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Program Document CPBOK

PD 6103

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BODY OF KNOWLEDGE

ROLE DESCRIPTION: Planner
SPECIAL PROCESS: Heat Treatment
METHOD: Heat Resisting Alloys

All PRI Qualification[SM] program examinations are created using the applicable PRI Qualification[SM] program Body of Knowledge (BoK), which defines the baseline knowledge and experience required to be considered competent to perform the specified job role in aerospace special process manufacturing.

All BoKs are created by subject matter experts who participate in the PRI Qualification[SM] Body of Knowledge Review Boards. All BoKs are updated periodically according to the latest revision of PRI Qualification[SM] program documentation (PD6100: Industry Managed Special Process Bodies of Knowledge) to ensure consistency with current industry practice.

1. INTRODUCTION

This document has been created by the PRI Qualification[SM] program Heat Treatment Body of Knowledge Review Board (HT BoKRB) according to the requirements of PD6100.

This document constitutes the PRI Qualification[SM] program BoK for (Heat Treatment, Heat Resisting Alloys, Planner). It defines the baseline knowledge and experience required to be considered competent to perform this role.

Unless otherwise stated, the HT BoKRB has followed guidelines as detailed in the current revision of International Aerospace Quality Group IAQG Guidance PCAP 001 (Competence Management Guideline) to develop this BoK.

The information in this BoK will provide guidance for the following:

- Training providers who wish to develop training courses intended to support PRI Qualification[SM] program examination candidate preparation
- Heat Treatment Examination Review Board (HT-ERB) for the development of PRI Qualification[SM] program examinations
- Candidates taking PRI Qualification[SM] program examinations who wish to prepare in advance

2. REFERENCES

PRI Qualification[SM] program documents:

PD6000	Governance & Administration of PRI Qualification[SM] Program
PD6100	Industry Managed Special Process Bodies of Knowledge
PD6200	Industry Managed Special Process Examinations System

IAQG documents:

IAQG Guidance PCAP 001 Competence Management Guideline

3. DEFINITIONS

Definitions described within are specific to the Special Process BoK. For program-specific definitions, please refer to either the PD 6000 or the PRI Qualification[SM] Dictionary.

BODY OF KNOWLEDGE (BoK): Baseline knowledge and experience required to be considered competent for a target position.

GENERAL EXAMINATION: The General Examination is designed to ascertain the candidate's general knowledge required for a particular job, role or activity. All of the questions will be derived from the corresponding BoK.

EXPERIENCE: The accumulation of knowledge or skill that results from direct participation in events or activities over a period of time.

KNOWLEDGE: Information / understanding acquired over a period of time. Information acquired through study and retained over that period of time (education, training, experience etc.) The combination of data and information, to which is added expert opinion, skills and experience, to result in a valuable asset which can be used to aid decision making and problem solving.

LEVEL: A class or division of a group based on education, training and experience. There are 3 levels: Operator/Technician, Planner and Owner. Please refer to the current revision of PD 6000 for definition of these levels.

METHOD: A well-defined division of a SPECIAL PROCESS widely recognized by industry. A specific area of a special process for example anodizing within Chemical Processing

NON-SPECIAL PROCESS RELATED REQUIREMENTS: Miscellaneous requirements such as Health and Safety, Environmental, etc.

PERSONAL ATTRIBUTES: A quality or characteristic expected and required for a particular job, role or activity.

PRACTICAL EXAMINATION: The Practical Examination shall consist of a demonstration of proficiency in performing tasks that are typical of those to be accomplished in the performance of the candidate's duties. The examination content is derived from the corresponding BoK.

SKILL: Ability to perform a particular task. The quality of being able to do something that is acquired or developed through training or experience.

SPECIFIC EXAMINATION: The Specific Examination shall cover requirements and use of the specifications, codes, equipment, operating procedures and test techniques the candidate may use in the performance of his/her duties with the employer. Examination content will be derived from the corresponding BoK where applicable.

WEIGHTING: The "weighting" of each line item, using a scale of 1, 3, 7, 10, (1 being least important; 10 being most important) indicates the relative importance of that aspect of the BoK and will determine the likelihood and frequency of a question on that topic appearing in the examination.

4. GUIDANCE TO EXAMINATION CANDIDATES

All PRI Qualification[SM] examination candidates are recommended to read all documents referenced in section 2 of this document.

As stated in PRI Qualification[SM] document PD6200, every exam question shall relate directly to and be derived from the information as detailed in the current revision of the BoK.

Re-assessment of candidates to this BoK is required every **5 years**, unless otherwise specified.

Candidates are therefore advised to ensure familiarity with all aspects of the BoK as detailed in Table 1. This can be done through:

- Self-study
- Completion of internal training
- Completion of external training (a list of Approved Training Providers can be found at https://p-r-i.org/)

Records of all qualified personnel shall be maintained and include:

- Date of Qualification
- Results of Written Exam
- Results of Practical Exam (if applicable)
- Summary of Experience

5. LEVELS

	Level		
Descriptors	***Operator (OP)/Technician(T)*** ***For descriptions, please refer to current version of PD6000***	***Planner (PL)*** ***For descriptions, please refer to current version of PD6000***	***Owner (OW)*** ***For descriptions, please refer to current version of PD6000***
Heat Treat Specific Criteria	**N/A**	**N/A**	**N/A**
Technical Knowledge	Basic knowledge of the special process, its main processes, methods and tools.	Good level of knowledge in all aspects of the special process, all its processes, methods and tools. Ability to coach others on contents and methods in the context of their workplace.	High or extensive knowledge in all aspects of the special process, all its processes, methods and tools to assess and validate improvements. Able to contribute to set externally recognized standards. Ability to define contents and methods for using knowledge effectively in influencing and developing international processes. Ability to influence the process with one's knowledge.
Experience	Sufficient experience to deal with recurrent activity.	Has enough experience to deal with unforeseen issues.	Wide proven experience of the subject. Is recognized specialist within the special process.
Personal Attributes	Takes into consideration behavioral characteristics such as but not limited to: team working, communication, direction and purpose, innovation and problem solving, mutual trust and respect, confidentiality and trustworthiness.		
Skills	Describes the activities necessary to perform each level of job function to comply with the Body of Knowledge		
Non-Special Process Related Requirements	Health & Safety, Environmental, Quality System Requirements.		

6. TABLE 1

ROLE DESCRIPTION: Planner
SPECIAL PROCESS: Heat Treatment
METHOD: Heat Resisting Alloys
REFERENCE GUIDELINES: ***Addendum 1 is a list of the International Standards and Reference Documents applicable to heat resisting alloy heat treating processes.***

Row #	COMPETENCE	Weight (1,3,7,10)	Exam Type Written/ Practical	Reference Guidelines
	KNOWLEDGE: The basic knowledge of the special processes, methods and tools			
1	**General Quality Systems Knowledge:**			
2	Knowledge and understanding of Aerospace Quality Systems and compliance.	7	GEN	AS9100, AC7102 3.0, AC7102/8 8.0
3	Full and complete understanding of company practices for content of internal work instructions as well as interpretation of industry standards (see Addendum -1 of this document)	7	GEN	AS9100, AC7102, AC7102/8
4	Knowledge and understanding of how non-conformance is controlled using tools such as Root Cause Corrective Action	7	GEN	AS9100 8.2, 8.3, 8.5, AC7102 3.3, 3.4
5	Knowledge and understanding of safety compliance requirements as applicable.	10	GEN	AS9100, AMS2769
6	Knowledge and understanding of traceability of calibration to NIST or equivalent agencies.	7	GEN	AS9100 7.6, AC7102/8 2.1.2
7	Knowledge and understanding that contracts and incoming purchase orders must be reviewed and flowed down internally and to subcontractors	7	GEN	AS9100 7.2.2, AC7102 3.2.1
8	Knowledge and understanding that there must be a procedure in place to address software control, that there must be evidence to support this. In addition, software revisions must be verified by first lot inspection to ensure compliance with customer requirements	7	GEN	AS9100 7.5.1.3, 7.6, AC7102 3.10
9	Knowledge and understanding that identification, count and quality discrepancies must be resolved prior to processing of parts and that incoming customer documents remain traceable to specific jobs, as applicable.	7	GEN	AS9100 7.5.3, AC7102 5.1.1, 5.1.2
10	Knowledge and understanding that the acceptance status and any test data are recorded on the shop paper only after the operation for that job has been completed.	7	GEN	AS9100 7.5.1.1, AC7102 6.1.4
11	Knowledge and understanding that sampling plans have requirements based on specification and customer requirements	7	GEN	AS9100 8.2.4, AC7102 6.2
12	Knowledge and understanding that current operating manuals or instructions must be available to furnace operators, maintenance personnel and other personnel requiring the information.	7	GEN	AS9100 4.2.3, AC7102 9.1.1.1
13	Knowledge and understanding that all components of each furnace that can affect the functionality are inspected and maintained in accordance with a documented preventative maintenance schedule.	7	GEN	AS9100 8.5.3, AC7102 9.2.1
14	Knowledge and understanding that internal procedures must specify how atmospheres are to be controlled and monitored to ensure conformance to requirements of specifications and customer requirements.	7	GEN	AS9100 7.6, AC7102 9.3.1
15	Knowledge and understanding that flow meters be operational and appropriate for the gas and flow rates used, that inspection and maintenance schedule include periodic checks of flow meters, and that there should be an internal procedure to address the safety shut-off valves and the emergency gas purges.	7	GEN	AC7102 9.4.1, 9.4.2, 9.4.3
16	Knowledge and understanding that unless otherwise specified by the cognizant engineering or quality assurance organization, the heat treatment processor shall be responsible for performance of all tests and inspections specified in AMS2773 or AMS2774, as applicable. The processor may use its own facilities or any commercial laboratory acceptable to the cognizant engineering or quality assurance organization.	7	GEN	AMS2773, AMS2774
17	Knowledge and understanding that the procuring activity reserves the right to perform any surveillance, tests, or inspection of parts and to review heat treatment records and results of processor's tests and inspections to verify that the heat treatment conformed to specified requirements.	7	GEN	AMS2773, AMS2774
18	Knowledge and understanding that records shall be kept available to purchaser for not less than 5 years after heat treatment. The records shall contain all data necessary to verify conformance to requirements of this specification.	7	GEN	AMS2773, AMS2774

19	**Qualification** Knowledge and understanding that facilities performing heat treatment in accordance with AMS2773 or AMS2774 shall be approved by the cognizant organization. In addition, personnel performing or directing the performance of heat treatment in accordance with AMS2773 or AMS2774 shall be approved in accordance with ARP1962 or other established procedures acceptable to the cognizant organization.	7	GEN	AMS2773, AMS2774, AC7102, ARP1962
20	**Approval** Knowledge and understanding that approval of heat treatment processors shall be accomplished by the cognizant organization and will normally be based on approval of the heat treatment processor's shop procedure document, which shall include a full description of all equipment and procedures that will be used to meet requirements of AMS2773 or AMS2774, depending on the form of the alloy, and AMS2750.	7	GEN	AMS2773, AMS2774, AC7102, AMS2750
21	**Logs** Knowledge and understanding that a record (written or electronic storage media), traceable to temperature recording information (chart(s) or electronic storage media) and to shop travelers or other documentation, shall be kept for each furnace and load. The information on the combination of documents shall include: equipment identification, approved personnel's identification, date; part number or product identification, number of parts, alloy, lot identification, AMS2773 or AMS2774, with revision, or other applicable specification, actual thermal processing times and temperatures used. When applicable, atmosphere control parameters, quench delay, quenchant type, polymer concentration and quenchant temperature shall also be recorded. The maximum thickness, when process parameters are based on thickness, shall be recorded and shall be taken as the minimum dimension of the heaviest section of the part. The log data shall be recorded in accordance with the heat treater's documented procedures.	7	GEN	AMS2773, AMS2774, AC7102
22	**Report/Certification** Knowledge and understanding that the heat-treating processor shall furnish, with each shipment of parts, a certified quality assurance report, traceable to the heat treat control number(s), stating that the parts were processed in accordance with the requirements of AMS2773 or AMS2774, with revision, (or other applicable specification). The report shall include: purchase order number, part number or product identification, alloy, temper/strength designation, quantity of parts in the shipment, identification of furnace(s) used, actual thermal processing times and temperatures used. When applicable, the report shall also include: atmosphere type, quenchant (including polymer concentration range), hot straightening temperature and method of straightening (e.g., press, fixtures), actual test results, (e.g., hardness, conductivity, tensile, shear, etc.) and a statement of their conformance/nonconformance to requirements. This data shall be reported in accordance with the heat treater's documented procedures.	7	GEN	AMS2773, AMS2774
23	**Preparation for Delivery** Knowledge and understanding that identification of parts provided to the heat treatment processor shall be maintained on the parts at delivery.	7	GEN	AMS2773, AMS2774
24	Knowledge and understanding that parts shall be packaged to ensure protection from damage during shipment and storage. Packages of parts shall be prepared for shipment in accordance with commercial practice and in compliance with applicable rules and regulations pertaining to the handling, packaging, and transportation of the parts to ensure carrier acceptance and safe delivery.	7	GEN	AMS2773, AMS2774
25	**Acknowledgment** Knowledge and understanding that the heat treatment processor shall mention the applicable specification number and its revision letter in all quotations and when acknowledging purchase orders	7	GEN	AMS2773, AMS2774
26	**Rejections** Knowledge and understanding that parts not heat treated in accordance with requirements of AMS2773 or AMS2774, as applicable to the form of heat resisting alloy being heat treated, or with modifications authorized by purchaser, will be subject to rejection.	7	GEN	AMS2773, AMS2774
27	**Cognizant Organization** Knowledge and understanding that the cognizant organization is the engineering organization responsible for the design of the parts, or its allied quality assurance organization, or a designee of these organizations	7	GEN	AMS2773, AMS2774
28	**GENERAL METALLURGICAL KNOWLEDGE RELATED TO HEAT TREATING HEAT RESISTING ALLOYS (Applicable to all specifications):**			
29	Understand the importance of generating work instructions that incorporate Pyrometry requirements including temperature sensors, instrumentation, thermal processing equipment, system accuracy tests, and temperature uniformity surveys and reporting of non-conformance.	7	PRAC	AS9100, AMS2750
30	Knowledge and understanding that when re-heat treatment is performed it must be checked for its allowance and requirements.	7	PRAC	AC7102 3.3.2

31	**Understanding of Heat Treatments applied to Heat Resisting Alloys:** • Solution Heat Treating • Homogenization • Stabilization • Annealing • Stabilization Annealing • Interstage Annealing • Precipitation • Equalization • Stress Relief	7	GEN	AMS2773, AMS2774
32	**Understanding of the definitions and importance of terms applicable to Heat Treatment of Heat Resisting Alloys:** • Set temperature • Recovery time • Start of soak • End of soak • Straightening • Quenchant Medium • Quenchant Temperature • Eutectic Melting • Leak Rate • Hardness • Surface Contamination	7	GEN	AMS2773, AMS2774, AMS2769, AC7102
33	Understanding of why correct selection and flow down to operators of set temperatures and furnace uniformity is important.	7	GEN	AMS2773, AMS2774, AMS2769, AC7102
34	Understanding of the importance of selecting minimum and maximum treatment times, including clear definition to operators as to how start and end of soak are determined and whether they are based on furnace (controller) readings or actual metal temperature (load thermocouples).	7	GEN	AMS2773, AMS2774, AC7102
35	Knowledge and understanding of when planning requires the use of a vacuum and the level of vacuum required	7	GEN	AMS2773, AMS2774, AC7102
36	Knowledge and understanding that planning must reflect use of heat treating equipment and instruments for the heat treatment of titanium alloys that are in accordance with applicable specifications.	7	GEN	AC7102, AC7102/8
37	Knowledge and understanding that planning must specify heat treating facilities that possess the correct temperature uniformity, instrument accuracy and resolution for the heat treating of titanium alloys in accordance with applicable specifications.	7	GEN	AC7102, AC7102/8
38	**Heating Media** Knowledge and understanding that above 1550 °F (843 °C) or 1600 °F (871 °C), depending on the form (wrought, cast, etc.) heat resisting alloy planning must incorporate the applicable testing, atmosphere, and restrictions.	7	GEN	AMS2773, AMS2774
39	Knowledge and understanding that for non-age-hardening heat resisting alloys only, neutral salt baths and exothermic gas atmospheres are acceptable protective atmospheres when approved by the cognizant engineering organization	7	GEN	AMS2773, AMS2774
40	Knowledge and understanding that direct fired furnaces shall be controlled so that there is no direct flame impingement on heat resisting alloy parts.	7	GEN	AMS2773, AMS2774
41	Knowledge and understanding that there are composition requirements based on specifications for argon, helium and hydrogen gases used in heat treating heat resisting alloys. In addition, the dew point requirements of gas entering the furnace must be known as well as purity requirements.	7	GEN	AMS2773, AMS2774, AMS2769, AC7102
42	Knowledge and understanding that vacuum and partial pressure atmospheres must be sufficient to avoid contamination or degradation of any part surface which will not have surface material removed after heat treatment. Also, that there are cold leak rate requirements and specific ways to determine those rates.	7	GEN	AMS2773, AMS2774, AMS2769, AC7102
43	Knowledge and understanding that a mixture of argon and helium may be used to achieve partial pressures whenever necessary to avoid surface alloy depletion by sublimation of high vapor pressure elements such as aluminum and chromium.	7	GEN	AMS2773, AMS2774
44	Knowledge and understanding that cooling may be accelerated by back-filling with argon or helium, nitrogen or combinations thereof conforming to applicable specifications and dew point requirements.	7	GEN	AMS2773, AMS2774
45	Knowledge and understanding that exothermic atmospheres, when allowed, shall be produced by the combustion of fuel gas in air, shall be neutral to slightly reducing with respect to the parts being treated, and shall be sufficiently low in sulfur content to avoid contamination or degradation of any part surfaces which will not have surface material removed after heat treatment	7	GEN	AMS2773, AMS2774
46	**Auxiliary Equipment** Knowledge and understanding that fixtures, jigs, hangers, trays, racks, etc. shall not cause contamination of the surface of parts and shall not reduce the heating, cooling, or quenching rates below those required for proper heat treatment.	7	GEN	AMS2773, AMS2774

47	**Racking** Knowledge and understanding that except for small parts, parts shall be racked to ensure uniform heating and cooling throughout the load. Parts shall not be nested unless tests with load thermocouples have demonstrated that the arrangement will not affect uniformity of heating and cooling and will not reduce cooling rate below minimum requirements.	7	GEN	AMS2773, AMS2774, AC7102
48	Knowledge and understanding that small parts may be racked or heated and soaked in baskets or in a continuous furnace. Parts shall not be nested. Maximum thickness of layers, and minimum spacing between layers, shall be 1 inch (25 mm).	7	GEN	AMS2773, AMS2774, AC7102
49	**Cooling** Knowledge and understanding that cooling shall be provided to cool parts according to the heat treatment requirements specified for each alloy. Acceptable cooling media may include air, oil, water, water-polymer solutions, salt, brine (nominally 10% by weight NaCl), argon, helium, hydrogen, nitrogen, and vacuum. In addition, the medium selected shall not contaminate or degrade any part surface which will not be machined after heat treatment.	7	GEN	AMS2773, AMS2774, AC7102
50	Knowledge and understanding that when air cooling (AC) or rapid air cooling (RAC) is specified, cooling media shall be used which will provide protection, if required, to avoid contamination or degradation of finished surfaces. Cooling rates for media other than air shall be achieved that will be equivalent to, or faster than, rates that would be achieved by AC or RAC, as specified.	7	GEN	AMS2773, AMS2774, AC7102
51	Knowledge and understanding that quenching baths shall permit complete immersion of parts and free circulation of the quenchant adjacent to all surfaces of parts. In addition, equipment shall agitate or circulate the quenchant and/or the parts. There may be additional quenchant temperature requirements as well.	7	GEN	AMS2773, AMS2774, AMS2769, AC7102
52	**Cleaning** Knowledge and understanding that prior to heat treatment, parts shall be thoroughly cleaned to remove all foreign material, including greases, oils, inks, pencil marks, and metal particles such as may be produced by machining or straightening operations.	7	GEN	AMS2773, AMS2774, AMS2769, AC7102
53	Knowledge and understanding that after heat treatment parts which have been heat treated in molten salt or cooled in oil, molten salt, brine, or water-polymer solution shall be thoroughly cleaned to remove all residues of these materials	7	GEN	AMS2773, AMS2774, AC7102
54	**Control Instruments** Knowledge and understanding that control instruments shall be set either at the set temperature specified or at the offset temperature based on the last temperature uniformity determination (TUS). The offset temperature shall be within 5 °F (3 °C) for precipitation treatments, and 10 °F (6 °C) for other treatments, of the specified set temperature. The offset temperature shall be selected to optimize the temperature distribution within the furnace so that the highest and lowest temperatures are equidistant from the set temperature.	7	GEN	AMS2773, AMS2774, AC7102, AC7102/8
55	Knowledge and understanding that the posting of the offset temperature shall include, or consist of, a statement of both the “desired” temperature and the corresponding “set” temperature; e.g., “When 1000 °F is desired, set at 1004 °F.”	7	GEN	AMS2773, AMS2774, AC7102/8
56	**Start of Soaking Time** Knowledge and understanding that for batch furnaces, soaking time starts when all furnace temperature sensors reach the specified set or offset temperature. If load thermocouples are used, soaking start time depends the applicable specification.	7	GEN	AMS2773, AMS2774, AC7102
57	Knowledge and understanding that for vacuum furnaces, unless otherwise specified (UOS) by the cognizant engineering organization, load thermocouples shall be used to determine the start of soaking time except when this is impractical, such as with two or three chamber oil or gas quench furnaces, in which case tests shall be conducted to establish the correct heat-up time for the load. Once a load has been qualified with load thermocouples, subsequent loads may be run without load thermocouples provided records detailing the number of parts in the first qualified load are kept on file, and provided that subsequent loads have an equal or fewer number of similar parts in the load, and the distribution of the parts is the same as the distribution in the first load.	7	GEN	AMS2773, AMS2774, AC7102
58	Knowledge and understanding that continuous furnaces shall be operated so that all part temperatures are within the allowed range (the range described by the specified set temperature and the tolerance specified in the temperature uniformity requirements of the governing specification) for the specified time. Conformance to this requirement shall be verified by temperature uniformity tests, performed at the frequency specified in AMS2750, using load thermocouples, in a load representative of the weight and traverse speed of the parts to be heat treated.	7	GEN	AMS2773, AMS2774, AC7102, AMS2750
59	**Straightening** Knowledge and understanding that straightening after heat treat shall be performed only when the straightening procedure and any subsequent stress-relief are approved by the cognizant engineering organization.	7	GEN	AMS2773, AMS2774, AC7102
60	**Surface Contamination** Knowledge and understanding that the heat treatment processor shall assume surfaces will not be machined after heat treatment unless the minimum amount of surface material to be removed after heat treatment is determined.	7	GEN	AMS2773, AMS2774, AC7102
61	Knowledge and understanding that surfaces of parts which are not to have surface material removed after heat treatment shall have no carburization, sulfidation, nitriding, nor intergranular oxidation resulting from the heat-treating operations;	7	GEN	AMS2773, AMS2774, AC7102

62	Knowledge and understanding that evidence of surface contamination shall be a continuous or general condition in the microstructure at the surface determined by metallurgical examination at approximately 500X magnification, of etched specimens prepared in accordance with ASTM E3. The chord method described in ARP1820 may be used to enhance this examination.	7	GEN	AMS2773, AMS2774, AC7102, ASTM E3, ARP1820
63	Knowledge and understanding that on surfaces which are to have material removed after heat treatment, the depth of carburization, sulfidation, nitriding, or intergranular oxidation resulting from the heat treating shall not exceed the depth of surface material to be removed in finishing the part.	7	GEN	AMS2773, AMS2774, AC7102
64	Knowledge and understanding that surface contamination is a periodic test and shall be performed monthly, with some exceptions, on each furnace, for each type of atmosphere used in each furnace when the heat-treating temperature is above 1550 °F (843 °C) or 1600 °F (871 °C), depending on the specification, and parts have less than 0.008 inch (0.20 mm) finishing stock on any surface	7	GEN	AMS2773, AMS2774, AC7102
65	Knowledge and understanding that periodic surface contamination tests are not required on vacuum furnaces operating under 10 microns (µm) pressure except whenever parts which have less than 0.008 inch (0.20 mm) finishing stock on any surface, and which have been heat treated at a temperature above 1550 °F (843 °C) or 1600 °F (871 °C), depending on the specification, show abnormal surface discoloration after heat treatment.	7	GEN	AMS2773, AMS2774, AC7102
66	Knowledge and understanding that the cognizant engineering organization is responsible for defining “abnormal surface discoloration”.	7	GEN	AMS2773, AMS2774, AC7102
67	Knowledge and understanding that surface contamination is a preproduction test when heat treating temperature is above 1550 °F (843 °C) or 1600 °F (871 °C), depending on the specification or alloy form, and parts have less than 0.008 inch (0.20 mm) finishing stock on any surface, although there may be other instances which require preproduction testing as well.	7	GEN	AMS2773, AMS2774, AC7102
68	Knowledge and understanding that preproduction tests shall be performed prior to, or on, the first production lot heat treated in each type of furnace equipment and for each type of atmosphere to be used in each furnace type.	7	GEN	AMS2773, AMS2774, AC7102
69	Knowledge and understanding that for preproduction surface contamination tests, sample material of the same alloy representing the parts shall be supplied to the heat treatment processor by purchaser, or destructive testing of a part shall be authorized by purchaser.	7	GEN	AMS2773, AMS2774, AC7102
70	Knowledge and understanding that for periodic surface contamination tests, sample material shall be prepared by machining or grinding at least one surface prior to furnace exposure. The test samples shall be exposed to the heat-treating atmosphere at the maximum temperature, or higher, and for the maximum time, or longer, required for heat treating the production parts. The sample material shall be either the same alloy as the production parts to be heat treated or shall be an alloy selected from the appropriate table in either AMS2773 or AMS2774.	7	GEN	AMS2773, AMS2774, AC7102
71	**Hardness** Knowledge and understanding that if hardness requirements are not specified on the engineering drawing or purchase order, age-hardening alloys shall meet the hardness specified appropriate table in either AMS2773 or AMS2774.	7	GEN	AMS2773, AMS2774, AC7102/5
72	Knowledge and understanding that if hardness is not specified on the engineering drawing or purchase order or in the appropriate table in AMS2773 or AMS2774, then parts shall conform to the hardness requirements of the applicable material specification when the material specification contains hardness requirements for the heat treatment condition represented by the parts.	7	GEN	AMS2773, AMS2774, AC7102/5
73	Knowledge and understanding that hardness shall be determined in accordance with ASTM E10, ASTM E18, or ASTM E384, as applicable. Unless otherwise specified by the cognizant quality assurance organization, hardness tests shall be performed on the thickest section of the part which is practical to test and where the test will not be detrimental to the function of the part.	7	GEN	AMS2773, AMS2774, AC7102/5, ASTM E10, ASTM E18, ASTM E384
74	Knowledge and understanding that for age-hardenable alloys, if hardness requirements are specified, hardness is an acceptance test and shall be performed on each part or lot according to a sampling plan, depending on the specification requirements.	7	GEN	AMS2773, AMS2774, AC7102/5
75	Knowledge and understanding that hardness tests shall be performed nondestructively on parts except when the parts are not of suitable size or shape, or when the test will be detrimental to the function of the part; in these cases, suitable sample material which represents the parts shall be supplied to the heat treatment processor by purchaser for hardness tests.	7	GEN	AMS2773, AMS2774, AC7102/5
76	**SPECIFIC REQUIREMENTS RELATED TO HEAT TREATMENT OF HEAT RESISTING CAST PRODUCTS TO AMS2773 (ONLY APPLICABLE IF PROCESSING TO AMS2773)**			Paragraph references are for AMS2773 unless otherwise specified
77	Knowledge and understanding that AMS2773 specifies the engineering requirements for heat treatment, by part fabricators (users) or their vendors or subcontractors, of parts made of cast nickel or cobalt alloys and of fabricated assemblies in which cast nickel or cobalt alloys are the primary structural components. It is not intended to provide requirements for heat treating operations that are a responsibility of the casting supplier in meeting the requirements of the casting commodity specification.	7	GEN	1.1
78	Knowledge and understanding that detailed heat treating instructions are specified for the age-hardenable (precipitation-hardenable) and non-age-hardenable alloys listed in paragraph 8.2 /Table 7 of AMS2773. However, AMS2773 also may be used for alloys other than those listed in 8.2 provided that temperatures, soaking times, and cooling requirements are specified by the cognizant engineering organization.	7	GEN	1.2.1

<table>
<tr><td>79</td><td>Knowledge and understanding of the alloys listed in table 7:

<table>
<tr><th>UNS No</th><th>Most Common Manufacturer's Trademark or Common Trade Name</th><th>Reference AMS</th><th>Reference Table for Heat Treatment Requirements</th></tr>
<tr><td>N06002</td><td>Alloy X</td><td>AMS5390</td><td>1</td></tr>
<tr><td>N26625 N26010</td><td>INCONEL® Alloy 625
INCONEL® Alloy 625</td><td>AMS5401
AMS5402</td><td>1</td></tr>
<tr><td>N07041</td><td>Rene'® 41 Alloy</td><td>AMS5399</td><td>3</td></tr>
<tr><td>N07500</td><td>UDIMET® Alloy 500</td><td>AMS5384</td><td>3</td></tr>
<tr><td>N07713</td><td>INCONEL® Alloy 713C</td><td>AMS5377</td><td>3</td></tr>
<tr><td>N07718</td><td>INCONEL® Alloy 718</td><td>AMS5383</td><td>3</td></tr>
<tr><td>N10001</td><td>Alloy B</td><td>AMS5396</td><td>1</td></tr>
<tr><td>N10002</td><td>Alloy C</td><td>AMS5388</td><td>1</td></tr>
<tr><td>N13246</td><td>MAR-M® 246</td><td>None</td><td>3</td></tr>
<tr><td>-</td><td>MAR-M® 247</td><td>None</td><td>3</td></tr>
<tr><td>-</td><td>IN-738 C & LC</td><td>AMS5410</td><td>3</td></tr>
<tr><td>R30031</td><td>Stellite® Alloy 31</td><td>AMS5382</td><td>1</td></tr>
</table>
INCONEL® is a registered Trademark of the Inco family of companies. Stellite® is a registered Trademark of Stoody Deloro Stellite, Inc. Rene'® is a registered Trademark of Teledyne. UDIMET® is a registered Trademark of Special Metals Corporation. MAR-M® is a registered Trademark of Lockheed Martin Corporation.</td><td>7</td><td>GEN</td><td>8.2</td></tr>
<tr><td>80</td><td>Knowledge and understanding that temperature uniformity (tolerance) shall be in accordance with AMS2750.</td><td>7</td><td>GEN</td><td>3.1.2.1</td></tr>
<tr><td>81</td><td>Knowledge and understanding that the temperature tolerance for heat treating per material specifications AMS5383, AMS5384 and AMS5399 may not be the same as specified in AMS2773</td><td>7</td><td>GEN</td><td>AMS2773 3.1.2.1, AMS5383 3.5, AMS5384 3.5, AMS5399 3.5</td></tr>
<tr><td>82</td><td>Knowledge and understanding that in addition to the common requirements for control systems in AMS2773 and AMS2774, AMS2773 allows the offset temperature to be programmed into the control system when a programmable system is in use instead of having it posted on the instrument.</td><td>7</td><td>GEN</td><td>AMS2773 3.2.3, AMS2774 3.2.3, AC7102 12.4, AC7102/8 6.6</td></tr>
<tr><td>83</td><td>Heat Treatment
Knowledge and understanding that heat treatment shall be performed as specified in paragraph 3.2.4 and subparagraphs unless an alternate treatment has been specified by purchase order or by the cognizant engineering organization.</td><td>7</td><td>GEN</td><td>3.2.4</td></tr>
<tr><td>84</td><td>Knowledge and understanding of that the specified solution and stress-relief treatment for the non-age-hardening alloys shall be performed in accordance with Table 1 and that the soaking times from Table 2 shall be used when not specified in Table 1.</td><td>7</td><td>GEN</td><td>3.2.4.1</td></tr>
<tr><td>85</td><td>Knowledge and understanding that the specified homogenization, solution, precipitation, and stress relief treatments for age-hardening alloys shall be performed in accordance with Table 3.</td><td>7</td><td>GEN</td><td>3.2.4.1</td></tr>
<tr><td>86</td><td>Knowledge and understanding that tolerances for the soaking times for both aging-hardening and non-age-hardening alloys shall be as shown in Table 4.</td><td>7</td><td>GEN</td><td>3.2.4.1</td></tr>
<tr><td>87</td><td>Knowledge and understanding that soaking time tolerance for heat treating per material specifications AMS5383, AMS5384 and AMS5399 may not be the same as specified in AMS2773</td><td>7</td><td>GEN</td><td>AMS2773 3.2.4.1, AMS5383 3.5, AMS5384 3.5, AMS5399 3.5</td></tr>
<tr><td>88</td><td>Knowledge and understanding that age-hardening alloys parts shall be heat treated to the precipitation hardened condition. When a stabilization heat treatment is also specified for age-hardening alloys, the stabilization treatment shall be applied to solution treated parts before precipitation treatment. With the exception of the specific alloys this is also true for alloys in AMS2774.</td><td>7</td><td>GEN</td><td>3.2.4.1.1, AMS2774 3.2.4.1.1</td></tr>
<tr><td>89</td><td>Knowledge and understanding that where temperature ranges are specified in Tables 1 (non-age-hardening) and 3 (age-hardenable), it is the responsibility of the heat treatment processor to select, for each heat of material, the specific temperature and time, within the ranges specified, which will produce heat treated parts meeting all technical requirements of the drawing and applicable material specification. With the exception of the specific alloys this is also true for alloys in AMS2774.</td><td>7</td><td>GEN</td><td>3.2.4.1.2, AMS2774 3.2.4.1.2</td></tr>
<tr><td>90</td><td>Knowledge and understanding that heat treatments of cast parts made of alloys not covered by AMS2773, shall be as specified by the purchase order or the cognizant engineering organization. This information shall include the heat treatment name (e.g., solution, precipitation), the set temperature, the soaking time, and the quenchant or cooling medium.</td><td>7</td><td>GEN</td><td>3.2.4.2</td></tr>
<tr><td>91</td><td>Knowledge and understanding that heat treatment of cast parts fabricated with wrought alloys in a single assembly shall be the heat treatment designated by AMS2773 for the cast alloy.</td><td>7</td><td>GEN</td><td>3.2.4.3</td></tr>
<tr><td>92</td><td>Knowledge and understanding that for batch furnaces using load thermocouples, the soaking time starts when the coldest load thermocouple reaches the required temperature minus the appropriate tolerance.</td><td>7</td><td>GEN</td><td>3.2.5.1</td></tr>
<tr><td>93</td><td>Knowledge and understanding that not more than two re-heat-treatment cycles or portions thereof shall be performed.</td><td>7</td><td>GEN</td><td>3.2.7</td></tr>
</table>

94	Knowledge and understanding that for age-hardenable alloy hardness acceptance, hardness testing shall be performed on each part unless a sampling plan is authorized by the cognizant organization.	7	GEN	4.3.1
95	Knowledge and understanding that surface contamination is a periodic test and shall, unless otherwise authorized by the cognizant organization, be performed monthly on each furnace, except as provided in paragraph 4.3.2.1, for each type of atmosphere used in each furnace when heat treating temperature is above 1600 °F (871 °C) and parts have less than 0.008 inch (0.20 mm) finishing stock on any surface.	7	GEN	4.3.2
96	Knowledge and understanding that periodic surface contamination tests are not required on vacuum furnaces operating under 10 microns (µm) pressure except as provided in 4.3.2.2.	7	GEN	4.3.2.1
97	Knowledge and understanding that surface contamination tests shall also be performed whenever parts which have less than 0.008 inch (0.20 mm) finishing stock on any surface, and which have been heat treated at a temperature above 1600 °F (871 °C), show abnormal surface discoloration after heat treatment.	7	GEN	4.3.2.2
98	Knowledge and understanding that surface contamination is a preproduction test when heat treating temperature is above 1600 °F (871 °C) and parts have less than 0.008 inch (0.20 mm) finishing stock on any surface.	7	GEN	4.3.3
99	**SPECIFIC REQUIREMENTS RELATED TO HEAT TREATMENT OF HEAT RESISTING WROUGHT PRODUCTS TO AMS2774 (ONLY APPLICABLE IF PROCESSING TO AMS2774)**			Paragraph references are for AMS2774 unless otherwise specified
100	Knowledge and understanding that AMS2774 specifies the engineering requirements for heat treatment, by part fabricators (users) or their vendors or subcontractors, of parts made of wrought nickel or cobalt alloys, of raw materials during fabrication, and of fabricated assemblies in which wrought nickel or cobalt alloys are the primary structural components.	7	GEN	1.1
102	Knowledge and understanding that detailed heat treating instructions are specified for the age-hardenable (precipitation-hardenable) and non-age-hardenable alloys listed in paragraph 8.2 /Table 9 of AMS2774. However, AMS2774 also may be used for alloys other than those listed in 8.2 provided that temperatures, soaking times, and cooling requirements are specified by the cognizant engineering organization.	7	GEN	1.2.1

<table>
<tr><td>103</td><td>Knowledge and understanding of the alloys listed in table 9:
<table><tr><th>UNS No.</th><th>Most Common Manufacturer's Trademark or Common Trade Name</th><th>Reference AMS</th></tr><tr><td>N02201</td><td>Nickel 201</td><td>5553</td></tr><tr><td>N05500</td><td>MONEL® Alloy K-500</td><td>4676</td></tr><tr><td>N06002</td><td>HASTELLOY® X Alloy</td><td>5536, 5587, 5588, 5754</td></tr><tr><td>N06075</td><td>NIMONIC® Alloy 75</td><td>--</td></tr><tr><td>N06230</td><td>HAYNES® 230™ Alloy</td><td>5878, 5891</td></tr><tr><td>N06600</td><td>INCONEL® Alloy 600</td><td>5540, 5580, 5665</td></tr><tr><td>N06601</td><td>INCONEL Alloy 601</td><td>5870, 5715</td></tr><tr><td>N06617</td><td>INCONEL Alloy 617</td><td>5887, 5888, 5889</td></tr><tr><td>N06625</td><td>INCONEL Alloy 625</td><td>5581, 5599, 5666</td></tr><tr><td>N07001</td><td>Waspaloy ® Alloy</td><td>5544, 5586, 5706, 5708</td></tr><tr><td>N07041</td><td>Rene' 41® Alloy</td><td>5545, 5712</td></tr><tr><td>N07080</td><td>NIMONIC Alloy 80A</td><td>--</td></tr><tr><td>N07090</td><td>NIMONIC Alloy 90</td><td>--</td></tr><tr><td>N07263</td><td>NIMONIC Alloy 263</td><td>5872, 5886</td></tr><tr><td>N07500</td><td>UDIMET® Alloy 500</td><td>--</td></tr><tr><td>N07718</td><td>INCONEL Alloy 718</td><td>5589, 5590, 5596, 5597,</td></tr><tr><td>N07722</td><td>INCONEL Alloy 722</td><td>5664</td></tr><tr><td>N07750</td><td>INCONEL Alloy X-750</td><td>5541, 5714</td></tr><tr><td>N08800</td><td>INCOLOY® Alloy 800</td><td>5542, 5582, 5583, 5598,</td></tr><tr><td>N08810</td><td>INCOLOY Alloy 800HT</td><td>5670, 5671, 5698, 5747</td></tr><tr><td>N08825</td><td>INCOLOY Alloy 825</td><td>5766, 5871</td></tr><tr><td>N09706</td><td>INCONEL Alloy 706</td><td>--</td></tr><tr><td>N09901</td><td>INCOLOY Alloy 901</td><td>--</td></tr><tr><td>N09902</td><td>NI-SPAN-C® Alloy 902</td><td>5605, 5606, 5701, 5702</td></tr><tr><td>N09979</td><td>D 979 Alloy</td><td>5660, 5661</td></tr><tr><td>N10003</td><td>HASTELLOY N Alloy</td><td>5221, 5223, 5225</td></tr><tr><td>N10004</td><td>HASTELLOY W Alloy</td><td>5746</td></tr><tr><td>N10276</td><td>HASTELLOY C-276 Alloy</td><td>5607, 5771</td></tr><tr><td>N10665</td><td>HASTELLOY B-2 Alloy</td><td>5755</td></tr><tr><td>N13017</td><td>Astroloy® M</td><td>--</td></tr><tr><td>N13020</td><td>UDIMET Alloy 700</td><td>--</td></tr><tr><td>N19909</td><td>INCOLOY Alloy 909</td><td>5882</td></tr><tr><td>R30003</td><td>ELGILOY® Alloy</td><td>5846</td></tr><tr><td>R30006</td><td>Stellite® Alloy 6</td><td>5884, 5892, 5893</td></tr><tr><td>R30035</td><td>MP-35N® Alloy</td><td>5833, 5876</td></tr><tr><td>R30159</td><td>MP159® Alloy</td><td>5894</td></tr><tr><td>R30155</td><td>MULTIMET® Alloy (N-155)</td><td>5844</td></tr><tr><td>R30188</td><td>HAYNES 188 Alloy</td><td>5842</td></tr><tr><td>R30556</td><td>HAYNES 556™ Alloy</td><td>5532, 5585, 5769</td></tr><tr><td>R30605</td><td>HAYNES 25 Alloy (L-605)</td><td>5608, 5772
5874, 5877
5537, 5759</td></tr></table>
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<tr><td>104</td><td>Knowledge and understanding that temperature uniformity (tolerance) shall be as shown in Table 1 and tested in accordance with AMS2750</td><td>7</td><td>GEN</td><td>3.1.2.1</td></tr>
<tr><td>105</td><td>Knowledge and understanding that in addition to quenching requirements that are common to both AMS2773 and AMS2774, the volume of the quenchant and the capabilities of auxiliary equipment shall be sufficient to maintain the quenchant temperatures shown in Table 2 of AMS2774 for various quenchants.</td><td>7</td><td>GEN</td><td>AMS2773 3.1.4.1, AMS2774 3.1.4.1, AC7102 9.10.1, 12.3.4, 13.3.4</td></tr>
<tr><td>106</td><td>Heat Treatment
Knowledge and understanding that heat treatment shall be performed as specified in paragraph 3.2.4 and subparagraphs unless an alternate treatment has been specified by purchase order or by the cognizant engineering organization.</td><td>7</td><td>GEN</td><td>3.2.4</td></tr>
<tr><td>107</td><td>Knowledge and understanding that the specified solution, annealing, stress-relief, and stabilization treatment for the non-age-hardening alloys listed in 8.2 shall be performed in accordance with Table 3. Soaking times from Table 5 shall be used when soaking times are not specified in Table 3.</td><td>7</td><td>GEN</td><td>3.2.4.1</td></tr>
</table>

108	Knowledge and understanding that the specified solution, stabilization, precipitation, annealing, and stress relief treatments for age- hardening alloys listed in 8.2 shall be performed in accordance with Table 4.	7	GEN	3.2.4.1
109	Knowledge and understanding that the tolerances for the soaking times for both age-hardening and non-age-hardening alloys shall be as shown in Table 6.	7	GEN	3.2.4.1
110	Knowledge and understanding that parts made of age-hardening alloys shall be heat treated to the precipitation hardened condition. When a stabilization heat treatment is also shown for the alloy in Table 4, stabilization shall be applied to solution treated parts before precipitation treatment. With the exception of the specific alloys this is also true for alloys in AMS2773.	7	GEN	3.2.4.1.1, AMS2773 3.2.4.1.1
111	Knowledge and understanding that where temperature ranges are specified in Tables 3 (non-age-hardendable) and 4(age-hardenable), it is the responsibility of the heat treatment processor to select, for each lot of material, the specific temperature and time, within the ranges specified, which will produce heat treated parts meeting all technical requirements of the drawing and applicable material specification. With the exception of the specific alloys this is also true for alloys in AMS2773.	7	GEN	3.2.4.1.2, AMS2773 3.2.4.1.2
112	Knowledge and understanding that heat treatments for alloys covered in AMS2774 may or may not match the minimum soak times, tolerance on soak times, cooling rates, or set temperature of the relevant material specifications. The relevant material specification also may not specify all heat treatment parameters or specify additional heat treat requirements.	7	GEN	Tables 3,4,5 & 6
113	Knowledge and understanding that heat treatments for alloys not covered in AMS2774 and for assemblies of cast alloys fabricated with wrought forms of the nickel or cobalt alloys in which the cast material is the primary structural component, shall be as specified by the purchase order or by the cognizant engineering organization. This information shall include the heat treatment name (e.g., annealing, precipitation), the set temperature, the soaking time, and quenchant or cooling medium.	7	GEN	3.2.4.2
114	Knowledge and understanding that if wrought alloys covered by AMS2774 are fabricated with castings into a single assembly in which the wrought material is the primary structural component, the heat treatment designated for the wrought material shall be used for the assembly.	7	GEN	3.2.4.3
115	Knowledge and understanding that for batch furnaces using load thermocouples, the soaking time starts when the part temperature reaches the temperature described by the set or offset temperature minus the appropriate tolerance.	7	GEN	3.2.5.1
116	Knowledge and understanding that when required by the cognizant engineering organization, parts shall conform to tensile property and stress rupture requirements of the applicable material specification when the material specification contains requirements for the heat treatment condition represented by the parts.	7	GEN	3.4.3
117	Knowledge and understanding that tensile testing, when required by the cognizant engineering organization, shall be in accordance with ASTM E8/E8M, or ASTM E21, as applicable.	7	GEN	3.5.3 ASTM E21, ASTM E8/E8M
118	Knowledge and understanding that stress rupture testing, when required by the cognizant engineering organization, shall be in accordance with ASTM E139 or ASTM E292, as applicable.	7	GEN	3.5.4 ASTM E292 ASTM E139
119	Knowledge and understanding that for age-hardenable alloy hardness acceptance, hardness testing shall be performed on each lot according to a sampling plan which conforms to the heat treatment processor's shop procedures, unless otherwise specified by the cognizant engineering or quality assurance organization.	7	GEN	4.3.1
120	Knowledge and understanding that surface contamination is a periodic test and shall be performed monthly on each furnace, except as provided in 4.3.2.1, for each type of atmosphere used in each furnace when (a) heat treating temperature is above 1550 °F (843 °C) and parts have less than 0.008 inch (0.20 mm) finishing stock on any surface or (b) parts are made of an alloy which Table 3 or Table 4 specifies shall require a protective atmosphere for heat treatments at lower temperatures and parts have any surface which will not have surface material removed after heat treatment.	7	GEN	4.3.2
121	Knowledge and understanding that periodic surface contamination tests are not required on vacuum furnaces operating under 10 microns (10 µm) pressure except as provided in 4.3.2.2.	7	GEN	4.3.2.1
122	Knowledge and understanding that surface contamination tests shall also be performed whenever parts which have less than 0.008 inch (0.20 mm) finishing stock on any surface, and which have been heat treated at a temperature above 1550 °F (843 °C), show abnormal surface discoloration after heat treatment.	7	GEN	4.3.2.2
123	Knowledge and understanding that surface contamination is a preproduction test when (a) heat treating temperature is above 1550 °F (843 °C) and parts have less than 0.008 inch (0.20 mm) finishing stock on any surface or (b) parts are made of alloys which Table 3 or Table 4 specifies shall require a protective atmosphere for heat treatments at temperatures below 1550 °F (843 °C) and parts have any surface which will not have surface material removed after heat treatment.	7	GEN	4.3.3
124	Knowledge and understanding that when specified by the cognizant engineering or quality assurance organization, hardness, tensile, and stress-rupture shall also be preproduction tests and shall be performed prior to, or on, the first production lot heat treated in each type of furnace equipment and for each type of atmosphere used in each furnace type.	7	GEN	4.3.3.1
125	Knowledge and understanding that when tensile or stress rupture properties are required, sample material which represents the parts to be heat treated and is a size suitable for obtaining the test specimens required, shall be supplied to the heat treatment processor by purchaser, or	7	GEN	4.4.2

	destructive testing of a part shall be authorized by purchaser.			
	SKILLS: Defined within these rolls describes the range of skills. The skills required to perform a particular special process task			
126	Capable of understanding, interpreting and complying with various customer requirements for precedence of documents	7	GEN	General Industry
127	Capable of understanding, interpreting and complying with various customer requirements for how to handle documents which have been revised, superseded or canceled	7	GEN	General Industry
128	Ability to interpret specification requirements and customer flow-down requirements	7	GEN	General Industry
129	Has knowledge and understanding to be able to recognize conflicts within customer requirements and deviations from specifications and to assure that they are resolved prior to issue of final planning	7	GEN	General Industry
130	Capable of generating clear and complete work instructions consistent with company practices and higher level quality requirements for general and specific procedures, operator training and approvals.	7	GEN	General Industry
131	Capable of reviewing and approving records required to demonstrate compliance with customer requirements including: • Set temperature • Soak Time • Quench delay time • Quench concentration • Quench temperature before and after quench • Cooling rate • Heating rate (as applicable) • Leak rate • Dew point • Periodic and lot acceptance test requirements and results	7	GEN	General Industry
132	Capable of evaluating the potential product impact of deviation from process parameters or other events which may have a negative impact on product quality	7	GEN	General Industry
133	Basic understanding of the operation, maintenance and calibration requirements for equipment used for testing, evaluation and acceptance or the specifications used for such testing, evaluation and acceptance (e.g., tensile testing, hardness)	7	GEN	General Industry
134	Basic understanding of pyrometry testing requirements including instrument calibrations, SAT and TUS testing	7	GEN	General Industry
135	Capable of reviewing calibration, SAT and TUS reports when required	7	GEN	General Industry
136	Capable of documenting an on-going plan for pyrometry compliance at site level per AMS2750	7	GEN	General Industry
137	Capable of providing timely notification of calibration requirements	7	GEN	General Industry
138	Capable of conducting periodic self-audits	7	GEN	General Industry
139	Capable of conducting internal personal qualification exam in order to comply with HT BoK ERB requirements	7	GEN	General Industry
140	Understands the safety concerns involved with heat treatment including the need to include in planning instructions the proper use of handling tools and personal protective equipment	7	GEN	General Industry
141	Understands precautions to be taken when handling thermocouples to avoid damage	7	GEN	General Industry
142	Understanding of the Preventive Maintenance Program and how it is incorporated into planning	7	GEN	General Industry
143	**Sequencing** Has an appropriate understanding of where heat resisting alloy heat treating and contingent processes fall in the sequence of events and how to reflect that in planning so that operators can also understand it.	7	GEN	General Industry
	PERSONAL ATTRIBUTES: Are statements that will enable judgment of the person's personal attributes			
144	Willingness to train and mentor co-workers	**NA**	**NA**	
145	Good communicator at all levels, especially with respect to clear written instructions	**NA**	**NA**	
146	Understands and responds positively when operators challenge work instructions that do not appear to conform to specification or customer requirements	**NA**	**NA**	
147	Personal integrity	**NA**	**NA**	
148	Attentive to details	**NA**	**NA**	
	EXPERIENCE: Are the minimum experience requirement expected to demonstrate their competence.			
149	NOTE: ARP 1962 (Aerospace Recommended Practice -Training and Approval of Heat-Treating Personnel) requires that suppliers have a documented personnel training program including documented training to an established outline and initial and periodic evaluation of the competency. Evaluation to the requirements of this program should be used in completing this section. The following are recommendations and would be superseded by the supplier's specific documented program. The supplier program may define alternative criteria, waivers and equivalences.	**NA**	**NA**	
150	**Recommended Minimum Classroom Training** Heat Treatment – 80 hours; Paperwork – 40 hours; Test, Inspection, Maintenance – 40 hours or Continuing Education Unit (CEU) Heat Treatment – 8 hours; Paperwork – 4 hours; Test, Inspection, Maintenance – 40 hours or Heat Cap Lessons (Heat Treating Certificate of Educational Achievement Program) Heat Treatment – 20 hours; Paperwork – 10 hours; Test, Inspection, Maintenance – 10 hours	**NA**	**NA**	ARP1962, Table 1

<table>
<tr><td>151</td><td>Suggested Minimum On-The-Job Training Requirements

<table><tr><th>Material or Process Category (1)</th><th>Minimum Months of Total On-The-Job Training (2)(3)</th></tr><tr><td>Air atmosphere</td><td>9</td></tr><tr><td>Salt bath</td><td>9</td></tr><tr><td>Controlled atmosphere</td><td>12</td></tr><tr><td>Inert gas atmosphere</td><td>12</td></tr><tr><td>Vacuum</td><td>12</td></tr><tr><td>Nickel and cobalt alloys</td><td>12</td></tr></table>NOTES:
(1) If two or more categories apply to the same job, the more stringent category applies.
(2) Training in multiple alloys and processes may be covered concurrently providing substantial time is devoted to each category and function.
(3) On-the-job training for various categories may run concurrently; however, all categories must be thoroughly covered.</td><td>NA</td><td>NA</td><td>ARP 1962, Table 2</td></tr>
<tr><td>152</td><td>Testing and Evaluation
Initial and periodic evaluation of personnel is required. The type of frequency of the evaluation shall be determined by the company employing the individual, except that each individual shall be evaluated at least every 5 years. This shall be defined in a formal written program. Personnel shall be evaluated as necessary to ensure adequate knowledge of those functions, materials, and processes for which they are responsible and will be approved. Evaluation may consist of any combination of written or oral examination or testing, structured checklist review, employee performance appraisal, company employee specific audit program or other appropriate methodology defined in the formal written program.</td><td>NA</td><td>NA</td><td>ARP 1962 3.3.1.4, 3.3.1.4.1, 3.3.1.4.2</td></tr>
<tr><td></td><td>NON-SPECIAL PROCESS RELATED REQUIREMENTS:
Defined within these rolls are other general or pre-requisite needed</td><td></td><td></td><td></td></tr>
<tr><td>153</td><td>Must have a thorough understanding of general Quality Systems (AS9100) or equivalent.</td><td>7</td><td>GEN</td><td>General Industry</td></tr>
<tr><td>154</td><td>Must have a thorough understanding of customer specific requirements.</td><td>7</td><td>GEN</td><td>General Industry</td></tr>
<tr><td>155</td><td>Must have a thorough understanding of Control of Nonconformance for equipment and product including containment, customer notification and disposition.</td><td>7</td><td>GEN</td><td>General Industry</td></tr>
</table>

8. DOCUMENT REVISION HISTORY

REVISION DATE	SUMMARY
4 December 2019	Editorial revision to update program name from eQualified to PRI Qualification[SM.]

ADDENDUM 1

LIST OF INTERNATIONAL STANDARDS & REFERENCE DOCUMENTS FOR HEAT TREATING

SPECIAL PROCESS	DOCUMENT TITLE	DOCUMENT NUMBER
Heat Treating	Nadcap Audit Criteria for Heat Treating	AC7102 H
Heat Treating	Nadcap Audit Criteria for Heat Treating Pyrometry	AC7102/8 N/A
Heat Treating	Nadcap Audit Criteria for Hardness and/or Conductivity Testing for Heat Treating	AC7102/5 C
Heat Treating	SAE Aerospace Material Specification - Pyrometry	AMS2750 E
Heat Treating	SAE Aerospace Material Specification - Heat Treatment of Parts in a Vacuum	AMS2769 B
Heat Treating	SAE Aerospace Material Specification - Heat Treatment Cast Nickel Alloy and Cobalt Alloy Parts	AMS2773 E
Heat Treating	SAE Aerospace Material Specification - Heat Treatment Wrought Nickel Alloy and Cobalt Alloy Parts	AMS2774 E
Heat Treating	SAE Aerospace Material Specification - Nickel Alloy, Corrosion and Heat-Resistant, Investment Castings (Inconel 718)	AMS5383 E
Heat Treating	SAE Aerospace Material Specification - Alloy Castings, Investment, Corrosion and Heat Resistant (Udimet Alloy 500)	AMS5384 E
Heat Treating	SAE Aerospace Material Specification - Nickel Alloy, Corrosion and Heat-Resistant, Investment Castings (Rene' 41 Alloy)	AMS5399 D
Heat Treating	SAE Aerospace Recommended Practice - Training and Approval of Heat Treating Personnel	ARP1962 A
Quality	SAE Aerospace Standard - Quality Management Systems - Requirements for Aviation, Space and Defense Organizations	AS9100 C
Heat Treating	Preparation of Metallographic Specimens	ASTM E3
Heat Treating	Tension Testing of Metallic Materials	ASTM E8/E8M
Heat Treating	Brinell Hardness of Metallic Materials	ASTM E10
Heat Treating	Rockwell Hardness of Metallic materials	ASTM E18
Heat Treating	Elevated Temperature Tension Tests for Metallic Materials	ASTM E21
Heat Treating	Conducting Creep, Creep-Rupture, and Stress Rupture Tests of Metallic Materials	ASTM E139
Heat Treating	Conducting Time-for-Rupture Notch Tension Tests of Materials	ASTM E292
Heat Treating	Knoop and Vickers Hardness of Materials	ASTM E384