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Program Document HTBOK

PD 6103

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BODY OF KNOWLEDGE:

ROLE DESCRIPTION: Planner

SPECIAL PROCESS: Heat Treatment

METHOD: Performance of Stainless and PH Steel Alloys Requirements

All PRI QualificationSM program examinations are created using the applicable PRI QualificationSM 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 QualificationSM Body of Knowledge Review Boards. All BoKs are updated periodically according to the latest revision of PRI QualificationSM 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 QualificationSM program Heat Treat Body of Knowledge Review Board (HT-BoKRB) according to the requirements of PD6100.

This document constitutes the PRI QualificationSM program BoK for Stainless and PH Steels, 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 version 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 QualificationSM program examination candidate preparation
- Heat Treat Examination Review Board (HT-ERB) for the development of PRI QualificationSM program examinations
- Candidates taking PRI QualificationSM program examinations who wish to prepare in advance

2. REFERENCES

PRI QualificationSM 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 Body of Knowledge. For program-specific definitions, please refer to either the PD 6000 or the PRI QualificationSM 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 version of PD 6000 for definitions.

METHOD: A well-defined division of a SPECIAL PROCESS widely recognised 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 Body of Knowledge.

SERVICE PROVIDER: A company or individual that provides a service or product. Service provider is generally used to refer to external or out-sourced (third party) suppliers of services and product although large organizations may have Internal Service Providers for example IT. Examples may include instrument calibration, periodic tests (TUS, SAT), analysis or testing which is outside the capability of internal resources. Service providers may also be suppliers of goods for example thermocouples, pure gases etc.

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 QualificationSM program examination candidates are recommended to read all documents referenced in section 2 of this document.

As stated in PRI QualificationSM program document PD6200, every exam question shall relate directly to and be derived from the information as detailed in the current version of the BoK.

Re-assessment 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 (Owner level only)

5. LEVELS

Descriptors	Level		
	Operator (OP)/ Technician(T) <i>For descriptions, please refer to current version of PD6000</i>	Planner (PL) <i>For descriptions, please refer to current version of PD6000</i>	Owner (OW) <i>For descriptions, please refer to current version of PD6000</i>
Stainless and Precipitation Hardening Steels - Specific Criteria	Basic understanding of the specific requirements for HT of Stainless and Precipitation Hardening steel s –including cleaning , loading ,start and end of soak, atmospheres quenching tempering and Refrigeration	In addition to knowing what the Operator does, the Planner must: be able to interpret Customer requirements and convert them into clear Work Instructions at the appropriate level of Operator understanding Manage HT shop that contracts the service provider and reviews reports. Technician must have higher understanding and be able to conduct and analyze output from TUS/SAT testing.	In addition to knowing what the Operator and Planner do, the Owner must: Manage people that perform the work and evaluate and reviews reports; must have knowledge of “how” to run the testing.
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: Performance of Stainless and PH Steel Alloys Requirements

REFERENCE GUIDELINES: *Addendum 1 is a list of the International Standards and Reference Documents applicable to Heat Treatment Processes*

Row #	COMPETENCE	Weight (1,3,7,10)	Exam Type Written/ Practical	Reference Guidelines (See description above)
	Understands: The basic knowledge of the special processes, methods and tools			
	GENERAL QUALITY SYSTEMS KNOWLEDGE:			
1.	Knowledge and understanding of Aerospace Quality Systems and compliance.	7	GEN	AS9100
2.	Full and complete understanding of internal work instructions as well as industry standards. (see Addendum -1 of this document).	7	GEN	AS9100
3.	Knowledge and understanding of how non-conformance is controlled using tools such as Root Cause Corrective Action and 5 why's.	7	GEN	AS9100
4.	Knowledge and understanding of the need to meet safety compliance requirements as applicable.	10	GEN	AS9100
5.	Knowledge and understanding of the requirements for traceability of calibration to NIST or equivalent agencies for Pyrometry equipment. (In-sourced or Out-sourced).	7	GEN	AS9100
	Parts and Raw Material			
6.	Knowledge and understanding that Parts as covered here by AMS2759/3, AMS2759/4 and AMS2759/5 are usually identified by a customer Part Number and are heat treated, usually to the end use condition to meet the requirements of a drawing, contract, purchase order, or heat treatment specification. At the time of heat treatment, they may resemble Raw Material.	7	GEN	AMS2759/3 AMS2759/4 AMS2759/5
7.	Knowledge and understanding that Raw Material as covered here by AMS-H-6875 includes but is not limited to items such as Sheet, Plate, Wire, Rod, Bar, Forgings or Extrusions. It is usually identified by a Heat, Charge, Batch, or Lot number. It may or may not have been heat treated by the producer	7	GEN	AMS-H-6875
8.	Caution: The primary difference in interpretation of parts versus raw material focuses on Castings and Forgings. Some Primes consider Castings and Forgings as Parts, while others consider them as Raw Material. It is the responsibility of the Supplier to know and demonstrate compliance with the policy of each individual Prime Customer. See the Nadcap Heat Treat Audit Handbook for specific information by Prime			
	PYROMETRY			
9.	Knowledge and understanding of the importance of compliance with all Pyrometry requirements including temperature sensors, instrumentation, thermal equipment, system accuracy tests, and temperature uniformity surveys and including reporting of non-conformance.	7	GEN	AMS2750
10.	Knowledge and understanding of the importance of producing Work Instructions that are in compliance with customer requirements and AMS 2750 related to Pyrometry and furnace class (uniformity) including, sensors (thermocouples) calibration, instrumentation class and type, TUS and SAT.	10	GEN	AMS2750
11.	WARNING NOTE – Heat Treatment of Stainless and PH steels shall not be implemented without a prerequisite understanding of the Pyrometry requirements which affect these materials types.			
	GENERAL METALLURGICAL KNOWLEDGE RELATED TO HEAT TREATING STAINLESS AND PH STEELS (Applicable to all specifications referencing AMS2759 and AMS2769)			
12.	Knowledge and understanding of the metallurgy of stainless and PH steels and the effect this must have on planning.	7	GEN	AMS2759/3, AMS2759/4, AMS2759/5 & AMS-H-6875
13.	The ability to clearly plan Heat Treatment instructions applied to Stainless and PH Steels to provide direction on the following: <ul style="list-style-type: none"> • Annealing • Austenite Conditioning • Carbide Solutioning • Subcritical Annealing • Stress Relieving • Precipitation Heat Treating (Aging) • Preheating • Hardening (Austenitizing and Quenching) 	7	GEN	AMS2759, AMS2769, AMS2759/3, AMS2759/4, AMS2759/5 & AMS-H-6875

	<ul style="list-style-type: none"> • Tempering • Snap Tempering • Solution Treating • Low Temperature / Cryogenic treatments 			
14.	<p>Knowledge and understanding of the definitions and importance of terms applicable to Heat Treatment of Stainless and PH Steels:</p> <ul style="list-style-type: none"> • Set temperature (Set Point) • Heating • Start of soak • Soak time • End of soak • Interruptions • Temper / Cryogenic delay • Protective Coatings • Cleaning • Homogenization (effects on Heat treatment response) 	10	GEN	AMS2759, AMS2769, AMS2759/3, AMS2759/4, AMS2759/5 & AMS-H-6875
15.	<p>Knowledge and understanding of the need to effectively plan and control the use and application of protective compounds to minimize possible contamination from furnace atmospheres. Coatings must be applied according to Customer / Prime requirements, which must be reflected on Work Instructions.</p>	7	GEN	AMS2759, AMS2759/3, AMS2759/4, AMS2759/5 & AMS-H-6875
16.	<p>Knowledge and understanding that planning must reflect the use of equipment and instruments for the heat treatment of stainless and PH steels which must be in accordance with AMS2750 and all customer requirements.</p>	10	GEN	AMS2759, AMS2759/3, AMS2759/4, AMS2759/5 & AMS-H-6875
	Pyrometry			
17.	<p>Knowledge and understanding that planning must address that thermal processing equipment including refrigeration equipment must meet the requirements of AMS2750. Furnaces shall have a minimum of Type D instrumentation.</p>	10	GEN	AMS2759
	Furnace Equipment			
18.	<p>Knowledge and understanding that Furnace Classes are as defined in AMS2750 and are based on the minimum requirements for temperature uniformity. Unless otherwise specified in the applicable specification, planning must specify furnace classes as follows:</p> <ul style="list-style-type: none"> • Furnace for annealing, subcritical annealing, normalizing, hardening, austenitizing or solution treating, and stress relieving shall be Class 5 (+/- 25°F (14°C)) or better • Furnace for tempering or aging/precipitation hardening shall be Class 3 (+/- 15°F (8°C)) or better. <p>CAUTION: Furnace requirements for certain specific materials and processes may be contained in the individual specification.</p>	7	GEN	AMS2759
	Heating Environment			
19.	<p>Knowledge and understanding that Classes of Atmospheres are defined in AMS2759 as follows</p> <ul style="list-style-type: none"> • Class A: Argon, hydrogen, helium, nitrogen, nitrogen-hydrogen blends, vacuum, or neutral salt. Nitrogen from dissociated ammonia is not permitted. • Class B: Endothermic, exothermic, or carbon-containing nitrogen-base. • Class C: Air or products of combustion. 	7	GEN	AMS2759
	Atmosphere Control			
20.	<p>Knowledge and understanding that planning must address that atmosphere furnaces shall be controlled to ensure that surfaces of heat-treated parts are within the limits specified in the AMS2759/3, AMS2759/4 or AMS2759/5, as applicable.</p>	7	GEN	AMS2759
	Class A Atmospheres, Inert Gas Bulk Delivery			
21.	<p>Knowledge and understanding that procedures must control that the composition and dew point of the process gas shall be as required by the individual slash specification and traceable to a certificate of conformance. The dew point of the gas shall be -60 °F (-51 °C) or lower as the gas enters the furnace and shall be verified at least quarterly and also when the piping transmitting the gas is disturbed. In lieu of sampling the dew point at each furnace, the gas may be sampled at the end of each leg of supply piping, at the furthest point from the supply.</p>	5	GEN	AMS2759
	Servicing and Calibration of Atmosphere Control Equipment			
22.	<p>Knowledge and understanding procedures must control that instrumentation used to control furnace atmosphere shall be calibrated and serviced according to manufacturer's recommendation or by a suitable comparison method assuring the required accuracy is met, and in accordance with heat treater's documented procedures</p>	7	GEN	AMS2759
	Types of Parts			
23.	<p>Knowledge and understanding that parts shall be controlled by type, as follows, and planning must specify that they be heat treated in the class of atmosphere permitted for that type.</p> <p>Type 1 - Parts with 0.020-inch (0.51 mm) or more to be removed from all surfaces after heat treatment and parts with hot finished (as-forged, as-cast, or hot mill) surfaces at time of heat treatment with all surfaces to be removed after heat treatment.</p>	10	GEN	AMS2759

	Type 2 - Parts with finished surfaces, surfaces with less than 0.020 inch (0.51 mm) to be removed after heat treatment (including hot finished surfaces that will remain on the part), or combinations of these.			
24.	Knowledge and understanding that planning must include that if part type cannot be determined, the part shall be processed as Type 2.	10	GEN	AMS2759
25.	Knowledge and understanding that planning must address that parts with protective coating on all surfaces shall be processed in an atmosphere that will not destroy the coating during heat treatment.	10	GEN	AMS2759
	Quenching Equipment			
26.	Knowledge and understanding that planning must specify that the Quench System equipment and quench media shall be sufficient to achieve the properties required by the heat treat process. When quenching in vacuum furnaces using gas quenching, the quenching media and conditions shall be in accordance with AMS2769.	7	GEN	AMS2759
	Auxiliary Equipment			
27.	Knowledge and understanding that planning must control that fixtures and fixture materials shall not cause contamination of parts.	5	GEN	AMS2759
	Sub-Zero Cooling or Deep Freeze			
28.	Knowledge and understanding that planning must address that when required to complete transformation and provide desired microstructure, parts shall be cooled to a temperature within the range specified in the applicable slash specification, held at the selected temperature for a time commensurate with section thickness, and warmed in air to room temperature.	5	GEN	AMS2759
29.	Knowledge and understanding that planning must include that cleaning equipment shall be provided to clean parts before heat treatment, to remove oil from parts quenched in oil baths, and salt residue from parts heated or quenched in salt baths. When using polymer quenchants, a rinsing system shall be in place to remove quenchant from the parts.	5	GEN	AMS2759
30.	Knowledge and understanding that vacuum furnaces specified in planning must meet the requirements of AMS2769.	10	GEN	AMS2759
	Quenching Media			
31.	Knowledge and understanding that when liquid quenching is required, planning may only use quenching media as specified in AMS2759/3, AMS327509/4 or AMS2759/5, as applicable.	7	GEN	AMS2759
32.	Knowledge and understanding that planning must address that oil quenchants shall be in the range of 60 to 160 °F (16 to 71 °C) at the initiation of the quench operation. Oils shall not be used at temperatures exceeding the manufacturer's recommended maximum temperature.	10	GEN	AMS2759
33.	Knowledge and understanding that planning must address that polymer quenchants shall be in the range of 60 to 110 °F (16 to 43 °C) at the initiation of the quench operation or at a temperature specified by the manufacturer.	7	GEN	AMS2759
	Quenching from Salt Bath Furnaces			
34.	Knowledge and understanding that planning must address that water shall be monitored to ensure salt content does not exceed 2% by weight and that polymers shall be monitored to ensure salt content does not exceed 6% by weight.	5	GEN	AMS2759
	Quench Effectiveness			
35.	Knowledge and understanding that procedures must specify the frequency and methods for the testing of oil quenchants in accordance with all customer requirements and the records indicate that quenchant effectiveness is consistent and meets specification requirements.	7	GEN	AMS2759
	Polymer Quenchants			
36.	Knowledge and understanding that planning may specify polymer quenching only when permitted by the particular specification for the alloy and metal thickness and that planning, and records must indicate compliance	7	GEN	AC7102
37.	Knowledge and understanding that procedures must specify the frequency and methods for determining the polymer concentration in accordance with specification and customer requirements.	5	GEN	AC7102
	Salt Baths			
38.	Knowledge and understanding that planning must ensure that composition and maintenance of salt baths shall be such as to prevent contamination of the parts including carburization, decarburization, nitriding, and intergranular attack requirements. Salt baths shall be tested in accordance with AMS2759	10	GEN	AMS2759 AC7102
	Heat Treatment			
39.	Knowledge and understanding that planning must be in accordance with AMS2759/3, AMS2759/4 or AMS2759/5 for the required material and process. In case of conflict between AMS2759 and the slash specification, the slash specification shall take precedence.	10	GEN	AMS2759
	Cleaning			
40.	Knowledge and understanding that planning must address the requirement that parts shall be in a clean condition before heat treatment. Parts shall be visually inspected to verify freedom from grease, dirt, oil, corrosion and corrosion preventive coatings. All salt residue shall be removed from parts processed in salt baths or quenched in brine. NOTE: It is the responsibility of the purchaser to supply clean parts to the processor or specify the cleaning method prior to heat treatment to the processor	7	GEN	AMS2759

41.	Knowledge and understanding that planning must specify that following heat treatment operations, parts shall be cleaned when specified. Post heat treat cleaning is not required unless specified.	7	GEN	AMS2759 AC7102
	General Cleaning			
42.	Knowledge and understanding that planning must include documentation that when mandatory cleaning requirements are imposed by purchase order or applicable specification, they are complied with by the heat treater or performed by the customer prior to and after heat treatment and that compliance documented. Planning must have provisions for inspection prior to heat treatment when inspection or conditional cleaning is specified in the applicable specification	7	GEN	AC7102
43.	Knowledge and understanding that planning for vacuum heat treatment must include that, parts, fixtures, and materials charged into the heating chamber shall be free of contaminants which might evaporate and react with the material being heat treated or the furnace components. Handling of cleaned parts and fixtures shall be such as to prevent contamination prior to charging into the furnace.	7	GEN	AMS2769
	Racking			
44.	Knowledge and understanding that planning must provide that parts be racked and supported, or otherwise oriented to ensure access of the heating, cooling, and quenching media to all surfaces of all parts and to minimize warpage.	7	GEN	AMS2759
45.	Knowledge and understanding that there must be internal procedures, racking sketches, or other means to ensure that spacing between the parts is adequate for circulation of the heating medium and coolant/quenchant as required by the specifications and records to indicate that these procedures are followed	7	GEN	AC7102
46.	Knowledge and understanding that planning must identify any specially designed racks and fixtures and monitor and document their condition. Planning must reflect that specific fixtures or racks be required for the specific parts for which they are designed.	5	GEN	AC7102
47.	Knowledge and understanding that internal procedures must require that racks/fixtures/baskets are examined for integrity, and repaired or scrapped as necessary and records indicate that the procedures are followed	5	GEN	AC7102
	Purging			
48.	Knowledge and understanding that planning must include whenever active atmosphere types (e.g., neutral, carburizing, nitriding) are changed and when the prior atmosphere can have a deleterious effect on the subsequent parts being processed, prior to heating of parts, remnants of the previous atmosphere shall be removed from the furnace or retort and gas supply lines. For atmosphere furnaces, this shall be accomplished by purging with at least 5 volume changes of the purge gas or for a sufficient time, flow rate and temperature as verified by testing. For vacuum furnaces or atmosphere furnaces equipped with a vacuum pump, this shall be accomplished by pumping to the furnace's typical lowest vacuum level. NOTE: This requirement does not apply to Type 1 parts or if the heat treater has documented confirmation that material removal after heat treatment will ensure that all surfaces of finished parts will be free from contamination.	10	GEN	AMS2759 AC7102
	Loading			
49.	Knowledge and understanding that procedures must not allow parts to be loaded into a furnace with the temperature higher than the set temperature, unless load are attached to the part to ensure the part temperature does not exceed the set temperature.	7	GEN	AMS2759
	Set Temperature			
50.	Knowledge and understanding that planning must provide that control instrument(s) shall be set at the temperature specified by AMS2759/3, AMS2759/4 or AMS2759/5 as applicable.	7	GEN	AMS2759
	Heat Treatment in Vacuum Furnaces			
51.	Knowledge and understanding that internal procedure or other documentation must specify cleaning of parts, tooling and baskets by methods and with materials that ensure freedom from contamination during vacuum heat treating	7	GEN	AC7102
52.	Knowledge and understanding that internal procedure, photographic evidence, or other documentation specify placement of load thermocouples, racking of parts, and furnace loading	5	GEN	AC7102
53.	Knowledge and understanding that planning must ensure that vacuum furnaces used must meet the requirements of AMS 2769 and Customer / Prime specifications and be capable of achieving the vacuum levels and leak rates specified.	7	GEN	AMS2769
54.	Knowledge and understanding that planning must take account of the requirement to carry out regular contamination checks for which representative test coupons must be available and analyzed with results being documented. Knowledge and understanding of quality system requirements should the results fail to meet requirements.	7	GEN	AMS2769
55.	Knowledge and understanding that planning must take account of requirements to check condition of door and other seals (e.g. thermocouple entry ports) which must be clean and free from damage or tears. Also understanding of the requirements for cleaning and greasing different types of sealing material which must be documented on work instructions, the traveler / data card, or in specific internal instructions.	5	GEN	AMS2769
56.	Knowledge and understanding of the need for documenting repairs or changes of seals particularly on doors, thermocouple entry ports and gauges.	5	GEN	AMS2750

	Soak			
57.	Knowledge and understanding of why adherence to set temperatures and furnace uniformity is critical and the ability to clearly convey that through planning.	10	GEN	AMS2759
58.	Knowledge and understanding of how planning must convey requirements for start and end of soak in accordance with specification requirements through clear and concise work instructions.	10	GEN	AMS2759
	Quench			
59.	Knowledge and understanding that planning must include that quench mechanisms (manual or automated) must be capable of meeting the maximum quench delay if required by Customer / Prime specifications and results recorded and verified for each individual load	7	GEN	AC7102
60.	Knowledge and understanding that planning must include a requirement that the temperature of quench media must be controlled and documented in accordance with Customer / Prime requirements.	10	GEN	AC7102
61.	Knowledge and understanding that planning must include that records must demonstrate that quench media has been at the specified temperature before, during and after the parts were quenched.	7	GEN	AC7102
62.	Knowledge and understanding that planning must include a requirement to verify that agitation of quench media or the parts during quenching conforms to applicable specifications.	5	GEN	AC7102
	Gas Quenching in Vacuum furnaces			
63.	Knowledge and understanding that planning must include requirements for selection of quench gas type (e.g. Nitrogen/Argon/Helium), gas pressure during quench, and cooling direction	7	GEN	AMS2769
64.	Knowledge and understanding that planning must address how to check cooling rates on gas quenching when there are specific requirements.	5	GEN	AMS2769
	Low Temperature Treatment when Required by Specification			
65.	Knowledge and understanding that planning must take account of and convey, through concise written instructions the importance of meeting the maximum permitted process delays between Quench/Temper and Quench/Freeze/Temper, and the effect exceeding the requirement might have on the mechanical properties of the product. Planning must include that in-process delay times are recorded and subject to review if they are exceeded.	10	GEN	AC7102
66.	Knowledge and understanding that records must show that cooling after quench is in compliance with customer requirements specified in procedures or shop planning.	7	GEN	AC7102
67.	Knowledge and understanding that procedures and job planning must specify time/temperature limits for sub-ambient/subzero treatments	7	GEN	AC7102
68.	Knowledge and understanding that planning must include recording the temperature in each refrigeration cycle to allow verification against Customer / Prime requirements	7	GEN	AC7102
	Records			
69.	Knowledge and understanding that planning must provide for collection of the appropriate data so that a furnace log, or equivalent documentation such as shop travelers, traceable to temperature recorder chart(s), shall be maintained.	10	GEN	AMS2759
	Qualification			
70.	Knowledge and understanding that planning and procedures must include that all facilities, including subcontractors, performing heat treatment in accordance with this specification shall be approved as specified by the cognizant quality assurance organization.	10	GEN	AMS2759
	Test Methods			
71.	<p>Knowledge and understanding that planning must provide for the following tests, as applicable:</p> <ul style="list-style-type: none"> Hardness shall be determined in accordance with ASTM A370, ASTM E10, ASTM E18, and ASTM E384, as applicable. Portable hardness testing, in accordance with ASTM E110, may be used when the size or configuration of parts is such that bench testing is impractical. To verify conformance to the tensile requirements, the approximate conversion of hardness to tensile strength in ASTM A370 shall be used. Hardness tests shall be performed on the thickest section, unless otherwise specified. Hardness of parts shall be as specified by the applicable slash specification or the purchase order. Tensile Properties shall be determined in accordance with ASTM E8/E8M at a strain rate of 0.005 in/in/min. When tensile testing is required to accept the parts, the purchaser shall provide all test materials Quench System Monitoring The consistency of the quench system shall be monitored quarterly, as required by AMS2759 or as approved by the cognizant engineering authority. Testing of water quench systems is not required. When destructive mechanical property testing is required for part acceptance, quench system monitoring is not required. Quench Media Control shall be per AMS2759 Surface contamination testing shall be per AMS2759 	5	GEN	AMS2759
72.	<p>Surface Contamination Testing:</p> <p>Test Methods</p> <p>Knowledge and understanding that planning must provide for the following test methods, as applicable:</p>	7	GEN	AMS2759

	<ul style="list-style-type: none"> • Micro-Hardness testing for determination of partial decarb shall be done in accordance with ASTM E384. If specified for greater accuracy the chord method of ARP-182 shall be used. Test specimens shall be the same alloy as the parts. Testing shall be done in the as-quenched condition except for secondary hardening steels such as H-11 Shall be tempered. • Direct hardness measurement methods for determoienation shall be in accordance with ASTM E18. Bulk hardness test readings comparing HRA or Superficial HR15N scale to HRC scale readings shall be used. • Visual determination for the presence of complete decarb, carburization or nitriding shall be done be etching with an appropriate etchant and examination at 200X minimum, or as specified in the applicable slash sheet. Ref. ASTM E1077 for examples. • Depth of intergranular attack shall be determined metallographically on an unetched specimen at 200X, or as specified in the applicable slash sheet. 			
	Rejection Criteria			
73.	<p>Knowledge and understanding that planning must provide for the following:</p> <ul style="list-style-type: none"> • Rejection criterion for depth of partial decarburization using the microindentation hardness method shall be the depth at which the hardness reading is 25 points Knoop, or equivalent, lower than the average core hardness. • Rejection criteria for nitriding and carburizing shall be the depth at which the hardness reading is 25 Knoop (or equivalent) higher than the average core hardness. • When using the direct hardness method, the rejection criteria shall be the depth where the superficial hardness test differs by more than 1.5 HRC from the direct surface hardness reading in HRC. 	10	GEN	AMS2759
	Additional Processes			
74.	Knowledge and understanding that planning must assure that parts are not subjected to thermal operations other than those specified in the ordering document	10	GEN	AMS2759
	Surface Contamination			
75.	<p>Knowledge and understanding that planning must provide for the control of surface contamination when heating parts above 1250 °F (677 °C) and evaluation as follows:</p> <ul style="list-style-type: none"> • When less than 0.020 inch (0.051 mm) of metal is to be removed from any surface, the heat treat medium (protective atmosphere or salt baths), shall be controlled to prevent carburization or nitriding and to prevent complete decarburization. Partial decarburization, carburization or nitriding shall not exceed 0.003 inch (0.075 mm). Intergranular attack and complete decarburization shall not exceed 0.0007 inch (0.018 mm). • Unless specified that at least 0.020 inch (0.51 mm) will be removed from all surfaces of parts, the heat-treating processor shall heat treat the parts as if less than 0.020 inch (0.51 mm) will be removed. • Parts that will be machined after heat treatment, but that will have less than 0.020 inch (0.51 mm) of metal removed from any machined surface may be reclassified as Type 1, by the purchaser and need not meet the requirements as heat treated. • Each furnace load shall contain test specimens of the same alloy family as the parts. The surface contamination requirements also apply to the cumulative effects of operations such as normalizing followed by austenitizing or austenitizing followed by re-austenitizing. For reheat treatments, the original specimen or a portion thereof shall accompany the parts and be tested after the reheat treatment. • Parts that will have all contamination removed shall not require testing. 	10	GEN	AMS2759
	Strength Ranges			
76.	Knowledge and understanding that when only a minimum tensile strength is specified and the heat treating processor has the option of selecting the tempering or aging temperature, the planning must control the process and inspections so that maximum tensile strength (converted to hardness) shall be 20.0 ksi (138 MPa) above the specified minimum for strength levels up to and including 260 ksi (1793 MPa) minimum and 25.0 ksi (172 MPa) above minimum for strength levels over 260 ksi (1793 MPa) minimum.	5	GEN	AMS2759
77.	Knowledge and understanding that when both the minimum tensile strength and the tempering temperature are specified, planning must control the process and inspections so that the maximum strength shall be 30.0 ksi (207 MPa) above the specified minimum.	5	GEN	AMS2759
	Acceptance tests			
78.	Knowledge and understanding that planning must include acceptance testing and documentation as specified in the AMS2759/3, AMS2759/4 or AMS2759/5, as applicable	7	GEN	AMS2759
	Periodic Testing			
79.	Knowledge and understanding that planning must take account of the need for periodic testing which must be scheduled and documented.	5	GEN	AMS2759 AMS2769
80.	Knowledge and understanding that planning must have a process to ensure that periodic testing is performed per procedures and the customer requirements and in accordance with AMS2759 and AMS2769.	5	GEN	AMS2759 AMS2769

Surface Contamination Testing				
81.	Knowledge and understanding that internal testing procedures must cover the following as applicable: <ul style="list-style-type: none"> • Partial decarburization • Total decarburization • Carburization • IGO/IGA (Inter Granular Oxidation/Inter Granular Attack) test • Surface Contamination by metallurgical examination 	5	GEN	AC7102, AMS2759/3, AMS2759/4
82.	Knowledge and understanding that there must be a system in place to ensure that decarburization tests are performed at the proper frequency, whether it is periodic or with the load.	5	GEN	AC7102
Additional Periodic Tests				
83.	Knowledge and understanding that planning must address periodic tests as specified in AMS2759/3, AMS2759/4 or AMS2759/5, as applicable. The following requirements are equipment periodic tests and shall be performed at the frequency specified herein on each piece of equipment in service. Weekly Salt content monitoring of water and polymer quenchants when quenching from salt bath furnaces Quarterly Quench system monitoring Semi-Annually Quench media cooling rate determination	5	GEN	AMS2759
Preproduction Tests				
84.	Knowledge and understanding that planning and procedures must address that all periodic tests are preproduction tests and shall be performed prior to the first production run.	10	GEN	AMS2759
Sampling and Testing				
85.	Knowledge and understanding that planning must provide that frequency of hardness testing shall be in accordance with AMS2759 or other applicable requirements. NOTE: When hardness testing would be destructive or impractical to accomplish, the method for verification of correct heat treatment shall be as specified by the cognizant engineering or quality engineering organization	7	GEN	AMS2759
86.	Knowledge and understanding that planning must provide that after final operation (hardening and tempering, aging, etc.), every part must be hardness tested unless statistical sampling is authorized by the cognizant quality assurance organization or when parts are subjected to 100% testing after thermal processing subsequent to final hardening operation.	10	GEN	AMS2759
87.	Knowledge and understanding that when heat treating standard components, such as nuts and bolts, for which the frequency of testing is specified, planning shall provide that the requirements of the component specifications take precedence.	3	GEN	AMS2759
88.	Knowledge and understanding that planning must include that unless otherwise specified, the test location shall be the thickest or heaviest section of the part.	7	GEN	AMS2759
89.	Knowledge and understanding that planning must provide for the collection of data necessary to comply with specification and customer requirements for Logs, Records and Reports/Certification.	5	GEN	AMS2759
Corrosion Protection				
90.	Knowledge and understanding that planning must provide that parts susceptible to corrosion (e.g., martensitic stainless steels) shall be protected from corrosion during processing and storage.	5	GEN	AMS2759
PROCESS VERIFICATION				
91.	Knowledge and understanding that planning must provide that each heat treatment cycle is reviewed for job traceability, correct temperature, time at temperature and all other related parameters and that this review is documented	10	GEN	AC7102
92.	Knowledge and understanding that planning must provide for this review to be performed by Quality Assurance, other designated personnel, or self-inspected by an automated computer control and monitoring system	7	GEN	AC7102
REQUIREMENTS SPECIFIC TO PRODUCT PROCESSED IN ACCORDANCE WITH SPECIFIC AMS STANDARDS DESCRIBED ABOVE (Competence)				
A) SPECIFIC REQUIREMENTS RELATED TO THE PROCESSING OF: Precipitation-Hardening Corrosion-Resistant and Maraging steel parts AMS 2759/3				
93.	Knowledge and understanding that planning must communicate through work instructions or procedures that this specification establishes the heat treatment of PARTS manufactured to the specification above.	7	GEN	AMS2759/3
94.	Knowledge and understanding that planning must apply this specification to those materials listed. Parts made from steels other than those specified in this specification may be heat treated in accordance with the applicable requirements herein using processing temperatures, times, and other parameters recommended by the material producer unless otherwise specified by the purchaser.	7	GEN	AMS2759/3
PYROMETRY				
95.	Knowledge and understanding that planning must be in accordance with the requirements of AMS2759 and AMS 2750 (Pyrometry).	7	GEN	AMS2759/3

96.	<p>Knowledge and understanding that planning must only use equipment that conforms to the Furnace Class requirements of AMS2750 as listed below:</p> <ul style="list-style-type: none"> a) Furnaces used at temperatures of 1400 °F (760 °C) and higher and for stress relieving: Class 5. +/- 25°F (14°C) b) Furnaces used at temperatures from 1300 to 1375 °F (704 to 746 °C): Class 3. +/- 15°F (+/-8°C) c) Furnaces used at temperatures below 1300 °F (704 °C): Class 2. +/- 10°F (+/- 6°C) d) Furnaces shall have a minimum of type D instrumentation in accordance with AMS2750. 	7	GEN	AMS2759/3
Heating environment / Atmospheres				
97.	<p>Knowledge and understanding that planning must ensure that atmospheres are controlled such that they do not contaminate parts being treated. Parts being heat treated shall be suitably isolated from products of combustion. Materials that could attack or contaminate metal shall not contact parts during heat treatment.</p>	7	GEN	AMS2759/3
98.	<p>Knowledge and understanding that planning must provide that furnaces used to heat treat other classes of steel using atmospheres that could contaminate precipitation-hardening, maraging, or secondary hardening steel parts, such as endothermic, exothermic, carbon-containing nitrogen-base, etc., shall have purge cycle run and then shall be tested to ensure that the surfaces of parts are not contaminated beyond the limits specified.</p>	7	GEN	AMS2759/3
99.	<p>Knowledge and understanding that planning must provide that composition and maintenance of salt baths shall be such as to prevent contamination of the parts. Salt baths shall be in accordance with AMS2759.</p>	7	GEN	AMS2759/3
Heating Environment				
100.	<p>Knowledge and understanding that planning must address the following</p> <ul style="list-style-type: none"> • Type 1 parts shall be heat treated in air or protective atmosphere. • Type 2 parts shall be heat treated in air or protective atmosphere when heating at or below 1450 °F (788 °C) and shall be heat treated in a protective atmosphere when heating above 1475 °F (802 °C). 	10	GEN	AMS2759/3
101.	<p>Knowledge and understanding that planning must include that acceptable protective atmospheres shall be in accordance with AMS2759, and are limited to helium, argon, hydrogen, neutral salt, nitrogen, nitrogen-hydrogen blends, and vacuum in accordance with AMS2769. For scale-free or discoloration-free parts, air atmospheres and air cooling should be avoided.</p>	7	GEN	AMS2759/3
102.	<p>Knowledge and understanding that planning must be consistent with the following</p> <ul style="list-style-type: none"> • Nitrogen and nitrogen-hydrogen blends are permitted below 1475 °F (802 °C). • Nitrogen and nitrogen-hydrogen blends are permitted at or above 1475 °F (802 °C) for Type 1 parts only. • Nitrogen and nitrogen-hydrogen blends are permitted up to 1975 °F (1079 °C) as a backfill quench for vacuum furnaces. • The use of nitrogen from dissociated ammonia is prohibited. 	7	GEN	AMS2759/3
Coatings				
103.	<p>Knowledge and understanding that a supplemental coating is permitted to minimize oxidation of parts heated in air.</p>	7	GEN	AMS2759/3
Cleaning				
104.	<p>Knowledge and understanding that planning must provide that cleaning shall be in accordance with AMS2759.</p>	7	GEN	AMS2759/3
105.	<p>Knowledge and understanding that planning must require that all PH steel parts with any finish machined surfaces are handled with clean gloves after cleaning</p>	7	GEN	AC7102
Soaking				
106.	<p>Knowledge and understanding that planning must provide that Start of Soak shall be in accordance with AMS2759. When a load thermocouple is used it shall be in contact with the thickest cross-section within each furnace load.</p>	10	GEN	AMS2759/3
Start of Soaking				
107.	<p>When only furnace control sensors are used, soaking time starts when the temperature indicated by the furnace control instrument recovers to within 5 °F (3 °C) of the set heat treating temperature.</p> <p>When furnace control sensors and recording thermocouples are used, soaking time starts when the temperature indicated by all recorded sensors reaches the minimum of the required temperature tolerance applicable to the set heat treating temperature.</p> <p>When load thermocouples are used, soaking time commences when the part temperature reaches the minimum of the required temperature tolerance for the set heat treating temperature.</p>	10	W	AMS2579
Preheating and Normalizing of Secondary Hardening Grades				
108.	<p>Knowledge and understanding that planning must provide that parts should be preheated at 1200 to 1250 °F ± 25 °F (649 to 677 °C ± 14 °C) for a minimum of 30 minutes before normalizing or solution annealing. Normalizing shall be accomplished by heating to the temperature specified, soaking for the time specified, and cooling in air or a protective atmosphere to ambient temperature.</p>	5	GEN	AMS2759/3

	Annealing of Secondary Hardening Grades			
109.	Knowledge and understanding that planning must specify that annealing shall be accomplished by heating to the temperature and soaking for the time specified, and cooling in air or a protective atmosphere to ambient temperature.	5	GEN	AMS2759/3
	Re-Resolution of Secondary Hardening Grades			
110.	Knowledge and understanding that planning must provide that re-resolution treatment shall be accomplished by heating to the required temperature and soaking for the time specified. When reworking material (e.g., material with low hardness and/or mechanical properties, equipment malfunctions, interrupted cycles beyond specified limits, normalizing and annealing are not required before re-resolution as long as the solution temperature has not been exceeded.	5	GEN	AMS2759/3
	Solution Heat Treating (Solution Annealing), Austenite Conditioning, and Aging (Precipitation Heat Treating)			
111.	Knowledge and understanding that planning must provide that these processes shall be accomplished by heating to the temperature specified, soaking for the time specified, and cooling as specified. Times for low temperature processes (90 °F (32 °C) and below) are cumulative. When a strength or hardness range not listed in AMS2759/3 is called out by customer purchasing documents, process the parts at the times and temperatures appropriate to achieve the desired properties. Gas quenching in a vacuum furnace is acceptable when an air cool is specified in AMS2759/3.	7	GEN	AMS2759/3
	Aging Cycle Interruption			
112.	Knowledge and understanding that planning must provide that If the aging cycle is interrupted due to power loss or furnace malfunction that causes the furnace temperature to drop below the required setpoint tolerance, the aging cycle can be continued to complete the required soak time. For example, if power is lost 1 hour and 20 minutes into a 4-hour age cycle, the parts can be re-heated to the aging temperature and aged for 2 hours and 40 minutes in order to complete the 4-hour age. In no cases can the cumulative aging time exceed the maximum time tolerance (for example, 4-hour ages allow +30 minutes, the cumulative aging time cannot exceed 4 hours and 30 minutes). Only one such interruption is allowed per aging cycle. Further interruptions or exceeding the aging time tolerance require reworking via re-resolution treatment.	7	GEN	AMS2759/3
	Resolution heat treatment			
113.	Knowledge and understanding that planning must provide that Re-Resolution Heat Treating is required in the following cases: <ul style="list-style-type: none"> Material previously heat treated to the H1150M condition. Material previously heat treated to a lower strength/hardness. Material with low hardness or mechanical properties, equipment malfunctions, interrupted cycles exceeding allowable limits. 	7	GEN	AMS2759/3
	Stress relieving			
114.	Knowledge and understanding that planning must ensure that Stress relieving, if required, shall be performed in accordance with AMS2759/11.	7	GEN	AMS2759/3
	Carbide solution treatment for AM-355			
115.	Knowledge and understanding that planning must provide that when required, carbide solutioning shall be accomplished by heating to 1900 °F (1038 °C), soaking for the specified times for the respective section thickness, water quenching to room temperature, cooling to -90 °F (-68 °C) or colder, holding for a minimum of 3 hours, and warming in air to room temperature	7	GEN	AMS2759/3
	Straightening			
116.	Knowledge and understanding that planning must provide that straightening may be accomplished at ambient temperature, during aging, or after aging by heating to not higher than 50 °F (28 °C) below the final aging temperature. Straightening performed after aging shall be followed by stress relieving.	7	GEN	AMS2759/3
	Properties			
117.	Knowledge and understanding that planning must address the following property requirements Hardness - Parts shall conform to the hardness ranges stated for the required condition. Tensile - Tensile properties shall conform to those stated in AMS2759/3 for the following alloys and conditions. If no properties are listed for a given material and condition, then the tensile properties shall conform to those specified by the applicable material specification. <ul style="list-style-type: none"> AM 350 and AM 355 parts 17-7 PH and PH 15-7 Mo parts heat treated to an RH Condition 15-5 PH and 17-4 PH parts heat treated to the H1100 and H1150 Conditions, excluding the H1150M condition. 	7	GEN	AMS2759/3
	Surface contamination			
118.	Surface Contamination for Precipitation Hardenable and Maraging Steels Knowledge and understanding that planning must provide that <ul style="list-style-type: none"> When any surface of a part is not to be machined after heat treatment, the protective atmosphere or backfill medium in furnaces for heating parts above 	7	GEN	AMS2759/3

	<p>1450 °F (788 °C) shall be controlled to not produce carburization or nitriding and intergranular oxidation shall not exceed 0.0007 inch (0.018 mm). Parts heat treated in salt baths shall be free of residual salts.</p> <ul style="list-style-type: none"> Unless specifically informed that the parts will be machined all over, the heat-treating processor shall process the parts as though some surfaces will not have subsequent metal removal, and therefore shall heat treat above 1450 °F (788 °C) with controlled atmosphere that will conform to the surface contamination requirements. Unless specified, controlled atmosphere is not required for parts with only raw material surfaces, except those made from sheet or strip. Furnaces used exclusively to heat treat parts which will have all contamination removed shall not require testing. 			
119.	<p>Knowledge and understanding that planning must provide that Surface Contamination for Secondary Hardening Steels shall be tested in accordance with AMS2759/2.</p>	5	GEN	AMS2759/3
	Test Methods			
120.	<p>Knowledge and understanding that planning must provide that testing shall be carried out in accordance with AMS 2759.and as follows</p> <p>Surface Contamination Precipitation Hardenable and Maraging Grades – Testing shall be by metallurgical examination between 400 and 600X magnification of etched specimens prepared in accordance with ASTM E3. The chord method in ARP1820 may be used to enhance this examination. Secondary Hardening Grades – Testing shall be performed in accordance with the surface contamination requirements of AMS2759/2.</p>	7	GEN	AMS2759/3
	QUALITY ASSURANCE PROVISIONS			
121.	<p>Knowledge and understanding that planning must provide that the responsibility for inspection, classification of tests, sampling and testing, approval, records, record retention and report/certification shall be in accordance with AMS2759 and as follows.</p> <p>Acceptance Tests Hardness and tensile are acceptance tests and shall be performed on each lot of parts. In the event of conflict between hardness and tensile properties, parts shall not be rejected on the basis of hardness if the tensile properties are acceptable when determined on specimens taken from the same heat and load.</p> <p>Periodic Tests Surface contamination is a periodic test and shall be performed on each piece of equipment after the purging of atmospheres whenever the heat treat equipment has been used previously with atmospheres, such as endothermic exothermic, carbon-containing nitrogen-base, etc., that could contaminate precipitation-hardening or maraging steels.</p> <p>Preproduction Tests Surface contamination is a preproduction test and shall be performed prior to any production heat treating for each piece of equipment and for each type of atmosphere to be used in each furnace.</p>	7	GEN	AMS2759/3
122.	<p>Knowledge and understanding that planning must provide that sampling and testing must be carried out in accordance with AMS 2759.and as follows</p> <p>Tensile Testing</p> <ul style="list-style-type: none"> For AM 350 and AM 355 Parts - One or more tensile samples shall be processed with each austenite-conditioning load. It shall be of the same alloy designation as the parts and shall continue with the parts through final aging. For 17-4 PH and 15-5 PH parts heat treated to the H1100 and H1150 conditions, excluding the H1150M condition - One or more tensile samples shall be processed with each aging load. It shall be of the same alloy designation as the parts. (H1100 and H1150 parts exhibiting tensile properties lower than required may be re-solution treated and precipitation hardened. A precipitation hardening temperature of up to 100 °F (56 °C) less than originally employed may be used, but in no instance shall a time less than 4 hours be employed. Parts not meeting tensile requirements under these conditions are not acceptable and shall be rejected.) For 17-7 PH and PH 15-7 Mo Parts Heat Treated to the RH Condition - One or more tensile samples shall be processed with each austenite-conditioning load. It shall be of the same alloy designation as the parts and shall continue with the parts through final aging. <p>Surface Contamination Testing</p> <ul style="list-style-type: none"> One or more specimens shall be processed and tested. 	7	GEN	AMS2759/3
	B) SPECIFIC REQUIREMENTS RELATED TO THE PROCESSING OF: Heat Treatment of Austenitic Corrosion Resistant Steel Parts AMS 2759/4			
123.	<p>Knowledge and understanding that planning must communicate through work instructions or procedures that this specification establishes the heat treatment of PARTS manufactured to the specification above.</p>	7	GEN	AMS2759/4
124.	<p>Knowledge and understanding that this specification is applicable to parts made from the following corrosion-resistant steels: 201, 202, 301, 302, 303, 304, 304L, 305, 309, 310, 314, 316, 316L, 321, 347, and 348. (Including letter designations of the same alloy, unless otherwise indicated. Examples: 302B, 303S, 303Se, 304L, 309S, 310S, 316L, etc.</p>	7	GEN	AMS2759/4

	PYROMETRY			
125.	Knowledge and understanding that planning must be in accordance with the requirements of AMS2759 and AMS 2750 (Pyrometry).	7	GEN	AMS2759/4
126.	Knowledge and understanding that planning must only use equipment that at a minimum conforms to the AMS2750 Class 5 requirements +/- 25°F (14°C).	7	GEN	AMS2759/4
	Heating Environment / Atmospheres			
127.	Knowledge and understanding that planning must ensure that atmospheres are controlled such that they do not contaminate parts being treated including vacuum and salt baths.	7	GEN	AMS2759/4
128.	Knowledge and understanding that planning must provide that furnaces used to heat treat other classes of steel using atmospheres that could contaminate austenitic corrosion-resistant steel parts shall have purge cycles run and then shall be tested to ensure that the surfaces of parts are free from nitriding and intergranular oxidation.	7	GEN	AMS2759/4
129.	Knowledge and understanding that planning must provide that parts being heat treated shall be suitably isolated from products of combustion. Materials that could attack or contaminate metal shall not contact parts during heat treatment. Composition and maintenance of salt baths shall be such as to prevent contamination of the parts. Salt baths shall be tested in accordance with AMS2759.	7	GEN	AMS2759/4
130.	Knowledge and understanding that planning must provide that parts shall be heat treated in either air or protective atmosphere. Acceptable protective atmospheres include argon, helium, hydrogen, neutral salt, and vacuum. Nitrogen and nitrogen-hydrogen blends are permitted as a backfill quench for vacuum furnaces and as a protective atmosphere if a minimum of 0.020 inch (0.51 mm) is to be removed from all surfaces after heat treatment. For scale-free or discoloration-free parts, an air atmosphere and air cooling should be avoided.	7	GEN	AMS2759/4
131.	Knowledge and understanding that the use of nitrogen manufactured by the dissociation of ammonia is prohibited.	10	GEN	AMS2759/4
	Protective coating			
132.	Knowledge and understanding that procedures must ensure that the use of protective coatings is permitted only when approved by the cognizant engineering authority. Approval is not required when it can be demonstrated that the coating can effectively prevent intergranular oxidation in excess of 0.0007 inch (0.018 mm). All protective coatings shall be removed after heat treatment.	7	GEN	AMS2759/4
133.	Knowledge and understanding that planning must provide that fixtures and fixture materials shall not cause contamination of parts and shall not reduce heating, or cooling rates to less than that required to prevent carbide precipitation.	7	GEN	AMS2759/4
	Cleaning			
134.	Knowledge and understanding that planning must ensure that cleaning is in accordance with AMS2759.	7	GEN	AMS2759/4
	SOAKING			
	Solution Heat Treatment, and Austenite conditioning			
135.	Knowledge and understanding that planning must provide that heating shall be controlled, as described in AMS2759, such that either the heating medium or the part temperature, as applicable, is maintained at the required set temperature for the specified soak time. The start of soaking time shall be in accordance with AMS2759.	7	GEN	AMS2759/4
136.	Knowledge and understanding that planning for annealing shall be as required in AMS2759/4.	7	GEN	AMS2759/4
137.	Knowledge and understanding that planning must assure awareness that heat treating or slow cooling of unstabilized grades, except 304L and 316L, between 875 and 1500 °F (468 and 816 °C) is prohibited	7	GEN	AMS2759/4
	Straightening			
138.	Knowledge and understanding that planning must specify that straightening shall be accomplished at ambient temperature with a post-straightening stress relief in accordance with AMS2759/11, cycle 2	7	GEN	AMS2759/4
	Properties			
	Surface Contamination			
139.	Knowledge and understanding that planning must provide that Surface Contamination shall be in accordance with AMS2759 and as follows. <ul style="list-style-type: none"> When any surface of a part is not machined after heat treatment, the protective atmosphere or backfill medium in furnaces, for heating parts above 1350 °F (732 °C), shall be controlled to prevent nitriding and/or intergranular oxidation. Parts heat treated in salt baths shall be free of residual salts. Furnaces used exclusively to heat treat parts which will have all contamination removed shall not require testing. 	7	GEN	AMS2759/4
	Carbide precipitation			
140.	Knowledge and awareness that other means of cooling than those tabulated in AMS2759/4 are permitted provided testing substantiates that the cooling rate is rapid enough to prevent carbide precipitation	7	GEN	AMS2759/4
	Test Methods			
141.	Knowledge and understanding that testing shall be carried out in accordance with AMS 2759 and as follows.	7	GEN	AMS2759/4

	Surface Contamination			
142.	Knowledge and understanding that testing shall be by metallurgical examination at between 400 and 600X magnification of etched specimens prepared in accordance with ASTM E3. The chord method in ARP1820 may be used to enhance this examination.	7	GEN	AMS2759/4
	Carbide Precipitation			
143.	Knowledge and understanding that planning must provide that carbide precipitation shall be determined in accordance with ASTM A262	7	GEN	AMS2759/4
	QUALITY ASSURANCE PROVISIONS			
144.	Knowledge and understanding that planning must provide that the responsibility for inspection, classification of tests, sampling and testing, approval, records, record retention, and report/certification shall be in accordance with AMS2759 and the following Preproduction Tests Surface contamination is a preproduction test and shall be performed prior to any production heat treating for each piece of equipment and type of atmosphere to be used in each furnace. Carbide precipitation if applicable is a preproduction test and shall be performed prior to any production heat treatment for each piece of equipment and each alternate quenching and cooling method used. Sampling Shall be in accordance with AMS2759 and that for Surface Contamination Testing one or more samples shall be processed.	7	GEN	AMS2759/4
	C)) SPECIFIC REQUIREMENTS RELATED TO THE PROCESSING OF Heat Treatment Martensitic Corrosion-Resistant Steel Parts to AMS2759/5			
145.	Knowledge and understanding that planning must communicate through work instructions or procedures that this specification establishes the heat treatment of PARTS manufactured to the specification above.	7	GEN	AMS2759/5
146.	Knowledge and understanding that planning must apply this specification to those materials listed. Parts made from other martensitic stainless steels other than those specified may be heat treated in accordance with the applicable requirements using processing temperatures, times, and other parameters recommended by the material producer unless otherwise specified by purchaser	7	GEN	AMS2759/5
	Pyrometry			
147.	Knowledge and understanding that planning must be in accordance with the requirements of AMS2759 and AMS 2750.	7	GEN	AMS2759/5
148.	Knowledge and understanding that planning must only use equipment that conforms to the TUS Class requirements listed below: a) Annealing, subcritical annealing, hardening, straightening, stress relieving and baking shall be a minimum of Class 5 (+/- 25°F (14°C)) b) Tempering shall be a minimum of Class 3 (+/- 15°F (+/-8°C))	7	GEN	AMS2759/5
	Heating Environment / Atmospheres			
149.	Knowledge and understanding that planning must control parts by type and use only the class of atmosphere permitted for that type when heating above 1250°F (677°C).	7	GEN	AMS2759/5
150.	Knowledge and understanding that planning must provide that when treating below 1250°F (677°C) atmosphere types A, B or C may be used.	7	GEN	AMS2759/5
151.	Knowledge and understanding that planning must classify parts according to the rules related to machined, partially machined or as supplied condition.	7	GEN	AMS2759/5
152.	Knowledge and understanding that planning must control parts such that if the part type cannot be determined it shall be processed as Type 2 – Parts with finished surfaces, surfaces with less than 0.020 inch (0.51 mm) to be removed after heat treatment (including hot finished surfaces that will remain on the part), or combinations of these.	7	GEN	AMS2759/5
153.	Knowledge and understanding that planning shall control the heat treatment of parts through work instructions or procedures such that atmospheres shall be limited to those permitted.	7	GEN	AMS2759/5
154.	Knowledge and understanding that planning must only use atmosphere furnaces equipped and controlled to meet the surface contamination limits of this specification. Salt baths shall be controlled and tested in accordance with AMS2759. Vacuum furnaces shall be controlled and tested in accordance with AMS2769.	7	GEN	AMS2759/5
	Cleaning			
155.	Knowledge and understanding that planning must ensure that cleaning shall be in accordance with AMS2759.	7	GEN	AMS2759/5
	Preheating			
156.	Knowledge and understanding that planning should address the preheating recommendations of the specification.	7	GEN	AMS2759/5
	Soaking			
157.	Knowledge and understanding that planning must ensure that start of soak shall be in accordance with AMS 2759 and soak time shall be as required in this specification	7	GEN	AMS2759/5
158.	Knowledge and understanding that through work instructions and procedures parts protected by copper plating or coated with reflective coatings which tend to reflect radiant heat shall have their soaking time increased by 50% when processing at setpoints above 1200 °F (649 °C), unless load thermocouples are used.	7	GEN	AMS2759/5
159.	Knowledge and understanding that planning must provide that annealing shall be accomplished by heating to the specified temperature for the required time and cooling to	7	GEN	AMS2759/5

	below the specified temperature at the rate shown followed by air cooling or equivalent to ambient temperature. Isothermal annealing treatments may be used providing equivalent hardness and microstructure are obtained.			
160.	Knowledge and understanding that planning must provide that when Subcritical Annealing is required, it shall be performed prior to hardening by heating in the range 1350 to 1450 °F (732 to 788 °C), except 431 alloy, which shall be at 1150 to 1200 °F (621 to 649 °C) and 440C alloy, which shall be at 1250 to 1350 °F (677 to 732 °C), soaking for the required time, and cooling to ambient temperature.	7	GEN	AMS2759/5
161.	Knowledge and understanding that planning must provide that Hardening (Austenitizing and Quenching) shall be accomplished by heating to the austenitizing temperature shown, soaking for the specified time, and quenching as required. The parts shall be cooled to or below the liquid quenchant temperature or to a temperature low enough to achieve complete transformation before tempering. Quench liquids shall be controlled and tested as specified in AMS2759. Vacuum quench media shall be controlled and tested as specified in AMS2769.	7	GEN	AMS2759/5
	Vacuum Furnace Gas Pressure Quenching			
162.	Knowledge and understanding that for all materials listed in AMS2759/5, planning must provide that forced gas quenching is only permitted for parts where the minimum dimension of the maximum thickness of the part is 1 inch or less. For thickness greater than 1-inch (25.4 mm) qualification is required.	7	GEN	AMS2759/5
163.	Knowledge and understanding that planning must provide that quench gases shall be in accordance with AMS2769. Single gas types or mixtures may be used for gas pressure quenching provided the quenching process is qualified in accordance with the requirements contained in this document.	7	GEN	AMS2759/5
164.	Knowledge and understanding that planning must provide that after quenching and prior to tempering, subzero cooling may be required. It is recommended that subzero cooling begin within 2 hours from end of quench. For subzero treatments, interruptions of the soaking period are permitted. The total soak time shall not include any time when the temperature is warmer than -90 °F (-68 °C) due to interruptions.	7	GEN	AMS2759/5
165.	Knowledge and understanding that planning must provide that Tempering shall be accomplished by heating quenched parts to the temperature required to develop the required properties,	7	GEN	AMS2759/5
166.	Knowledge and understanding that suggested temperatures for specific hardness or tensile strengths for specific alloys are given in AMS2759/5.	7	GEN	AMS2759/5
167.	Knowledge and understanding that planning must provide that initial tempering should begin within 2 hours from end of quench or within 2 hours from when subzero cooled parts have reached ambient temperature.	5	GEN	AMS2759/5
168.	Knowledge and understanding that planning must provide that Soaking time shall be not less than 2 hours plus 1 hour additional for each inch (25 mm) of thickness or fraction thereof greater than 1 inch (25 mm). Thickness is defined in AMS2759. When load thermocouples are used, the soaking time shall be not less than 1 hour.	7	GEN	AMS2759/5
169.	Knowledge and understanding that planning must provide that multiple tempering is permitted for all alloys and required for some. When multiple tempering is used, parts shall be cooled to ambient temperature (or below, if specified) between tempering treatments.	7	GEN	AMS2759/5
170.	Knowledge and understanding that planning must provide that if parts cannot be tempered within 2 hours from end of quench or within 2 hours from when subzero cooled parts have reached ambient temperature, parts may be snap tempered for a minimum of 2 hours at 300 °F (149 °C). If the tempering temperature is below 325 °F (163 °C) the snap temper shall be no greater than 25 °F (14 °C) degrees below the final tempering temperature.	7	GEN	AMS2759/5
	Straightening			
171.	Knowledge and understanding that planning must provide that when straightening of heat-treated parts is required and the procedure is not specified, straightening shall be performed as follows: <ul style="list-style-type: none"> Hardened parts shall be straightened during tempering, in between tempers or after the tempering operation. Hardened and tempered parts shall be straightened at ambient temperature or at an elevated temperature not exceeding 50 °F (28 °C) degrees below the tempering temperature. Ambient or elevated temperature straightening shall be followed by stress relieving at a temperature 50 °F (28 °C) degrees below the tempering temperature, unless otherwise specified. 	7	GEN	AMS2759/5
172.	Knowledge and understanding that planning must provide that when required stress relieving shall be in accordance with AMS2759/11.	7	GEN	AMS2759/5
	Properties Hardness			
173.	Knowledge and understanding that planning must provide that parts shall conform to the minimum hardness converted from the required tensile strength stated. Frequency of hardness testing shall be in accordance with AMS2759.	7	GEN	AMS2759/5
	Surface Contamination			
174.	Knowledge and understanding that planning must provide that requirements shall be in accordance with AMS2759, except partial decarburization shall not exceed 0.005 inch. These requirements also apply to the cumulative effects of operations such as austenitizing	7	GEN	AMS2759/5

	followed by re-austenitizing. For reheat treatments, the original specimen, sample part or a portion thereof shall accompany the parts and be tested after reheat treatment.			
175.	Knowledge and understanding planning must provide that parts that are completely masked with a copper plate, not less than 0.0008 inches (20 microns) thick in accordance with AMS2418 shall not require testing. Parts exhibiting blistering, peeling or porosity of the plating are required to be tested.	7	GEN	AMS2759/5
	Test methods			
176.	Knowledge and understanding that planning must provide that testing shall be carried out in accordance with AMS2759.	7	GEN	AMS2759/5
	Classification of tests			
177.	Knowledge and understanding that planning must provide that inspection, classification of tests, sampling and testing, approval, records, record retention and report/certification shall be in accordance with AMS2759 and as follows.	7	GEN	AMS2759/5
	Acceptance Tests			
178.	Knowledge and understanding that planning must provide that hardness is an acceptance tests and shall be performed on each lot of parts. Surface contamination for Type 2 parts with tensile strength 220 ksi (46 HRC) or above is an acceptance test and shall be performed on each lot except as allowed in AMS2759/5.	7	GEN	AMS2759/5
	Periodic Tests			
179.	Knowledge and understanding that planning must provide that surface contamination is a periodic test for Type 2 parts with tensile strength less than or equal to 220 ksi (46 HRC). The test shall be performed monthly for each furnace in service heating parts above a setpoint of 1250 °F (677 °C) and for each class of atmosphere to be used in each furnace.	7	GEN	AMS2759/5
	Preproduction Tests			
180.	Knowledge and understanding that planning must provide that surface contamination is a preproduction test and shall be performed prior to any production heat treating for each furnace heating above 1250 °F (677 °C) and for each class of atmosphere to be used in each furnace.	7	GEN	AMS2759/5
	Sampling and Testing			
181.	Knowledge and understanding that planning must provide that when Surface Contamination Testing is required, One or more samples shall be processed. For parts heat treated in a vacuum, lot acceptance testing for surface contamination testing is not required if the weekly leak rate test is acceptable per AMS2769. For other heating environments, an alternate sampling plan as described in AMS2759/5 may be used	7	GEN	AMS2759/5
182.	Knowledge and understanding that planning must provide that heating below 1400 °F (760 °C) with Class B atmosphere containing 5% or more of hydrogen (H ₂), carbon monoxide (CO), or methane (CH ₄), may result in explosion and fire.	10	GEN	AMS2759/5
183.	Knowledge and understanding that planning must provide that when supplemental plating or coating is used that does not meet AMS2418, all atmosphere controls and surface contamination tests are still required on a plated or coated test specimen.	7	GEN	AMS2759/5
	D) SPECIFIC REQUIREMENTS RELATED TO THE PROCESSING OF: Heat Treatment of Raw Material to AMS-H-6875 parts B, C and D			
184.	Knowledge and understanding that planning must communicate through work instructions or procedures that this specification establishes the heat treatment of Raw Material. It is not applicable to the treatment of parts.	7	GEN	AMS H 6875
185.	Knowledge and understanding that planning must apply this specification only to those materials listed.	7	GEN	AMS H 6875
186.	Knowledge and understanding that in terms of Stainless and PH Steels this specification only applies to types B, C and D.	7	GEN	AMS H 6875
	Furnace media and protective coatings Atmospheres			
187.	Knowledge and understanding that planning must provide that gases used as furnace atmospheres must only be used for the appropriate class of parts. Supplementary protective coatings may be used where necessary.	7	GEN	AMS H 6875
188.	Knowledge and understanding that planning must provide that furnaces for Mill Products shall be supplied with a consistent atmosphere gas that meets the requirements of the material specification.	7	GEN	AMS H 6875
189.	Knowledge and understanding that planning must ensure that atmospheres are controlled such that they do not contaminate parts being treated including vacuum and salt baths.	7	GEN	AMS H 6875
190.	Knowledge and understanding that planning must take into account the need or requirement to carry out purges before treating materials in furnaces whose use is not limited solely to aerospace work.	7	GEN	AMS H 6875
191.	Knowledge and understanding that planning must provide that salt baths may only be used for Class B steels (Martensitic Corrosion Resistant Steels) and must be tested initially and at least weekly to prevent carburization, decarburization, IGA, IGO.	7	GEN	AMS H 6875
	Temperature Uniformity			
192.	Knowledge and understanding that planning must be in accordance with the requirements of AMS 2750 (Pyrometry).	7	GEN	AMS H 6875
193.	Knowledge and understanding that that planning must require furnaces that have instrumentation to a minimum of Type D.	7	GEN	AMS H 6875

194.	Knowledge and understanding that planning must provide that Furnace Class requirements are per AMS2750 as follows: Aging of (Class D) PH stainless steels at 1025 °F (552 °C) and below - Furnace Class 2 +/- 10°F (+/- 6°C) Aging of (Class D) PH stainless steels above 1025 °F (552 °C) - Furnace Class 3 +/- 15°F (+/-8°C) and All Other Processes - Furnace Class 5 +/-25°F (+/-14°C).	7	GEN	AMS H 6875
Quench tanks				
195.	Knowledge and understanding that planning must provide that Quench tanks must permit total immersion and provide adequate circulation to produce the required properties in the largest material processed.	7	GEN	AMS H 6875
196.	Knowledge and understanding that planning must provide that for Oil Quenching medium must be between 60°F and 160°F (15°/71°C) at the beginning of the quench and shall not exceed 200°F (93°C) at any time. The temperature of the oil quenching media shall not exceed the manufacturers recommended operating range. Quench oil used in integral quench vacuum furnace systems, where the quench chamber is below atmospheric pressure, shall be vacuum degassed at approximately the maximum recommended temperature for the quenchant initially and after each major addition of oil.	7	GEN	AMS H 6875
197.	Knowledge and understanding that planning must provide that Aqueous Polymer Quenchants may be used as permitted in AMS H 6875. Baths must have adequate circulation.	7	GEN	AMS H 6875
Quenching from Salt Bath Furnaces				
198.	Knowledge and understanding that planning must provide that water-quenching baths employed in cooling steel parts that have been heated in salt-bath furnaces should be provided with an inflow of fresh water to prevent a concentration of dissolved salts in the tanks. Polymer quenching baths when used in conjunction with salt bath furnaces shall be monitored weekly so that the salt content of the bath shall not exceed 6% by weight of the bath. All salt residues shall be removed from parts processed in salt-bath furnaces or quenched in brine, during or immediately following quenching.	7	GEN	AMS H 6875
Thermal Treatment				
199.	Knowledge and understanding that planning must provide that heating rates must be controlled to prevent damage to material.	7	GEN	AMS H 6875
200.	Knowledge and understanding that planning must provide that material in Class B shall be hardened by Austenitizing, Quenching and Tempering.	7	GEN	AMS H 6875
201.	Knowledge and understanding that planning must provide that Austenitizing temperature and times shall conform to AMS H 6875.	7	GEN	AMS H 6875
202.	Knowledge and understanding that planning must provide that Quenching shall be carried out in the quenchant specified.	7	GEN	AMS H 6875
203.	Knowledge and understanding that that when planning allowance should be made where if hardened material cannot be tempered within 2 hours after quenching material may be Snap Tempered at 400°F +/- 25°F (204°C +/- 14°C) for 1 hour or as appropriate to prevent cracking.	10	GEN	AMS H 6875
204.	Knowledge and understanding that planning must provide that Tempering shall be carried out in compliance with AMS H 6875. Tempering temperatures of AMS H 6875 are recommended unless indicated as mandatory.	7	GEN	AMS H 6875
205.	Knowledge and understanding that planning must provide that Class D steel parts shall be hardened by precipitation heat treatment of material which has been either solution heat treated, or solution treated and cold worked. Thermal treatment for Type D material shall conform to AMS H 6875. The temperature in AMS H 6875 may be adjusted higher to meet specific tensile strengths.	7	GEN	AMS H 6875
206.	Knowledge and understanding that planning must provide that annealing (full annealing) or sub-critical (partial) annealing of Class B or C material shall be accomplished in accordance with AMS H 6875	7	GEN	
Stress Relieving				
207.	<ul style="list-style-type: none"> Knowledge and understanding that planning must provide that stress relieving after hardening of Classes B material shall be accomplished by heating to a maximum temperature of 50 °F below the tempering temperature. Stress relieving after hardening is prohibited on parts that have been peened or cold deformed; e.g., roll threaded. Knowledge and understanding that planning must provide that stress relieving of Class C material shall be accomplished by either heating to 875 °F ± 25 maximum or to 1900 °F and rapid cooling. Knowledge and understanding that planning must provide that hardened Class D material shall be stress relieved for a minimum of 1 hour at 30 °F below the aging temperature. 	7	GEN	AMS H 6875
Cleaning				
208.	Knowledge and understanding that planning must provide that material shall be cleaned prior to heat treatment to remove contaminants and leave no substance that could have a deleterious effect. Cleaning prior to heat treatment is not required for Mill products provided no surface condition is retained that could have a deleterious effect on the product.	7	GEN	AMS H 6875

	Spacing			
209.	Knowledge and understanding that planning must provide that material shall be racked or supported to allow circulation of heating and quenching media exposure to heating or quenching media and to minimize warpage.	7	GEN	AMS H 6875
210.	Knowledge and understanding that planning must provide that approval from the cognizant engineering organization must be obtained prior to the use of coatings or plating for protection of surfaces during heat treatment.	7	GEN	AMS H 6875
	Mechanical Properties			
211.	Knowledge and understanding that planning must take account of the specific requirements of AMS H 6875 for the relevant class of material in determining the heat treatment parameters required to achieve the desired mechanical properties.	10	GEN	AMS H 6875
	Surface Contamination			
212.	Knowledge and understanding that that planning must provide when material is hardened, normalized, or re-hardened the requirements for Decarburization, Carburization and Nitriding and inter-granular attack (IGA) shall apply unless it is definitely known that sufficient material will be subsequently removed to eliminate deleterious surface conditions.	7	GEN	AMS H 6875
	Decarburization, Carburization and Nitriding and inter-granular attack (IGA)			
213.	Knowledge and understanding that process planning must take into consideration the need to control decarburization of Class B material. For furnaces required to treat material to >HRC46 (220ksi/1517Mpa) partial decarburization shall be judged excessive if greater than 0.003-inch-deep on any finish machined surface. For furnaces used to heat-treat material whose final hardness will be less than HRC 46 (220 ksi) decarburization shall be not greater than 0.005-inch-deep on any finish machined surface.	7	GEN	AMS H 6875
214.	Knowledge and understanding that planning must provide that total decarburization is not acceptable.	10	GEN	AMS H 6875
215.	Knowledge and understanding that planning must provide that furnaces used for Heat Treatment above 1250°F(676°C) must be controlled to preclude carburizing or nitriding.	7	GEN	AMS H 6875
216.	Knowledge and awareness that planning must provide that furnaces used for Heat Treatment above 1250°F(676°C) shall be controlled to preclude IGA exceeding 0.0007 inches(0.018mm) on material heat treated to <220 ksi (1517Mpa) and 0.0005 inches (0.013mm) on other materials.	7	GEN	AMS H 6875
	Quenchant effectiveness			
217.	Knowledge and that planning must provide that the consistency of quenchant effectiveness must be determined in each quench tank initially then at least quarterly by one of the methods detailed. Results shall be recorded for ongoing comparison. When results deviate outside of required limits then the test shall be repeated after appropriate corrective action has been taken.	7	GEN	AMS H 6875
	Heat Treatment of Parts			
218.	Knowledge and understanding that planning must take into consideration that under this specification PARTS must be treated in accordance with AMS 2759 and that any reference in this specification (AMS H 6875) to PARTS is superseded by the requirements of AMS 2759.	7	GEN	AMS H 6875
	Control Records			
219.	Knowledge and understanding that planning must provide that records of system accuracy tests, furnace temperature surveys, calibration of control and recording instruments and date, time, temperature, and quenchant used in heat treating material shall be on file and available for review by contractors and Government representatives for 5 years. In addition, heat treaters of final parts shall keep furnace recorder charts for 5 years.	5	GEN	AMS H 6875
	Surface Contamination Tests			
220.	Knowledge and understanding that procedures must ensure that each furnace used for normalizing and austenitizing of Classes B material and solution treating and austenite conditioning of Class D material shall be tested for conformance with surface contamination requirements. (A furnace used exclusively for heat-treatment of material where all contamination on that material will subsequently be removed need not be tested)	7	GEN	AMS H 6875
221.	Knowledge and understanding that planning must provide that specimens of Classes B material may be tested either in the tempered or in the un-tempered condition at the option of the cognizant engineering organization.	5	GEN	AMS H 6875
222.	Knowledge and understanding that procedures must assure that for material made from Classes B and D steels, at least one specimen shall be tested as follows with the first load of each alloy group: <ul style="list-style-type: none"> • Each month for atmosphere furnaces, • Each week for salt baths, and • Each occurrence that purge cycles are run for Class D steel 	10	GEN	AMS H 6875
	Mechanical Properties			
223.	Knowledge and understanding planning must provide for conformance to testing requirements, including: <ul style="list-style-type: none"> • Hardness Test of Heat Treated Material • Tensile Tests (when specified) • Metallographic Tests 	7	GEN	AMS H 6875

224.	<p>Knowledge and understanding that procedures must address testing for Quench Rate Control using one of the following</p> <ul style="list-style-type: none"> • Comparative Cooling Curve Evaluation • Magnetic Quenchometer • Hot Wire Test • Mechanical Properties Test 	7	GEN	AMS H 6875
GENERAL/QMS REQUIREMENTS AFFECTING ALL PROCESSING/SPECIFICATIONS				
225.	Knowledge and awareness that the responsibility for Inspection lies with the special process provider and includes the verification and control of activities carried out by authorized third party contractors or approved suppliers.	7	GEN	AC7102
226.	Knowledge and understanding that the responsibility for compliance lies with the special process provider.	7	GEN	AC7102
227.	Knowledge and understanding that records of SAT, TUS, Calibration, Initial, Periodic, Acceptance Tests, Test results on product and records of all related process parameters and controls must be maintained and available for inspection for a period specified by regulating bodies or customers whichever is the greatest.	7	GEN	AMS2750
SKILLS:				
The skills required to perform a particular special process task. Within these rows enter text that describes the range of skills specified in the Body of Knowledge.				
228.	Has knowledge and understanding to be able to recognize and report in real time deviations from process parameters or other events which may have a negative impact on product quality.	7	GEN	AS9100
229.	Capable of understanding, interpreting and complying with various customer requirements for precedence in documents.	7	GEN	AS9100
230.	Capable of understanding interpreting and complying with various requirements for identification, review and revision of documents (Document Control).	7	GEN	AS9100
231.	Ability to understand and interpret specification requirements and customer flow-down requirements.	7	GEN	AS9100
232.	Has knowledge and understanding to be able to recognize conflicts within customer requirements and deviations from specifications and to ensure that they are resolved prior to final planning.	7	GEN	AS9100
233.	Capable of generating clear and concise Work Instructions consistent with company practices and 'higher level' QMS requirements for general and specific procedures, operator training and approvals.	7	GEN	AS9100
234.	<p>Capable of reviewing and approving records required to demonstrate compliance with customer requirements including:</p> <ul style="list-style-type: none"> • Set temperature • Soak Time • Quench delay time • Quench concentration • Quench temperature before and after quench • Cooling after quench including refrigeration temperature • Periodic and lot acceptance test requirements and results • Temper delay • Heating and Cooling rates (where applicable) 	7	GEN	AC7102
235.	Capable of evaluating potential product impact of deviations from process parameters or other events which may have a negative impact on product quality.	7	GEN	AS9100
236.	Knowledge and understanding of the proper operation, maintenance, and calibration requirements for equipment used for testing evaluation and acceptance (e.g. Hardness)	7	GEN	AC7102/5
237.	Knowledge and understanding of Pyrometry testing requirements including Furnace Class and Type, Calibration, Sensors (thermocouples), SAT and TUS.	7	GEN	AMS2750
238.	Capable of reviewing Calibration, SAT and TUS reports when required.	7	GEN	AMS2750
239.	Capable of documenting an on-going plan for Pyrometry compliance to AMS 2750 at shop and site level.	7	GEN	AMS2750
240.	Capable of planning, monitoring and making timely reminders/notifications of Pyrometry requirements and test frequencies.	7	GEN	AMS2750
241.	Capable of carrying out 'Self Audits.'	7	GEN	AC7102
242.	Capable of conducting internal training and personal qualification exams to comply with HT BoK /ERB requirements	7	GEN	ARP1962
243.	Understanding the safety concerns involved with heat treatment including the need to include in planning instructions the need for the safe use of handling tools and personal protective equipment.	7	GEN	
	Knowledge and understanding of the Preventive Maintenance Program.	7	GEN	AMS2750
Sequencing				
	Has an appropriate understanding of where this process falls in the sequence of events and why it should not deviate without customer/end user permission.	10	GEN	

	PERSONAL ATTRIBUTES: <i>Are statements that will enable judgment of the person's personal attributes</i>			
244.	Define within the following rows statements from the Body of Knowledge or statements from Company sources that will enable judgment of the person's personal attributes.	7	GEN	
245.	Willingness to train and mentor co-workers.			
246.	Good communicator at all levels.	7	GEN	
247.	Takes responsibility to challenge work instructions that do not appear to conform to specification or customer requirements.	10	GEN	
248.	Personal integrity.	7	GEN	
249.	Attentive to details.	7	GEN	
	EXPERIENCE: <i>Are the minimum experience requirement expected to demonstrate their competence.</i>			
	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.			
	Recommended Minimum Classroom Training			
250.	Heat Treatment – 80 hours Paperwork – 40 hours Test, Inspection, Maintenance – 40 hours	10	GEN	ARP 1962
	Recommended Minimum On-the-Job-Training			
251.	Furnace atmospheres and atmosphere control –12 months Stainless and PH Steels – annealing, stress relief and dimensional stabilization – 12 months All other treatments except those above - 24 months	10	GEN	ARP 1962
	Testing and Evaluation			
252.	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 the formal written program. 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.	10	GEN	ARP 1962
	NON-SPECIAL PROCESS RELATED REQUIREMENTS: Defined within these rolls are other general or pre-requisite needed			
253.	Must have a thorough understanding of general Quality Systems (AS9100) or equivalent.	7	GEN	AS9100
254.	Must have a thorough understanding of customer specific requirements developed through the contract review process.	7	GEN	AS9100
255.	Must have a thorough understanding of Control of Non-Conformance for equipment and product including containment, customer notification and disposition.	7	GEN	AS9100

7. DOCUMENT REVISION HISTORY

REVISION DATE	SUMMARY
1 May 2018	Updated to new template
11 October 2018	Reviewed by eQualified Content Developer to ensure it was up to date.
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 TREATMENT

SPECIAL PROCESS	DOCUMENT TITLE	DOCUMENT NUMBER
Heat Treating	Nadcap Audit Criteria for Heat Treatment	AC7102
Heat Treating	Nadcap Audit Criteria for Hardness and Conductivity Testing	AC7102/5
Heat Treating	Nadcap Audit Criteria For Heat Treating Pyrometry	AC7102/8
Heat Treating	SAE Aerospace Materials Specification – Pyrometry	AMS2750
Heat Treating	SAE Aerospace Materials Specification –Heat Treatment of Steel Parts General Requirements	AMS2759
Heat Treating	SAE Aerospace Materials Specification – Heat Treatment of Parts in Vacuum	AMS2769
Heat Treating	SAE Aerospace Materials Specification – Precipitation-Hardening Corrosion-Resistant and Maraging Steel parts	AMS2759/3
Heat Treating	SAE Aerospace Materials Specification – Heat Treatment of Austenitic Corrosion-Resistant Steel Parts	AMS 2759/4
Heat Treating	SAE Aerospace Materials Specification – Heat Treatment Martensitic Corrosion-Resistant Steel Parts	AMS 2759/5
Heat Treating	SAE Aerospace Materials Specification – Heat Treatment of Steel Raw Materials	AMS-H-6875
Heat Treating	SAE Aerospace Recommended Practice - Training and Approval of Heat- Treating Personnel	ARP 1962
Quality	AS9100 Quality Management Systems - Requirements for Aviation, Space and Defense Organizations	AS9100
Quality	Quality Standards	ISO9001