PRI Qualification 161Thorn Hill Road Warrendale, PA 15086-7527	**Program Document HTBOK**	**PD 6103** HTBoK-002/OW-3 REV B Issued: 27-DEC-13 Revised: 26-JAN-17 Superseding: 27-DEC-13

BODY OF KNOWLEDGE:

ROLE DESCRIPTION: PYROMETRY PROCESS OWNER
SPECIAL PROCESS: Pyrometry
METHOD: Performance of Pyrometric Requirements for Thermal Processing Equipment

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 Treating Body of Knowledge Review Board (HT-BoKRB) according to the requirements of PD6100.

This document constitutes the PRI Qualification[SM] program BoK for Pyrometry Process, Owner. 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.

IN-HOUSE (or IN-SOURCING): Keeping responsibility and control of key or critical processes inside an organization by using available internal resources in-house control (in-sourcing) is often preferred to ensure compliance of critical with specific customer or statutory requirements – the opposite of out-sourcing

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 recognised by industry. A specific area of a special process for example anodizing within Chemical Processing.

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

OUT-SOURCED: is the contracting out of a business process to a third-party (external) supplier. It relates to both product and services.

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.

SERVICE PROVIDER: A company or individual that provides a service or product. Service provider is generally used to refer to external or outsourced (third party) suppliers of services and product although large organizations may have Internal Service Providers for example IT.

Examples may include Instrument calibration, Periodic Tests (TUS, SAT), analysis or testing which is outside the capability of internal resources. Service providers may also be suppliers of goods for example thermocouples pure gases etc.

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

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

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

4. GUIDANCE TO EXAMINATION CANDIDATES

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

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

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

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

- Self-study
- Completion of internal training
- Completion of external training (a list of Approved Training Providers can be found at http://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)

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*
Pyrometry Specific Criteria	*Basic understanding of Heat Treating processes, Pyrometry Testing and Calibration.* *Authorized to performing Temperature Uniformity Surveys, System Accuracy Tests, Calibrations of Controlling, Monitoring and Recording Instruments.* *Responsible for reporting results of Pyrometry Tests and Calibrations, and capable of detecting non-0conforming results.*	*In addition to knowing the roles of the Operator, the Planner:* *Provides work instructions/procedures for Pyrometry Tests and Calibrations performed by the Operator.* *Provides forms for recording the results of Pyrometry Tests and Calibrations.* *Maintains records of Pyrometry Tests and Calibrations.* *Is authorized to define, assign or perform actions related to Pyrometry Test and Calibrations results.*	*In addition to knowing the roles of the Operator and Planner, the Owner:* *Manages, oversees and trains Planners and Operators.* *Approves Pyrometry Test and Calibration work instructions/procedures.* *Approves Purchase Orders for performing Pyrometry Test and Calibrations.* *Is authorized to review and approve Pyrometry Tests and Calibration results.* *Approves actions taken by Planner or Operator related to Pyrometry Test and Calibration results.* *Is responsible for the conformance of heat treating equipment to customer requirements and provisions.*
Technical Knowledge	Basic knowledge of the special process, its main processes, methods and tools.	Good level of knowledge in all aspects of the special process, all its processes, methods and tools. Ability to coach others on contents and methods in the context of their workplace.	High or extensive knowledge in all aspects of the special process, all its processes, methods and tools to assess and validate improvements. Able to contribute to set externally recognized standards. Ability to define contents and methods for using knowledge effectively in influencing and developing international processes. Ability to influence the process with one's knowledge.
Experience	Sufficient experience to deal with recurrent activity.	Has enough experience to deal with unforeseen issues.	Wide proven experience of the subject. Is recognized specialist within the special process.
Personal Attributes		Takes into consideration behavioral characteristics such as but not limited to: team working, communication, direction and	

	purpose, innovation and problem solving, mutual trust and respect, confidentiality and trustworthiness.
Skills	Describes the activities necessary to perform each level of job function to comply with the Body of Knowledge
Non-Special Process Related Requirements	Health & Safety, Environmental, Quality System Requirements.

(1) Important to be aware that the special process provider is ultimately responsible for the compliance of his Pyrometry Service Providers compliance

6. **TABLE 1**

ROLE DESCRIPTION: PYROMETRY PROCESS OWNER
SPECIAL PROCESS: PYROMETRY
METHOD: Performance of Pyrometric Requirements for Thermal Processing Equipment
REFERENCE GUIDELINES: *Addendum 1 is a list of the international Standards and Reference Documents applicable to Pyrometry processes.*

Row #	COMPETENCE	Weight (1,3,7,10)	Exam Type Written / Practical	Reference Guidelines (See description above)
	KNOWLEDGE: **The basic knowledge of the special processes, methods and tools**			
1	**GENERAL KNOWLEDGE:**			
2	Aerospace Quality Systems and compliance	7	W	AS9100 AC7102/8
3	Full and complete understanding of Internal Work Instructions as well as Industry Standards (see Addendum 1 of this document)	7	W	AC7102/8
4	The importance of an effective Root Cause and Corrective Action system and how the analysis is conducted	7	W	AMS2750 AC7102/8
5	Tools and techniques to identify non-conformance and respond to non-conformance, root cause and 'risk management'	10	W	AMS2750 AS9100 AC7102/8
6	Safety compliance requirements as applicable	7	W	ISO14001 & OHSAS 18001
7	Understand the importance of temperature sensors, instrumentation, thermal processing equipment, system accuracy tests, and temperature uniformity surveys	10	W	AMS2750 AC7102/8
8	The importance of traceability of calibration to NIST or equivalent agencies	7	W	AMS2750 AC7102/8
9	The need for clear and accurate 'flow down' of requirements for compliance including customer specific requirements **– applies to all services from external sources including Calibration, SAT and TUS where outsourced**	7	W	AMS2750
10	**SENSORS (THERMOCOUPLES)**			
11	sensor types and proper applications taking into account upper temperature usage recommendations and thermocouple manufacturers shielding recommendations	7	W	AMS2750 AC7102/8
12	Temperature range recommendations, atmosphere effects, construction, and usage restrictions	7	W	AMS2750 AC7102/8
13	Recalibration, reuse, salvage and replacement requirements and how compliance with those requirements is controlled and documented.	7	W	AMS2750 AC7102/8
14	Extension wires and proper connections and wireless transmitters	7	W	AMS2750 AC7102/8
15	Calibration and reporting requirements taking into account the statement in AMS2750 that the thermocouple calibration intervals are the maximum permitted and that the Process Owner is responsible for ensuring that the calibration intervals will prevent excessive drift under conditions of exposure for the equipment under the pyrometric control of the Process Owner.	7	W	AMS2750 AC7102/8
16	Thermocouple failures and subsequent actions	7	W	AMS2750 AC7102/8
17	When and how correction factors are used and when they are required by AMS2750	7	W	AMS2750 AC7102/8
18	**INSTRUMENTATION:**			
19	Test instrumentation hierarchy	7	W	AMS2750 AC7102/8
20	Test instrumentation calibration and reporting requirements	7	W	AMS2750 AC7102/8
21	Understands that all test instruments must be digital and in compliance with AMS 2750 or other specifications if these are more stringent	7	W	AMS2750 AC7102/8
22	Instrument Sensitivity	7	W	AMS2750 AC7102/8
23	Controlling, monitoring and recording instrumentation calibration and reporting requirements	7	W	AMS2750 AC7102/8
24	When and how offset may be used when allowed by AMS2750	7	W	AMS2750 AC7102/8

25	Resolution requirements for chart recorders (Analog chart recording instruments)	7	W	AMS2750 AC7102/8
26	Software (Electronic Program Control and Data Acquisition)	7	W	AMS2750 AC7102/8
27	The differences between Analog and Digital instrument requirements	7	W	AMS2750 AC7102/8
28	**THERMAL PROCESSING EQUIPMENT:**			
29	Understand how to distinguish Furnace Class and Instrumentation Type and how that establishes the requirements for SAT and TUS frequencies	10	W	AMS2750 AC7102/8
30	Understand different types of Thermal Processing Equipment including oven, furnaces, quench baths and refrigeration equipment, etc. and their basic function and usage	7	W	AMS2750 AC7102/8
31	**SYSTEM ACCURACY TESTS**			
32	Understand how to perform System Accuracy Test (SAT)	7	W	AMS2750 AC7102/8
33	How SAT is performed to assure the accuracy of the furnace control and recording system in each control zone and any other sensors required for a particular Instrumentation Type.	7	W	AMS2750 AC7102/8
34	Equipment maintenance actions (replacement of a sensor or instrument, adjustment of an instrument, etc.) that will require an SAT in addition to periodic requirements.	10	W	AMS2750 AC7102/8
35	Understanding of the requirements for relative location of the SAT sensor to the sensor being checked and how that is verified for the particular equipment configuration.	7	W	AMS2750
36	The information that must be included in the system accuracy test report.	7	W	AMS2750 AC7102/8
37	How a Preventive Maintenance Program can impact SAT interval	7	W	AMS2750 AC7102/8
38	Limitations to use of resident thermocouples for SAT, including limitations to use of base metal thermocouples, non-expendable thermocouples and the requirement that resident thermocouples be a different wire type than the thermocouple being checked.	7	W	AMS2750 AC7102/8
39	Difference in furnace test interval requirements for processing parts vs. raw material	7	W	AMS2750 AC7102/8
40	How Periodic SAT shall be performed in accordance with the interval shown in applicable specifications or AMS2750	10	W	AMS2750 AC7102/8
41	SAT Data Collection – Recording and Evaluation	7	W	AMS2750
42	How to perform the SAT difference calculations, including application of correction factors and offsets when required, and to compare the results to specification requirements	7	W	AMS2750 AC7102/8
43	The alternate SAT requirements, SAT waivers and conditions for frequency reductions.	7	W	AMS2750 AC7102/8
44	**TEMPERATURE UNIFORMITY SURVEYS:**			
45	How to perform Temperature Uniformity Survey (TUS) and understanding of why it is important	7	W	AMS2750 AC7102/8
46	Qualified operating temperature ranges and the selection of appropriate test temperatures,	10	W	AMS2750 AC7102/8
47	The difference between modifications and repairs and which maintenance actions will require a new Initial TUS to be performed.	7	W	AMS2750 AC7102/8
48	How a Preventive Maintenance Program can impact TUS interval	7	W	AMS2750
49	The differences in furnace test interval requirements for processing parts vs. raw material	7	W	AMS2750 AC7102/8
50	How an Initial TUS shall be performed in accordance with AMS2750 or more stringent customer requirements.	10	W	AMS2750 AC7102/8
51	How Periodic TUS shall be performed in accordance with the interval shown in applicable Specification AMS2750 and when a new initial TUS is required	10	W	AMS2750 AC7102/8
52	TUS Data Collection – recording and evaluation	7	W	AMS2750 AC7102/8
53	The requirements for number and location of thermocouples in order to determine planning requirements for the equipment being tested.	7	W	AMS2750 AC7102/8
54	How to select TUS parameters that reflect the normal operation of the equipment in production	10	W	AMS2750 AC7102/8
55	How changes to TUS parameters will result in the need to perform a new initial TUS as well as loss of extended interval status	7	W	AMS2750 AC7102/8
56	The requirements for a successful survey and the actions to be taken in the event of survey failure	7	W	AMS2750 AC7102/8
57	The difference in TUS setup based on furnace design. •Atmosphere •Vacuum •E-torch	7	W	AMS2750 AC7102/8

	•Salt bath/Fluid Bed •Continuous •Batch			
58	The requirements for data collection and the differences in Data Collection method depending on furnace design and reporting requirements	7	W	AMS2750 AC7102/8
59	Where solution treatment of Aluminum Alloys using furnaces with heating elements in the walls is performed, knowledge and understanding of the requirement for radiation surveys	10	W	AMS2750
60	The specific requirements for pyrometry testing of laboratory furnaces	7	W	AMS2750 AC7102/8
	SKILLS: **Defined within these rolls describes the range of skills. The skills required to perform a particular special process task**			
61	**READ AND UNDERSTAND WRITTEN INSTRUCTIONS:**			
62	Ability to understand specification requirements and customer flow-down requirement	**7**	**W**	General Industry AC7102/8
63	Develop testing or calibration schedule to comply with customer requirements.	**7**	**W**	General Industry AC7102/8
64	Develop practices to ensure operations are in compliance with calibration, SAT and TUS requirements	**7**	**W**	AMS2750 AC7102/8
65	**Instrumentation and Equipment handling skills and Safety Practices**			
66	Able to review and assess equipment technical data and determine its compliance to Pyrometry specification (add Tech Sheet(s) for test) • Able to determine conformance to instrument requirements • Able to determine acceptability for controlling, monitoring and recording instruments, field instruments and secondary instrument	**7**	**W**	AMS2750 AC7102/8
67	Ability to review requirements and establish instrumentation, satisfying instrumentation type	**7**	**W**	AMS2750 AC7102/8
68	**Review, Analyze/Evaluate and Report the data and Establish Appropriate Action**			
69	Report and analyze SAT Data	**7**	**W**	AMS2750 AC7102/8
70	Report and analyze TUS Data	**7**	**W**	AC7102/8
71	Report and analyze Calibration Data	**7**	**W**	AMS2750 AC7102/8
72	Material-Specific Requirements consistent with AMS 2750	**7**	**W**	AMS2750
73	Take responsibility for ensuring compliance of procedures and processes used by External Service Providers with AMS 2750 and customer specific requirements	**7**	**W**	AMS2750 AS9100
74	**Preventive Maintenance**:			
75	Knowledge and understanding of the Preventive Maintenance Program	**7**	**W**	
	Sequencing:			
76	Has an appropriate understanding of where this process falls in the sequence of events	10	W	
	PERSONAL ATTRIBUTES: **Are statements that will enable judgment of the person's personal attributes**			
77	Train and mentor			General Industry
78	Overall responsibility, ownership and authority on site level pyrometry activities			AMS2750
79	Writing work instructions and procedures and align them to the top level quality requirements			AS9100
80	Responsible review and signatory authority			AS9100
81	Responsible for documenting an on-going plan for pyrometry compliance at site level per AMS2750			AMS2750
82	Responsible for conducting periodic self-audits			AS9100
83	Responsible for continuous preventative maintenance plan			AS9100
84	Responsible for conducting internal personal qualification exam in order to comply with HT BoK ERB requirements			PRI Qualification
85	Responsible for timely notification of calibration intervals			AMS2750
86	Good communicator at all levels			
	EXPERIENCE: **Are the minimum experience requirement expected to demonstrate their competence**			
	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 competency. While it does not specifically address pyrometry, it does speak to planning. The following are recommendations and would be superseded by the supplier's specific documented program. The supplier program may define alternative	5		

	criteria, waivers and equivalences.			
87	**Education**			
88	As determined by supplier's procedures Recommended minimum - High School Graduate / GED	5		
89	**Recommended Minimum Classroom Training**			
90	Paperwork – 40 hours Test, Inspection, Maintenance – 40 hours	7		ARP1962
91	**Recommended Minimum On-the-Job-Training**			
92	There is no specific minimum requirement but documentation of training in the functions being performed is required.	5		ARP1962
93	**Testing and Evaluation**			
94	Initial and periodic evaluation of personnel is required. The type of frequency of the evaluation shall be determined by the company employing the individual, except that each individual shall be evaluated at least every 5 years. This shall be defined in the formal written program. Evaluation may consist of any combination of written or oral examination or testing, structured checklist review, employee performance appraisal, company employee specific audit program or other appropriate methodology defined in the formal written program.	10		ARP1962
	NON-SPECIAL PROCESS RELATED REQUIREMENTS: **Defined within these rolls are other general or pre-requisite needed**			
95	Must have a thorough understanding of general Quality Systems (AS9100) or equivalent	**7**	**W**	AS9100
96	Must have a thorough understanding of customer specific requirements	**7**	**W**	General Industry
97	Must have a thorough understanding of control of non-conformance for equipment and product including containment, customer notification and disposition	**7**	**W**	ISO9001 AS9100

7. PORTFOLIO REQUIREMENTS

Row #	COMPETENCE	Exam Type Written / Practical	Reference Guidelines
	PORTFOLIO REQUIREMENTS *(for OWNER LEVEL Qualification Only)* **Portfolio must include the following components for consideration**		
98	Planner Exam Score *(Must receive at least 80%)*		
99	Planner Exam Validity *(Must be within 6 months of requalification)*		
99	Experience Survey		
100	Resume of Experience *(Description of Current and Previous Jobs)*		
101	Employer / Client Verification *(Signed Statement of Corroboration by either current employer or client)*		
	NOTE: The above components will be scored accordingly		

8. DOCUMENT REVISION HISTORY

REVISION DATE	SUMMARY
03 Oct 14	Editorial change to formatting and definitions
03 Jun 15	Name change from Pyrometry Service In-House to Pyrometry Service Processor
08 Feb 16	Name change from Pyrometry Service Processor to Pyrometry Process
17 Jun 16	Editorial change made to update BoK with new template revisions
26 Jan 17	Revised Pyrometry Specific Criteria wording – all levels Removed 'Knowledge and understanding of' from all line items Removed 'Has Knowledge and understanding of' from all line items Revised wording for line items Added document ARP1962 to Addendum 1 Added Addendum 2 REACh Regulation Information
04 Jan 19	Editorial changes: Updated logo Removed Addendum 2 REACh Regulation Information Removed paragraph references
4 December 2019	Editorial revision to update program name from eQualified to PRI Qualification[SM.]

ADDENDUM 1

LIST OF INDUSTRY STANDARDS & REFERENCE DOCUMENTS FOR PYROMETRY

SPECIAL PROCESS	DOCUMENT TITLE	DOCUMENT NUMBER
Heat Treating	Nadcap Audit Criteria for Heat Treating Pyrometry	AC7102/8
Pyrometry	Pyrometry	AMS2750
Training	Training and Approval of Heat-Treating Personnel	ARP1962
Quality	\Quality Management Systems - Requirements for Aviation, Space and Defense Organizations	AS9100
Quality	Quality Standards	ISO9001
Health & Safety	Environmental Management Systems - Specification with Guidance for Use	ISO14001
Health & Safety	Occupational Health and Safety Management System	OHSAS 18001