation Hardening / Aging	
Date of Previous Evaluation:			
		<b>Process Table 2</b>	
		Nitriding (Gas)	
		Ferritic-Nitrocarburizing (Gas or Salt)	
		<b>Process Table 3</b>	
		Aluminum Heat Treatment	
		<b>Process Table 4</b>	
		Induction Heat Treating	

Current Quality Certification(s)	
Date of Re-evaluation (if necessary):	

Personnel Contacted:			
Name	Title	Phone	Email

Auditors/Assesors			
Name	Company	Phone	Email

Number of "Not Satisfactory" Findings

## **Instructions for completing Sections 1 – 3**

Sections 1 - 3 contain questions and the requirements/guidance for each question. The Sections are:

- Section 1 – Management Responsibility & Quality Planning
- Section 2 – Floor and Material Handling Responsibility
- Section 3 – Equipment

The assessor shall assess the heat treater's compliance to Sections 1 – 3 by comparing the evidence presented by the heat treater to the requirements listed in the "Requirements/Guidance" column.

NOTE 1: In the "Requirements/Guidance" column, the word "shall" indicates a requirement and the term "such as" indicates that any suggestions given are for guidance only.

NOTE 2: The "Requirements/Guidance" column will indicate to the assessor when the Process Tables are pertinent to the Questions. When the Process Tables are pertinent to the Question, the assessor shall assess the heat treater's compliance to the specified section(s) in the Process Tables.

NOTE 3: If the question is not applicable to the heat treater, then the assessor shall place a checkmark in the "N/A" Assessment column. If the observed evidence is in compliance to the question, the assessor shall note the evidence in the "Objective Evidence" column and place a check mark in the "Satisfactory" column. If the observed evidence is not in compliance to the question, then the assessor shall note the non-compliance in the "Objective Evidence" column and place a check mark in the "Not Satisfactory" column.



# Special Process: Heat Treat System Assessment



Special Process: Heat Treat Process Assessment						
Question Number	Question	Requirements / Guidance	Objective Evidence	Assessment		
				N/A	Satisfactory	Not Satisfactory
<b>Section 1 - Management Responsibility &amp; Quality Planning</b>						
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.				
1.2	Does the heat treater perform APQP?	The organization shall incorporate a documented Advance Product and Quality Planning (APQP) 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 Production Part Approval Process (PPAP) 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 significant processes change shall be documented.				
1.3	Are heat treat PFMEAs up to date and reflecting current processing?	The organization shall incorporate the use of a documented Process Failure Mode and Effects Analysis (PFMEA) procedure and ensure the PFMEAs are updated to reflect current part quality status. The PFMEA 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, including a production operator, shall be used in the development of the PFMEA, and items with the highest Risk Priority Numbers (RPNs) shall be addressed annually. All significant or critical characteristics, as defined by the organization and its customers, shall be identified, defined, and addressed in the PFMEA.				

Special Process: Heat Treat Process Assessment							
Question Number	Question	Requirements / Guidance	Objective Evidence	Assessment			
				N/A	Satisfactory	Not Satisfactory	Needs Immediate Action
1.4	Are heat treat process control plans up to date and reflecting current processing?	<p>The organization shall incorporate the use of a documented Control Plan procedure and ensure the Control Plans are updated to reflect current controls.</p> <p>The Control Plans shall be written for each part or part family or they may be process-specific and written for each process. In any case, they shall address all process steps from part receipt to part shipment and identify all equipment used and all key heat treat process parameters as defined by the organization.</p> <p>A cross-functional team, including a production operator, shall be used in the development of Control Plans, which shall be consistent with all associated documentation such as work instructions, shop travelers, and PFMEAs. All significant or critical characteristics, as defined by the organization and its customers, shall be identified, defined, and addressed in the Control Plans. Sample sizes and frequencies for evaluation of process and product characteristics shall also be addressed consistent with the minimum requirements listed in the Process Tables, Sections 3.0 and 4.0.</p>		N/A	Satisfactory	Not Satisfactory	Needs Immediate Action

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Special Process: Heat Treat Process Assessment						
Question Number	Question	Requirements / Guidance	Objective Evidence	Assessment		
				N/A	Satisfactory	Not Satisfactory
1.5	<p>Are all heat treat related and referenced specifications current and available? For Example: SAE; AIAG, ASTM, General Motors, Ford, and DaimlerChrysler.</p>	<p>To ensure all customer requirements are both understood and satisfied, the organization shall have all related heat treat and customer referenced standards and specifications available for use and a method to ensure that they are current. Such standards and specifications include, but are not limited to, those relevant documents published by SAE, AIAG, ASTM, General Motors, Ford, and DaimlerChrysler. The organization shall have a process to ensure the timely review, distribution, and implementation of all relevant customer and industry engineering standards and specifications. This process shall be executed as soon as possible and shall not exceed two 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.</p>				
1.6	<p>Is there a written process specification for all active processes?</p>	<p>The heat treater shall have written process specifications for all active processes and identify all steps of the process including relevant operating parameters. Examples of operating parameters include process temperatures, cycle times, load rates, atmosphere or gas flow settings, heat 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.</p>				

Special Process: Heat Treat Process Assessment						
Question Number	Question	Requirements / Guidance	Objective Evidence	Assessment		
				N/A	Satisfactory	Not Satisfactory
1.7	Has a valid capability study been performed initially and after process equipment has been relocated, or had a major rebuild?	<p>To demonstrate each process is capable of yielding acceptable product the organization shall perform product capability study for the initial validation of each process, after relocation of any process equipment, &amp; after a major rebuild of any equipment. The organization shall define what constitutes a major rebuild. Initial product capability studies shall be conducted for all heat treat processes per furnace line defined in scope of work &amp; annually thereafter. A furnace line may include a combination of equipment that is integrated in the performance of a heat treatment process, i.e. hardening, quenching, and tempering. Capability study techniques shall be appropriate for the heat treat product characteristics, i.e. 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.</p>				
1.8	Does the heat treater collect and analyze data over time, and react to this data?	<p>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 significant product or process parameters. The organization shall determine which significant parameters to include in such analysis.</p>				

# Special Process: Heat Treat System Assessment



Special Process: Heat Treat Process Assessment						
Question Number	Question	Requirements / Guidance	Objective Evidence	Assessment		
				N/A	Satisfactory	Not Satisfactory
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.				
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. Concerns shall be addressed in a timely manner.				
1.11	Is there a system in place to authorize reprocessing and is it documented?	The quality management system shall include a documented process for reprocessing that shall include authorization from a designated individual. The reprocessing procedure shall describe product characteristics for which reprocessing is allowed as well as those characteristics for which reprocessing is not permissible. Any reprocessing activity shall require a new processing control sheet issued by qualified technical personnel denoting the necessary heat treat modifications. Records shall clearly indicate when and how any material has been reprocessed. The Quality Manager or a designee shall authorize the release of reprocessed product.				
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.				

Special Process: Heat Treat Process Assessment						
Question Number	Question	Requirements / Guidance	Objective Evidence	Assessment		
				N/A	Satisfactory	Not Satisfactory
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.				
1.14	Does the Quality Manager or designee authorize the disposition of material from quarantine status?	The Quality Manager is responsible for authorizing and documenting appropriate personnel to disposition quarantine material.				
1.15	Is there an operations manual available to heat treat personnel covering the entire heat treating process?	An operations manual shall be available to heat treat personnel covering the entire heat treating process. The manual shall include procedures or work instructions 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 cover all steps of the operation from product receipt to product shipment and shall be accessible to shop floor personnel.				
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 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.				

# Special Process: Heat Treat System Assessment



Special Process: Heat Treat Process Assessment						
Question Number	Question	Requirements / Guidance	Objective Evidence	Assessment		
				N/A	Satisfactory	Not Satisfactory
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.				
1.18	Is there a preventive maintenance program? Is maintenance data being utilized to form a predictive maintenance program?	The organization shall have a documented preventive maintenance program for key process equipment (as identified by the organization). The program shall be a closed-loop process that tracks maintenance efforts from request to completion to assessment of effectiveness. Equipment operators shall have the opportunity to report problems, and problems shall also be handled in a closed-loop manner. Company data, e.g., downtime, quality rejects, first-time-through capability, recurring maintenance work orders, and operator-reported problems, shall be used to improve the preventive maintenance program. Furnaces and generators shall be scheduled for burn-out at frequencies determined by the organization (see Section 1 of the Process Tables). Maintenance data shall be collected and analyzed as part of a predictive maintenance program.				
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.				

Special Process: Heat Treat Process Assessment						
Question Number	Question	Requirements / Guidance	Objective Evidence	Assessment		
				N/A	Satisfactory	Not Satisfactory
<b>Section 2 - Floor and Material Handling Responsibility</b>						
2.1	Does the facility ensure that the data entered in the receiving system matches the information on the customer's shipping documents?	<p>It is critical that all customer requirements and lot identification be adequately transferred to internal heat treat documents. The facility shall ensure that the data entered in the receiving system match the information on the customer's shipping documents. Documented processes and evidence of compliance shall exist, e.g., shop travelers, work orders, etc. Sometimes the material received does not precisely correspond to customer shipping documents. The facility shall have a detailed process in place to resolve receiving discrepancies.</p> <p>The requirements stated above also apply to captive heat treat departments. This process refers to receiving and shipping the parts in and out of the heat treat department.</p>				
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. Green, in-process, and finished product shall be properly segregated and identified. All material shall be staged in a dedicated and clearly defined area.				
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.				



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Question Number	Question	Requirements / Guidance	Objective Evidence	Assessment		
				N/A	Satisfactory	Not Satisfactory
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.				
2.5	Is there a system to identify trap points in the entire heat treat process to reduce risk of mixed parts (foreign, green, 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 (foreign, green, 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.				
2.6	Are containers free of foreign material?	Containers handling customer product shall be free of foreign material. Containers shall be inspected for foreign material and the source of the foreign material shall be notified. After emptying and before re-using containers, containers shall be inspected to ensure that all parts have been removed. This is to ensure that no green (un-heat treated) parts contaminate the finished lot.				
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.				

Special Process: Heat Treat Process Assessment						
Question Number	Question	Requirements / Guidance	Objective Evidence	Assessment		
				N/A	Satisfactory	Not Satisfactory
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.				
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. 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.				
2.10	Are plant cleanliness, housekeeping, environmental, and working conditions conducive to quality improvements?	Plant cleanliness, housekeeping, environmental, and working conditions shall be conducive to quality improvements. 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.				

# Special Process: Heat Treat System Assessment



Special Process: Heat Treat Process Assessment					
Question Number	Question	Requirements / Guidance	Objective Evidence	Assessment	
				N/A	Satisfactory
2.11	<p>Are parts free from contaminants that would be detrimental to the heat treatment of the product?</p>	<p>Many heat-treated parts are subjected to surface finish or appearance operations such as plating or coating after heat treatment. Parts shall be free from contaminants that are detrimental to subsequent processes or the product. Pre-wash (if applicable) and post-wash parameters shall be monitored and documented. Oils and other contaminants or residues can be difficult to remove once subjected to the heat treatment process. Review the chemical supplier's recommendation for cleaning the system. Parts shall be free of rust, burrs, chips, detrimental amounts of drawing compound, cutting fluids, rust preventing oils, lubricants, etc., prior to heat treat.                      Note: Refer to the appropriate heat treaters' requirements and specifications to determine acceptability. Refer to Process Table, Section 5.0, for frequency of checking washer solutions.</p>			
2.12	<p>Is the quenching system monitored, documented, and controlled?</p>	<p>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 treaters' 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 treaters for parts that are quenched and tempered, e.g., carburizing, carbonitriding, neutral hardening, solution treating and aging.</p>			

Special Process: Heat Treat Process Assessment						
Question Number	Question	Requirements / Guidance	Objective Evidence	Assessment		
				N/A	Satisfactory	Not Satisfactory
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.				
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.				
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.				
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.				

# Special Process: Heat Treat System Assessment



Special Process: Heat Treat Process Assessment						
Question Number	Question	Requirements / Guidance	Objective Evidence	Assessment		
				N/A	Satisfactory	Not Satisfactory
<b>Section 3 - Equipment</b>						
3.1	Do furnaces, generators, and quench systems have proper process control equipment?	The heat-treat furnaces, generators, and quench systems shall have proper process controls and related equipment. Examples include temperature, carbon potential/dew point, gas flows, quench monitoring system including agitation, temperature control and quenching oil analysis, etc. as listed in the applicable Process Tables, Section 1.0.				
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.				
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.				
3.4	Are temperature uniformity surveys performed per requirements in Process Tables?	Temperature uniformity surveys shall be conducted per the requirements in the applicable Process Tables, Section 2.0. The frequency reductions allowed in AMS 2750 are not allowed under this document. Certain furnace designs, e.g., rotary retorts preclude direct temperature profiles. Indirect product studies are acceptable for furnaces where temperature uniformity studies are not possible.				
3.5	Is the variation of the furnace controlled thermocouple from set point within the requirements in the Process Table?	The variation between the furnace-control thermocouple and the set point temperature shall be within the limits defined in the applicable Process Tables, Section 2.0. This does not apply to the first zone of a multi-zone continuous furnace.				
3.6	Are the process & equipment alarm checks being tested quarterly or after any repair or rebuild?	The heat treater shall have a list of heat treat process and equipment alarms. These alarms shall be independently tested quarterly at a minimum, and after any repair or rebuild. These checks shall be documented.				

Special Process: Heat Treat Process Assessment					
Question Number	Question	Requirements / Guidance	Objective Evidence	Assessment	
				N/A	Satisfactory
3.7	<p>Are generators and furnace atmospheres continuously monitored, automatically controlled, and documented?</p>	<p>Generator and furnace atmosphere carbon potential/dew point shall be continuously monitored, automatically controlled, and documented. This requirement is specific to Process Table 1, Sections 1.0 and 3.0, for carburizing, carbonitriding, and neutral hardening. Continuous monitoring and automatic control of the carbon potential/dew point is required for all generators and atmosphere furnaces except rotary retort and shaker furnaces that preclude in situ control and monitoring. This requirement is specific to carburizing, carbonitriding, and neutral hardening. If generators are not used, the flow rates of the supplied atmosphere gases shall be monitored and controlled. The assessor shall verify the effectiveness of the atmosphere control system per customer requirement, the heat treater's control plan, and internal procedures. The atmosphere control system shall maintain the atmosphere dew point/carbon potential set point within the parameters specified in the control plan or internal procedures. The heat treater shall have a back-up method of checking the carbon potential/</p>	<p></p>	<p></p>	<p></p>

# Special Process: Heat Treat System Assessment



Special Process: Heat Treat Process Assessment						
Question Number	Question	Requirements / Guidance	Objective Evidence	Assessment		
				N/A	Satisfactory	Not Satisfactory
3.8	<p>When the back-up verification check of the atmosphere does not agree or correlate within pre-established limits with the primary control method (carbon potential/dew point reading), is correlation of the carbon-bearing atmosphere to the primary control method re-established?</p>	<p>This issue is specific to Process Table 1, carburizing, carbonitriding, and neutral hardening. When the back-up verification check of the atmosphere does not agree or correlate within pre-established limits with the primary control method (carbon potential/dew point reading), the heat treater shall resolve the out-of-limit discrepancy. The back-up atmosphere monitoring system reading and the automatically controlled atmosphere dew point/carbon potential reading shall be maintained within the correlation limits specified in the control plan or internal procedures. These range tolerances vary with the specific heat treat process and the equipment used. The heat treater shall make appropriate technical adjustments and corrections and then re-establish/demonstrate the correlation of the actual atmosphere carbon potential/dew point reading to the primary control and back-up atmosphere reading. The range tolerances for correlation between the two readings shall be in the control plan or internal procedures. The back-up carbon potential/dew point reading shall be established using:</p> <ul style="list-style-type: none"> <li>• Carbon bar or slug</li> <li>• Shim stock</li> <li>• 3-gas analyzer</li> <li>• Dew point</li> <li>• Hot wire resistance</li> </ul>	<p>FOR INTERNAL USE ONLY</p>			

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



# Special Process: Heat Treat System Assessment



Special Process: Heat Treat Process Assessment						
Question Number	Question	Requirements / Guidance	Objective Evidence	Assessment		
				N/A	Satisfactory	Not Satisfactory
3.12	For threaded fasteners, are all continuous belt furnaces equipped with sight glass inspection ports and infrared pyrometers at discharge end of the hardening furnace?	Infrared temperature pyrometers are required at the exit end of continuous belt furnaces running threaded fasteners to monitor for under temperature parts. The temperature alarm shall be within 280C (50oF) of the furnace set point temperature. Results shall be strip charted or continuously data logged. Infrared (IR) units shall be calibrated annually at a minimum and certified. All sight glasses shall be cleaned per the preventive maintenance schedule.				
3.13	Is salt chemistry in the austenitizing salt bath monitored?	Applicable to ferritic-nitrocarburizing, austempering, and neutral hardening in salt. The heat treater shall check the salt chemistry in the austenitizing salt bath, or part decarburization, daily. Refer to the applicable Process Tables, Section 3.0, for frequency of checks.				
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. • 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.				

FOR GM INTERNAL USE ONLY

Special Process: Heat Treat Process Assessment						
Question Number	Question	Requirements / Guidance	Objective Evidence	Assessment		
				N/A	Satisfactory	Not Satisfactory
<b>FOR INDUCTION HEAT TREATING</b>						
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.				
3.16	Does the heat treater control the energy or power for each part?	The heat treater shall control the energy or power for each part. <ul style="list-style-type: none"> <li>• 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).</li> <li>• An energy monitor or equivalent is acceptable if approved by the design authority.</li> </ul>				
3.17	Does the supplier have a coil management system? Coil refers to the heating coil and the quench plenum.	The heat treater shall have a coil management system. Coil refers to the heating coil and the quench plenum. <ul style="list-style-type: none"> <li>• Spare coils for each part shall be available on-site.</li> <li>• Coils shall conform to the approved original design.</li> <li>• Engineering change approval from the customer is required whenever the coil design is changed.</li> </ul>				
3.18	Is quench system automatic?	The quench system shall be an automatic operation. No manual quenching is allowed unless specifically approved by the design authority. Quenching shall be automatically initiated and controlled.				
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				

# Special Process: Heat Treat System Assessment



## **Instructions for completing the Job Audit**

The organization is to complete a minimum of one heat treat part job audit during each assessment. This should be done preferably on a part identified for one of the customers requiring compliance to this document. More part job audits may be done if time permits. Preferably, safety or critical parts should be audited. This may not be easily determined with fasteners, especially if the fastener manufacturer does not identify the end customer (auto manufacturer, tier one, etc.). It is recommended that the job audit be performed at the end of the heat treat system assessment.

The job audit is not the only or main focus of the HTSA. The other three sections on Management Responsibility and Quality Planning, Floor and Material Handling Responsibility, and Equipment are equally if not even more important. The job audit of one part, one heat process, and one furnace is not sufficient to use as a basis to complete the other sections of the complete HTSA.

The job audit is a compliance type audit/review of a specific part and its related paperwork and processing, including heat treat equipment and processing records for that job from the beginning receipt of a part through processing in the heat treat operation and inspection to packaging. Parts shall be taken from the shipping area at the dock or the end of the heat treat operation. If an automotive manufacturer's part is not available or identifiable, then parts from other customers requiring compliance with this document shall be done.

The part or lot checked shall represent a major heat treat operation such as quench and tempering, carburizing and tempering, induction hardening for steel, solution treating and aging of aluminum, etc. In subsequent heat treat system assessments, different parts and heat treat processes shall be checked.

The specific heat treat processing parameters (applies to 4.7 in the Job Audit) that are required in the job audit shall be added to the job audit form. This can be done by reviewing the customer specification(s), the Control Plan, the PFMEA, and the floor work/job order. Each processing step shall be reviewed for proper production records/compliance/inspection. These steps can be compared to those in the Heat Treat System Assessment for the actual job/heat treat process being reviewed for compliance. The heat treat and furnace records for the actual time frame/shift etc. that the job was processed shall also be checked. The actual furnace equipment and instrumentation certification shall be verified as being in compliance to the appropriate equipment requirements in the equipment section.

## Section 4 - Job Audit

**Job Identity:** \_\_\_\_\_  
**Customer:** \_\_\_\_\_  
**Purchase Order:** \_\_\_\_\_  
**Order Number:** \_\_\_\_\_  
**Part Number:** \_\_\_\_\_  
**Part Description:** \_\_\_\_\_  
**Material:** \_\_\_\_\_  
**Heat Treat Requirements:** \_\_\_\_\_

Clause #	Job Audit Clause	HTSA Clause #	Customer or Internal Requirement	Job (Shop) Order or Reference Documentation Requirement	Actual Condition (Objective Evidence)	Pass / Fail / N/A
4.1	Are contract review, APQP, PFMEA, Control plans, etc., performed by competent individuals?	1.2 1.3 1.4 1.17				
4.2	Does the heat treat facility have the customer specifications for the part?	1.5				
4.3	Is a shop traveler created to meet customer requirements?	1.6 2.1				
4.4	Is material identification (part numbers, lot numbers, heat numbers, contract numbers, etc.) maintained throughout the heat treat process?	2.2 2.3 2.4				
4.5	Is there documented evidence of Receiving Inspection?	2.1				
4.6	Are the Loading / Racking requirements identified?	1.6 2.7				

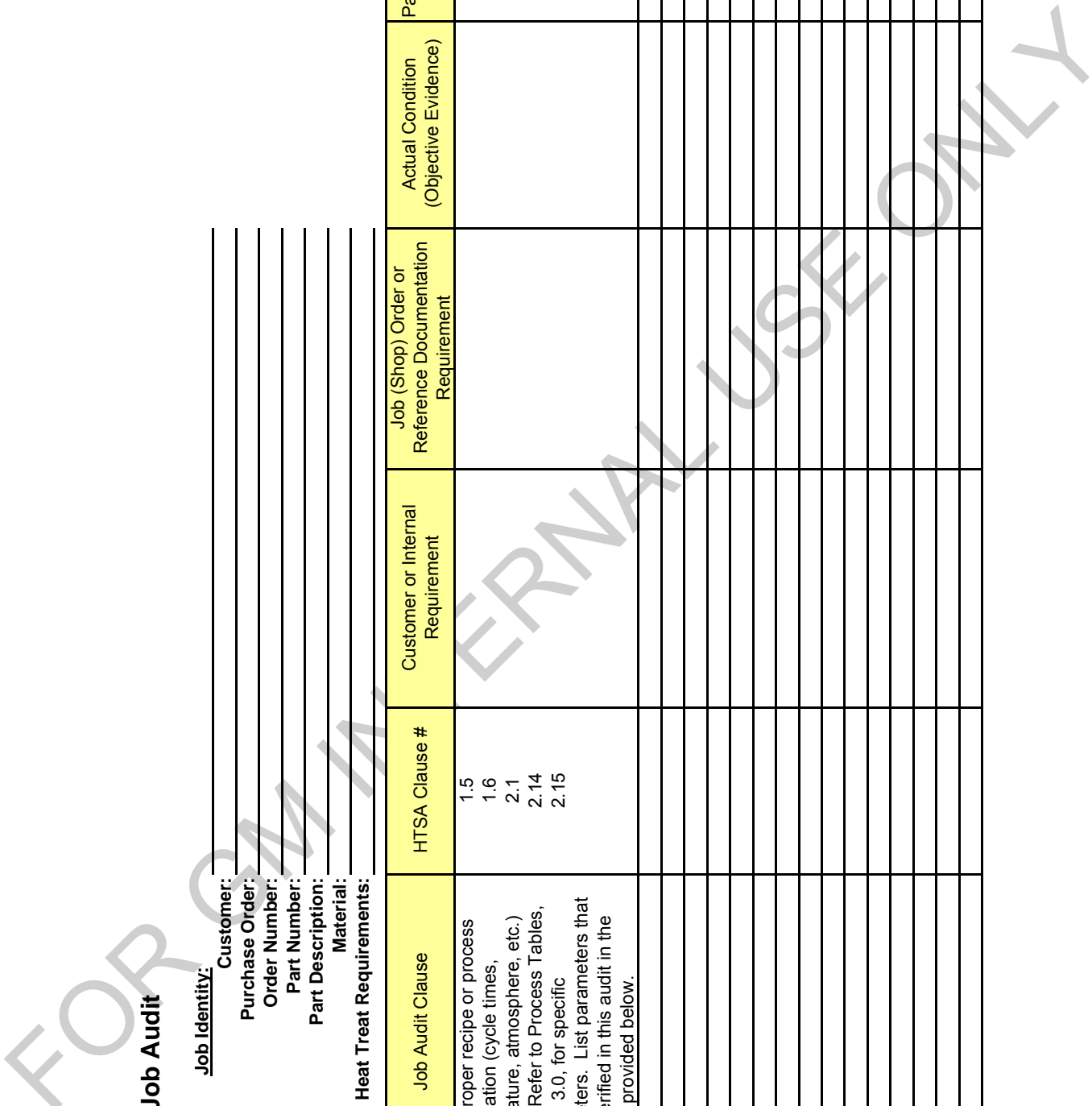
# Special Process: Heat Treat System Assessment



## Section 4 - Job Audit

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

Clause #	Job Audit Clause	HTSA Clause #	Customer or Internal Requirement	Job (Shop) Order or Reference Documentation Requirement	Actual Condition (Objective Evidence)	Pass / Fail / N/A
4.7	Is the proper recipe or process specification (cycle times, temperature, atmosphere, etc.) used? Refer to Process Tables, Section 3.0, for specific parameters. List parameters that were verified in this audit in the spaces provided below.	1.5 1.6 2.1 2.14 2.15				



## Section 4 - Job Audit

Job Identity: \_\_\_\_\_  
Customer: \_\_\_\_\_  
Purchase Order: \_\_\_\_\_  
Order Number: \_\_\_\_\_  
Part Number: \_\_\_\_\_  
Part Description: \_\_\_\_\_  
Material: \_\_\_\_\_  
Heat Treat Requirements: \_\_\_\_\_

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

# Special Process: Heat Treat System Assessment



## Section 4 - Job Audit

**Job Identity:** \_\_\_\_\_  
**Customer:** \_\_\_\_\_  
**Purchase Order:** \_\_\_\_\_  
**Order Number:** \_\_\_\_\_  
**Part Number:** \_\_\_\_\_  
**Part Description:** \_\_\_\_\_  
**Material:** \_\_\_\_\_  
**Heat Treat Requirements:** \_\_\_\_\_

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

## Section 4 - Job Audit

**Job Identity:** \_\_\_\_\_  
**Customer:** \_\_\_\_\_  
**Purchase Order:** \_\_\_\_\_  
**Order Number:** \_\_\_\_\_  
**Part Number:** \_\_\_\_\_  
**Part Description:** \_\_\_\_\_  
**Material:** \_\_\_\_\_  
**Heat Treat Requirements:** \_\_\_\_\_

Clause #	Job Audit Clause	HTSA Clause #	Customer or Internal Requirement	Job (Shop) Order or Reference Documentation Requirement	Actual Condition (Objective Evidence)	Pass / Fail / N/A
	<b>Packaging Requirements</b>					
4.17	Are packaging requirements identified?	2.9				
4.18	Are parts packaged to minimize mixed parts (parts packed over height of container)?	2.6 2.11				
	<b>Shipping Requirements</b>					
4.19	Were the parts properly labeled?	2.3 2.9				



# Special Process: Heat Treat System Assessment



## APPENDIX A – PROCESS TABLES

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## **PROCESS TABLE 1 - Carburizing / Carbonitriding / Carbon Correction / Neutral Hardening / Austempering / Martempering / Tempering / Precipitation Hardening - Aging**

All requirements given below are subordinate to customer specific requirements. Reduction of minimum requirements require approval from the customer (customer documentation shall be on file at the supplier).

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

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

\*\* Does not apply to furnaces operating below 760C (1400F).

	SP-HTSA Clause #		Batch Furnace	Continuous Furnace *	Generators
<b>1.0</b>		<b>PROCESS AND TEST EQUIPMENT REQUIREMENTS</b>			
1.1	3.1	All furnaces, generators and quench systems shall have temperature indicating instruments.	Yes	Yes	Yes
1.2	3.1	Continuous strip charts and/or data loggers are required for temperature and carbon monitoring unit, e.g., dew point, oxygen probe, IR gas analyzer, etc.	Yes	Yes	Yes
1.3	1.18	A program for furnace and generator burnout is required (applies to carbon bearing atmospheres).	Yes	Yes	Yes
1.4	3.2	Furnace weigh scales shall be calibrated quarterly at a minimum.	Yes	Yes	N/A
1.5	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.	----	----	----
1.6	3.2	Verification of calibration of spectrometers, and carbon IR combustion analyzers, shall be checked daily or prior to use.	Yes	----	----
1.7	3.2	Verification of calibration of 3-gas analyzers with zero gas and span gas shall be performed weekly at a minimum.	----	----	----
1.8	3.2	Oxygen probe controllers shall be calibrated quarterly at a minimum.	Yes	Yes	Yes
1.9	2.16	All hardness test equipment (for each scale used) shall be calibrated semi-annually minimum, and verified daily minimum per the applicable ASTM standard.	----	----	----
1.10	2.16	Files shall be verified daily (or prior to use) with provers per SAE J864.	----	----	----
1.11	3.2	Refractometers (typically used to check polymer quenchants and washer solutions) shall be verified daily (with distilled water) and calibrated annually (per manufacturer's requirements) at a minimum.	----	----	----

# Special Process: Heat Treat System Assessment



## PROCESS TABLE 1 - Carburizing / Carbonitriding / Carbon Correction / Neutral Hardening / Austempering / Martempering / Tempering / Precipitation Hardening - Aging

All requirements given below are subordinate to customer specific requirements. Reduction of minimum requirements require approval from the customer (customer documentation shall be on file at the supplier).

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

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

\*\* Does not apply to furnaces operating below 760C (1400F).

	SP-HTSA Clause #		Batch Furnace	Continuous Furnace *	Generators
<b>2.0</b>		<b>PYROMETRY</b>			
2.1	3.2 3.3	Thermocouples and calibration of thermocouples shall conform to AMS 2750.	Yes	Yes	Yes
2.2	3.2 3.3	Instrument Calibration per AMS 2750 shall be quarterly at a minimum.  Frequency reductions per AMS 2750 are not allowed.	Yes	Yes	Yes
2.3	3.2 3.3	System Accuracy Test (SAT): refer to AMS 2750 for procedures. SAT frequency shall be monthly for equipment operating above or at 760C (1400 F) and quarterly for equipment operating below 760C (1400 F). Maximum allowable SAT error is +/- 10 F (+/- 5 C). Frequency reductions per AMS 2750 are not allowed.  Protection Tubes shall be visually checked at same frequency as thermocouples.	Yes	Yes	Yes
2.4	3.4	Temperature Uniformity Survey (TUS): refer to AMS 2750 for procedures. TUS frequency shall be annual and after major rebuild.  Temperature uniformity tolerance for hardening furnaces shall be +/- 14 C (25 F). Temperature uniformity tolerance for tempering furnaces shall be +/- 11 C (20 F).  Frequency reductions per AMS 2570 are not allowed.	Yes	Yes	N/A
2.5	3.5	Recorded temperature(s) for austenitizing processes shall be controlled within +/- 9C (15F) of the set point as evidenced by continuous recording pyrometers. Furnace temperature shall be controlled with soak times starting at the lower tolerance limit (as defined above).	Yes	Yes	N/A
2.6	3.5	Recorded temperature(s) for tempering and precipitation hardening processes shall be controlled within +/- 6C (10F) of the set point as evidenced by continuous recording pyrometers. Furnace temperature shall be controlled with soak times starting at the lower tolerance limit (as defined above).	Yes	Yes	N/A
2.7	3.2	Infrared pyrometers shall be calibrated to a black body furnace annually.			N/A



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# Special Process: Heat Treat System Assessment

## **PROCESS TABLE 1 - Carburizing / Carbonitriding / Carbon Correction / Neutral Hardening / Austempering / Martempering / Tempering / Precipitation Hardening - Aging**

All requirements given below are subordinate to customer specific requirements. Reduction of minimum requirements require approval from the customer (customer documentation shall be on file at the supplier).

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

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

\*\* Does not apply to furnaces operating below 760C (1400F).

	SP-HTSA Clause #		Batch Furnace	Continuous Furnace *	Generators
<b>3.0</b>		<b>PROCESS MONITOR FREQUENCIES</b>			
3.1	1.4 2.14	Monitor primary temperature control instrument(s).	Each batch or continuous recording with sign-off every 2 hours. Alarm systems satisfy the sign-off requirement	Each lot or continuous recording with sign-off every 2 hours. Alarm systems satisfy the sign-off requirement	Each Shift
3.2	1.4 2.14 3.7	Monitor generator atmospheres	N/A	N/A	Continuous
3.3	1.4 2.14 3.7	Monitor primary furnace atmosphere control(s)**.	Continuous recording with sign-off every 2 hours. Alarm systems satisfy the sign-off requirement	Continuous recording with sign-off every 2 hours. Alarm systems satisfy the sign-off requirement	N/A
3.4	1.4 2.14 3.7	Verify primary atmosphere control method by back-up method**.	Daily	Daily	Daily
3.5	1.4 2.14 3.13	For salt baths: check salt chemistry (soluble oxides) in salt baths or decarburization on the parts.	Daily	Daily	N/A
3.6	1.4 2.12	<b>Monitor condition of quench media</b>			
		- Temperature	Each batch or continuous recording with sign-off every 2 hours. Alarm systems satisfy the sign-off requirement	Each lot or continuous recording with sign-off every 2 hours. Alarm systems satisfy the sign-off requirement	N/A
		- Quench Level	Daily	Daily	N/A
		- Agitation	- Daily visual check is required  - Monitor each load in the absence of an alarm system.	- Daily visual check is required  - Monitor every 2 hrs in the absence of an alarm system	N/A
3.7	1.4 2.14	Monitor time in furnace, cycle time or belt speed	Each batch	Twice/shift & after any change in the belt speed	N/A
3.8	1.4 2.7	Monitor load size or fixturing or loading rate as applicable.	Each batch	Twice/shift & after any change in loading rate	N/A
3.9	1.4 2.12	Quench Delay Time - Alarm system shall be based on the time that the load exits the furnace to the time the load is at the bottom of the quench tank.	Each batch	Each basket for pusher-type continuous furnaces. Not applicable for belt furnaces.	N/A

# Special Process: Heat Treat System Assessment



## PROCESS TABLE 1 - Carburizing / Carbonitriding / Carbon Correction / Neutral Hardening / Austempering / Martempering / Tempering / Precipitation Hardening - Aging

All requirements given below are subordinate to customer specific requirements. Reduction of minimum requirements require approval from the customer (customer documentation shall be on file at the supplier).

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

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

\*\* Does not apply to furnaces operating below 760C (1400F).

	SP-HTSA Clause #		Batch Furnace	Continuous Furnace *	Generators
<b>4.0</b>		<b>IN-PROCESS/FINAL TEST FREQUENCIES</b>			
4.1	1.4 2.15	Microstructure	Daily per furnace	Daily per furnace	N/A
4.2	1.4 2.15	Surface hardness	Each batch	Every 2 hours minimum	N/A
4.3	1.4 2.15	Core hardness (when specified)	Each batch	Every 4 hours	N/A
4.4	1.4 2.15	Case depth (when specified)	Each batch	Every 4 hours	N/A
<b>5.0</b>		<b>QUENCHANT AND SOLUTION TEST FREQUENCIES</b>			
5.1	2.12 3.14	<b>Polymer Quench Media</b> - Concentration - Quenchability Check; e.g., cooling curve, viscosity, or titration	Daily Semiannual	Daily Semiannual	N/A N/A
5.2	2.12 3.14	<b>Water Quench Media</b> - Suspended solids	Semiannual	Semiannual	N/A
5.3	2.12 3.14	<b>Salt Media</b> - Analysis & Contaminants (for salts not used in quenching) - Analysis & Contaminants (for salts not used in quenching)	Semiannual Monthly	Semiannual Monthly	N/A N/A
5.4	2.12 3.14	<b>Brine or Caustic Quench Media</b> - Concentration and/or Specific Gravity - Suspended solids	Daily Semiannual	Daily Semiannual	N/A N/A
5.5	2.12 3.14	<b>Oil Quench Media</b> - Water content, suspended solids, viscosity, cooling curve, total acid, and flash point.	Quarterly	Quarterly	N/A
5.4	2.13	<b>Rust Preventive - Soluble Oil</b> - Concentration	2x / week	2x / week	N/A
5.5	2.11	<b>Washers</b> - Concentration of cleaner - Temperature of solution (required if temperature is specified to be above ambient temperature).	Daily Each shift	Daily Each shift	N/A N/A

## PROCESS TABLE 2 - Nitriding (Gas) and Ferritic-Nitrocarburizing (Gas or Salt)

All requirements given below are subordinate to customer specific requirements. Reduction of minimum requirements require approval from the customer (customer documentation shall be on file at the supplier).

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.

	SP-HTSA Clause #		Batch Furnace	Continuous Furnace*	Generators	Salt Bath
<b>1.0</b>		<b>PROCESS AND TEST EQUIPMENT REQUIREMENTS</b>				
1.1	3.1	All furnaces, generators and quench systems shall have temperature indicating instruments.	Yes	Yes	Yes	Yes
1.2	3.1	Continuous strip charts and/or data loggers are required for temperature and carbon monitoring unit, e.g., dew point, oxygen probe, IR gas analyzer, etc.	Yes	Yes	Yes	Yes
1.3	1.18	A program for furnace and generator burnout is required. Not required for retort gas nitriding.	Yes	Yes	Yes	N/A
1.4	3.12	Salt chemistry (soluble oxides) in salt baths used for austenitizing, or decarburization on the parts, shall be checked daily.	N/A	N/A	N/A	Yes
1.5	3.2	Furnace weigh scales shall be calibrated quarterly at a minimum.	Yes	Yes	N/A	N/A
1.6	3.2	Dew pointers and gas analyzers, used to verify proper atmosphere in furnaces, shall be calibrated annually at a minimum.	----	----	----	----
1.7	2.16	All hardness test equipment (for each scale used) shall be calibrated semi-annually minimum, and verified daily minimum per the applicable ASTM standard.	----	----	----	----
1.8	2.16	Files shall be verified daily (or prior to use) with provers per SAE J864.	----	----	----	----
1.9	3.2	Refractometers (typically used to check polymer quenchants and washer solutions) shall be verified daily (with distilled water) and calibrated annually (per manufacturer's requirements) at a minimum.	----	----	----	----

# Special Process: Heat Treat System Assessment



## PROCESS TABLE 2 - Nitriding (Gas) and Ferritic-Nitrocarburizing (Gas or Salt)

All requirements given below are subordinate to customer specific requirements. Reduction of minimum requirements require approval from the customer (customer documentation shall be on file at the supplier).

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.

	SP-HTSA Clause #		Batch Furnace	Continuous Furnace*	Generators	Salt Bath
<b>2.0</b>		<b>PYROMETRY</b>				
2.1	3.2 3.3	Thermocouples and calibration of thermocouples shall conform to AMS 2750.	Yes	Yes	Yes	Yes
2.2	3.2 3.3	Instrument Calibration per AMS 2750 shall be quarterly at a minimum.  Frequency reductions per AMS 2750 are not allowed.	Yes	Yes	Yes	Yes
2.3	3.2 3.3	System Accuracy Test (SAT): refer to AMS 2750 for procedures. SAT frequency shall be monthly. Maximum allowable SAT error is +/- 10 F ( +/- 5 C). Frequency reductions per AMS 2750 are not allowed.  Protection tubes shall be visually checked at same frequency as thermocouples.	Yes	Yes	Yes	Yes
2.4	3.4	Temperature Uniformity Survey (TUS): refer to AMS 2750 for procedures. TUS frequency shall be annual and after major rebuild.  Temperature uniformity tolerance shall be +/- 9 C (15 F).  Frequency reductions per AMS 2570 are not allowed.	Yes	Yes	N/A	Yes
2.5	3.5	Recorded temperature(s) shall be controlled within +/- 9C (15F) of the set point as evidenced by continuous recording pyrometers. Furnace temperature shall be controlled with soak times starting at the lower tolerance limit (as defined above).	Yes	Yes	N/A	Yes
2.6	3.2	Infrared pyrometers shall be calibrated to a black body furnace annually .				



# Special Process: Heat Treat System Assessment

## PROCESS TABLE 2 - Nitriding (Gas) and Ferritic-Nitrocarburizing (Gas or Salt)

All requirements given below are subordinate to customer specific requirements. Reduction of minimum requirements require approval from the customer (customer documentation shall be on file at the supplier).

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.

	SP-HTSA Clause #		Batch Furnace	Continuous Furnace*	Generators	Salt Bath
<b>3.0 PROCESS MONITOR FREQUENCIES</b>						
3.1	1.4 2.14	Monitor primary temperature control instrument(s).	Each batch or continuous recording with sign-off every 2 hours. Alarm systems satisfy the sign-off requirement	Each lot or continuous recording with sign-off every 2 hours. Alarm systems satisfy the sign-off requirement	Each Shift	Every 2 hrs & after any change
3.2	1.4 2.14 3.7	Monitor generator atmospheres, if applicable.	N/A	N/A	Continuous	N/A
3.3	1.4 2.14 3.7	Monitor primary furnace atmosphere control(s).	Each batch (rotary furnaces only) or continuous recording with sign-off every 2 hours. Alarm systems satisfy the sign-off requirement	Continuous recording with sign-off every 2 hours. Alarm systems satisfy the sign-off requirement	N/A	Daily
3.4	1.4 3.7	Dissociation of ammonia shall be checked in gas nitriding.	Each batch and every 4 hours minimum	Every 4 hours	Daily	N/A
3.5	1.4 3.7	Gas ratios for ferritic nitrocarburizing shall be checked.	Each batch	Every 2 hours minimum		
3.6	1.4 2.14 3.13	Check salt chemistry (soluble oxides) in salt baths used for austenitizing, or decarburization on the parts.	N/A	N/A	N/A	Daily
3.7	1.4 2.12	<b>Monitor condition of quench media if applicable:</b>				
		- Temperature	Each batch or continuous recording with sign-off every 2 hours. Alarm systems satisfy the sign-off requirement	Each lot or continuous recording with sign-off every 2 hours. Alarm systems satisfy the sign-off requirement	N/A	Each batch or continuous recording with sign-off every 2 hours. Alarm systems satisfy the sign-off requirement
		- Quench Level	Daily	Daily	N/A	Daily



# Special Process: Heat Treat System Assessment



## PROCESS TABLE 2 - Nitriding (Gas) and Ferritic-Nitrocarburizing (Gas or Salt)

All requirements given below are subordinate to customer specific requirements. Reduction of minimum requirements require approval from the customer (customer documentation shall be on file at the supplier).

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.

	SP-HTSA Clause #		Batch Furnace	Continuous Furnace*	Generators	Salt Bath
		- Agitation	- Daily - Monitor each load in the absence of an alarm system.	- Daily - Monitor every 2 hrs in the absence of an alarm system	N/A	Daily
3.8	1.4 2.14	Monitor time in furnace, cycle time or belt speed	Each batch	Twice/shift & after any change in the belt speed	N/A	Each batch
3.9	1.4 2.7	Monitor load size or fixturing or loading rate as applicable.	Each batch	Twice/shift & after any change in loading rate	N/A	Each batch
3.10	1.4 2.12	Quench Delay Time if applicable - Alarm system shall be based on the time that the load exits the furnace to the time the load is at the bottom of the quench tank.	Each batch	Each basket if applicable	N/A	Each batch
4.0		<b>IN-PROCESS/FINAL TEST FREQUENCIES</b>				
4.1	1.4 2.15	Microstructure	Daily per furnace	Daily per furnace	N/A	Daily per furnace
4.2	1.4 2.15	Surface hardness	Each batch	Every 2 hours minimum	N/A	Each batch
4.3	1.4 2.15	Core hardness (when specified)	Each batch	Every 4 hours	N/A	Each batch
4.4	1.4 2.15	Case depth (when specified)	Each batch	Every 4 hours	N/A	Each batch

## PROCESS TABLE 2 - Nitriding (Gas) and Ferritic-Nitrocarburizing (Gas or Salt)

All requirements given below are subordinate to customer specific requirements. Reduction of minimum requirements require approval from the customer (customer documentation shall be on file at the supplier).

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.

	SP-HTSA Clause #		Batch Furnace	Continuous Furnace*	Generators	Salt Bath
5.0		<b>QUENCHANT AND SOLUTION TEST FREQUENCIES</b>				
		<b>Quench Media Controls If Applicable</b>				
5.1	2.12 3.14	<b>Polymer Quench Media</b>				
		- Concentration	Daily	Daily	N/A	N/A
		- Quenchability Check; e.g., cooling curve, viscosity, or titration	Semiannual	Semiannual	N/A	N/A
5.2	2.12 3.14	<b>Water Quench Media</b>				
		- Suspended solids	Semiannual	Semiannual	N/A	N/A
5.3	2.12 3.14	<b>Salt Media</b>				
		- Analysis & Contaminants	N/A	N/A	N/A	Monthly
5.4	2.12 3.14	<b>Brine or Caustic Quench Media</b>				
		- Concentration and/or Specific Gravity	Daily	Daily	N/A	N/A
		- Suspended solids	Semiannual	Semiannual	N/A	N/A
5.5	2.12 3.14	<b>Oil Quench Media</b>				
		- Water content, suspended solids, viscosity, cooling curve, total acid, and flash point.	Quarterly	Quarterly	N/A	N/A
5.6	2.13	<b>Rust Preventive - Soluble Oil</b>				
		- Concentration	2x / week	2x / week	N/A	2x / week
5.7	2.11	<b>Washers</b>				
		- Concentration of cleaner	Daily	Daily	N/A	Daily
		- Temperature of solution (required if temperature is specified to be above ambient temperature).	Each shift	Each shift	N/A	Each shift

# Special Process: Heat Treat System Assessment



## PROCESS TABLE 3 - Aluminum Heat Treating

All requirements given below are subordinate to customer specific requirements. Reduction of minimum requirements require approval from the customer (customer documentation shall be on file at the supplier).

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.

			Batch Solution Treating and Aging Furnaces	Continuous Solution Treating and Aging Furnaces	Annealing Furnace
	SP-HTSA Clause #				
<b>1.0</b>		<b>PROCESS AND TEST EQUIPMENT REQUIREMENTS</b>			
1.1	3.1	All furnaces and quench systems shall have temperature indicating instruments.	Yes	Yes	Yes
1.2	3.1	Continuous strip charts and/or data loggers are required for temperature sensors.	Yes	Yes	Yes
1.3	2.16	All hardness test equipment (for each scale used) shall be calibrated semi-annually minimum, and verified daily minimum per the applicable ASTM standard.	-----	-----	-----
1.4	3.2	Furnace weigh scales shall be calibrated quarterly at a minimum	Yes	Yes	Yes
1.5	3.2	Refractometers (typically used to check polymer quenchants and washer solutions) shall be verified daily (with distilled water) and calibrated annually (per manufacturer's requirements) at a minimum.	-----	-----	-----

## PROCESS TABLE 3 - Aluminum Heat Treating

All requirements given below are subordinate to customer specific requirements. Reduction of minimum requirements require approval from the customer (customer documentation shall be on file at the supplier).

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.

			Batch Solution Treating and Aging Furnaces	Continuous Solution Treating and Aging Furnaces	Annealing Furnace
<b>2.0</b>		<b>PYROMETRY</b>			
2.1	3.2 3.3	Thermocouples and calibration of thermocouples shall conform to AMS 2750.	Yes	Yes	Yes
2.2	3.2 3.3	Instrument Calibration per AMS 2750 shall be quarterly at a minimum.  Frequency reductions per AMS 2750 are not allowed.	Yes	Yes	Yes
2.3	3.2 3.3	System Accuracy Test (SAT): refer to AMS 2750 for procedures. SAT frequency shall be monthly for solution treating and aging furnaces and quarterly for annealing furnaces. Maximum allowable SAT error is +/- 3 C (+/- 5 F). Frequency reductions per AMS 2750 are not allowed.  Protection tubes shall be visually checked at same frequency as thermocouples.	Yes	Yes	Yes
2.4	3.4	Temperature Uniformity Survey (TUS): refer to AMS 2750 for procedures. TUS frequency shall be quarterly and after major rebuild.  Temperature uniformity tolerance for solution treating and aging furnaces shall be +/- 6 C (+/- 10 F). Temperature uniformity tolerance for annealing furnaces shall be +/- 14 C (+/- 25 F).  Frequency reductions per AMS 2750 are not allowed.	Yes	Yes	Yes
2.5	3.5	Recorded temperature(s) shall be controlled within +/- 6C (10F) of the set point as evidenced by continuous recording pyrometers. Furnace temperature shall be controlled with soak times starting at the lower tolerance limit (as defined above).	Yes	Yes	N/A
2.6	3.5	Recorded temperature(s) shall be controlled within +/- 9C (15F) of the set point as evidenced by continuous recording pyrometers. Furnace temperature shall be controlled with soak times starting at the lower tolerance limit (as defined above).	N/A	N/A	Yes
2.7	3.2	Infrared pyrometers shall be calibrated to a black body furnace annually			

# Special Process: Heat Treat System Assessment



**PROCESS TABLE 3 - Aluminum Heat Treating**

All requirements given below are subordinate to customer specific requirements. Reduction of minimum requirements require approval from the customer (customer documentation shall be on file at the supplier).

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.

	SP-HTSA Clause #		Batch Solution Treating and Aging Furnaces	Continuous Solution Treating and Aging Furnaces	Annealing Furnace
<b>3.0</b>		<b>PROCESS MONITOR FREQUENCIES</b>			
3.1	1.4 2.14	Monitor primary temperature control instrument(s).	Each batch or continuous recording with sign-off every 2 hours. Alarm systems satisfy the sign-off requirement	Each lot or continuous recording with sign-off every 2 hours. Alarm systems satisfy the sign-off requirement	Each batch or continuous recording with sign-off every 2 hours. Alarm systems satisfy the sign-off requirement
3.2	1.4 2.12	<b>Monitor condition of quench media</b>			
		- Heat treater shall specify temperature range based on product form and material. Temperature shall be monitored as noted.	Each batch or continuous recording with sign-off every 2 hours. Alarm systems satisfy the sign-off requirement	Each lot or continuous recording with sign-off every 2 hours. Alarm systems satisfy the sign-off requirement	N/A
		- Quench Level	Daily	Daily	N/A
		- Agitation	- Daily visual check is required	- Daily visual check is required	N/A
			- Monitor each load in the absence of an alarm system.	- Monitor every 2 hrs in the absence of an alarm system	
3.3	1.4 2.14	Monitor process cycle time	Each batch	Twice/shift & after any change in the indexing speed	Each batch
3.4	1.4 2.7	Monitor load size or fixturing as applicable.	Each batch	Twice/shift & after any change in loading rate	Each batch
3.5	1.4 2.12	Quench Delay Time - Quench delay time shall be based on the time that the load exits the furnace to the time the load is at the bottom of the quench tank.	Each batch	Each load	N/A
<b>4.0</b>		<b>IN-PROCESS/FINAL TEST FREQUENCIES</b>			
4.1	1.4 2.15	Hardness or tensile testing (post aging),	Each batch	Every 4 hours	Each batch or every 4 hours for continuous furnaces
<b>5.0</b>		<b>QUENCHANT AND SOLUTION TEST FREQUENCIES</b>			
5.1	2.12 3.14	<b>Polymer Quench Media</b>			
		- Concentration	Daily	Daily	N/A
		- Suspended solids	Semiannual	Semiannual	N/A
		- Quenchability Check; e.g., cooling curve, viscosity, or titration	Semiannual	Semiannual	N/A
5.2	2.12 3.14	<b>Water Quench Media</b>			
		- Suspended solids	Semiannual	Semiannual	N/A
5.3	2.11	<b>Washers</b>			
		- Concentration of cleaner	Daily	Daily	Daily
		- Temperature of solution (required if temperature is specified to be above ambient temperature).	Each shift	Each shift	Each shift

## PROCESS TABLE 4 - Induction Heat Treating

All requirements given below are subordinate to customer specific requirements. Reduction of minimum requirements require approval from the customer (customer documentation shall be on file at the supplier).

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.

	SP-HTSA Clause #		Per Coil
<b>1.0</b>		<b>PROCESS AND TEST EQUIPMENT REQUIREMENTS</b>	
1.1	---	Per customer requirement	
1.2	2.16	All hardness test equipment (for each scale used) shall be calibrated semi-annually minimum, and verified daily minimum per the applicable ASTM standard.	-----
1.3	2.16	Files shall be verified daily (or prior to use) with provers per SAE J864	
1.4	3.2	Refractometers (typically used to check polymer quenchants and washer solutions) shall be verified each shift (with distilled water) and calibrated annually (per manufacturer's requirements) at a minimum.	-----

# Special Process: Heat Treat System Assessment



## **PROCESS TABLE 4 - Induction Heat Treating**

All requirements given below are subordinate to customer specific requirements. Reduction of minimum requirements require approval from the customer (customer documentation shall be on file at the supplier).

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.

	SP-HTSA Clause #		Per Coil
<b>2.0</b>		<b>PYROMETRY</b>	
2.1	3.2	Infrared pyrometers shall be calibrated to a black body furnace annually	
<b>3.0</b>		<b>PROCESS MONITORING FREQUENCIES</b>	
All process parameters shall be checked the beginning of every shift, tool change, or any equipment repair. In absence of process parameter alarms, also check process parameters at end of shift or lot (whichever is the greater frequency).			
3.1	1.4 2.12	Monitor condition of quench media if applicable	Alarm system for high and low temperature is required.
		- Temperature	
		- Quench Level	Daily
		- Quench Pressure and Flow	- Quench pressure and flow may checked at manifold. Quench flow shall be checked visually at each coil. - In the absence of an alarm system, monitor every 2 hours or after any change
3.2	1.4 2.14	Monitor cycle time	Check cycle time at start up and after any process change.
3.3	1.4 2.14 3.16	Monitor: 1) Volts or Amps, and 2) Kilowatts Use of an energy monitor or signature monitor satisfies 1) and 2)	- this requirement applies to each power supply (not per coil) - in the absence of an alarm system, monitor every 2 hours or after any change

## **PROCESS TABLE 4 - Induction Heat Treating**

All requirements given below are subordinate to customer specific requirements. Reduction of minimum requirements require approval from the customer (customer documentation shall be on file at the supplier).

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.

	SP-HTSA Clause #		Per Coil
<b>4.0</b>		<b>IN-PROCESS/FINAL TEST FREQUENCIES</b>	Production Setup or Coil Change - Per Coil (1st Piece Inspection)
4.4	1.4 2.15	Induction pattern length	1 part at start-up, end of production run, and every 4 hours minimum.
4.5	1.4 2.15	Total or Effective Case depth	1 part at start-up, end of production run, and 1 part per 8 hours minimum.
4.6	1.4 2.15	Surface hardness	1 part at start-up, end of production run, and every 4 hours minimum.
4.7	1.4 2.15	Core hardness (when specified)	1 part at start-up, end of production run, and every 4 hours minimum.
4.8	1.4 2.15	Microstructure	1 part at start-up.
<b>5.0</b>		<b>QUENCHANT AND SOLUTION TEST FREQUENCIES</b>	
		<b>Quench Media Controls If Applicable</b>	
5.1	2.12 3.14	<b>Polymer Quench Media</b>	
		- Concentration	Once per day
		- Quenchability Check; e.g., cooling curve, viscosity, or titration	Monthly
5.2	2.12 3.14	<b>Water Quench Media</b>	
		- Suspended solids	Quarterly
5.3	2.12 3.14	<b>Brine or Caustic Quench Media</b>	
		- Concentration and/or Specific Gravity	Monthly
		- Suspended solids	Quarterly
5.4	2.13	<b>Rust Preventive - Soluble Oil</b>	
		- Concentration	2x / week
5.5	2.11	<b>Washers</b>	
		- Concentration of cleaner	Daily
		- Temperature of solution (required if temperature is specified to be above ambient temperature).	Each shift



Special Process: Heat Treat System  
Assessment



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## GLOSSARY

**AIAG** – Automotive Industry Action Group

**AMS** -- Aerospace Material Specifications

**APQP** – Advance Product and Quality Planning

**ASTM** – American Society for Testing and Materials

**Capability** – The total range of inherent variation in a stable process. (see the Statistical Process Control reference manual published by AIAG).

**Control Plans** – Written descriptions of the system for controlling production parts or bulk materials and processes. They are written by organizations to address the important characteristics and engineering requirements of the product. Each part must have a Control Plan, but in many cases, “family” Control Plans can apply to a number of parts produced using a common process. Refer to **Advanced Product Quality Planning and Control Plan** reference manual, ISO/TS 16949, and customer-specific requirements.

**Critical Spare Parts List** – A list of service parts critical for the operation of equipment. Extended delay in obtaining spare parts would result in unacceptable delays in the heat treat operation.

**Cross-Functional Team** – A team of employees that represent the different functions within an organization. The team will typically consist of an operator, process engineer, metallurgist, and quality personnel. The term “cross-functional” is synonymous with the term “multi-disciplinary.”

**Customer** – The recipient of the organization's or supplier's product or service.

**Customer Requirements** – This term refers to the requirements or specifications from the original equipment manufacturer (typically the automobile company). These may be identified in the contract or purchase order, in engineering standards, parts specifications, etc.

**Design Authority** – The entity that controls the design (material specification and heat treat specification) of the part.

**Dew Pointer** – A meter especially suited for measuring the dew point of carbon-bearing atmospheres. Dew point is used to indirectly determine the carbon potential of the atmosphere.

**Energy Monitor** – An electronic monitor that measures and displays the actual energy delivered to the induction heating coil in kilowatt-seconds.

**Furnace Monitoring Systems** – A system that monitors the operation of the furnace.

**Heat Treater** – An organization that performs heat treating (see 2.2 Application) to production and/or service parts. The heat treating may be internal or “captive” to a manufacturing organization, or a separate commercial heat treating supplier.

**HTSA** – Heat Treat System Assessment

# Special Process: Heat Treat System Assessment



**IR** Infrared

**Nonconforming Product** – Product that does not conform to the customer requirements or specifications.

**Oxidizing Burn-Out** – A process to remove any residual ammonia from the furnace. The process usually involves removing most of the carbon-bearing protective atmosphere and then introducing oxygen.

**Oxygen Probe** – An *in-situ* measuring probe that determines the partial pressure of oxygen in carbon-bearing atmospheres. This measurement provides an indirect measurement for the carbon potential of the atmosphere.

**PFMEA** – Process Failure Mode and Effects Analysis

**PPAP** – Production Part Approval Process

**Process Tables** – Tables in the HTSA that list the required process controls for the heat treat processes covered. These tables contain minimum requirements.

**Quenchability Check** – A measure of the cooling dynamics of the quench media. A quencherometer is the inspection machine that displays the cooling curve of the quench media.

**Quench Delay** – The time delay between the end of the heat treat cycle and the start of the quench operation. For furnace heat treating, this is the period from the time the parts exit the furnace proper to the time the parts are at the bottom of the quench tank. For induction hardening systems, this is the time from the end of the heat cycle to the start of the quench flow (or when the parts enter a quench tank).

**Quenching Medium** – The medium used to quench parts after heat treating, e.g., oil, water, polymer, and salt.

**Recipe** – This term is typically used when a computer-based system sets and controls the process parameters, e.g., temperature, cycle time, carbon potential. The 'recipe' refers to the settings of the process parameters.

**Reprocessing** – Any process that is performed on nonconforming product so that it will meet the specified requirements.

**Responsibility Matrix** – A responsibility matrix defines the designated personnel for all key functions. This matrix includes the primary and secondary designees.

**RPN** – Risk Priority Number – A calculated number in the PFMEA. RPN is obtained by multiplying the Severity rating by the Occurrence rating by the Detection rating.

**SAE** – Society of Automotive Engineers

**Shop Traveler** – A document usually created in the receiving department for each batch or lot of parts received. The document defines the process routing of the parts.

**Signature Monitor** – An electronic monitor used to monitor induction heat treating systems. The monitor plots the energy unit, e.g., voltage or kilowatt, vs. time or distance.

**Special Characteristics** – are product characteristics or manufacturing process parameters which can affect safety or compliance with regulations, fit, function, performance or subsequent processing of product. Refer to customer-specific requirements.

**Temper Delay** – The time delay from when the parts exit the quench tank to the time when the parts are placed in the tempering furnace.

**3 (Three) Gas Analyzer** – An instrument that measures carbon monoxide, carbon dioxide, and methane in carbon-bearing atmospheres. This measurement provides an indirect measurement of the carbon potential of the atmosphere.

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# Special Process: Heat Treat System Assessment

**Three-Valve Fail-Safe Vent** (for ammonia lines) – An arrangement of three valves that prevents ammonia from inadvertently entering the furnace during carburizing or neutral hardening operations. The valves are arranged in such a way that, when the ammonia line to the furnace is shut off, any ammonia that might leak past the valve is vented to the atmosphere and thus prevented from entering the furnace. See the diagrams below.

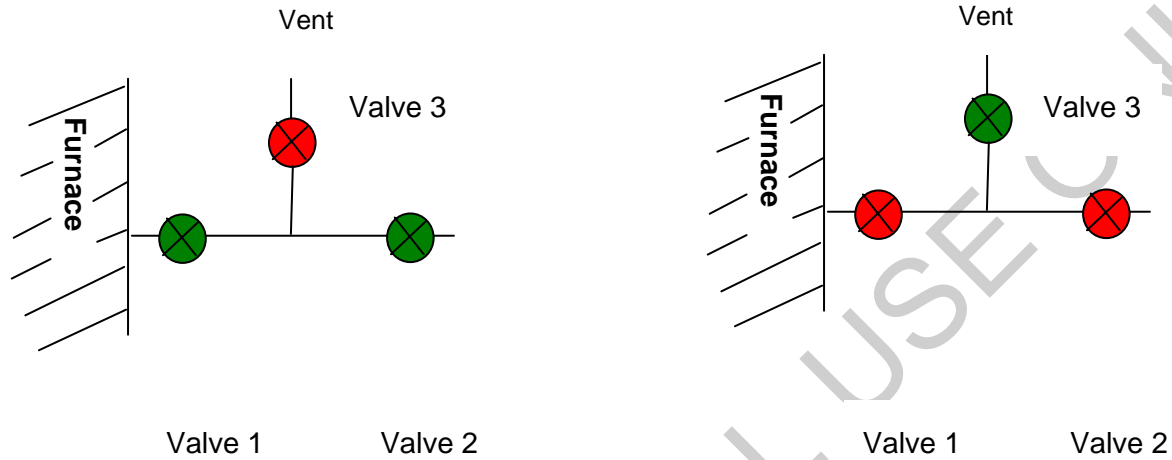


Figure 1 – Valves 1 and 2 are opened to allow ammonia flow into the furnace.

Figure 2 – Valves 1 and 2 are closed to prevent ammonia flow to furnace. If Valve 2 inadvertently leaks, ammonia is vented (Valve 3) to the atmosphere.

**Trap Points** – Areas in containers (baskets, fixtures, shipping boxes, etc.) or equipment that may inadvertently trap parts, allowing the potential for parts to be mixed between batches.

**Work Instructions** – Instructions that describe work conducted in one function in a company, e.g., setup, inspection, heat treat operation, process parameter tolerances, etc. The term “work instructions” is synonymous with the term “job instructions.”

## ABOUT AIAG

### Purpose Statement

To provide an open forum where members cooperate in developing and promoting solutions that enhance the prosperity of the automotive industry. Our focus is to continually improve business processes and practices involving trading partners throughout the supply chain.

### Core Values

- **People** – Our strength comes from passionate and personally committed volunteers and staff. We provide an environment of integrity, trust, teamwork, and mutual respect to foster open, frank communication as we achieve consensus on industry needs and solutions.
- **Innovation** – With a sense of urgency, we drive and support the development and implementation of common, leading-edge solutions that provide value to the automotive industry and its customers.
- **Excellence** – We provide quality and excellence in all we do and how we do it.

We do what's right for the industry!

### AIAG Organization

AIAG is made up of a board of directors, an executive director, associate directors, a full-time staff, and volunteers serving on project teams. Under the direction of the executive director, associate directors—along with the managing director, department managers, and program managers, plan, direct, and coordinate the association's activities. The executive director and loaned executives are *on loan* from member companies for varied lengths of time.

### AIAG Projects

Volunteer committees focus on business processes or supporting technologies and methodologies. They conduct research and develop, publish, and provide training on standards, conventions, standard business practices, white papers, and guidelines in the areas of automatic identification, CAD/CAM, EDI/electronic commerce, continual quality improvement, materials and project management, returnable containers and packaging systems, and transportation/customs.

AIAG - An Association Fostering Total Supply Chain Partnering

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# Special Process: Heat Treat System Assessment



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