PRI Qualification 161 Thorn Hill Road Warrendale, PA 15086-7527	**Program Document HTBOK**	**PD 6103** **HTBoK-015/PL-2 REV. B** Issued: **06-MAR-17** Revised: **27-OCT-22 B** Superseding: **HTBoK-015/PL-2 Rev. A**

BODY OF KNOWLEDGE

ROLE DESCRIPTION: Planner
SPECIAL PROCESS: Heat Treatment
METHOD: Performance of Carbon and Alloy Steel Requirements

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

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

1. INTRODUCTION

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

This document constitutes the PRI Qualification[SM] program BoK for Carbon and Alloy Steel Planner. It defines the baseline knowledge and experience required to be considered competent to perform this role.

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

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

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

2. REFERENCES

PRI Qualification[SM] program documents:

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

IAQG documents:
IAQG Guidance PCAP 001 Competence Management Guideline

3. DEFINITIONS

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

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

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

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

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

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

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

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

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

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

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

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

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

4. GUIDANCE TO EXAMINATION CANDIDATES

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

Re-assessment of candidates to this BoK is required every at least 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 PRI Qualification Approved Training Providers can be found at www.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)

For more information on data retention, please see PRI's privacy statement.

5. LEVELS

Level			
Descriptors	***Operator (OP) / Technician(T)*** ***For descriptions, please refer to current version of PD6000***	***Planner (PL)*** ***For descriptions, please refer to current version of PD6000***	***Owner (OW)*** ***For descriptions, please refer to current version of PD6000***
Heat Treat Specific Criteria	Basic understanding of the process for heat treatment of carbon and alloy steel including cleaning, loading, start and end of soak, atmospheres, quenching tempering, refrigeration, testing, and documentation.	In addition to knowing what the Operator does, the Planner must: Be capable of interpreting customer requirements and converting them into clear work instructions at the proper level of operator understanding.	In addition to knowing what the Operator and Planner do, the Owner must: Manage people who perform the work and who evaluate and review 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.	Sufficient experience to deal with unforeseen issues.	Widely proven experience as a 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: Carbon and Alloy Steel
REFERENCE GUIDELINES: *Addendum 1 is a list of the International Standards and Reference Documents applicable to carbon and alloy steel heat treatment processes.*

Note: The term "planning" as used in the following Table is meant to include any combination of company-wide procedures, local department resident work instructions, part specific routers or travelers, and documented training that has been determined to provide complete instructions to operators. It should not be implied that all necessary information will be found in a single document.

	COMPETENCE	Weight (1,3,7,10)	Exam Type Written/ Practical	Reference Guidelines
	KNOWLEDGE: The basic knowledge of the special processes, methods, and tools			
	General Quality Systems Knowledge			
1.	Aerospace Quality Systems and compliance.	**7**	**W**	AS9100
2.	Internal work instructions as well as industry standards. (see Addendum -1 of this document).	**7**	**W**	AS9100
3.	How non-conformance is addressed using tools such as Root Cause Corrective Action and 5 Why's.	**7**	**W**	AS9100
4.	The need to meet safety compliance requirements as applicable.	**10**	**W**	AS9100
5.	The requirements for traceability of calibration to NIST or equivalent national agencies.	**7**	**W**	AS9100
6.	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**	**W**	AS9100
7.	The responsibility for compliance lies with the special process provider.	**7**	**W**	AS9100
8.	Records of System Accuracy Tests, Temperature Uniformity Surveys, Calibration, and of Initial, Periodic and Acceptance Tests, of test results on product and 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**	**W**	AS9100
	Parts and Raw Material			
9.	Parts as covered here by AMS2759/1 and AMS2759/2 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**	**W**	AMS2759, AMS2759/1, AMS2759/2
10.	Raw Material as covered here by AMS-H-6875 and AMS2761 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**	**W**	AMS-H-6875, AMS2761
11.	*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.*	**NA**	**NA**	
	Pyrometry			
12.	The importance of compliance with all Pyrometry requirements including temperature sensors, instrumentation, classification of thermal processing equipment, system accuracy tests, and temperature uniformity surveys and including reporting of any non-conformances.	**7**	**W**	AMS2750
13.	The importance of producing Work Instructions which are in compliance with customer requirements and AMS2750 as related to Pyrometry including sensors (thermocouples) and instrument calibration, and furnace class (uniformity) and instrumentation type, Temperature Uniformity Surveys and System Accuracy Tests.	**7**	**W**	AMS2750
14.	*Caution: Heat Treatment of carbon and alloy steels shall not be implemented without a prerequisite understanding of the Pyrometry requirements which affect these material types.*	**NA**	**NA**	
	General Metallurgical Knowledge Related to Heat Treating Carbon and Alloy Steels (Applicable to all specifications referencing AMS2759, AMS2761, AMS2769 and AMS-H-6875)			
15.	The metallurgy of carbon and alloy steels and the effect this must have on planning.	**7**	**W**	AMS2759/1,

				AMS2759/2, AMS2761, AMS-H-6875
16.	The ability to clearly plan Heat Treatment instructions applied to Carbon and Alloy Steels including the following: • Annealing • Subcritical Annealing • Stress Relieving • Preheating • Hardening (Austenitizing and Quenching) • Tempering • Snap Tempering • Low Temperature / Cryogenic treatments • Normalizing	**7**	**W**	AMS2759, AMS2759/1, AMS2759/2 AMS2769, AMS-H-6875
17.	The definitions and importance of terms applicable to Heat Treatment of Carbon and Alloy Steels: • Set temperature (Set Point) • Heating • Start of soak • Soak time • End of soak • Interruptions • Temper / Cryogenic delay • Protective Coatings • Cleaning	**10**	**W**	AMS2759, AMS2759/1, AMS2759/2, AMS2761, AMS2769, AMS-H-6875
18.	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.	**7**	**W**	AMS2759, AMS2759/1, AMS2759/2, AMS2761, AMS-H-6875
19.	That planning must reflect the use of equipment and instruments for the heat treatment of carbon and alloy steels which must be in accordance with AMS2750 and all customer requirements.	**10**	**W**	AMS2750, AMS2759, AMS2759/1, AMS2759/2, AMS2761, AMS-H-6875
20.	**Pyrometry** 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, except Vacuum Furnaces. Vacuum Furnaces shall have a minimum of Type B instrumentation, unless otherwise qualified.	**10**	**W**	AMS2750, AMS2759, AMS2769
21.	**Furnace Equipment** 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: • Furnaces for annealing, subcritical annealing, normalizing, hardening, austenitizing or solution treating, and stress relieving shall be Class 5 (+/- 25°F (14°C)) or better • Furnaces for tempering or aging/precipitation hardening shall be Class 3 (+/- 15°F (8°C)) or better. *Caution: Furnace requirements for certain specific materials and processes may be contained in the individual specification.*	**7**	**W**	AMS2750, AMS2759
22.	**Heating Environment** Knowledge and understanding that Classes of Atmospheres are defined in AMS2759 as follows • 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**	**W**	AMS2759, AMS2769
23.	**Atmosphere Control** 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 AMS2759/1 or AMS2759/2, as applicable.	**7**	**W**	AMS2759, AMS2769
24.	**Class A Atmospheres, Inert Gas Bulk Delivery** Knowledge and understanding that procedures must control that the composition and dew point of the process gas shall be as required by AMS2759/1 or AMS2759/2 and traceable to a certificate of conformance. The dew point of the gas shall be -60 ºF (-51 ºC) or lower as the gas enters the furnace and shall be verified at least quarterly and when the piping transmitting the gas is disturbed. In lieu of	**5**	**W**	AMS2759

	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.			
25.	**Servicing and Calibration of Atmosphere Control Equipment** 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	**7**	**W**	AMS2759, AMS2769
	Types of Parts			
26.	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. 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. 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.	**10**	**W**	AMS2759
27.	Knowledge and understanding that planning must include that if part type cannot be determined, the part shall be processed as Type 2. For parts previously determined to be Type 3 or Type 4, the parts shall be processed as Type 2	**10**	**W**	AMS2759
28.	Knowledge and understanding that planning must address parts with protective coating on all surfaces shall be processed in an atmosphere that will not destroy the coating during heat treatment.	**10**	**W**	AMS2759
29.	**Quenching Equipment** 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**	**W**	AMS2759, AMS2769
30.	**Auxiliary Equipment** Knowledge and understanding that planning must control that fixtures and fixture materials shall not cause contamination of parts.	**5**	**W**	AMS2759, AMS2769
31.	**Sub-Zero Cooling or Deep Freeze** 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**	**W**	AMS2759
32.	**Cleaning Equipment** 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**	**W**	AMS2759
33.	Knowledge and understanding that vacuum furnaces specified in planning must meet the requirements of AMS2769.	**10**	**W**	AMS2759, AMS2769
34.	**Quenching Media** Knowledge and understanding that when liquid quenching is required, planning may only use quenching media as specified in AMS2759/1 or AMS2759/2, as applicable.	**7**	**W**	AMS2759
35.	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**	**W**	AMS2759
36.	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**	**W**	AMS2759
37.	**Quenching from Salt Bath Furnaces** 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**	**W**	AMS2759
38.	**Quench Effectiveness** 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**	**W**	AC7102
39.	**Polymer Quenchants** 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**	**W**	AC7102
40.	Knowledge and understanding that procedures must specify the frequency and methods for	**5**	**W**	AC7102

	determining the polymer concentration in accordance with specification and customer requirements.			
41.	**Salt Baths** 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**	**W**	AC7102, AMS2759
42.	**Heat Treatment** Knowledge and understanding that planning must be in accordance with AMS2759/1 or AMS2759/2 for the required material and process. In case of conflict between AMS2759 and the slash specification, the slash specification shall take precedence.	**10**	**W**	AMS2759
43.	**Cleaning** 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**	**W**	AMS2759
44.	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**	**W**	AMS2759, AC7102
45.	**General Cleaning** 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**	**W**	AC7102
46.	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**	**W**	AMS2769
47.	**Racking** 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**	**W**	AMS2759
48.	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**	**W**	AC7102
49.	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**	**W**	AC7102
50.	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**	**W**	AC7102
51.	**Purging** Knowledge and understanding that planning must include that 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**	**W**	AMS2759, AC7102, AMS2769
52.	**Loading** 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 thermocouples are attached to the part to ensure the part temperature does not exceed the set temperature.	**7**	**W**	AMS2759
53.	**Set Temperature** Knowledge and understanding that planning must provide that control instrument(s) shall be set at the temperature specified by AMS2759/1 or AMS2759/2 as applicable.	**7**	**W**	AMS2759
54.	**Heat Treatment in Vacuum Furnaces**	**7**	**W**	AC7102,

	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			AMS2769
55.	Knowledge and understanding that internal procedure, photographic evidence, or other documentation must specify placement of load thermocouples, racking of parts, and furnace loading	**5**	**W**	AC7102, AMS2769
56.	Knowledge and understanding that planning must ensure that vacuum furnaces used meet the requirements of AMS 2769 and Customer / Prime specifications and be capable of achieving the vacuum levels and leak rates specified.	**7**	**W**	AMS2769
57.	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**	**W**	AMS2769
58.	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**	**W**	AMS2769
59.	Knowledge and understanding of the need for documenting repairs or changes of seals particularly on doors, thermocouple entry ports and gauges.	**5**	**W**	AMS2750
60.	**Soak** Knowledge and understanding of why adherence to set temperatures and furnace uniformity is critical and the ability to clearly convey that through planning.	**10**	**W**	AC7102
61.	**Start of Soaking** 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. 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. 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.	**10**	**W**	AMS2759
62.	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**	**W**	AC7102
63.	**Quench** 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**	**W**	AC7102
64.	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**	**W**	AC7102
65.	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**	**W**	AC7102
66.	Knowledge and understanding that planning must include a requirement to verify that agitation of quench media or the parts during quenching conform to applicable specifications.	**5**	**W**	AC7102
67.	**Gas Quenching in Vacuum furnaces** 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**	**W**	AMS2769
68.	Knowledge and understanding that planning must address how to check cooling rates on gas quenching when there are specific requirements.	**5**	**W**	AMS2769
69.	**Low Temperature Treatment when Required by Specification** 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**	**W**	AC7102
70.	Knowledge and understanding that records must show that cooling after quench is in compliance with customer requirements specified in procedures or shop planning.	**7**	**W**	AC7102
71.	Knowledge and understanding that procedures and job planning must specify time/temperature limits for sub-ambient/subzero treatments	**7**	**W**	AC7102
72.	Knowledge and understanding that planning must include recording the temperature in each refrigeration cycle to allow verification against Customer / Prime requirements	**7**	**W**	AC7102
73.	**Records**	**10**	**W**	AMS2759

	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.			
74.	**Qualification** 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**	**W**	AMS2759
75.	**Test Methods** Knowledge and understanding that planning must provide for the following tests, as applicable: • 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**	**W**	AMS2759, ASTM A370, ASTM E8 / E8M, ASTM E10, ASTM E18, ASTM E110, ASTM E384
76.	**Rejection Criteria** Knowledge and understanding that planning must provide for the following: • 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**	**W**	AMS2759
77.	**Additional Processes** Knowledge and understanding that planning must assure that parts are not subjected to thermal operations other than those specified in the ordering document	**10**	**W**	AMS2759
78.	**Surface Contamination** Knowledge and understanding that planning must provide for the control of surface contamination when heating parts above 1250 °F (677 °C) and evaluation in accordance with at least one of the methods stated under Surface Contamination Test Methods, as follows: • 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 reaustenitizing. 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**	**W**	AMS2759
79.	**Strength Ranges** 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**	**W**	AMS2759
80.	Knowledge and understanding that when both the minimum tensile strength and the tempering	**5**	**W**	AMS2759

	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.			
81.	**Acceptance Tests** Knowledge and understanding that planning must include acceptance testing and documentation as specified in the AMS2759/1 or AMS2759/2, as applicable	**7**	**W**	AMS2759
82.	**Periodic Testing** Knowledge and understanding that planning must take account of the need for periodic testing which must be scheduled and documented.	**5**	**W**	AMS2759, AMS2769
83.	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**	**W**	AMS2759, AMS2769
84.	**Surface Contamination Testing** Knowledge and understanding that internal testing procedures must cover the following: • Partial decarburization • Total decarburization • Carburization • IGO/IGA (Inter Granular Oxidation/Inter Granular Attack) test	**5**	**W**	AC7102
85.	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**	**W**	AC7102
86.	**Additional Periodic Tests** Knowledge and understanding that planning must address periodic tests as specified in AMS2759/1 or AMS2759/2, 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**	**W**	AMS2759
87.	**Preproduction Tests** 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**	**W**	AMS2759
88.	**Sampling and Testing** 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**	**W**	AMS2759
89.	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**	**W**	AMS2759
90.	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**	**W**	AMS2759
91.	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**	**W**	AMS2759
92.	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**	**W**	AMS2759
93.	**Corrosion Protection** Knowledge and understanding that planning must provide corrosion protection measures for parts which are susceptible to corrosion (e.g. carbon and low alloy steels) during processing and storage.	**5**	**W**	AMS2759
94.	**Process Verification** 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**	**W**	AC7102
95.	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**	**W**	AC7102
	Requirements Specific to Product Processed in Accordance with Specific AMS Standards Described Above (Competence)			
	A) Specific Requirements Related to: AMS2759/1 – Heat Treatment of Carbon and Low-Alloy Steel Parts Minimum Tensile Strength Below 220 ksi (1517 MPa)			

96.	That this specification, in conjunction with the general requirements for steel heat treatment covered in AMS2759, establishes the requirements for heat treatment of carbon and low-alloy steel parts to minimum ultimate tensile strengths below 220 ksi (1517 MPa).	**7**	**W**	AMS2759/1
97.	That heat treatment of carbon and low-alloy steel parts to minimum ultimate tensile strengths below 220 ksi (1517 MPa) shall conform to AMS2759 and the requirements specified herein.	**7**	**W**	AMS2759/1
98.	That due to limited hardenability in these materials there are size limits in this specification which must be observed.	**7**	**W**	AMS2759/1
99.	That equipment shall conform to AMS2759.	**7**	**W**	AMS2759/1
100.	That planning must provide that equipment specifically used for tempering of H-11, D6AC, and 9Ni-4Co steels shall conform to AMS2750, Class 2.	**10**	**W**	AMS 2750, AMS2759/1
101.	**Heating Environment** That planning must provide that parts are controlled by type and heat treated in the class of atmosphere permitted by AMS2759/1 for that type when heating above 1250 °F (677 °C). When heating parts at 1250 °F (677 °C) or below, Class A, B, or C atmosphere may be used. Atmosphere Class and Part Type are described in AMS2759.	**7**	**W**	AMS 2759, AMS2759/1
102.	That per AMS2759/1, when heating above 1250 °F (677 °C) Class A, B or C atmospheres may be used for Type 1 parts and that only Class A atmospheres can be used for Type 2 parts. *Note: Class B atmospheres can be used for Type 2 parts provided the atmosphere is controlled to meet the surface contamination requirements of AMS2759/1*	**10**	**W**	AMS2759/1
103.	**Protective Coatings** That a supplemental coating or plating is permitted when approved by the cognizant engineering organization. Planning may specify that fine grain copper plating in accordance with AMS2418 or nickel plating in accordance with AMS2424 may be used without approval but surface contamination test specimens shall not be plated	**5**	**W**	AMS2418, AMS2424, AMS2759/1
104.	**Preheating** That preheating until furnace stabilization in the 900 to 1200 °F (482 to 649 °C) range is recommended before heating parts above 1300 °F (704 °C) if the parts have previously been heat treated to a hardness greater than 35 HRC, have abrupt changes of section thickness, have sharp reentrant angles, have finished machined surfaces, have been welded, have been cold formed or straightened, have holes, or have sharp or only slightly-rounded notches or corners.	**3**	**W**	AMS2759/1
	Soaking			
105.	That planning must provide that soaking time shall be in accordance with AMS2759.	**10**	**W**	AMS2759/1
106.	That planning must take into account that parts coated with copper plate or similar reflective coatings that tend to reflect radiant heat shall have their soak time increased by at least 50%, unless load thermocouples are used. This increase does not apply to salt bath heat treating, tempering, or sub-zero processing.	**7**	**W**	AMS2759/1
	Annealing			
107.	That planning for annealing must conform to AMS2759/1 and require heating to the specified set temperature, soaking for the time specified, and cooling to below the temperature specified at the rate shown followed by air cooling to ambient temperature.	**7**	**W**	AMS2759/1
108.	That isothermal annealing treatments may be used provided equivalent hardness is obtained. Planning for isothermal annealing must conform to AMS2759/1 and specify heating to the annealing temperature specified, soaking for the time specified, cooling to a temperature below the critical, holding for sufficient time to complete transformation, and air cooling to ambient temperature	**7**	**W**	AMS2759/1
109.	**Subcritical Annealing** That planning for subcritical annealing prior to hardening must specify heating to a set temperature between 1150 and 1250 °F (621 and 677 °C), soaking for the time specified in AMS2759/1, and cooling to ambient temperature.	**5**	**W**	AMS2759/1
110.	**Pre-Hardening Stress Relieving** That planning for pre-hardening stress relieving must specify heating shall be done in accordance with AMS2759/11 prior to hardening at a set temperature between 1000 and 1250 °F (538 to 677 °C), soaking for not less than the time specified in AMS2759/1, and cooling to ambient temperature.	**5**	**W**	AMS2759/1, AMS2759/11
111.	**Normalizing** That planning for normalizing must conform to AMS2759/1 and specify heating to the required temperature, soaking for the time specified, and cooling in air or atmosphere to ambient temperature. Circulated air or atmosphere is recommended for thicknesses greater than 3 inches (76 mm). Normalizing may be followed by tempering or subcritical annealing.	**5**	**W**	AMS2759/1
	Hardening (Austenitizing and Quenching)			
112.	That hardening shall be accomplished in accordance with AMS2759/1 by heating to the specified set temperature, soaking for the time required, and quenching as required. The parts shall be cooled to or below the quenchant temperature or to a temperature low enough to achieve complete transformation, before tempering. Parts may be gas quenched provided they have been qualified per	**7**	**W**	AMS2759/1

	AMS2759/1 Appendix A or in accordance with another procedure approved by the cognizant engineering organization. The alloy, part size and load size shall be qualified prior to processing hardware. Prior to initial tempering parts may be snap tempered for 2 hours minimum at a temperature, usually 400 °F (204 °C), that is lower than the tempering temperature.			
113.	As steel parts hardened to this specification have limited hardenability, which varies by alloy, the size limits of AMS2759/1 shall apply. Parts exceeding size limitations shall be machined to within 0.125 inches of the final dimensions prior to hardening. With cognizant engineering organization approval, parts may be greater than 0.125 inch (3.2 mm) of the final dimensions prior to hardening.	**7**	**W**	AMS2759/1
114.	Planning must include that welded parts, and brazed parts with a brazing temperature above the normalizing temperature, shall be normalized before hardening. For welded or brazed alloys that are not normalized (for example H-11), the parts shall be annealed. Welded parts should be preheated in accordance with AMS2759/1. Parts identified as damage tolerant, maintenance critical, or fracture critical shall be in the normalized condition before hardening, unless the alloy is not normalized, in which case the part shall be annealed.	**7**	**W**	AMS2759/1
	Tempering			
115.	That planning must include that tempering be accomplished by heating quenched parts to the set temperature required to produce the stated properties. Parts should be tempered within two hours of quenching. Suggested tempering temperatures for specific tensile strengths for each alloy and quenchant are given in AMS2759/1. Alternate tempering temperatures for listed alloys, based on as-quenched hardness, are also given.	**7**	**W**	AMS2759/1
116.	That planning must include that soaking time for tempering shall be not less than two hours plus one hour additional for each inch (25 mm) of thickness or fraction thereof greater than one inch (25 mm). Thickness is defined in AMS2759.	**7**	**W**	AMS2759/1
117.	That when load thermocouples are used, planning must include that the soaking time shall be not less than 2 hours.	**7**	**W**	AMS2759/1
118.	That multiple tempering is permitted and that when multiple tempering is used, planning must provide that parts be cooled to ambient temperature between tempering treatments.	**5**	**W**	AMS2759/1
119.	That planning must include that when tempering cannot be started within 4 hours from the end of quenching, parts shall be snap tempered for 2 hours minimum at a temperature that is lower than the final tempering set temperature; usually 400 °F (204 °C). *Note: Snap tempering is an intermediate low temperature treatment to relieve stresses and prevent cracking prior to the next operation. Final tempering to the specified requirements is performed after snap tempering.*	**3**	**W**	AMS2759/1
	Straightening			
120.	That planning may allow straightening for parts having minimum tensile strength below 180 ksi (1241 MPa) cold without stress relieving.	**5**	**W**	AMS2759/1
121.	That straightening of parts hardened and tempered to minimum tensile strength of 180 ksi (1241 MPa) and higher must be accomplished during tempering, or by heating to not higher than 50 °F (28 °C) below the tempering temperature.	**7**	**W**	AMS2759/1
122.	That planning must provide that hot or warm straightening after tempering shall be followed by stress relieving	**5**	**W**	AMS2759/1
123.	That it is permissible to re-temper at a temperature not higher than the last tempering temperature after straightening during tempering.	**5**	**W**	AMS2759/1
124.	**Properties** That planning shall provide that parts conform to the specified hardness or the hardness converted from the tensile strength ranges stated or the hardness converted from the tensile strength ranges of AMS2759/1, as applicable. Hardness testing shall not be used to reject parts that meet specified tensile properties. Frequency of hardness testing shall be in accordance with AMS2759.	**7**	**W**	AMS2759/1
	Surface Contamination			
125.	Planning shall address that surface contamination shall be in accordance with AMS2759, except partial decarburization shall not exceed 0.005 inch (0.13 mm).	**7**	**W**	AMS2759/1
126.	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, i.e., Type 2 parts may be reclassified as Type 1 parts and need not meet the requirements as heat treated, when it is demonstrated by tests on each load that all surface contamination exceeding the requirements will be removed from all machined surfaces, taking into account distortion after heat treatment. *Note: This allows the maker of these parts and the heat treater to pre-plan dimensions for adequate removal of decarburization without being constrained by atmosphere limits and leaving less than 0.020 inch (0.51 mm) stock to clean up. This also reflects the surface contamination requirement in AMS2759.*	**7**	**W**	AMS2759/1
127.	The heat treating processor shall be responsible for determining whether cumulative heat-treating operations at their facility have caused surface contamination in excess of that allowed.	**7**	**W**	AMS2759/1

128.	**Test Methods** That planning must provide for the required testing per AMS2759 and AMS2759/1. Test methods shall be in accordance with AMS2759.	**7**	**W**	AMS2759/1
129.	**Quality Assurance Provisions** That planning must address inspection, classification of tests, sampling, approval, entries, records, and reports in accordance with AMS2759 and AMS2759/1.	**7**	**W**	AMS2759/1
130.	**Acceptance Tests** Hardness is an acceptance test and shall be performed on each lot. Surface contamination on damage tolerant, maintenance critical, or fracture critical parts is an acceptance test and shall be performed on each lot. *Note: The terms "damage tolerant," "maintenance critical," or "fracture critical" are typically referenced on engineering drawings by the design authority.*	**10**	**W**	AMS2759/1
131.	**Periodic Tests** That planning must provide that, in addition the tests specified in AMS2759, tests for surface contamination shall be performed monthly on each furnace in service, each kind of atmosphere to be used in each furnace, and for each Class B atmosphere at two carbon potentials, up to 0.40% and over 0.40%. Furnaces used exclusively to heat treat parts that will have all contamination removed, i.e., Type 1 parts, shall not require testing.	**7**	**W**	AMS2759/1
132.	**Preproduction Tests** That procedures must address that, in addition to the tests specified in AMS2759, tests for surface contamination shall be performed prior to any production heat treating on each furnace, each kind of atmosphere to be used in each furnace, and for each Class B atmosphere at two carbon potentials, up to 0.40% and over 0.40%. Furnaces used exclusively to heat treat parts that will have all contamination removed, i.e., Type 1 parts, shall not require testing.	**7**	**W**	AMS2759/1
133.	That heating below 1400 °F (760 °C) with Class B atmospheres containing 5% or more of hydrogen (H2), carbon monoxide (CO), or methane (CH4), may result in explosion and fire.	**10**	**W**	AMS2759/1
134.	That use of a chromic-caustic etch to reveal intergranular attack/oxidation has been discontinued because (1) it is an environmental hazard (2) it is unnecessary for measurement of maximum depth of crevices, and (3) light etching zones extending beyond the crevices have been misinterpreted as manifestations of intergranular oxidation.	**3**	**W**	AMS2759/1
	B) Specific Requirements Related to: AMS2759/2 - Heat Treatment of Carbon and Low-Alloy Steel Parts 220 ksi (1517 MPa) Minimum Tensile Strength and Higher			
135.	That this specification, in conjunction with the general requirements for steel heat treatment covered in AMS2759, establishes the requirements for heat treatment of low-alloy steel parts to minimum ultimate tensile strengths of 220 ksi (1517 MPa) and higher. Parts are defined in AMS2759. Due to the limited hardenability of these materials, there are size limits included in this specification. *Note: The requirements for heat treatment of alloy Aermet100 are no longer part of this specification and can be found in AMS2759/3.*	**7**	**W**	AMS2759/2, AMS2759/3
136.	That heat treatment of low-alloy steel parts to minimum ultimate tensile strengths of 220 ksi (1517 MPa) shall conform to AMS2759 and the requirements specified herein.	**7**	**W**	AMS2759/2
137.	That equipment shall conform to AMS2759 except that tempering furnaces shall be in accordance with AMS2750 Class 2.	**7**	**W**	AMS2750, AMS2759/2
138.	**Heating Environment** That planning must provide that parts are controlled by type and heat treated in the class of atmosphere permitted in AMS2759/2 for that type when heating above 1250 °F (677 °C). When heating parts at 1250 °F (677 °C) or below, Class A, B, or C atmosphere may be used. Atmosphere Class and Part Type are described in AMS2759.	**7**	**W**	AMS2759/2
139.	That per AMS2759/2, when heating above 1250 °F (677 °C) Class A, B or C atmospheres may be used for Type 1 parts and that only Class A atmospheres can be used for Type 2 parts. *Note: Class B atmospheres can be used for Type 2 parts provided the atmosphere is controlled to meet the surface contamination requirements of AMS2759/2*	**10**	**W**	AMS2759/2
140.	**Protective Coatings** That a supplemental coating or plating is permitted when approved by the cognizant engineering organization. Planning may specify that fine grain copper plating in accordance with AMS2418 or nickel plating in accordance with AMS2424 may be used without approval but surface contamination test specimens shall not be plated. Failure of the unplated specimen to meet contamination requirements shall result in investigation and remedial action taken against the furnace. Additional surface contamination specimens, which include supplemental coating or plating may be processed and tested and shall be used to represent the parts within the load.	**5**	**W**	AMS2424, AMS2759/2
141.	**Preheating** That the following parts shall be preheated in the range of 900 to 1250 °F (482 to 677 °C) before heating above 1300 °F (704 °C) until such time as the furnace is stabilized at the required temperature: • Parts previously heat treated to a hardness of greater than HRC 35.	**7**	**W**	AMS2759/2

	• Parts that have been welded. • Parts that have been cold formed or straightened. • Parts that have geometries that would result in high thermally induced stresses such as abrupt changes in section, sharp angular changes, have holes or slots, sharp or slightly rounded notches or corners. • Parts that have been normalized without tempering.			
142.	Preheating in a separate furnace is allowed provided that parts are transferred without delay into the heat treatment furnace.	**7**	**W**	AMS2759/2
	Soaking			
143.	That planning must control that the start of soaking time shall be in accordance with AMS2759.	**7**	**W**	AMS2759/2
144.	That planning must take into account that parts coated with copper or nickel plate or similar reflective coatings that tend to reflect radiant heat shall have their soak time increased by at least 50%, for annealing, normalizing, sub-critical annealing, or austenitizing unless load thermocouples are used. This increase does not apply to salt bath heat treating, tempering, or sub-zero processing.	**7**	**W**	AMS2759/2
	Annealing			
145.	That planning for annealing must include heating to the temperature specified in AMS2759/2, soaking for the time specified, and cooling to below the temperature specified at the required rate followed by air cooling to ambient temperature.	**7**	**W**	AMS2759/2
146.	That isothermal annealing treatments may be used providing equivalent hardness and microstructure are obtained. Isothermal annealing shall be accomplished by heating to the annealing temperature specified in AMS2759/2, soaking for the time specified, cooling to a temperature below the critical, holding for sufficient time to complete transformation, and air cooling to ambient temperature.	**5**	**W**	AMS2759/2
147.	**Subcritical Annealing** That when subcritical annealing prior to hardening is required, planning must specify heating to a set temperature between 1150 and 1250 °F (621 to 677 °C), soaking for the time specified in AMS2759/2, and cooling to ambient temperature. Steel parts of the 9Ni - 4Co types shall be subcritical annealed as specified in AMS2759/2.	**7**	**W**	AMS2759/2
148.	**Pre-Hardening Stress Relieving** When required, pre-hardening stress relieving shall be done in accordance with AMS2759/11.	**5**	**W**	AMS2759/2, AMS2759/11, AMS2769
149.	**Normalizing** That planning for normalizing must specify heating to the temperature specified in AMS2759/2, soaking for the time specified, and cooling in air or atmosphere to ambient temperature. Circulated air or atmosphere is recommended for thicknesses greater than 3 inches (76 mm). Normalizing may be followed by tempering or subcritical annealing.	**7**	**W**	AMS2759/2
	Hardening (Austenitizing and Quenching)			
150.	That planning must include that all parts, except those made from H-11, shall be in one of the following conditions prior to austenitizing: normalized, normalized and tempered, or hardened and tempered.	**7**	**W**	AMS2759/2
151.	That planning must include that if such parts have been normalized only, without tempering or over-aging, they shall be preheated as required above before exposure to the austenitizing temperature.	**7**	**W**	AMS2759/2
152.	As steel parts hardened to this specification have limited hardenability, which varies by alloy, the size limits in AMS2759/2 shall apply. Planning must provide that parts exceeding size limitations shall be machined to within 0.125 inches of the final dimensions prior to hardening. With cognizant engineering organization approval, parts may be greater than 0.125 inch (3.2 mm) of the final dimensions prior to hardening.			AMS2759/2
153.	That planning for welded parts, and for brazed parts with a brazing temperature above the normalizing temperature, shall be normalized before hardening. Welded parts should be preheated as specified above.	**5**	**W**	AMS2759/2
154.	That planning must include that hardening shall be accomplished by heating to the austenitizing temperature specified in AMS2759/2, soaking for the time specified, and quenching as required. The parts shall be cooled to or below the quenchant temperature or to a temperature low enough to achieve complete transformation, before tempering. Parts made from alloys specifically noted in AMS2759/2 as allowing inert gas quenching shall have gas quenching qualified per Appendix A of AMS2759/2 or per another procedure approved by the cognizant engineering organization.	**10**	**W**	AMS2759/2
	Tempering			
155.	That planning must include that tempering, when required, be accomplished by heating to the set temperature specified in AMS2759/2. Parts should be tempered within 2 hours from the end of quenching. 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.	**7**	**W**	AMS2759/2
156.	That when load thermocouples are used, the soaking time shall be not less than 2 hours.	**7**	**W**	AMS2759/2

157.	That when multiple tempering cycles are required, parts shall be cooled to ambient temperature between tempering treatments.	**3**	**W**	AMS2759/2
158.	When a strength or hardness not listed in AMS2759/2 is specified, the parts shall be processed at times and temperatures appropriate to achieve the specified properties			AMS2759/2
159.	That planning must include that when tempering cannot be started within 4 hours from the end of quenching, parts shall be snap tempered for 2 hours minimum at a temperature that is lower than the final tempering set temperature; usually 400 °F (204 °C). *Note: Snap tempering is an intermediate low-temperature treatment to relieve stresses and prevent cracking prior to the next operation. Final tempering to the specified requirements is performed after snap tempering.*	**3**	**W**	AMS2759/2
160.	**Straightening** When approved by the cognizant engineering organization, straightening shall be accomplished as stated in an approved procedure.	**10**	**W**	AMS2759/2
	Post-Tempering Stress Relieving			
161.	That when required, post tempering stress relieving shall be in accordance with AMS2759/11.	**5**	**W**	AMS2759/2, AMS2759/11
	Properties:			
162.	**Hardness** Parts shall conform to the hardness range stated in AMS2759/2. Hardness testing shall not be used to reject parts that meet specified tensile properties. Frequency of hardness testing shall be in accordance with AMS2759.	**7**	**W**	AMS2759/2
163.	*Note: If tensile strength testing is specified to be performed and the hardness readings, converted to tensile strength, do not meet the specified tensile properties, the parts shall not be rejected as long as the tensile test results are conforming.*			AMS2759/2
	Surface Contamination			
164.	That planning must provide that when heating to a temperature above 1250 °F (677 °C), surface contamination shall be in accordance with AMS2759	**10**	**W**	AMS2759/2
165.	Planning must provide that when supplemental plating or coating, such as copper plate, is used, all atmosphere controls and surface contamination tests are required.	**10**	**W**	AMS2759/2
166.	**Test Methods** That planning must provide for the required testing per AMS2759	**7**	**W**	AMS2759/2
167.	**Quality Assurance Provisions** That planning must address inspection, classification of tests, sampling and testing, approval, records, record retention, and report/certification in accordance with AMS2759 and AMS2759/2 and as follows.	**7**	**W**	AMS2759/2
168.	**Acceptance Tests** That planning must provide that hardness, tensile properties, when required, and surface contamination are acceptance tests and shall be performed on each lot of Type 2 parts. Alternatively, if carbon potential is controlled automatically and either indicated or recorded, the frequency of surface contamination tests may be in accordance with an approved sampling plan.	**10**	**W**	AMS2759/2
169.	**Periodic Tests** In addition to the tests specified in AMS2759, planning must include that tests for surface contamination shall be performed monthly on each furnace in service, each kind of atmosphere to be used in each furnace, and for each Class B atmosphere at two carbon potentials, up to 0.40% and over 0.40%. Furnaces used exclusively to heat treat parts that will have all contamination removed shall not require testing.	**10**	**W**	AMS2759/2
170.	**Preproduction Tests** That procedures must address that, in addition to the tests specified in AMS2759, tests for surface contamination shall be performed prior to any production heat treating on each furnace, each kind of atmosphere to be used in each furnace, and for each Class B atmosphere at two carbon potentials, up to 0.40% and over 0.40%. Furnaces used exclusively to heat treat parts that will have all contamination removed shall not require testing.	**7**	**W**	AMS2759/2
171.	That planning may provide for an Alternative Sampling Plan to meet acceptance test requirements for heat treatment processes verified by statistical process control (SPC) to be stable and capable (that is, when statistical evaluation of the product and process parameters show that all measured values fall within established control limits).	**5**	**W**	AMS2759/2
172.	That heating below 1400 °F (760 °C) with Class B atmospheres containing 5% or more of hydrogen (H2), carbon monoxide (CO), or methane (CH4), may result in explosion and fire.	**10**	**W**	AMS2759/2
173.	That use of a chromic-caustic etch to reveal intergranular attack/oxidation has been discontinued because (1) it is an environmental hazard (2) it is unnecessary for measurement of maximum depth of crevices, and (3) light etching zones extending beyond the crevices have been misinterpreted as	**3**	**W**	AMS2759/2

	manifestations of intergranular oxidation			
174.	That Marquenching (Martempering) consists of quenching an austenitized alloy in a salt or hot oil bath at a temperature in the upper part of, or slightly above, the martensite range and holding until temperature uniformity throughout the part is obtained, usually followed by air cooling through the martensite range to ambient temperature.	**3**	**W**	AMS2759/2
	C) Specific Requirements Related to: AMS-H-6875 Heat Treatment of Steel Raw Material, Class A (Carbon and Alloy Steel)			
175.	That planning must communicate that this specification establishes requirements for the heat treatment of Raw Material. It is not intended to be used for the treatment of parts.	**7**	**W**	AMS-H-6875
176.	*Caution: AMS-H-6875 has been declared "STABILIZED" by AMS Committee E. This document will no longer be updated and may no longer represent standard industry practice.* *AMS Committee E recommends that AMS2761 Heat Treatment of Steel Raw Materials (see below) considered for future procurement.* *This recommendation does NOT constitute authority to substitute AMS2761 for the "STABILIZED" AMS-H-6875.* *Because of qualification and other legacy issues, some Design Authorities will likely continue to use AMS-H-6875 for some time.* *Be sure you understand your customers flowdown.*	**10**	**W**	AMS2761, AMS-H-6875
177.	*Caution: If this document is specified for what appear to be parts, contact the customer for clarification. There are some legacy contractual requirements where AMS-H-6875 could still be required.*			AMS-H-6875
178.	That this specification describes procedures that, when followed, will produce the desired properties and material qualities within the limitations of the respective alloys. Alloys other than those specifically covered herein may be heat treated using all applicable requirements of this specification.	**5**	**W**	AMS-H-6875
179.	That the Class A requirements of this specification apply to Carbon and Alloy Steels.	**5**	**W**	AMS-H-6875
	Furnace Media and Protective Coatings			
	Atmospheres			
180.	That gases used as furnace atmospheres must only be used for the appropriate Class. Supplementary protective coatings may be used in accordance with the requirements of this specification.	**7**	**W**	AMS-H-6875
181.	That unless otherwise specified by the cognizant engineering organization, planning may permit an air/product of combustion atmosphere only for tempering, stress relieving and 1400 °F (760 °C) or below transformation treatments. An air/product of combustion atmosphere may be used for treatment above 1400 °F (760 °C) for Class A material that will have a minimum of 0.020 inch (0.51mm) metal removed from all surfaces after heat treatment or have been protected by electroplates.	**7**	**W**	AMS-H-6875
182.	That planning must provide that exothermic, nitrogen based or endothermic atmosphere shall be refined or blended to avoid a change in carbon content at the surface of the material. A product of combustion at -40 °F (-40 °C) maximum dew point (e.g., endothermic) may be used for class A material that allows 0.003 inch (0.08 mm) maximum partial decarburization at the surface. Exothermic atmosphere is permissible for heat treatment of class A mill products.	**7**	**W**	AMS-H-6875
183.	That when using nitrogen, nitrogen based or exothermic atmospheres, planning may allow Class A steels to be fine grain copper plated 0.002 to 0.005 inch (0.05 to 0.13 mm) thick in accordance with AMS2418 or nickel plated per AMS2424 or AMS-QQ-N-290 or equivalent as a supplementary surface protection. Other supplementary protective coatings may be used if approved by the cognizant engineering organization	**5**	**W**	AMS2418, AMS2424, AMS-H-6875, AMS-QQ-N-290
184.	That dissociated ammonia is permissible for annealing of Class A mill products providing residual ammonia at the outlet of the generator does not exceed 15 ppm.	**7**	**W**	AMS-H-6875
185.	That furnaces for mill products shall be supplied with a consistent atmosphere gas that meets the requirements of the material specification.	**5**	**W**	AMS-H-6875
186.	That planning must ensure that atmospheres are controlled such that they do not contaminate parts being treated including vacuum and salt baths.	**7**	**W**	AMS-H-6875
187.	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**	**W**	AMS-H-6875
188.	That salt baths may be used for Class A (carbon and alloy) steels and must be tested initially and at least weekly to prevent general corrosion, carburization, decarburization and intergranular attack exceeding the limits of this specification	**7**	**W**	AMS-H-6875
189.	That procedures must control that additives used for adjustments shall be limited to salts in bath and rectifiers recommended by the salt manufacturer.	**5**	**W**	AMS-H-6875

190.	**Temperature Uniformity** That planning must be in accordance with the requirements of AMS2750 (Pyrometry) for control and testing of furnaces, ovens, salt baths, vacuum furnaces, refrigeration equipment and allied pyrometric equipment.	**10**	**W**	AMS2750, AMS-H-6875
191.	**Temperature Range and Set Temperature** That planning must provide that the set temperature on the furnace control instrument shall be such that the load temperature falls within the specified range, taking into account the temperature uniformity of the furnace. In continuous furnaces used to anneal and normalize mill products, a thermal head may be used. The temperature of the mill product shall not exceed the maximum processing temperature.	**10**	**W**	AMS-H-6875
192.	That furnaces must have instrumentation to a minimum of Type D per AMS2750.	**7**	**W**	AMS2750, AMS-H-6875
193.	That Furnace Class requirements per AMS2750 are Furnace Class 2 +/-10°F (+/- 6°C) for tempering after hardening of D6AC and 9Ni-4Co (Class A) alloy steels and other (Class A) low alloy steels - 220 ksi (1517 MPa) UTS and higher and Furnace Class 5 +/-25°F (+/-14°C) for all other processes.	**10**	**W**	AMS2750, AMS-H-6875
	Quench Baths			
194.	Quench baths shall permit complete immersion of material, provide for adequate circulation of the media or agitation of material, provide a means for indicating the temperature of the media and for cooling and heating, as applicable. Baths shall be adequate to produce the required properties in the most massive material to be quenched.	**7**	**W**	AMS-H-6875
195.	*Note: AMS 2750 requires that quench systems used for heat treatments that include a quenchant temperature requirement (minimum, maximum or both) shall be equipped with a recording instrument.*	**5**	**W**	AMS2750
196.	That planning must provide for documentation that oil quenching medium is 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 during the quenching operation, unless otherwise approved by the cognizant engineering organization	**10**	**W**	AMS-H-6875
197.	That procedures must ensure that the temperature of the oil quenching media shall not exceed the manufacturer's recommended operating range.	**5**	**W**	AMS-H-6875
198.	That procedures must ensure that quench oil used in integral quench vacuum furnace systems, where the quench chamber is below atmospheric pressure, is vacuum degassed at approximately the maximum recommended temperature for the quenchant initially and after each major addition of oil	**5**	**W**	AMS-H-6875
199.	That Aqueous Polymer Quenchants may be used as permitted in AMS-H-6875 for Class A Carbon and Alloy Steels. The temperature of the aqueous polymer quenchant baths shall not exceed the manufacturers recommended operating range. These baths shall also be adequately circulated to assure homogeneity of the aqueous polymer quenchant media.	**5**	**W**	AMS-H-6875
200.	**Quenching from Salt Bath Furnaces** 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.	**5**	**W**	AMS-H-6875
201.	**Alternative Quenchants** In lieu of the stated methods in Tables of AMS-H-6875, steam, air, water sprays, inert gases, polymers, molten salts or other commercial quenching media or processes may be used when approved by the cognizant engineering organization, providing equivalence with respect to mechanical properties and corrosion resistance, as applicable to the material and its application, can be substantiated. Equivalence tests shall be as specified by the cognizant engineering organization. Where air quenching is permitted, argon and helium may be used; other inert gases may be substituted when approved by the cognizant engineering organization.	**5**	**W**	AMS-H-6875
202.	**Location of Quenching Equipment** Quenching equipment shall be located in such a manner and handling facilities shall function with sufficient speed to prevent the initiation of transformation or sensitization prior to quenching.	**5**	**W**	AMS-H-6875
203.	**Miscellaneous Equipment** Suitable jigs, fixtures, trays, hangers, racks, ventilators, and so on, shall be employed as necessary for the proper handling of the work and for maintenance of the major items of equipment. The use of heat-treating fixtures or fixture materials where the contact with or proximity to the material could contaminate the material or reduce the heating, cooling or quenching rates to less than required for complete transformation or through-hardening of the material shall not be permitted.	**5**	**W**	AMS-H-6875
204.	**Cleaning Equipment** Equipment shall be provided to clean material in accordance with requirements. Where toxic or harmful cleaners are employed, they shall be used in compliance with the applicable health and safety regulations.	**5**	**W**	AMS-H-6875
	Thermal Treatment			AMS-H-6875

205.	That heating rates must be controlled to prevent damage to material. Pre-heating at 1000 to 1200 °F (538 to 649 °C) is recommended before heating material above 1300 °F (704°C) if the material: • Has been previously hardened above HRC 35, or is made of steel of 0.50 (nominal) percent carbon or over, or • Has abrupt changes of section, or sharp re-entrant angles, or • Has been finish machined	**5**	**W**	AMS-H-6875
206.	That material in Class A shall be hardened by Austenitizing, Quenching and Tempering.	**5**	**W**	AMS-H-6875
	Prior Condition of Class A Steel Parts			
207.	That planning shall provide that parts made from H-11 steel be in the annealed condition, prior to hardening, unless it has been hot headed. Hot headed H-11 material shall be annealed, prior to hardening, by furnace cooling from 1625 °F ± 25 (885°C ± 14) to at least 1000 °F (538°C), at a maximum rate of 50 °F (28°C) per hour.	**5**	**W**	AMS-H-6875
208.	That planning shall provide that parts made of 52100 or 1095 steel be hardened from the spheroidize annealed condition	**5**	**W**	AMS-H-6875
209.	That planning shall provide that parts made from other Class A steels to be hardened and tempered to 220 ksi (1517 MPa) and above shall be either normalized, normalized and tempered, or normalized and sub-critical annealed, prior to initial austenitizing.	**7**	**W**	AMS-H-6875
210.	That planning shall provide that parts that have been welded shall be normalized, prior to hardening.	**5**	**W**	AMS-H-6875
211.	That planning shall provide that parts identified as damage tolerant, maintenance critical or fracture critical shall be normalized, normalized and tempered or normalized and subcritical annealed, regardless of the strength that they are subsequently to be heat-treated.	**7**	**W**	AMS-H-6875
	Austenitizing			
212.	That planning must provide that parts be held within the specified austenitizing temperature range for sufficient time for the necessary transformation and diffusion to take place. The recommended holding times at temperature are listed in AMS-H-6875.	**10**	**W**	AMS-H-6875
	Quenching			
213.	Planning must provide that material shall be quenched from the austenitizing temperature in the quenchant specified in AMS-H-6875 as applicable.	**7**	**W**	AMS-H-6875
214.	That planning must ensure that material be cooled to or below the quenchant temperature before tempering.	**7**	**W**	AMS-H-6875
215.	Material should be tempered within 2 hours after quench or within 2 hours after reaching room temperature after cold treatment.	**5**	**W**	AMS-H-6875
216.	That planning allowance should be made that 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.	**5**	**W**	AMS-H-6875
217.	Mill products shall be quenched in a manner consistent with commercial practice. They shall be cooled sufficiently and tempered within a period of time adequate to prevent quench cracking or conditions deleterious to end product mechanical properties and corrosion resistance.	**5**	**W**	AMS-H-6875
218.	**Tempering** That planning shall include that tempering be carried out in compliance with AMS-H-6875. When multiple tempering is used, material shall be cooled to room temperature between tempering treatments. Tempering temperatures in AMS-H-6875 are recommended unless indicated as mandatory.	**5**	**W**	AMS-H-6875
219.	**Normalizing** That planning shall include that normalizing be accomplished by cooling from specified temperatures in circulated air or in a circulated protective atmosphere. The recommended minimum holding times at temperature are listed in AMS-H-6875.	**7**	**W**	AMS-H-6875
220.	**Annealing Class A Steel** That planning shall ensure that annealing (full annealing) of Classes A material shall be accomplished in accordance with AMS-H-6875 and at suggested holding times. Sub-critical (partial) annealing of Class A material shall be accomplished by heating to 1200 to 1250 °F (649°C to 677°C) and holding in that temperature range for 2 hours.	**7**	**W**	AMS-H-6875
	Stress Relieving			
221.	That planning must provide that stress relieving before hardening of Class A material be accomplished at any temperature between 1000 °F and 1250 °F (538°C to 677°C).	**7**	**W**	AMS-H-6875
222.	That planning must provide that stress relieving after hardening of Classes A material shall be accomplished by heating to a maximum temperature of 50 °F (28°C) below the tempering temperature. The recommended minimum holding times at temperature are listed in AMS-H-6875.	**7**	**W**	AMS-H-6875

223.	That stress relieving after hardening is prohibited on parts that have been peened or cold deformed; e.g., roll threaded	**10**	**W**	AMS-H-6875
224.	**Thermal Treatment of Mill Products** Unless otherwise specified in the contract or purchase order, processing of mill products for which the tables of AMS-H-6875 are not applicable (e.g., raw material that is continuously heat-treated) shall be annealed, austenitized, quenched and tempered with proven commercial practices. Such practices shall provide equivalence with respect to end product mechanical properties, corrosion resistance, and microstructure, as required by the applicable material specification or engineering drawing, and shall be substantiated by tests or methods determined by the cognizant engineering organization	**7**	**W**	AMS-H-6875
	Process Requirements			
225.	That planning must specify equipment and processing techniques employed in the heat-treatment of material are fully capable of providing the combination of mechanical properties, corrosion resistance and microstructure in the product as specified in the appropriate procurement document.	**7**	**W**	AMS-H-6875
226.	**Cleaning** That material shall be cleaned prior to heat treatment as required to remove contaminants and leave no substance that could have a deleterious effect. Cleaning prior to heat treatment of mill products is not required provided no surface condition is retained that could have a deleterious effect on the product	**5**	**W**	AMS-H-6875
227.	**Spacing** That material shall be racked or supported to allow circulation of heating and quenching media; to ensure exposure of surfaces to heating or quenching media and to minimize warpage during heating and quenching.	**7**	**W**	AMS-H-6875
228.	**Approval for Use of Coatings or Platings** That except for certain copper or nickel plating, 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**	**W**	AMS-H-6875
	Mechanical Properties			
229.	That planning must provide that frequency of hardness testing for material that has been final heat-treated, shall be in accordance with the sampling requirements of AMS2759.	**7**	**W**	AMS2759, AMS-H-6875
230.	That planning must ensure that hardness testing shall be performed in the heaviest section that is suitable and not detrimental to the function of the material.	**7**	**W**	AMS-H-6875
231.	That when heat treating standard components such as nuts and bolts or mill products, the sampling and hardness test requirements of the applicable component and steel specifications take precedence	**5**	**W**	AMS-H-6875
232.	That planning must provide that hardness test data be converted to equivalent tensile strengths as specified by ASTM A370 and the tensile strengths shall conform to the design requirements. Where a dispute exists in the hardness test, the tensile tests hall be performed in accordance with ASTM E8 / E8M and the test results shall conform to the design requirements	**5**	**W**	AMS-H-6875, ASTM A370, ASTM E8 / E8M
233.	**Permissible Variations of Classes A Steel from Design Ultimate Strength** That when a minimum acceptable strength level and no maximum strength level is specified by design or the applicable material specification, the maximum strength shall be 20 ksi (138 MPa) above the minimum, except for Hy-Tuf and H-11 steels for which a maximum strength of 30 ksi (207 MPa) above the minimum is acceptable. For 300 M steel, a maximum strength of 30 ksi (207 MPa) above the minimum is acceptable, provided the maximum tensile strength does not exceed 305 ksi (2103 MPa).	**5**	**W**	AMS-H-6875
234.	**Surface Contamination** That planning must account for the following requirements for Surface Contamination when material is hardened, normalized before hardening or is rehardened after hardening. The requirements do not apply provided it is definitely known that sufficient material will be subsequently removed to eliminate deleterious surface conditions.	**7**	**W**	AMS-H-6875
	Decarburization, Carburization and Nitriding and inter-granular attack (IGA)			
235.	That procedures must control the heating medium in furnaces used for normalizing and for hardening Classes A material so as not to produce excessive decarburization.	**7**	**W**	AMS-H-6875
236.	That procedures must provide that for furnaces used to heat-treat material whose final hardness will be HRC 46 (220 ksi/1517 MPa) and above, partial decarburization shall be judged excessive if greater than 0.003 inch (0.08 mm) deep on any finish machined surface.	**10**	**W**	AMS-H-6875
237.	That procedures must provide that for furnaces used to heat-treat material whose final hardness will be less than HRC 46 (220 ksi/1517 MPa) decarburization shall be not greater than 0.005 inch (0.13mm) deep on any finish machined surface	**7**	**W**	AMS-H-6875
238.	That any total decarburization at the surface is not acceptable.	**7**	**W**	AMS-H-6875
239.	That furnaces used for heat-treating materials shall be controlled to preclude carburization or nitriding.	**7**	**W**	AMS-H-6875

240.	That furnaces used for Heat Treatment above 1250°F (676°C) shall be controlled to preclude intergranular attack exceeding 0.0007 inch (0.018 mm) on material under 220 ksi (1517 MPa) and 0.0005 inch (0.013 mm) on other materials.	**7**	**W**	AMS-H-6875
241.	Quenchant effectiveness That the consistency of quenchant effectiveness must be determined by testing each quenchant in each tank initially and quarterly thereafter by one of the test method specified in AMS-H-6875 and comparing the results with those obtained previously by the same method. Procedures must establish control limits for each quenching system. If the results indicate that a quenchant is outside the established limits, corrective action shall be taken and the test shall be repeated to verify restoration of the prior condition	**7**	**W**	AMS-H-6875
	Heat Treatment of Parts That finished or semi-finished parts shall be heat treated in accordance with AMS2759. Raw materials shall be heat treated in accordance with the requirements specified herein. Any references to parts heat treatment in this document are superseded by the requirements specified in AMS2759. *Caution: If this document is specified for what appear to be parts, contact the customer for clarification. There are some legacy contractual requirements where AMS-H-6875 could still be required.*	**5**	**W**	AMS2759, AMS-H-6875
	Control Records	**5**	**W**	
242.	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.			
	Surface Contamination Test Procedures			
243.	That procedures must ensure that each furnace used for normalizing and austenitizing of Classes A 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**	**W**	AMS-H-6875
244.	That specimens of Class A material, except H-11, may be tested either in the tempered or in the un-tempered condition at the option of the cognizant engineering organization. However, procedures must provide that H-11 specimens be tested after completion of heat treatment.	**5**	**W**	AMS-H-6875
245.	That procedures must assure that for material made from Class A steels with a final strength of 220 ksi (1517 MPa) or hardness of HRC 46 or higher, at least one specimen of the same alloy shall be heat treated with each load.	**10**	**W**	AMS-H-6875
246.	That procedures must assure that for material that is damage tolerant or fracture critical, a minimum of one specimen of the same alloy shall be heat-treated with each load regardless of the final strength or hardness.	**10**	**W**	AMS-H-6875
247.	That if such material is reheat-treated, the original specimen, or a portion of the original specimen must accompany the material and be tested for conformance to surface contamination requirements after the reheat-treatment.	**10**	**W**	AMS-H-6875
248.	That procedures must assure that for lower strength material, under 220 ksi (1517 MPa), made from Class A steels, at least one specimen shall be tested for conformance to surface contamination requirements as follows with the first load of each alloy group (Class A steels of 0.45 percent carbon and lower. and Class A steels of above 0.45 percent carbon are considered as separate alloy groups): • Each month for atmosphere furnaces, • Each week for salt baths	**7**	**W**	AMS-H-6875
249.	**Mechanical Properties** Planning must provide for conformance to testing requirements and procedures of AMS-H-6875 including: Hardness Tests of Heat Treated Material Tensile Tests (when specified) Metallographic Tests	**7**	**W**	AMS-H-6875
250.	That procedures must address testing for Quench Rate Control using one of the following: • Comparative Cooling Curve Evaluation • Magnetic Quenchometer • Hot Wire Test • Mechanical Properties Test	**7**	**W**	AMS-H-6875
	D) Specific Requirements Related to the Processing of: Heat Treatment of Raw Material to AMS2761			
251.	Knowledge and understanding that planning must communicate through work instructions or procedures that this specification establishes the heat treatment of Raw Material by producers or for producers. It is not applicable to the treatment of parts.	**10**	**W**	AMS2761
252.	This specification covers the requirements for furnace equipment, test procedures and information for	**3**	**W**	AMS2761

	heat-treating procedures, heat-treating temperatures, and material test procedures.			
253.	This specification describes procedures that will produce the desired properties and material qualities of the alloys covered herein. Alloys other than those specifically covered herein may be heat treated using all applicable requirements of this specification.	**5**	**W**	AMS2761
254.	*Caution: AMS Committee E has recommended that this specification, AMS2761 be considered for future procurement in place of AMS-H-6875. It has NOT been made a supersession, however. This recommendation does not constitute authority to substitute. Because of qualification and other legacy issues, some Design Authorities will likely continue to use AMS-H-6875 for some time BE SURE YOU UNDERSTAND YOUR CUSTOMER FLOWDOWN REQUIREMENTS*	**10**	**W**	AMS2761, AMS-H-6875
255.	Unless otherwise specified, this specification is not applicable to heating or to intermediate (non-final) heat treatment, of raw material; e.g., hot working. This specification and the controls specified herein are applicable to capability heat treats required by material specifications to verify response to heat treatment. Processes not covered include deliberate surface heat-treating and specialized heat-treating, such as induction hardening, flame hardening, carburizing, and nitriding; however, this specification may be referenced for equipment and controls. Austempering, ausbay quenching, and martempering may be used when specified by the cognizant engineering organization.	**3**	**W**	AMS2761
256.	Final heat treat condition as used in this specification is defined as the end item condition specified in the raw material specification or the purchase order.	**3**	**W**	AMS2761
257.	**Thermal Processing Equipment** Planning must require thermal processing equipment meeting the requirements of AMS 2750 (Pyrometry).	**7**	**W**	AMS2761, AMS-H-6875
258.	Planning must require furnaces that have instrumentation to a minimum of Type D per AMS2750.	**7**	**W**	AMS2750, AMS2761
259.	Unless the material specification temperature tolerance or range requires a different furnace class or otherwise indicated as follows, Furnace class requirements per AMS2750 shall be used. • Tempering (after hardening) of alloy steel greater than 220 ksi, except H-11, D6AC, and 9Ni-4Co Class 2 or better • ll Other Processes - Furnace Class 5 or better	**7**	**W**	AMS2750, AMS2761
260.	**Atmospheres** Planning must provide that furnaces be supplied with gases of a consistent analysis such that the material meets the requirements of the appropriate material specification. Ducts and working zones shall be sealed to prevent contamination by outside gases. Vacuum systems shall conform to AMS2769. Planning must provide that all atmosphere furnaces and gas supply lines shall be purged with the designated and approved atmosphere gas for the specific steel to be heat treated as listed in AMS2761.	**7**	**W**	AMS2761, AMD2769
261.	Planning must provide that the gaseous medium for heat treating carbon and alloy steel above 1250 °F (677 °C) shall be air/products of combustion, argon, helium, hydrogen, nitrogen, or blends of these gases, vacuum, exothermic, endothermic, nitrogen based, or dissociated ammonia conforming to the limitations shown in AMS2761. In particular: • Unless otherwise specified, an air/product of combustion atmosphere shall be limited to tempering, stress relieving, and 1400 °F (760 °C) transformation treatments. An air/product of combustion atmosphere may be used for treatment above 1400 °F (760 °C) for carbon and low alloy steel material that will have a minimum of 0.020 inch (0.51 mm) metal removed from all surfaces after heat treatment. • For argon, helium and nitrogen, Dew point shall be not higher than -40 °F (-40 °C) at the inlet of the furnace. Permissible nitrogen atmosphere does not include nitrogen from dissociated ammonia except for mill products as noted below. • Exothermic, nitrogen based or endothermic atmospheres shall be refined or blended to avoid a change in carbon content at the surface of the material, A product of combustion at -40 °F (-40 °C) maximum dew point (e.g., endothermic) may be used for carbon and low alloy steel material that allows 0.003 inch (76 µm) maximum partial decarburization at the surface. • Dissociated ammonia is permissible only for annealing or annealing/quenching of mill products providing residual ammonia at the outlet of the generator does not exceed 15 ppm.	**7**	**W**	AMS2761
262.	**Salt Baths** Salt baths may be used for heat treatment. Salt baths shall be tested initially and shall be adjusted to assure that surfaces shall be free from contamination. Additives used for adjustments shall be limited to salts in bath and rectifiers recommended by the salt manufacturer.	**7**	**W**	AMS2761
263.	**Quenching Equipment** The quench system equipment and quench media specified shall be sufficient to achieve the properties required by the heat treat process and material specification.	**7**	**W**	AMS2761
264.	**Auxiliary Equipment**	**5**	**W**	AMS2761

	Fixtures and fixture materials shall not cause contamination of material. Fixtures and fixture materials shall be designed to allow maximum flow of heat around the material; otherwise, the mass and section size of heat treat fixtures shall be accounted for during establishment of heat up times, soak times, and quench rates.			
265.	**Sub-Zero Cooling or Deep Freeze** When required to complete transformation and provide desired microstructure, planning shall require that material shall be cooled to a temperature within the range specified, held at the selected temperature for a time commensurate with section thickness, and warmed in air to room temperature.	**5**	**W**	AMS2761
266.	**Quenchants** Planning must provide 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.	**7**	**W**	AMS2761
267.	Planning must provide 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. When salt bath furnaces are used (quenching from salt bath furnaces), planning shall provide that polymers shall be monitored to ensure salt content does not exceed 6% by weight.	**7**	**W**	AMS2761
268.	Water quenchant requirements and limitations (including purity) shall be defined by the material producer.	**5**	**W**	AMS2761
269.	Alternative quenching methods may be used when qualified by a methodology approved by the cognizant engineering organization.	**5**	**W**	AMS2761
270.	**Cleaning** Cleaning shall be defined by the producer. At a minimum, planning shall provide the material shall be clean enough such that contaminants do not have a detrimental effect on the material as defined by the material specification.	**5**	**W**	AMS2761
271.	**Racking** Planning shall provide that material be racked and supported, or otherwise oriented, to ensure free circulation of the heating, cooling, and quenching media and to minimize distortion.	**7**	**W**	AMS2761
272.	**Loading** For batch furnaces, planning shall provide that material shall not be loaded into a furnace with the temperature higher than the set temperature. For continuous furnaces, process parameters (e.g., furnace temperature set points, heat input, travel rate, etc.) for continuous heat treating lines shall be established by the material producer and validated by testing of product to the requirements of the material specification, this specification, or the purchase order.			AMS2761
273.	**Temperature Control** Planning shall provide that control instrument(s) be set in the temperature ranges specified by the material specification or as stated in AMS2761.	**10**	**W**	AMS2761
274.	**Rate of Heating** Planning must provide that heating rates be controlled to prevent damage to the material. Pre-heating at 1000 to 1200 °F (538 to 649 °C) is recommended before heating material above 1300 °F (704 °C) if the material has any of the following conditions: • Has been previously hardened above HRC 35. • Is made of steel of 0.50 (nominal) percent carbon or higher. • Has abrupt changes of section, or sharp re-entrant angles.	**7**	**W**	AMS2761
275.	**Start of Soaking** When only furnace control sensors are used, planning must provide that 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, or as approved by their cognizant engineering organization. When furnace control sensors and recording sensors are used, planning must provide that soaking time starts when the temperatures indicated by all recording sensors reach the minimum of the required temperature tolerance applicable to the set heat treating temperature. For continuous furnaces, planning must provide that soaking time starts when material enters the zone of the furnace shown by the last temperature uniformity test to be within the range described by the set temperature and the applicable tolerance.	**10**	**W**	AMS2761
276.	**Soaking Time** Recommended soaking time should be in accordance with AMS2761 *Note: AS1260 indicates the approximate equivalence of various shapes to equivalent round sections and shall be used when estimating soak times for various shapes and especially complex shapes.*	**5**	**W**	AMS2761
	Thermal Treatments			
277.	**Hardening** Planning shall provide that carbon and low alloy steel material shall be hardened by austenitizing and quenching	**7**	**W**	AMS2761
278.	**Austenitizing** The austenitizing temperature should conform to AMS2761 for carbon and low alloy steel. Material	**7**	**W**	AMS2761

	should be held within the specified temperature range for sufficient time for the necessary transformation and diffusion to take place. The recommended holding times at temperature are listed in AMS2761			
279.	**Quenching** Material should be quenched from the austenitizing temperature. The material should be transferred from the furnace into a quench medium (i.e., water, oil, air, polymer, etc.) in a timely manner such that a successful quench shall be achieved. The material shall be cooled to a temperature low enough to achieve complete transformation, before tempering. The start time of tempering after the completion of the quench is as specified by the producer based on material grade, geometry, section size, etc.	**7**	**W**	AMS2761
280.	**Tempering** Carbon and low alloy steels should be tempered at the temperatures shown in AMS2761. Time at temperature and the number of tempers should be as shown in AMS2761. When multiple tempering is used, material shall be cooled to ambient temperature between tempering treatments.	**7**	**W**	AMS2761
281.	**Normalizing Carbon Steel and Low Alloy Steel** Normalizing of carbon and low alloy steels should be accomplished by cooling from the specified temperatures in air or in a circulated protective atmosphere. The recommended minimum holding times at temperature are listed in AMS2761	**5**	**W**	AMS2761
282.	**Annealing of Carbon and Low Alloy Steel** Full annealing of carbon and low alloy steels should be accomplished in accordance with AMS2761 Sub-critical (partial) annealing of steel material should be accomplished by heating to 1200 to 1400 °F (649 to 760 °C) and at suggested holding times in AMS2761.	**3**	**W**	AMS2761
283.	**Stress Relieving** Planning shall provide for the following: • Stress relieving before hardening of low alloy steel material shall be accomplished at any temperature between 800 °F and 1400 °F (427 °C and 760 °C). • Stress relieving after hardening of steel material shall be accomplished by heating to a maximum temperature of 50 °F (28 °C) below the tempering temperature. The recommended minimum holding times at temperature are listed in AMS2761.	**5**	**W**	AMS2761
284.	**Additional Processes** Material shall not be subjected to thermal operations other than those specified in the ordering document.	**10**	**W**	AMS2761
	Properties			
285.	**Hardness** Planning must provide that hardness shall be as specified by the material specification or purchase order.	**7**	**W**	AMS2761
286.	**Tensile Strength and Testing Method** Planning must provide that tensile strength and testing method shall be in accordance with the material specification or as otherwise specified. If no test method is specified, then testing shall be in accordance with ASTM A370. Unless otherwise specified, the strain rate shall be set at 0.005 in/in/min (0.005 mm/mm/min) and maintained within a tolerance of ±0.002 in/in/min (±0.002 mm/mm/min) through 0.2% offset yield strain. After the yield strain, the speed of the testing machine shall be set between 0.05 in/in and 0.5 in/in (0.05 mm/mm and 0.5 mm/mm) of the length of the reduced section (or distance between the grips for specimens not having a reduced section) per minute. Alternatively, an extensometer and strain rate indicator may be used to set the strain rate between 0.05 in/in/min and 0.5 in/in/min (0.05 mm/mm/min and 0.5 mm/mm/min).	**7**	**W**	AMS2761, ASTM A370
287.	**Surface Contamination** Planning shall provide that surface contamination testing and test methods shall be as specified. If not specified, and less than 0.020-inch (0.51 mm) stock is to be removed from finished raw material during final part fabrication, the surface contamination test shall be as required in AMS2759. The surface contamination test methods shall be in accordance with AMS2759.	**10**	**W**	AMS2759, AMS2761
288.	**Classification of Tests** Planning shall provide that all testing shall be as specified by the material specification or purchase order.	**7**	**W**	AMS2761
289.	**Approval of Heat Treat Processor's Facilities** The approval of a facility shall be in accordance with that specified by the cognizant quality assurance organization. The procedures of the heat treating processor shall be available for review.	**5**	**W**	AMS2761
290.	**Records** Planning shall provide that a record (written or electronic storage media), traceable to temperature recording information (chart(s) or electronic storage media) and to shop paperwork or other documentation, shall be kept for each furnace and load. The log data shall be recorded in accordance with the heat treat processor's documented procedures.	**7**	**W**	AMS2761
291.	**Heat Treatment of Parts** Knowledge and understanding that planning must take into consideration that PARTS must be treated	**7**	**W**	AMS2759, AMS2761

	in accordance with AMS 2759 and that any reference in this specification (AMS2761) to PARTS is superseded by the requirements of AMS 2759.			
	SKILLS: The skills required to perform a particular special process task.			
292.	Has 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**	**W**	AS9100
293.	Capable of understanding, interpreting and complying with various customer requirements for precedence in documents.	**7**	**W**	AS9100
294.	Capable of understanding interpreting and complying with various requirements for identification, review and revision of documents (Document Control).	**7**	**W**	AS9100
295.	Ability to understand and interpret specification requirements and customer flow-down requirements.	**7**	**W**	AS9100
296.	Has 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**	**W**	AS9100
297.	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**	**W**	AS9100
298.	Capable of reviewing and approving records required to demonstrate compliance with customer requirements including: • Set temperature • Soak Time • Quench delay time • Quench concentration • Quench temperature before and after quench • Cooling after quench including refrigeration temperature • Periodic and lot acceptance test requirements and results • Temper delay • Heating and Cooling rates (where applicable)	**7**	**W**	AC7102
299.	Capable of evaluating potential product impact of deviations from process parameters or other events which may have a negative impact on product quality	**7**	**W**	AS9100
300.	The proper operation, maintenance, and calibration requirements for equipment used for testing evaluation and acceptance (e.g. Hardness)	**7**	**W**	AS9100
301.	Pyrometry testing requirements including Furnace Class and Type, Calibration, Sensors (thermocouples), SAT and TUS.	**7**	**W**	AMS2750
302.	Capable of reviewing Calibration, SAT and TUS reports when required.	**7**	**W**	AMS2750
303.	Capable of documenting an on-going plan for Pyrometry compliance to AMS 2750 at shop and site level.	**7**	**W**	AMS2750
304.	Capable of planning, monitoring and making timely reminders/notifications of Pyrometry requirements and test frequencies.	**7**	**W**	AMS2750
305.	Capable of carrying out 'Self Audits.'	**7**	**W**	AC7102
306.	Capable of conducting internal training and personal qualification exams to comply with Heat Treatment Body of Knowledge /Examination Review Board requirements	**7**	**W**	ARP1962
307.	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**	**W**	AS9100
308.	The Preventive Maintenance Program.	**7**	**W**	AC7102
	PERSONAL ATTRIBUTES: Are statements that will enable judgment of the person's personal attributes.			
309.	Willingness to train and mentor co-workers.	**NA**	**NA**	
310.	Good communicator at all levels.	**NA**	**NA**	
311.	Takes responsibility to challenge unclear customer requirements or those that do not appear to conform to specification or customer requirements.	**NA**	**NA**	
312.	Personal integrity.	**NA**	**NA**	
313.	Attentive to details.	**NA**	**NA**	
314.	**EXPERIENCE:** Are the minimum experience requirement expected to demonstrate their competence.			
315.	*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*	**NA**	**NA**	

	following are recommendations and would be superseded by the supplier's specific documented program. The supplier program may define alternative criteria, waivers and equivalences.			
316.	Recommended Minimum Classroom Training Heat Treatment – 80 hours Paperwork – 40 hours Test, Inspection, Maintenance – 40 hours	**NA**	**NA**	ARP 1962
317.	Recommended Minimum On-the-Job Training Air Atmosphere – 9 months Salt Bath – 9 months Furnace Atmospheres and Atmosphere Control – 12 months Inert Gas Atmosphere – 12 months Vacuum – 12 months Carbon and Alloy Steel Hardening – 12 months High-strength Steel (220 ksi (1515 MPa) and higher) - 24 months	**NA**	**NA**	ARP 1962
318.	Testing and Evaluation Initial and periodic evaluation of personnel is required. The type of frequency of the evaluation shall be determined by the company employing the individual, except that each individual shall be evaluated at least every 5 years. This shall be defined in 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.	**NA**	**NA**	ARP 1962
319.	**NON-SPECIAL PROCESS RELATED REQUIREMENTS:** Defined within these rows are other general or pre-requisite needed to perform the role described in this BoK.			
320.	Must have a thorough understanding of general Quality Systems (AS9100) or equivalent.	**7**	**W**	AS9100
321.	Must have a thorough understanding of customer specific requirements	**7**	**W**	AS9100
322.	Must have a thorough understanding of Control of Non-Conformance for equipment and product including containment, customer notification and disposition.	**7**	**W**	AS9100
323.	**CONTRACT REVIEW:** Knowledge of the Quality Management Contract Review process as required for participating in, and contributing to, the following tasks:			
324.	Determining the requirements of the product or service	**10**	**W**	AS9100 or AC7004
325.	Establishing criteria for accepting and performing a process or service	**7**	**W**	AS9100 or AC7004
326.	Implementing process controls in accordance with the criteria	**1**	**W**	AS9100 or AC7004
327.	Creating and managing documentation to validate process compliance and define conformance of product characteristics	**7**	**W**	AS9100 or AC7004
328.	Identifying suitable monitoring and measuring resources implementing them at appropriate stages	**7**	**W**	AS9100 or AC7004
329.	Validating and controlling the performance of Special Processes	**3**	**W**	AS9100 or AC7004
330.	Determining the methods of measuring variable data	**1**	**W**	AS9100 or AC7004
331.	Identifying in-process inspection/verification points	**7**	**W**	AS9100 or AC7004
332.	Controlling equipment, tools, and software programs	**7**	**W**	AS9100 or AC7004
333.	Reviewing and controlling changes to the provision of a product or service	**10**	**W**	AS9100 or AC7004

7. DOCUMENT REVISION HISTORY

REVISION DATE	SUMMARY
26 June 2018	Editorial change to delete paragraph references and update logo and colors
12 November 2018	Reviewed by eQualified Content Developer to ensure document is up to date.
4 December 2019	Editorial revision to update program name from eQualified to PRI Qualification[SM.]
27 October 2022	Updated by PRI Qualification Content Developer to ensure document is up to date. Technical and editorial changes made as per eAuditNet.

ADDENDUM 1

LIST OF INTERNATIONAL STANDARDS & REFERENCE DOCUMENTS FOR HEAT TREATMENT OF CARBON AND ALLOY STEELS

SPECIAL PROCESS	DOCUMENT TITLE	DOCUMENT NUMBER
Quality	Nadcap Audit Criteria for Quality Management Systems	AC7004
Heat Treatment	Nadcap Audit Criteria for Heat Treating	AC7102
Plating	Plating, Copper	AMS2418
Plating	Plating, Nickel, Low-Stressed Deposit	AMS2424
Heat Treatment	Pyrometry	AMS2750
Heat Treatment	Heat Treatment of Steel Parts, General Requirements	AMS2759
Heat Treatment	Heat Treatment of Carbon and Low-Alloy Steel Parts, Minimum Tensile Strength Below 220 ksi (1517 MPa)	AMS2759/1
Heat Treatment	Heat Treatment of Low-Alloy Steel Parts, Minimum Tensile Strength 220 ksi (1517 MPa) and Higher	AMS2759/2
Heat Treatment	Heat Treatment, Precipitation-Hardening Corrosion-Resistant and Maraging Steel Parts	AMS2759/3
Heat Treatment	Stress Relief of Steel Parts	AMS2759/11
Heat Treatment	Heat Treatment of Steel Raw Materials	AMS2761
Heat Treatment	Heat Treatment of Parts in a Vacuum	AMS2769
Heat Treatment	Heat Treatment of Steel Raw Materials	AMS-H-6875
Plating	Nickel Plating (Electrodeposited)	AMS-QQ-N-290
Heat Treatment	Training And Approval of Heat-Treating Personnel	ARP1962
Quality	Quality Management Systems - Requirements for Aviation, Space and Defense Organizations	AS9100
Testing	Mechanical Testing of Steel Products	ASTM A370
Testing	Tension Testing of Metallic Materials	ASTM E8 / E8M
Testing	Brinell Hardness of Metallic Materials	ASTM E10
Testing	Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials	ASTM E18
Testing	Standard Test Method for Rockwell and Brinell Hardness of Metallic Materials by Portable Hardness Testers	ASTM 110
Testing	Knoop and Vickers Hardness of Materials	ASTM E384