DCMA NSEO MANUFACTURING PROCESS SURVEILLANCE (MPS) CHECKLIST #39

FORGING OPERATIONS

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| **SUPPLIER & CAGE:**  |  |
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| **LOCATION:** |  |
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| **PROCESS:** |  |

**Program Type:**

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|  | Level I/SUSBAFE (LI/SS) |  | Navy Propulsion Program (NPP) |  | Deep Submergence Systems/Scope of Certification Program (DSS-SOC) |
|  | Nuclear Plant Material (NPM) |  | Naval Nuclear Propulsion Program (NNPP) |  | Aircraft Launch & Recovery Equipment (ALRE) |
|  | Fly By Wire Ships Control Systems (FBWSCS) |  | Ships Critical Safety Items (SCSIs) |  | Other: |

**Contractual Requirement(s) for this process:**

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**Supplier Procedure Number(s), Title(s) & Revision Level(s)/Date(s):**

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| Surveillance Performed By:  |  |
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| Date(s) of Surveillance: |  |
| Contract Number(s): |  |
|  |  |
| Part Number(s)/Serial number(s)/NSN: |  |
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| Part Nomenclature(s): |  |
|  |  |
| Supplier Personnel Contacted and Titles: |  |
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| Drawing Number & Revision: |  |

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**Process Concerns and Guidance:**

* 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.
* Inadequate procedures for chemical check analysis prior to pouring a melt can result in unacceptable material being processed.
* Holding the material at too high a temperature or too long at proper temperature will cause grain growth. This can adversely affect mechanical properties and limit ability of the ultrasonic waves to penetrate the forging. 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.
* 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.
* Improper thermal-mechanical processing can adversely affect corrosion resistance properties which are necessary for satisfactory service. Corrosion resistance properties are rarely checked by specified lot acceptance tests.
* For commercial specifications, some forging vendors have different opinions about what is considered a representative test specimen. This has resulted in retesting or scrapping of parts when the test specimens were not considered representative by the customer.
* Insufficient hot working has resulted in forgings that could not pass Charpy V-notch impact tests. Improper forging or other metal forming techniques may cause voids and excessive pitting.
* Mechanical tensile tests have been performed properly, but calculations performed incorrectly, resulting in “acceptable” test values reported for unacceptable material.
* 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.
* 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.
* Test material has been 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.
* Vendors have used marking materials and forging lubricants that did not meet contract requirements for detrimental materials.
* There have been deviations from customer approved product qualification or 1st Article test reports. Weld repair of forgings was performed without the welding procedure being approved.
* There have been failures to obtain forging sketch and test specimen location approvals when required by contract.
* Failure to maintain material control can result in the use of incorrect raw materials and additives which can affect the mechanical properties of the material produced. Improper marking of rejected material has resulted in comingling with acceptable product.
* Non-Destructive Testing has not been performed according to procedure or has been performed using improper calibration techniques.
* Inadequate control of alloys materials, and additives has resulted in scrapped heats.

**QARs should use the “BASIS OF DETERMINATION” column to document the objective quality evidence and/or clarify the rationale used to support their decision. (e.g. direct observation, documents verified etc.)**

S = Satisfactory U = Unsatisfactory

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| **SURVEILLANCE QUESTIONS** | **S** | **U** | **BASIS OF DETERMINATION** |
| 1. Are the personnel performing the manufacturing, testing, and quality assurance functions of the appropriate skill/experience level and/or properly trained/qualified in the procedure/specification? ***What are the requirements?***
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| 1. Is **inspection and testing** **equipment** of the required adequacy, accuracy, precision, and range to assure supplies produced comply with specifications and drawings? *What Items were sampled and were they part of the supplier’s calibration program and within the calibration/check cycle?*
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| 1. Is **manufacturing equipment** adequate to produce/assess conforming supplies in compliance with contractual specifications and drawing(s)? *What Items were sampled and were they part of the supplier’s calibration program and within the calibration/check cycle?*
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| 1. Are work instructions, test procedures, travelers, etc. being used adequate, clear, and up to date (latest revision)? *What documents (identifying number & rev) were reviewed?*
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| 1. Is there a documented procedure/process to determine the acceptability of raw materials (ingots, billets, bars, etc.)? Are certifications for raw materials used in the forging process reviewed for acceptance and maintained on file for review? Do the raw materials comply with contract/specification and/or supplier-imposed technical requirements?
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| 1. For Level I material, is the product controlled and traceable throughout the process?
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| 1. Is the condition of the forging furnaces, including bottoms, burners and seals, satisfactory for the operation being performed?
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| 1. Does the foundry have a documented procedure for controlling, storing, and issuing raw materials and additives?
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| 1. Is the ingot/billet/bar (including “drops” and “cutoffs”) identification and traceability maintained during storage? If an ingot is to be cropped top and/or bottom, is a sufficient amount of metal removed?
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| 1. Are heat/lot traceability markings forged into final product or marked immediately after removal from the dies and cooling? Or, is a process in place to assure traceability is maintained until markings are applied?
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| 1. Does the forge conduct surface preparation/cleaning in accordance with established procedures? If shot blast is used, is the same shot blast used on all alloys? Is recycling of shot blast allowed?
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| 1. Is inspection data reviewed and accepted by qualified personnel? Is operator identification recorded? (name, badge number, clock, shift, etc.)
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| 1. Does the forge use documented qualified procedures for performing welding repair on their forgings? Does the forge maintain records showing the training and qualification of the welders?
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| 1. Is the correct forging method used, such as drop forge, pressure forge, ring rolling or other method, per applicable requirements?
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| 1. Are the proper number of blows/strokes being applied during each hammer/press step, for each portion of the forging process?
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| 1. Are adequate controls in place to assure that the correct type of forging die is used during the forging process?
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| 1. Is the forge closely monitoring die wear, to ensure the forged product(s) meet the as-forged dimensional requirements of the customer?
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| 1. Are the number and temperature of reheats used during the forging process per applicable requirements?
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| 1. Does the forge use a documented procedure for performing and evaluating NDT on the final product?
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| 1. When a portion of an as-forged material lot undergoes further material processing which alters material properties, is that portion of the original material lot re-identified for traceability? Is additional material properties testing performed?
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| 1. Is a particular melt type (EAF, VAR, ESR, VIM, etc.) and grade of material used to make forgings?
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| 1. Are specification requirements and effective revision communicated and controlled in the purchase order to the supplier/melt source for the forging ingots/billets/bars?
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| 1. Are inspections for physical markings, heat identification, visual and dimensional inspection of ingots/billets/bars performed by forge personnel? Is the chemistry of the ingots/billets/bars starting material verified?
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| 1. Are the starting material condition, size, and reduction taken into consideration in making the determination of the amount of ingot reduction to be performed during the forging operation?
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| 1. Do mechanical test samples conform to the forging drawing? Was a production forging or prolongation used to obtain the test specimen? Was the test sample location and orientation correct per the applicable specification, forging drawing, or specific customer requirement? Was a separate specimen forged specifically for the mechanical testing?
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| 1. Is furnace heating for forging and heat treatment to specification or customer requirements for: a) Atmosphere; b) Temperature, hold time, and tolerances; c) Type of quench; d) Maximum furnace to quench time; e) Furnace controls (surveys, thermocouples, calibration, etc.); f) Map identifying location of forgings within the furnace, if necessary?
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| 1. Is a final inspection/review to verify the forging conforms to the customer contract requirements, prior to shipment, performed by the forge? What items are included in the review?
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| 1. Is the work area where the work is being performed clean and free from dirt and debris, beyond that common for this facility type?
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| 1. Are there an adequate number of fire protection devices maintained and readily available for use? Are eye-wash stations and other applicable safety resources located in the work area, and are they easily accessible?
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| Other observations: |  |  |  |
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| **Overall MPS Results:** | **SATISFACTORY** |  | **UNSATISFACTORY** |  |

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| **Corrective Action Generated?** | **No** |  |  | **Yes** |  |  | **CAR#** |  |

**FOLLOW-UP ACTION REQUIRED?**

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**SUMMARY/NOTES/COMMENTS/CONCERNS**:

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