



161 Thorn Hill Road  
Warrendale, PA 15086-7527

## Program Document HTBOK

PD 6103

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### BODY OF KNOWLEDGE:

**ROLE DESCRIPTION:** PYROMETRY PROCESS / CALIBRATION AND TEST  
**SPECIAL PROCESS:** Pyrometry  
**SCOPE/METHOD:** Performance of Pyrometry Requirements for Thermal Processing Equipment  
**LEVEL:** Pyrometry Operator / Technician

All eQualified examinations are created using the applicable eQualified 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 eQualified BoKs are created by subject matter experts through an exhaustive job analysis process as detailed in the eQualified Program Document 6100: Industry Managed Special Process Bodies of Knowledge. All eQualified BoKs are updated periodically according to the requirements of the current eQualified PD6100 document to ensure they are consistent with current industry practice.

## 1. INTRODUCTION

This document has been created by the eQualified Heat Treat Body of Knowledge Review Board (HT BoKRB) according to the requirements of eQualified Program Document PD6100 Industry Managed Special Process Bodies of Knowledge.

This document constitutes the eQualified BoK for Pyrometry Process Operator and Calibration and Test Technician. It defines the baseline knowledge and experience required to be considered competent to perform this role.

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

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

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

## **2. REFERENCES**

eQualified documents:

PD6000	Governance & Administration of eQualified 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 eQualified 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.

**HEAT TREATMENT OPERATOR:** The individual(s) responsible for preparing, loading, running and repacking customer product (Parts or Material) after treatment. Responsibilities include requirement to ensure that Heat Treatment processes are carried out in compliance with written instructions and procedures – not to be confused with Pyrometry Operator

**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 (Insourcing) is often preferred to ensure compliance of critical with specific customer or statutory requirements – The opposite of Outsourcing

**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, Planner and Planner. Please refer to the current version of PD 6000 for definitions

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

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

**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.

**PYROMETRY OPERATOR:** Individual(s) with a basic level of pyrometry knowledge. This (these) individual(s) provide a service to ensure that processes and methods used for periodic verification comply with the requirements of AMS 2750 (current issue) and any additional customer specific requirements which are more

stringent. Examples may include setting up for and carrying out and recording thermocouple or Instrument calibration and results from Periodic Tests (TUS, SAT).

A Pyrometry Operator has authority and responsibility to carry out tests and record results and in accordance with the above.

A Pyrometry Operator does not have responsibility and authority to review, report or react to the results which their tests have generated

The role of Pyrometry Operator must not be confused with the role of Heat Treatment Operator

**PYROMETRY PLANNER:** Individual(s) with a significantly higher level of Pyrometry knowledge. In addition to knowing and being able to do what is expected from an Operator the Pyrometry Planner must have authority and responsibility for reviewing and acting on the results generated by the Operators tests, liaising with Operations /Production and external service providers where required. The Pyrometry Planner must be able to write and maintain procedures and works instructions related to Pyrometry

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

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

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

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

- Self-study
- Completion of internal training
- Completion of external training (a list of eQualified approved providers can be found at [www.eQualified.com](http://www.eQualified.com))

Records of all qualified personnel shall be maintained and include:

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

5. LEVELS

<b>Level</b>			
<b>Descriptors</b>	<b>Operator (OP)</b> <i>Understand and perform the hands-on operations of the special process for which qualification is sought.</i>	<b>Planner (PL)</b> <i>Capable of selecting manufacturing processes and interpreting process procedures to conform to customer specification and requirements.</i>  <i>Capable of problem solving and resolving day to day issues.</i>	<b>Owner (OW)</b> <i>Capable of writing, reviewing and approving processes, procedures and qualifications of Operators and Planners. Capable of designing new processes and resolving issues among other levels.</i>
<b>Pyrometry Specific Criteria</b>	<p>Basic understanding of the HT / Pyro process</p> <p>Capable of recognizing when processes are 'deviating</p> <p>A Pyrometry Operator has authority and responsibility to carry out tests and record result</p> <p>A Pyrometry Operator does not have responsibility and authority to review, report or react to the results</p>	<p>In addition to knowing what the Operator does, the Planner must:</p> <p>manage HT shop that contracts the service provider and reviews reports</p> <p>Pyro Svc. Tech. needs to have higher understanding; conduct calibration, TUS testing, Thermocouple Calibrations, and SAT Tests.</p> <p>the Pyrometry Planner must have authority and responsibility for reviewing and acting on the results generated by the Operators tests</p>	<p>In addition to knowing what the Operator and Planner do, the Process Owner must:</p> <p>Manage people that perform the work and evaluate and reviews reports; must have knowledge of "how" to run the testing and trains.</p> <p>Takes responsibility for accuracy of purchase order information flowed down to service provider, Takes responsibility for ensuring that Service providers processes and procedures conform in all aspects with AMS 2750 / customer specific requirements (1)</p>
<b>Technical Knowledge</b>	Basic knowledge of the special process, its main processes, methods and tools.	<p>Good level of knowledge in all aspects of the special process, all its processes, methods and tools.</p> <p>Ability to coach others on contents and methods in the context of their workplace.</p>	<p>High or extensive knowledge in all aspects of the special process, all its processes, methods and tools to assess and validate improvements.</p> <p>Able to contribute to set externally recognized standards.</p> <p>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.</p>
<b>Experience</b>	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?
<b>Personal Attributes</b>	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.		
<b>Skills</b>	Describes the activities necessary to perform each level of job function to comply with the Body of Knowledge		
<b>Non-Special Process Related Requirements</b>	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

**Special Process Bodies of Knowledge Review Boards must complete Table 1 to form the BoK**

**TABLE 1**

The guidelines for table 1 boxes are as noted:

**Box 1 – Knowledge – Are knowledge based questions.**

**Box 2 – Skills – Defined within these rolls describes the range of skills.**

**Box 3 – Personal Attributes – Are statements that will enable judgment of the person’s personal attributes.**

**Box 4 – Experience – Are the minimum experience requirement expected to demonstrate their competence.**

**Box 5 – Non-Special Process Related Requirements – Defined within these rolls are other general or pre-requisite needed.**

Row #	COMPETENCE	Level (e.g. OP, PL, OW, T1)	Weight (1,3,7,10)	Exam Type Gen/Specific/P ractical	Reference Guidelines (See description above)
1	<b>SPECIAL PROCESS: PYROMETRY PROCESS OPERATOR AND CALIBRATION AND TEST TECHNICIAN</b> <b>SCOPE / METHOD:</b> Performance of Pyrometry Requirements for Thermal Processing Equipment <b>REFERENCE GUIDELINES:</b> All paragraph references are applicable to AMS2750 (latest revision) unless otherwise identified.				
	<b>Understands:</b> <b>The basic knowledge of the special processes, methods and tools</b>				
2	<b>GENERAL QUALITY SYSTEMS KNOWLEDGE:</b>	OP		GEN	
3	A general understanding of why an Aerospace Quality system and compliance with it are necessary.	OP	7	GEN	AS9100; AC7102/8 2.1, 8.0
4	A fundamental understanding of working precisely to Internal Work \instructions (Job Sheet /Traveler/Data Card etc.).	OP	7	GEN	AS9100; AC7102/8 2.1, 8.0
5	A general understanding of the relationship between work instruction /customer requirements / requirements of external standards.	OP	7	GEN	AS9100; AC7102/8 2.1, 8.0
6	A general understanding of the cause and effect of Nonconformance and the importance of having an effective process able to identify Root Cause and Corrective Action.	OP	7	GEN	4.2 & AS9100; AC7102/8 2.1,8.0
7	A general understanding of the importance of the links between the Thermal Process being carried out and the Pyrometry controls required by AMS 2750 to ensure compliance.	OP		GEN	
8	Awareness / general understanding of temperature sensors, instrumentation, thermal processing equipment, system accuracy tests, and temperature uniformity surveys.	OP	7	GEN	AMS 2750 AC7102/8 2.1; 8.0
9	General understanding of the need for traceability of customer product through each process step.	OP	7	GEN	AMS 2750 AC7102/8 2.1; 8.0
10	General understanding of the need for TRACEABILITY of calibration to an independent Nationally recognized source example NIST or equivalent National agencies.	OP	7	GEN	2.2.40,3.1.2.2.6 AS9100 AC7102/8 2.1; 80
11	Has knowledge and understanding to be able to recognize and report in real time deviations from process parameters or other events which may have a negative impact on product quality.	OP	7	GEN	2.2.40,3.1.2.2.6 AS9100 AC7102/8 2.1; 80
12	Basic understanding of the metallurgy of the processes carried out and how these are affected by compliance with AMS 2750.	OP	10	GEN	4.1
13	Knowledge and understanding of the need for compliance with internal and external requirements pre-treatment including but not limited to incoming product condition (fitness to treat), cleaning, handling, load make up inclusion of representative test material load breakdown packaging and dispatch to customer.	OP	7	GEN	4.1
14	<b>SENSORS (THERMOCOUPLES):</b>	OP	10	GEN	4.1
15	Basic knowledge understanding of sensor types and their proper applications.	OP		GEN	
16	Basic knowledge and understanding of temperature ranges, atmospheres, and usage.	OP	7	GEN	3.1.1.4 AC7102/8 3.0
17	Basic understanding that there are specific requirements controlling recalibration, reuse, salvage and replacement requirements, calibration and reporting.	OP	7	GEN	AC7102/8 3.0

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18	Basic understanding that there are specific requirements for proper connection including use of extension wires and wireless transmitters.	OP	7	GEN	3.1.1.4 / 3.1.2 AC7102/8 3.0
19	Understanding of how to recognize temperature sensor (Thermocouple) failures and the subsequent actions which must be taken to minimize impact on product.	OP	7	GEN	AC7102 /8 3.0
20	Basic understanding of correction factors and their application.	OP	10	GEN	3.4.5.4, 3.5.16, 3.5.19 AC7102 /8 3.0
21	<b>INSTRUMENTATION:</b>				
22	Basic knowledge and understanding of the variety of instrumentation function (controlling, monitoring and recording) and that the differences in accuracy requirements for specific functions example Instruments used for SAT and TUS must be digital and calibrated as test Instruments.	OP	7	GEN	3.2 table4,6,7,8, 9, fig 3 AC7102/8 4.2;4.2.4
23	General understanding of when and how offset are permitted to be used (or not), limitations for use and recording of their use when required by AMS2750.	OP	7	GEN	3.2.4, Fig 6, 3.4.5.6, table 6, table 7 AC7102/8 6.6
24	Basic understanding of types of Furnace software (Electronic Program Control and Data Acquisition) in use at the Operators location and related to process carries out.	OP	7	GEN	3.2.7.1.2 Table 4 AC7102/8 4.3
25	General Knowledge of programming and program verification where process cycles are run under computerized systems.	OP	7	GEN	AS9100
26	Understanding of initial survey requirements when changes are made to automated programs.	OP	10	GEN	AS9100
27	<b>INSTRUMENT CALIBRATION</b>				
28	General knowledge and understanding of instrumentation hierarchy and differences between test instruments and other instruments	OP	10	GEN	
29	General knowledge and understanding of test and other instrument calibration and reporting requirements Understands that all Test Instruments must be digital and in compliance with AMS 2750 or other specifications if these are more stringent.	OP	10	GEN	3.2, Table 4,6,7,8,9, figure 3 AC7102/8 4.1;4.1.1
30	General knowledge and understanding of Instrument Sensitivity	OP	10	GEN	2.2.58, table 3 AC7102/8 4.2;4.2.4
31	<b>THERMAL PROCESSING EQUIPMENT:</b>				
32	Basic understand how to identify or determine Furnace Class and Instrumentation Type and how this relates to processing product at any particular site.	OP	7	GEN	3.3 AC7102/8 4.4
33	Basic understanding the different types of Thermal Processing Equipment on any particular site including but not limited to oven, furnaces, HIP units quench baths and refrigeration equipment, etc. and their basic function and usage related to the metallurgy of the treatments carried out and alloy type being treated.	OP	7	GEN	3.3.1 through 3.3.6.1 AC7102/8 4.4
34	<b>SYSTEM ACCURACY TESTS:</b>	OP		GEN	
35	Knowledge, understanding and ability to demonstrate practically how to perform System Accuracy Test (SAT) using Industry standard instrumentation.	OP	10	GEN	AMS 2750 3.4 AC7102/8
36	Knowledge and understanding of the scope of SAT in relation to sensor type and in compliance with AMS 2750.	OP	7	GEN	3.4; 3.4.1; 3.4.2 AC7102/8 5.1; 5.3
37	Knowledge and understanding of how to maintain records system accuracy test report.	OP	7	GEN	3.4.8
38	Basic understanding of any limitations to use of different temperature sensor types (K N R etc.).	OP	7	GEN	3.4.2; 3.4.7.2.1.2
39	Knowledge and understanding of the difference in furnace test interval requirements for processing parts vs. raw material Test Method / Loading conditions or" in running" variations in frequency related to Furnace Class and Instrumentation Type, application of more stringent customer requirements in addition to not in place of the requirements of AMS2750.	OP	10	GEN	Table 6 and table 7
40	Knowledge and understanding of SAT Data Collection and requirements for reporting.	OP	7	GEN	3.4.8
42	<b>TEMPERATURE UNIFORMITY SURVEYS:</b>	OP		GEN	
43	General understanding of why TUS is important.	OP	7	GEN	AMS 2750 3.5 AC7102/8 6.0; 6.5.4
44	Understand how to set up, program load and monitor a Temperature Uniformity Survey (TUS) using Industry standard instrumentation.	OP	7	GEN	3.5.3; 3.5.4 AC7102/8 6.0; 6.5.4
44	Knowledge and understanding of how Periodic TUS shall be performed in accordance with the interval shown in applicable Specification AMS2750.	OP	7	GEN	3.5 AC7102/8 6.0; 6.5.4

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45	Knowledge and understanding of issues which may arise during a survey which may 'fail' the survey during running (Overshoot, Temperature sensor failure) and what is the appropriate action to take in response.	OP	7	GEN	3.5.16; 3.5.19
46	Understanding and ability to relate load plans (maps) to furnace design and type to comply with the requirements of AMS 2750 and customer requirements which are more stringent.	OP	7	GEN	3.5.21.1.c AC7102/8 6.2
1	<b>SKILLS:</b> The skills required to perform a particular special process task	OP			
2	<b>READ AND UNDERSTAND WRITTEN INSTRUCTIONS:</b>	OP		GEN	General Industry
3	Understand internal instructions related to Pyrometry and Processes being carried out at the specific location.	OP		GEN	General Industry
4	Has knowledge and understanding to be able to recognize and report in real time deviations from process parameters or other events which may have a negative impact on product quality.	OP		GEN	General Industry
5	Knowledge and understanding of the specific equipment types to be tested and calibrated. i.e. access to specs, Manual and details procedures.	OP	10	GEN	Job Knowledge
1	<b>Sequencing</b>				
2	Has an appropriate understanding of where this process falls in the sequence of events.	OP	10	GEN	
1	<b>NON-SPECIAL PROCESS RELATED REQUIREMENTS:</b> Defined within these rolls are other general or pre-requisite needed				
2	Must have a thorough understanding of general Quality Systems principles (AS9100) or equivalent.	OP		GEN	General Industry
3	Must have a thorough understanding of customer specific requirements.	OP		GEN	General Industry
4	Must have a thorough understanding of Control of Non Conformance for equipment and product including Containment , Customer notification and disposition.	OP		GEN	General Industry

ADDENDUM 1

LIST OF INDUSTRY STANDARDS FOR PYROMETRY

<b>SPECIAL PROCESS</b>	<b>DOCUMENT TITLE</b>	<b>DOCUMENT NUMBER</b>
Pyrometry	SAE Aerospace Materials Specification – Pyrometry	AMS 2750
Quality	AS9100 Quality Management Systems - Requirements for Aviation, Space and Defense Organizations	AS 9100
Heat Treating	Baseline Nadcap Audit Criteria for Heat Treating	AC7102/8
Quality	Quality Standards	ISO9001