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| --- | --- | --- | --- |
| **Company:** |  | **Supplier I.D.:** |  |
| **Address:** |  | **CAGE Code:** |  |
| **City:** |  | **Date:** |  |
| **State, Zip:** |  |  |  |

|  |  |  |  |
| --- | --- | --- | --- |
| Type of company ownership: |  | | |
|  | | |  |
| Business ownership/relationship with other organizations: | |  | |
|  | | | |
|  | | | |

Company Personnel Contacted:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Name** |  | **Title** |  | **Phone or e-mail** |
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Introduction:

## Governing Specification

* 1. The material specifications for the items being forged contain the requirements for forging and sampling.

1. Most material specifications, both military and commercial, have only indirect requirements for the forging process. These include requirements for internal soundness, uniformity, grain size, and ability to be ultrasonically tested.
2. Very few material specifications have any requirements for percent reduction or forging temperature.
3. Sample location and orientation requirements are given in the material specification. Forging drawings depicting location of mechanical test samples is generally a customer requirement.
4. Military specifications often require the supplier to provide and maintain a comprehensive Process Control Procedure (PCP) proven by qualification / first article testing. The supplier and prime contractor representatives agree on the critical attributes during supplier qualification or first article and the supplier will usually retain the PCP at his facility to ensure consistent and repeatable results.
   1. DFAR requirements limiting country of melt for the starting material apply.

## Technical Concerns

1. The molten metal for the starting material for forgings can be cast into ingots or continuous cast into strands. The non homogeneous dendritic grains in the cast material normally have poor mechanical properties and may also contain voids or porosity. The cast ingot must be hot worked enough to break up the grain structure, close voids and, if annealed, effect complete re-crystallization.
2. Holding the material at too high a temperature or for too long will cause grain growth. This can adversely affect mechanical properties and limit ability of the ultrasonic waves to penetrate the forging.
3. Cooling rate and test specimen orientation with respect to the principal direction of metal flow can affect the mechanical test results. The intent is to have test specimen properties representative of the properties achieved during the production forging process.
4. Improper thermal-mechanical processing can adversely affect corrosion resistance properties necessary for satisfactory service; corrosion resistance properties are rarely checked by specified lot acceptance tests.
5. Be aware that for commercial specifications some forging vendors take a very liberal view of what is considered a representative test specimen that has on occasion resulted in retesting or scrapping of parts because test specimen were not considered representative.

## Known Process Problems

1. Insufficient hot working has resulted in forgings that could not pass Charpy V-notch impact tests.
2. Samples taken from areas of forgings that received more hot work or were cooled more rapidly than the remainder of the forging they represented had mechanical properties that satisfied specification minimum requirements. However, samples taken from other areas of the forging did not meet the specified requirements.
3. Forgings that had the direction of metal flow incorrectly oriented with respect to the way the forging was stressed have failed due to poor mechanical properties or leaks.
4. Forgings that did not receive enough hot working between heating cycles or were heated too high or for too long had large grains and could not be ultrasonically tested.
5. Test material was taken from incorrect locations or separate test coupons that did not represent the final forging in the amount of work, cross section, or heat treatment. This has occurred primarily with new vendors or with commercial specifications that do not require the vendor to provide a forging drawing.
6. Vendor used marking materials and forging lubricants that did not meet contract requirements for detrimental materials.
7. Deviations from customer approved product qualification or 1st Article test report.
8. Failure to obtain forging sketch and test specimen location approvals when required by contract.

|  | Administrative information | Yes | No | N/A |
| --- | --- | --- | --- | --- |
| 1 | Employee Information: |  |  |  |
|  | 1. Is a degreed metallurgical engineer on staff? Name |  |  |  |
|  | 1. Number of employees: |  |  |  |
|  | 1. Number of Quality related personnel: |  |  |  |
|  | 1. Number of Process Engineering related personnel: |  |  |  |
| 2 | How are product requirements expressed and conveyed by customers to this facility? |  |  |  |
| 3 | Briefly describe the Contract Review and Order Entry process.  Procedure # |  |  |  |
| 4 | Describe types of parts forged (physical description of size & configuration, material types & alloys) at this facility. |  |  |  |
| 5 | Describe the application of the parts forged at this facility, if known. |  |  |  |
| 6 | Do your customers supply military products? |  |  |  |
| 7 | What specification requirements does the quality system meet at this facility?  Quality System:  MIL-I-45208  ISO 9001-2008  Other:  Calibration System:  ISO 10012  ANSI Z540  MIL-STD-45662 | | | |
| 8 | Has this facility and operation been audited by a third party for compliance with the stated quality system requirements and process control requirements:  If yes, provide auditing party’s name and date of audit |  |  |  |
| 9 | Are customer contract requirements flowed down into shop work instructions after order entry?   1. Who is responsible?     1. Procedure # |  |  |  |
| 10 | Is a particular melt type (EAF, VAR, ESR, VIM, etc) and grade of material used to make forgings?     1. How is type and grade determined? |  |  |  |
| 11 | Melt source for the forging ingots/billets/bars: |  |  |  |
|  | 1. Are specification requirements and effective revision communicated and controlled in the purchase order to sub-tier suppliers?    1. Procedure # |  |  |  |
|  | 1. Are material reduction and reduction ratios addressed in material purchase orders? |  |  |  |
|  | 1. If a sub-tier melter is used, is performance by that sub-tier evaluated (receiving inspection results, on-site audit, mail-in survey, positive material inspection, alloy identity verification, source inspection, etc.)? |  |  |  |
|  | 1. Are all applicable customer requirements (e.g., DFAR requirements) passed down in purchase orders to sub-tier suppliers? |  |  |  |

|  | **Receiving Inspection** | **Yes** | **No** | **N/A** |
| --- | --- | --- | --- | --- |
| 12 | Receiving inspection of ingots / billets / bars: |  |  |  |
|  | 1. Who performs the receiving inspection?     1. Procedure # |  |  |  |
|  | 1. Are inspections for physical markings, heat identification, visual and dimensional inspection performed?    1. Sample objective evidence for prior receipts: |  |  |  |
|  | 1. Is the chemistry of the starting material verified (alloy verification test, independent testing, MTR review, etc.)? |  |  |  |
|  | 1. Is this verification to ensure compliance with the specification requirements documented? Verify objective evidence.    1. Who performs the verification?    2. What actions are taken when defects are found? |  |  |  |
| 13 | Is the ingot / billet / bar (including “drops” and “cutoffs”) identification and traceability maintained during storage? |  |  |  |
| 14 | If an ingot is to be cropped top and/or bottom, is a sufficient amount of metal removed?   1. How is this verified? |  |  |  |

|  | **Forging Process** | **Yes** | **No** | **N/A** |
| --- | --- | --- | --- | --- |
| 15 | Amount of reduction:   1. Who determines amount of ingot reduction to be performed during forging operation? |  |  |  |
|  | 1. What factors are considered? |  |  |  |
|  | 1. Is a calculation performed? |  |  |  |
|  | 1. Are the starting material condition, size, and reduction considered? |  |  |  |
|  | 1. Is there a process procedure for determining the amount of reduction?    1. Procedure # |  |  |  |
| 16 | Forging work instructions and procedures: |  |  |  |
|  | 1. Paper traveler or on-line computer? |  |  |  |
|  | 1. Who is responsible for preparing and approving forging instructions? |  |  |  |
|  | 1. Is the issue of starting material for production controlled (heat, size, etc.)? |  |  |  |
|  | 1. Is weight and starting material size controlled? |  |  |  |
|  | 1. Is forging press or hammer size controlled? |  |  |  |
|  | 1. Forging Procedure # |  |  |  |
| 17 | Work station review: |  |  |  |
|  | 1. Are the instructions available at workstations? |  |  |  |
|  | 1. Do the instructions reference processing steps? |  |  |  |
|  | 1. Do the instructions control identification traceability? |  |  |  |
|  | 1. Review a sampling of in-process or completed work instructions. Does the information appear sufficient and correct? Check for operator signatures and dates.    1. Sampled Work Instructions: |  |  |  |
|  | 1. Are corrections or revisions to work instructions controlled by procedure and correctly documented? (Line out, initialed and dated by an authorized person.) |  |  |  |
|  | * 1. Correction to document Procedure # |  |  |  |
| 18 | Operation description:   1. Explain the actual hammer or press steps (approximate number of blows or strokes) in the forging (reduction) process being reviewed? |  |  |  |
|  | 1. Is the percent reduction controlled for each step? |  |  |  |
|  | 1. Is a minimum reduction required by the customer? |  |  |  |
|  | 1. Is the minimum reduction that is required measured and ensured? How? |  |  |  |
|  | 1. Is it necessary to control the primary working direction (grain flow) of the final product? If yes, how? |  |  |  |
|  | 1. Is there heat conditioning (re-heating) between forging cycles? If Yes, How is temperature controlled? |  |  |  |
| 19 | Maintain identification traceability:   1. Is the original mill traceability identification maintained during the forging operation on the traveler or on the work piece? |  |  |  |
|  | 1. Is the forging unique identification physically applied to provide traceability to the modified mechanical properties? |  |  |  |
|  | 1. How is the physical identification marking applied and who verifies proper marking? |  |  |  |
| 20 | Surface Preparation:   1. Is the forged surface cleaned (de-scaled) and prepared for heat treatment or further processing? |  |  |  |
|  | 1. Is there a procedure?    1. Procedure # |  |  |  |
|  | 1. Is shot blast used?    1. If so, what type of medium is used? If steel shot is used, how is iron contamination of nonferrous forgings prevented? |  |  |  |
|  | 1. Is it recycled, and is the same shot blast used on all alloys? |  |  |  |
|  | 1. If shot blast is not used, how are forgings cleaned after removal from the die or hammer? |  |  |  |
|  | 1. Is pickling or other cleaning method used? |  |  |  |
|  | 1. Is the physical forging identification marking verified after surface treatment, if applicable?    1. Who verifies proper marking? |  |  |  |
| 21 | Process Control:   1. Is there an observer or QC over check at the forging operation?    1. Describe function and authority: |  |  |  |
|  | * 1. Are internal audits performed to verify procedure compliance? Verify by reviewing sample records.      1. Sample records reviewed: |  |  |  |
|  | * 1. How are deviations handled? |  |  |  |
| 22 | Method to obtain mechanical test specimen: |  |  |  |
|  | 1. Is a forging drawing required for location of test specimen? |  |  |  |
|  | 1. If so, is approval by the customer necessary and obtained? |  |  |  |
|  | 1. Verify the test samples conform to the forging drawing? |  |  |  |
|  | 1. Is a production forging or prolongation used to obtain test specimen? |  |  |  |
|  | 1. Is the sample location & orientation correct per the specification, forging drawing, or customer requirement? |  |  |  |
|  | 1. Is a separate specimen forged specifically for mechanical testing? |  |  |  |
|  | * 1. Same heat of material? |  |  |  |
|  | * 1. Same process steps as forging, as closely as possible? |  |  |  |
|  | * 1. Same size (cross section) as forging? |  |  |  |
|  | * 1. Representative of forging? |  |  |  |
|  | 1. Is the number of samples controlled (tensile tests, elevated tensile, charpy, hardness, grain size, micro cleanliness, corrosion, etc.) as required by specification? |  |  |  |
|  | 1. Is identification and traceability of test samples controlled? |  |  |  |
|  | 1. Is the method for obtaining mechanical test specimen representative of the hammer operation(s) or press operation(s)? |  |  |  |

|  | **Forging furnace evaluation** | **Yes** | **No** | **N/A** |
| --- | --- | --- | --- | --- |
| 23 | 1. Is the heating equipment satisfactory for the forging operation?    1. Number of furnaces:    2. Size of furnaces:    3. Fuel & atmosphere:    4. Temperature ranges: |  |  |  |
|  | 1. Is the condition of the furnaces satisfactory for the operation being performed? |  |  |  |
|  | * 1. Bottom, Burners, Seals |  |  |  |
| 24 | 1. Is heating controlled for the forging operation? |  |  |  |
|  | 1. Are there written instructions and /or procedures?    1. Work Instruction/Procedure #: |  |  |  |
|  | 1. Are heating rates, temperatures, hold times, and tolerances specified and controlled? |  |  |  |
|  | 1. Are the instructions readily available to the forging crew?    1. Procedure # |  |  |  |
|  | 1. Are the operators familiar with the instructions and procedures? |  |  |  |
|  | 1. Are records maintained as objective evidence for process completion? Check dates and signatures of process instructions/records. |  |  |  |
|  | 1. Is a heat log or chart maintained to demonstrate compliance with specified requirements?    1. Who reviews the log or chart? |  |  |  |
|  | 1. Is there an observer or QC over check of the process and documentation? |  |  |  |
|  | 1. Are deviations identified and segregated? |  |  |  |
|  | 1. Is identification maintained, including identification of material in the oven (location layout/map within the oven) if necessary? |  |  |  |
| 25 | 1. Do procedures specify limitations on heating cycles during forging operations (number of cycles and temperature)?    1. What are the heating cycles? |  |  |  |
|  | 1. Is there a working temperature range for the work piece?    1. How is the temperature range controlled, and what is the Objective Quality Evidence? |  |  |  |
|  | 1. Are precautions in place to avoid coarse grains (temperature too high)?    1. Describe: |  |  |  |
| 26 | Instrumentation and controls for forging furnaces: |  |  |  |
|  | 1. Are thermocouples used?    1. If Yes, number and location: |  |  |  |
|  | 1. Are controllers and recording instruments used? |  |  |  |
|  | 1. Is a calibration program in place with NIST traceable standards? |  |  |  |
|  | 1. Are instrumentation and gauging within calibration period? |  |  |  |
|  | 1. Are calibration procedures and records available? |  |  |  |
| 27 | 1. What is the allowed temperature deviation from set point? (+       degrees) |  |  |  |

|  | **Forging heat treat evaluation** | **Yes** | **No** | **N/A** |
| --- | --- | --- | --- | --- |
| 28 | 1. If heat treat is required, is it performed: |  |  |  |
|  | * 1. Internally (In-House)? |  |  |  |
|  | * 1. Externally (Out-Sourced)? If Out-Sourced, identify outsource: |  |  |  |
|  | 1. Do the heat treat parameters and operation meet specification or customer requirements for at least the following: |  |  |  |
|  | * 1. Atmosphere |  |  |  |
|  | * 1. Temperature, hold time, and tolerances |  |  |  |
|  | * 1. Type of quench |  |  |  |
|  | * 1. Maximum furnace to quench time |  |  |  |
|  | * 1. Furnace controls (surveys, thermocouples, calibration, etc.) |  |  |  |
|  | * 1. Map identifying location of forgings within the furnace, if necessary |  |  |  |
| 29 | Instrumentation and control of heat treat furnaces: |  |  |  |
|  | 1. Are thermocouples used?    1. If Yes, Number and Location: |  |  |  |
|  | 1. Are controllers and recording instruments used? |  |  |  |
|  | 1. Is a calibration program in place with NIST traceable standards? |  |  |  |
|  | 1. Are recording and sensing instruments within calibration period? |  |  |  |
|  | 1. Is temperature uniformity survey performed on the heat treat furnaces? |  |  |  |
|  | 1. What is the allowed temperature deviation from set point? (+       degrees) |  |  |  |
|  | 1. Are deviations from set point addressed / evaluated? |  |  |  |
|  | 1. Is there a procedure for performing surveys?    1. Procedure #: |  |  |  |
|  | 1. Is a frequency of surveys specified? |  |  |  |
|  | 1. Is the survey reviewed and approved?    1. Who reviews the survey? |  |  |  |
| 30 | Heat treat process and furnace controls: |  |  |  |
|  | 1. Are written instructions available? |  |  |  |
|  | 1. Are heating rates, temperatures, hold times, and tolerances specified and controlled?    1. What is the objective quality evidence? |  |  |  |
|  | 1. Are the procedures readily available to the heat treat crew?    1. Procedure # |  |  |  |
|  | 1. Are the operators familiar with the procedures? |  |  |  |
|  | 1. Are specification and customer required records maintained as evidence for process description and completion? |  |  |  |
| 31 | Heat Treat Control: |  |  |  |
|  | 1. Is there an observer or QC over check of the process and documentation? |  |  |  |
|  | 1. Are deviations addressed / evaluated? |  |  |  |
|  | 1. Is identification maintained, including identification of material in the furnace (location layout/map within the oven)? |  |  |  |
| 32 | 1. Is it necessary to uniquely re-identify the forgings and test specimen to provide traceability to the final heat treated condition for mechanical properties verification? Can each forging be traced back to a particular heat treat furnace load? |  |  |  |
|  | 1. Is the unique heat treat physical identification marking applied? |  |  |  |
|  | 1. Is the unique identification marking verified? If yes, who verifies? |  |  |  |

|  | **Final testing and inspection** | **Yes** | **No** | **N/A** |
| --- | --- | --- | --- | --- |
| 33 | Mechanical testing and disposition of the test specimen: |  |  |  |
|  | 1. If performed in-house: |  |  |  |
|  | * 1. Are procedures or work instructions available? |  |  |  |
|  | * 1. Are lab technicians trained and qualified? |  |  |  |
|  | * 1. Is mechanical test equipment calibrated? |  |  |  |
|  | 1. If out-sourced: |  |  |  |
|  | * 1. Does the forging supplier adequately describe in the purchase order the required testing and documentation required (material specification, customer requirements, etc.)? |  |  |  |
|  | * 1. Does the forging supplier exercise controls for selecting and maintaining the test lab provider (audits, source inspections, etc.)? |  |  |  |
|  | * 1. Are the testing facility/personnel qualified for the required testing (NADCAP, A2LA, etc.)? |  |  |  |
|  | 1. Does the forging organization verify that all testing results meet specification and customer requirements? Method of verification? |  |  |  |
|  | 1. Is the verifying analyst trained and capable? |  |  |  |
|  | * 1. Are capabilities and the test result dispositions audited and/or validated periodically? |  |  |  |
|  | * 1. Is there a procedure for evaluating acceptability of test results?      1. Procedure # |  |  |  |
|  | * 1. Does the procedure prevent release of material until mechanical test reports are approved? |  |  |  |
|  | * 1. Is the mechanical test specimen retained? For how long? |  |  |  |
| 34 | 1. Are certified material test reports generated for the mechanical properties? |  |  |  |
|  | 1. Does a review of certified material test reports indicate they meet the specification and/or customer requirements? |  |  |  |
| 35 | 1. Are the heat treated forgings cleaned? |  |  |  |
|  | 1. Is there a procedure? Procedure # |  |  |  |
|  | 1. Is shot blast used?    1. If so, what type of medium is used? If steel shot is used, how is iron contamination of nonferrous forgings prevented? |  |  |  |
|  | * 1. Is it recycled, and is the same shot blast used on all alloys? |  |  |  |
|  | 1. If shot blast is not used, how are forgings cleaned after final heat treatment? |  |  |  |
|  | * 1. Is this covered in a procedure? Procedure # |  |  |  |
|  | 1. Is the physical identification marking verified after surface cleaning / conditioning? Who verifies proper marking? |  |  |  |
| 36 | 1. Are there NDT requirements for forgings? |  |  |  |
|  | 1. Is there evidence that they have been satisfied and are acceptable? |  |  |  |
|  | * 1. Specification? |  |  |  |
|  | * 1. Procedure approval? |  |  |  |
|  | * 1. Properly completed test report? |  |  |  |
|  | * 1. Inspector/Operator qualification? |  |  |  |
| 37 | Control of weld repairs: |  |  |  |
|  | 1. Are weld repairs on forgings performed in-house? |  |  |  |
|  | 1. If not who performs the welding? |  |  |  |
|  | 1. Are the correct weld procedures identified in work instructions? |  |  |  |
|  | 1. Are customer approved weld procedures required and available? |  |  |  |
|  | 1. Is filler material certified and controlled in storage, at issue, and during use? |  |  |  |
|  | 1. If weld repairs are not allowed, how is this enforced? |  |  |  |
| 38 | 1. Is a final inspection/review performed to verify the forging conforms to the customer contract requirements prior to shipment?    1. What items are included in the review?    2. Who prepares the required documentation?    3. Who is authorized to sign test reports? |  |  |  |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Other Item Areas of Interest** | | | | Yes | No | N/A |
| 39 | 1. Is a preventive maintenance program documented? | | | |  |  |  |
|  | 1. Is there a documented training program to assure personnel are adequately trained in their assigned tasks prior to performing the task?    1. Procedure # | | | |  |  |  |
|  | 1. Are there controls to prevent contact with detrimental elements such as: | | | |  |  |  |
|  | * 1. Marking materials | | | |  |  |  |
|  | * 1. Forging lubricants | | | |  |  |  |
|  | * 1. Other potentially detrimental materials that may come in contact with the forgings | | | |  |  |  |
| **Additional comments and overall assessment**: | | | | | | | |
| **Evaluation results**: **Satisfactory**:  **Unsatisfactory**:  **If required, Request for Corrective Action (SCAR#)**:  Lead Auditor’s signature: Date:  Lead Auditor’s Printed Name:       Phone #: | | | | | | | |
| Auditor’s Signature: | |  | Date: |  | | | |
| Auditor’s Printed Name | |  |  |  | | | |
| Auditor’s Signature: | |  | Date: |  | | | |
| Auditor’s Printed Name | |  |  |  | | | |
| Auditor’s Signature: | |  | Date: |  | | | |
| Auditor’s Printed Name | |  |  |  | | | |
| Auditor’s Signature: | |  | Date: |  | | | |
| Auditor’s Printed Name | |  |  |  | | | |