



Predictive Maintenance Technician

Job Role Skill Set



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DOCUMENT TITLE

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1.1 OBJECTIVE

The objective of this deliverable is to provide an introduction to described Job Role within the applied skills definition model.

1.2 PURPOSE OF THE DELIVERABLE

The purpose of this deliverable is to define skills definitions of the Predictive Maintenance Technician job role within the ECQA skills definition model.

1.3 SCOPE OF THE DELIVERABLE

The deliverable contains

- Description of the content of the Job Role
- Description of used Skill Sets and skills definitions, coverage of Qualification Schemas

The deliverable does not cover:

- Course development, as this will be done after the skill definitions clearly outlined the set of required courses.

2 ECQA SKILLS DEFINITION MODEL

A skills definition contains the following items (see Fig. 1):

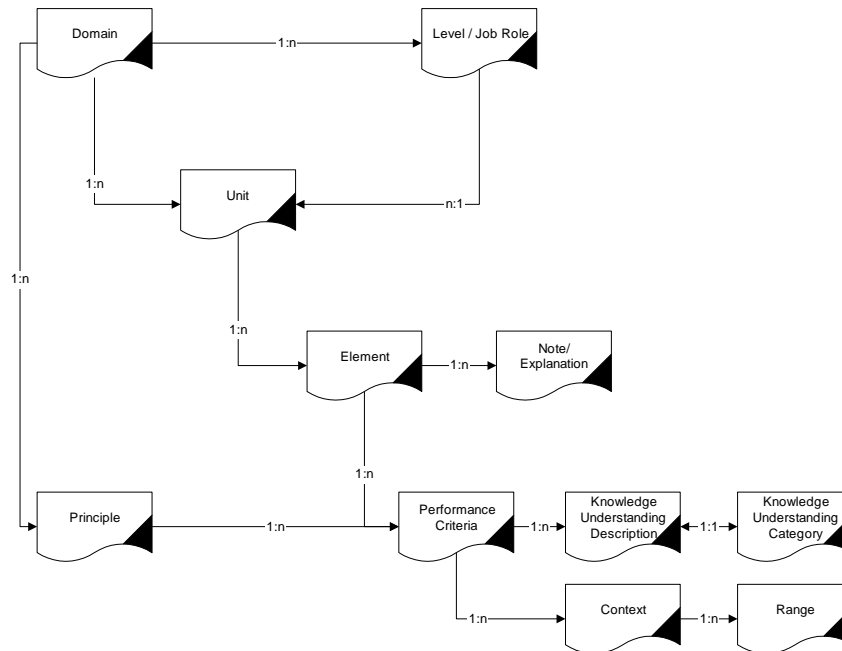


Figure 1 The Skill Definition Model (1:n = one to many relationship)

Context: A category of ranges; it represents some terminology used in a performance criterion that consists of different context, conditions or circumstances. A participant must be able to prove competence in all the different circumstances covered by the context.

Domain: An occupational category, e.g. childcare, first level management or software engineering.

Element: Description of one distinct aspect of the work performed by a worker, either a specific task that the worker has to do or a specific way of working. Each element consists of a number of performance criteria.

Evidence: Proof of competence.

Knowledge and understanding category: A category of knowledge and understanding descriptions.

Knowledge and understanding description: A description of certain knowledge and understanding. To be judged competent in a unit a participant must prove to have and to be able to apply all the knowledge and understanding attached to it.

NVQ (UK based): The National Vocational Qualification standard of England, Wales and N. Ireland.



Performance criterion: Description of the minimum level of performance a participant must demonstrate in order to be assessed as competent. A performance criterion may have relevant contexts.

Principle: A statement of good intentions; it underpins all competent domain practice.

Range: Description of a specific circumstance and condition of a performance criterion statement.

Qualification: The requirements for an individual to enter, or progress within a certain occupation.

Job Role: A certain profession that covers part of the domain knowledge. E.g. domain = Functional Safety, job role = Functional Safety Manager.

Unit: A list of certain activities that have to be carried out in the workplace. It is the top-level skill in the UK qualification standard hierarchy and each unit consists of a number of elements.

The rationales for developing the ECQA skills definition model is based on the skills definition proposed by the DTI (Department of Trade and Industry) in the UK for the NVQ (National Vocational Qualification) standards. These models have been re-used and slightly modified by other countries when they started employing skill cards [1], [2].

ECQA standards are used to describe the skills sets delivered within the DRIVES project (www.project-drives.eu). Further description and rationales are attached in annexes of this document. The ECQA structure was mapped in DRIVES project to DRIVES Reference and Recognition Framework with the links to ESCO[7], EQF[8], ECTS[9] and ECVET[10]. See more in deliverable DRIVES-D4.1.1 Reference and Recognition Framework – Analysis.pdf (www.project-drives.eu).

3 SKILLS DEFINITION FOR THE JOB ROLE “PREDICTIVE MAINTENANCE TECHNICIAN”

3.1 THE SKILLS HIERARCHY

Using the terminology outlined in the skills definition model and including the skills identified during the demand analysis at the beginning of the project, the following skills hierarchy for the job role “Predictive Maintenance Technician” has been designed.

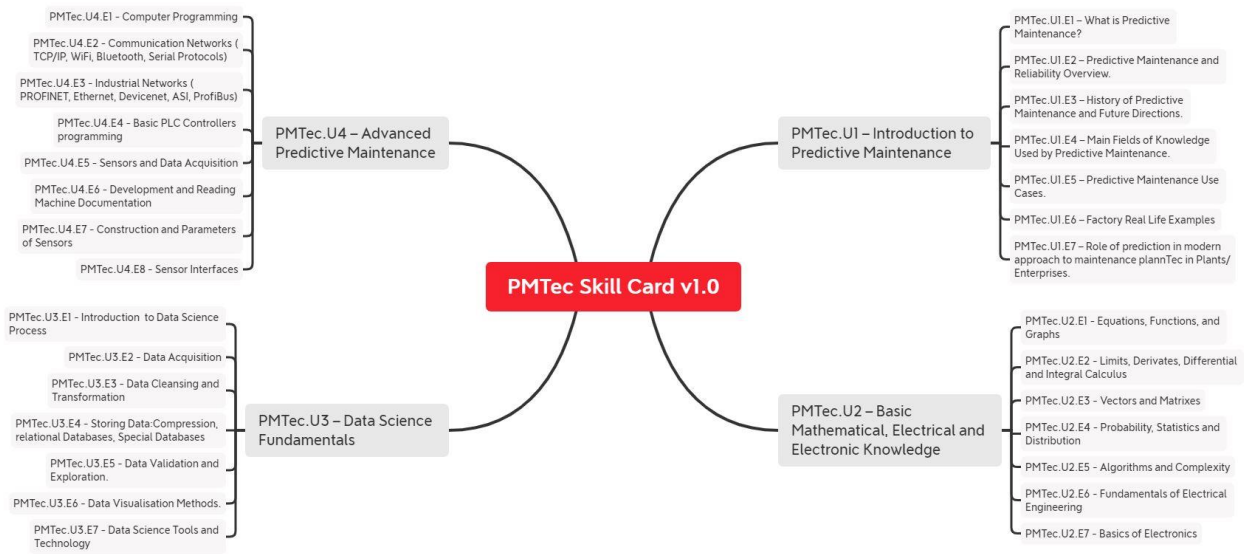


Figure 2: The Skills Set for ECQA Predictive Maintenance Technician

3.2 THE SKILLS DESCRIPTIONS – JOB ROLE PREDICTIVE MAINTENANCE TECHNICIAN

Domain Acronym: Engineering

Domain title: Maintenance

Domain Description:

Prediction, together with Reaction and Prevention is one of the Maintenance process base pillars. It is very important especially in automotive industry, where anticipate of malfunction allows us to be prepared and react immediately.

Job Role Acronym: PMTec

Job Role Title: Predictive Maintenance Technician

Description:

The Skill card comprises the following thematic learning units

Unit 1 – Introduction to Predictive Maintenance

Unit 2 – Basic Mathematical, Electrical and Electronic Knowledge



Unit 3 – Data Science Fundamentals

Unit 4 – Advanced Predictive Maintenance

3.3 UNIT PMTEC.U1 INTRODUCTION TO PREDICTIVE MAINTENANCE

Acronym: PMTec.U1

Title: Introduction to Predictive Maintenance

Description:

First Unit is an introduction to predictive maintenance methodology with description of classic and modern techniques. It consists from learning elements:

E1 What is Predictive Maintenance?

E2 Predictive Maintenance and Reliability Overview.

E3 History of Predictive Maintenance and Future Directions.

E4 Main Fields of Knowledge Used by Predictive Maintenance.

E5 Predictive Maintenance Use Cases.

E6 Factory Real Life Examples.

E7 Role of prediction in modern approach to maintenance planning in Plants/Enterprises.

3.3.1 Unit PMTec.U1 - Element 1: What is Predictive Maintenance?

Acronym: PMTec.U1.E1

Element Title: “What is Predictive Maintenance?”

Element Note:

This element describes idea of predictive maintenance based on definition, technologies and industry applications.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria/skills (PCs):

Performance Criterion	Evidence Check: The student can demonstrate
PMTEC.U1.E1.PC1	<p>Predictive Maintenance definition:</p> <p>Student is able to define what is predictive Maintenance.</p> <p>Student understands reasons why predictive maintenance is used.</p>
PMTEC.U1.E1.PC2	<p>Maintenance methodology – predictive versus preventive:</p>

Performance Criterion	Evidence Check: The student can demonstrate
	<p>Student knows how to recognise differences between predictive and preventive maintenance (also reactive)</p> <p>Student is able to classify different maintenance actions to proper group (preventive, reactive, predictive)</p>
PMTec.U1.E1.PC3	<p>Technologies of prediction maintenance:</p> <p>Student is able to classify predictive methods (destructive, non destructive tests)</p> <p>Student knows different of test methods.</p> <p>Student understands combination between prediction of failures and process efficiency.</p>
PMTec.U1.E1.PC4	<p>Commercial software to provide predictive maintenance:</p> <p>Student knows generally what kind of software can be used for predictive maintenance applications.</p>
PMTec.U1.E1.PC5	<p>Industry Application:</p> <p>Student knows in which industry prediction maintenance is applied.</p> <p>Student is able to list few examples of those industries.</p>

Table 1: Performance Criteria for the Element PMTec.U1.E1

3.3.2 Unit PMTec.U1 - Element 2: Predictive Maintenance and Reliability Overview

Acronym: PMTec.U1.E2

Element Title: “Predictive Maintenance and Reliability Overview”

Element Note:

This learning element classify typology of machine failures, describe machine different work conditions and introduce students to theory of reliability with calculation of its base indicators.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria/skills (PCs):

Performance Criterion	Evidence Check: The student can demonstrate
PMTec.U1.E2.PC1	<p>Typology of machine failures:</p> <p>Student is able to classify typology of machine failures</p> <p>Student knows different between them.</p>

	Student understands character of failure root cause.
PMTec.U1.E2.PC2	<p>Materials and work conditions:</p> <p>Student is able to describe different kind of materials (for machine parts)</p> <p>Student knows types of chronic factors with biggest impact for machine parts degradation.</p> <p>Student understands relationship between work condition and machine state.</p>
PMTec.U1.E2.PC3	<p>Theory of reliability – introduction:</p> <p>Student knows definition of reliability theory.</p> <p>Student is able to describe mathematic (statistic) elements of reliability theory.</p> <p>Student knows examples of reliability tools and techniques.</p>
PMTec.U1.E2.PC4	<p>Reliability KPI's¹ in modern maintenance:</p> <p>Student knows reliability KPI's,</p> <p>Students knows how to calculate reliability KPI's</p>

Table 2: Performance Criteria for the Element PMTec.U1.E2

3.3.3 Unit PMTec.U1 - Element 3: History of Predictive Maintenance and Future Directions

Acronym: PMTec.U1.E3

Element Title: “History of Predictive Maintenance and Future Directions”

Element Note:

This learning element present history of predictive approach in maintenance departments of different industries. Describe actual situation and new trends in this area, especially for machines equipped with IoT interfaces and working in 4.0 factories.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria/skills (PCs):

Performance Criterion	Evidence Check: The student can demonstrate
PMTec.U1.E3.PC1	Techniques of Predictive maintenance:

1 KPI – abbreviation of Key Performance Indicators.

	<p>Student is able to list and describe techniques of predictive maintenance.</p> <p>Student knows different between them.</p> <p>Student understands how measured value impact machine failures.</p>
PMTec.U1.E3.PC2	<p>Classic predictive algorithms and methods:</p> <p>Student is able to describe classic predictive methods.</p> <p>Student knows how to interpretate data from trend.</p>
PMTec.U1.E3.PC3	<p>Modern techniques and future directions:</p> <p>Student is able to describe modern predictive methods.</p> <p>Student knows base of mathematic statistic.</p> <p>Student is able to describe what means industry 4.0</p> <p>Student is able to describe new trends in data analysis.</p>

Table 3: Performance Criteria for the Element PMTec.U1.E3

3.3.4 Unit PMTec.U1 - Element 4: Main Fields of Knowledge Used by Predictive Maintenance.

Acronym: PMTec.U1.E4

Element Title: “Main Fields of Knowledge Used by Predictive Maintenance.”

Element Note:

This learning element shows students main areas of knowledge which is used to provide all activities according to predictive maintenance actions. It is essence of knowledge for students to achieve competencies of predictive maintenance expert. This learning element shows what kind of knowledge students will learn in next elements.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria/skills (PCs):



Performance Criterion	Evidence Check: The student can demonstrate
PMTec.U1.E4.PC1	<p>Math theory for Predictive maintenance:</p> <p>Student knows base mathematical functions and their trends analysis.</p> <p>Student knows base of probability theory.</p> <p>Student knows base of statistic theory.</p>
PMTec.U1.E4.PC2	<p>Data analysis theory:</p> <p>Student is able to list and describe base of statistic tools for data analysis.</p> <p>Student knows what is FFT².</p>
PMTec.U1.E4.PC3	<p>Computer software and configuration:</p> <p>Student is able to list and describe, what kind of software is needed to provide predictive maintenance.</p> <p>Student knows operating system and their network configuration tools.</p>

Table 4: Performance Criteria for the Element PMTec.U1.E4

3.3.5 Unit PMTec.U1 - Element 5: Predictive Maintenance Use Cases

Acronym: PMTec.U1.E5

Element Title: “Predictive Maintenance Use Cases”

Element Note:

This learning element describe machine elements and components applied in automotive industry. Shows students classification of those elements and methods of their technical condition assessment.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria/skills (PCs):

Performance Criterion	Evidence Check: The student can demonstrate
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2 FFT – abbreviation of Fast Fourier Transformation.



<p>PMTec.U1.E5.PC1</p>	<p>Automotive industry machine elements and components:</p> <p>Student knows base type of machine components applied in automotive industry.</p> <p>Student is able to classify those elements.</p>
<p>PMTec.U1.E5.PC2</p>	<p>Advance assessment of machine technical condition:</p> <p>Student is able to list and describe methods of assessment.</p> <p>Student knows what statistical machine modelling is.</p> <p>Student is able to describe machine communication interfaces</p>

Table 5: Performance Criteria for the Element PMTec.U1.E5

3.3.6 Unit PMTec.U1 - Element 6: Factory real life examples

Acronym: PMTec.U1.E6

Element Title: “Factory real life examples”

Element Note:

This learning element shows real life examples of predictive maintenance applications and tools. Production plant (factory) visit should be planned under this module.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria/skills (PCs):

Performance Criterion	Evidence Check: The student can demonstrate
<p>PMTec.U1.E6.PC1</p>	<p>Critical machine parameters monitoring examples</p> <p>Student is able to describe example of prediction system, from gathering data to visualization and analysis.</p> <p>Student knows what is RCA and can explain it.</p> <p>Student is able to describe example of ERP system and what kind of data it collect.</p>



Table 6: Performance Criteria for the Element PMTec.U1.E6

3.3.7 Unit PMTec.U1 - Element 7: Role of prediction in modern approach to maintenance planning in Plants/Enterprises.

Acronym: PMTec.U1.E7

Element Title: “Role of prediction in modern approach to maintenance planning in Plants/Enterprises.”

Element Note:

This learning element will show students aspect, what kind of benefits organisations can have using predictive maintenance approach. Describe the change from static to dynamic maintenance strategy based not only on scheduled prevention but rather on predictive analysis of machine actual condition.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria/skills (PCs):

Performance Criterion	Evidence Check: The student can demonstrate
PMTec.U1.E7.PC1	<p>Dynamic maintenance management:</p> <p>Student knows about methods of planning in maintenance department.</p> <p>Student knows what kind of computer system are used in maintenance – ERP³, CMMS⁴.</p>
PMTec.U1.E7.PC2	<p>Cost optimisation:</p> <p>Student is able to describe kind of maintenance strategies.</p> <p>Student is able to describe methods of spare parts management.</p>
PMTec.U1.E7.PC3	<p>Employees development:</p>

3 ERP – abbreviation of Enterprise Resource Planning.

4 CMMS – abbreviation of Computerised Maintenance Management System.

	Student is able to list and describe, what kind of competencies must have maintenance crew, to use predictive maintenance tools.
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Table 7: Performance Criteria for the Element PMTec.U1.E7

3.4 UNIT PMTEC.U2 BASIC MATHEMATICAL, ELECTRICAL AND ELECTRONIC KNOWLEDGE

Acronym: PMTec.U2

Title: Basic Mathematical, Electrical and Electronic Knowledge.

Description:

Second Unit is an introduction to Basic Mathematical, Electrical and Electronic Knowledge which is important to provide predictive analysis.

E1 Equations, Functions, and Graphs.

E2 Limits, Derivatives, Differential and Integral Calculus.

E3 Vectors and Matrixes.

E4 Probability, Statistics and Distribution.

E5 Algorithms and Complexity.

E6 Fundamentals of Electrical Engineering.

E7 Basics of Electronics.

3.4.1 Unit PMTec.U2 - Element 1: Equations, Functions and Graphs.

Acronym: PMTec.U2.E1

Element Title: “Equations, Functions and Graphs”

Element Note:

This element describes basic mathematical concepts such as equations, functions and graphs.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria/skills (PCs):

Performance Criterion	Evidence Check: The student can demonstrate
PMTec.U2.E1.PC1	Equations: Student is able to solve linear, simple polynomial, trigonometric, exponential and logarithmic equations.
PMTec.U2.E1.PC2	Functions:



Performance Criterion	Evidence Check: The student can demonstrate
	Student knows the formal function definition and is familiar with elementary functions such as polynomials, rational, trigonometric, exponential and logarithmic functions. Student is able to define multi-variable functions.
PMTec.U2.E1.PC3	Graphs: Student knows what is graph of the function and can draw it.

Table 8: Performance Criteria for the Element PMTec.U2.E1

3.4.2 Unit PMTec.U2 - Element 2: Limits, Derivatives, Differential and Integral Calculus

Acronym: PMTec.U2.E2

Element Title: “Limits, Derivatives, Differential and Integral Calculus”

Element Note:

This learning element explains the basic concepts of differential and integral calculus.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria/skills (PCs):

Performance Criterion	Evidence Check: The student can demonstrate
PMTec.U2.E2.PC1	Limits: Student knows the formal definition of limit and is able to calculate sequence limits.
PMTec.U2.E2.PC2	Differential calculus: Student knows the formal definition of derivative and is able to compute derivatives of elementary functions with single variable.
PMTec.U2.E2.PC3	Integral calculus: Student knows the Riemman definition of integral and is able to compute integrals of elementary functions.

Table 9: Performance Criteria for the Element PMTec.U2.E2

3.4.3 Unit PMTec.U2 - Element 3: Vectors and Matrixes.

Acronym: PMTec.U2.E3

Element Title: “Vectors and Matrixes.”

Element Note:

This learning element describes basic mathematical concepts of linear algebra.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria/skills (PCs):

Performance Criterion	Evidence Check: The student can demonstrate
PMTec.U2.E3.PC1	Vectors and linear spaces: Student knows the formal definition of vector, linear space and its base. Student is able to operate on vectors.
PMTec.U2.E3.PC2	Second-degree matrices The student knows the formal definition of a second degree matrix and is able to calculate its determinant
PMTec.U2.E3.PC3	Operations on vectors and matrices: The student is able to perform basic operations on matrices and vectors

Table 10: Performance Criteria for the Element PMTec.U2.E3

3.4.4 Unit PMTec.U2 - Element 4: Probability, Statistics and Distribution.

Acronym: PMTec.U2.E4

Element Title: “Probability, Statistics and Distribution.”

Element Note:

This learning element explains basic mathematical concepts of probability and statistics.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria/skills (PCs):

Performance Criterion	Evidence Check: The student can demonstrate
PMTec.U2.E4.PC1	Probability: The student knows the formal definition of probability for a finite elementary event space.

PMTec.U2.E4.PC2	Distribution: Student knows the formal definition of distribution, expected value and variance. Student is able to compute expected values and variances.
PMTec.U2.E4.PC3	Statistics: Student knows the formal definition of statistics, significance level and statistical test.

Table 11: Performance Criteria for the Element PMTec.U2.E4

3.4.5 Unit PMTec.U2 - Element 5: Algorithms and Complexity

Acronym: PMTec.U2.E5

Element Title: “Algorithms and Complexity”

Element Note:

This learning element describes mathematical concepts related to algorithms.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria/skills (PCs):

Performance Criterion	Evidence Check: The student can demonstrate
PMTec.U2.E5.PC1	Algorithms: Student is able to create block diagrams of algorithms.

Table 12: Performance Criteria for the Element PMTec.U2.E5

3.4.6 Unit PMTec.U2 - Element 6: Fundamentals of Electrical Engineering

Acronym: PMTec.U2.E6

Element Title: “Fundamentals of Electrical Engineering”

Element Note:

This element of learning describes the basic concepts, principles and definitions of electric current.

Performance Criteria:



The student must be able to show evidence of competencies for the following performance criteria/skills (PCs):

Performance Criterion	Evidence Check: The student can demonstrate
PMTec.U2.E6.PC1	DC current: The student knows the basic definitions and formulas describing direct current
PMTec.U2.E6.PC2	Connecting DC circuits: The student knows the basic elements of DC circuits, knows how to mark, describe and combine them.
PMTec.U2.E6.PC3	DC machines and devices: The student is able to recognize and name basic DC devices, knows their structure, can connect them, knows their markings in the diagram, can read their work parameters
PMTec.U2.E6.PC4	Alternating current AC: The student knows the basic definitions and formulas describing alternating current
PMTec.U2.E6.PC5	Connecting AC circuits: The student knows the basic elements of AC circuits, knows how to mark, describe and combine them.
PMTec.U2.E6.PC6	AC machines and devices: The student is able to recognize and name basic AC devices, knows their structure, can connect them, knows their markings in the diagram, can read their work parameters

Table 13: Performance Criteria for the Element PMTec.U2.E6

3.4.7 Unit PMTec.U2 - Element 7: Basics of Electronics

Acronym: PMTec.U2.E7

Element Title: “Basics of Electronics”

Element Note:

This element of learning describes the basic elements of electronics..

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria/skills (PCs):

Performance Criterion	Evidence Check: The student can demonstrate
PMTec.U2.E7.PC1	<p>Semiconductors:</p> <p>The student knows the types of semiconductors, is able to describe the principles of their operation, knows their use in technology.</p>
PMTec.U2.E7.PC2	<p>Semiconductor components:</p> <p>The student knows the semiconductor components, is able to describe the principle of their operation, knows their role in the electrical circuit</p>
PMTec.U2.E7.PC3	<p>Wiring diagrams:</p> <p>The student is able to read electrical and electronic diagrams, knows the designations of the elements in the diagram, can draw a simple diagram.</p>

Table 14: Performance Criteria for the Element PMTec.U2.E7

3.5 UNIT PMTEC.U3 DATA SCIENCE FUNDAMENTALS

Acronym: PMTec.U3

Title: Data Science Fundamentals.

Description:

Third Unit is dedicated to fundamentals of data science which are used in predictive maintenance.

E1 Introduction to Data Science Process

E2 Data Acquisition



- E3 Data Cleansing and Transformation
- E4 Storing Data: Compression, Relational Databases, Special Databases
- E5 Data Validation and Exploration
- E6 Data Visualization Methods
- E7 Data Science Tools and Technology

3.5.1 Unit PMTec.U3 - Element 1: Introduction to Data Science Process.

Acronym: PMTec.U3.E1

Element Title: “Introduction to Data Science Process”

Element Note:

This element describes information flow between sensors, applications and databases.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria/skills (PCs):

Performance Criterion	Evidence Check: The student can demonstrate
PMTec.U3.E1.PC1	<p>Databases:</p> <p>Student knows different types of data and know how they are stored in database.</p> <p>Student has basic knowledge of compression methods and its application in databases.</p>
PMTec.U3.E1.PC2	<p>Information flow process:</p> <p>Student knows the formal definition of information and is able to describe information flow between different applications.</p>

Table 15: Performance Criteria for the Element PMTec.U3.E1

3.5.2 Unit PMTec.U3 - Element 2: Data Acquisition

Acronym: PMTec.U3.E2

Element Title: “Data Acquisition”

Element Note:

This learning element describes methods of data acquisition.

Performance Criteria:



The student must be able to show evidence of competencies for the following performance criteria/skills (PCs):

Performance Criterion	Evidence Check: The student can demonstrate
PMTec.U3.E2.PC1	Data formats: Student knows how integers, floating numbers, binary strings, images, video and audio data are collected.
PMTec.U3.E2.PC2	Acquisition process: Student is able to insert collected data into database using SQL commands (case of relational databases). Student is able to insert collected data into special database (directories, files, indexes).

Table 16: Performance Criteria for the Element PMTec.U3.E2

3.5.3 Unit PMTec.U3 - Element 3: Data Cleansing and Transformation.

Acronym: PMTec.U3.E3

Element Title: “Data Cleansing and Transformation.”

Element Note:

This learning element describes methods for digital data processing.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria/skills (PCs):

Performance Criterion	Evidence Check: The student can demonstrate
PMTec.U3.E3.PC1	Data filtering: Student is able to use methods of Digital Signal Processing to filter the data to get data without noise.
PMTec.U3.E3.PC2	Signal recognition: Student is able to search patterns in images and sound signals.

Table 17: Performance Criteria for the Element PMTec.U3.E3

3.5.4 Unit PMTec.U3 - Element 4: Storing Data: Compression, Relational Databases, Special Databases.

Acronym: PMTec.U3.E4

Element Title: “Storing Data: Compression, Relational Databases, Special Databases.”

Element Note:

This learning element describes methods of data storing.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria/skills (PCs):

Performance Criterion	Evidence Check: The student can demonstrate
PMTec.U3.E4.PC1	<p>Compression:</p> <p>Student knows methods for data compression and is familiar with their properties. Student is able to choose and apply the appropriate compression method to a given data set.</p>
PMTec.U3.E4.PC2	<p>Relational databases:</p> <p>Student knows the structure of relational database and is familiar with most popular implementations.</p> <p>Student is able to create database and its structure using SQL commands.</p> <p>Student is able to create basic SQL queries and perform database operations.</p>
PMTec.U3.E4.PC3	<p>Special databases:</p> <p>Student knows other types of databases (different than relational).</p> <p>Student is able to indicate in which cases it is worth using special purpose database.</p>

Table 18: Performance Criteria for the Element PMTec.U3.E4

3.5.5 Unit PMTec.U3 - Element 5: Data Validation and Exploration.



Acronym: PMTec.U3.E5

Element Title: “Data Validation and Exploration”

Element Note:

This learning element explains how to explore and validate data stored in database.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria/skills (PCs):

Performance Criterion	Evidence Check: The student can demonstrate
PMTec.U3.E5.PC1	<p>Relational database exploration:</p> <p>Student knows advanced syntax of SQL queries. Student is able to obtain very specific information from the database.</p> <p>Student knows the fundamentals of database indexing and is able to index some types of data.</p>
PMTec.U3.E5.PC2	<p>Data validation:</p> <p>Student is able to perform data validation process.</p>

Table 19: Performance Criteria for the Element PMTec.U3.E5

3.5.6 Unit PMTec.U3 - Element 6: Data Visualization Methods.

Acronym: PMTec.U3.E6

Element Title: “Data Visualization Methods”

Element Note:

This learning element describes methods for data visualization and presentation.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria/skills (PCs):

Performance Criterion	Evidence Check: The student can demonstrate
PMTec.U3.E6.PC1	<p>Bases of vector and raster graphics:</p>

	<p>Student knows what is the main difference in presentation data in the format of vector or raster graphics.</p> <p>Student is able to use proper applications to create vector and raster graphics in given quality.</p>
PMTec.U3.E6.PC2	<p>Data readability:</p> <p>Student knows how data should be presented to give right level of readability.</p>
PMTec.U3.E6.PC3	<p>Data presentation formats:</p> <p>Student knows different file formats to store graphics both in vector and raster format.</p> <p>Students knows technical requirements for the presentation of data on various types of media.</p> <p>Student is able to use proper informatics tools to present different types of graphic files.</p>

Table 20: Performance Criteria for the Element PMTec.U3.E6

3.5.7 Unit PMTec.U3 - Element 7: Data Science Tools and Technology

Acronym: PMTec.U3.E7

Element Title: “Data Science Tools and Technology”

Element Note:

This learning element presents typical tools used in data science.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria/skills (PCs):

Performance Criterion	Evidence Check: The student can demonstrate
PMTec.U3.E7.PC1	Spreadsheet:

	The student is able to use the basic functions of the spreadsheet for the presentation and analysis of data.
PMTEC.U3.E7.PC2	Advanced applications: Student is able to use basic statistical software for data analysis and presentation.

Table 21: Performance Criteria for the Element PMTEC.U3.E7

3.6 UNIT PMTEC.U4 ADVANCED PREDICTIVE MAINTENANCE

Acronym: PMTEC.U4

Title: Advanced Predictive Maintenance.

Description:

Fifth Unit is advanced part of whole module, where students learn how to: integrate physical measuring circuit with PC (data application), setup communication channel, and gather data from sensors. Last two elements describes actual trends in data calculation and analysis using modern devices and methods. Whole Unit consist of following elements:

E1 Computer Programming

E2 Communication Networks (TCP/IP, WiFi, Bluetooth, Serial Protocols)

E3 Industrial Networks (PROFINET, Ethernet, Devicenet, ASI, ProfiBus)

E4 PLC Controllers Programming

E5 Sensors and Data Acquisition

E6 Development and Reading Machine Documentation

E7 Construction and Parameters of Sensors

E8 Sensor Interfaces

3.6.1 Unit PMTEC.U4 - Element 1: Computer Programming.

Acronym: PMTEC.U4.E1

Element Title: "Computer Programming"

Element Note:

This element describes basic of computer programming, which allows student to create simple algorithms for data gathering and processing. In this element, student learns basic programming in C++, VBA and also base of microcontrollers programming.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria/skills (PCs):

Performance Criterion	Evidence Check: The student can demonstrate
PMTec.U4.E1.PC1	<p>C++ basic of programming:</p> <p>Student knows C++ language data types,</p> <p>Student is able to create procedures & functions,</p> <p>Student can create data arrays, store data in them and provide operations on data tables.</p>
PMTec.U4.E1.PC2	<p>Operating systems:</p> <p>Student knows operating systems like: Windows Xp, 7, 10 and server editions,</p> <p>Student is able to work under Linux distributions in X-Window environment,</p> <p>Student can create and work with virtual machines (Vmware),</p> <p>Student knows basic rules of computer systems Maintenance,</p>
PMTec.U4.E1.PC3	<p>Visual Basic for Application in MS Office (Excel and Access):</p> <p>Student is able to present gathered data in tables and graphs.</p>
PMTec.U4.E1.PC4	<p>Microcontrollers programming examples – (Arduino):</p> <p>Student is able to connect controller to PC, via RS232 and setup transmission,</p> <p>Student knows how to connect sensors to microcontroller and read signals from them.</p>

Table 22: Performance Criteria for the Element PMTec.U4.E1

3.6.2 Unit PMTec.U4 - Element 2: Communication Networks (TCP/IP, WiFi, Bluetooth, Serial Protocols)

Acronym: PMTec.U4.E2



Element Title: “Communication Networks (TCP/IP, WiFi, Bluetooth, Serial Protocols)”

Element Note:

This learning element shows students which kind of communication standards and protocols are used for data exchange between electronic devices.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria/skills (PCs):

Performance Criterion	Evidence Check: The student can demonstrate
PMTEC.U4.E2.PC1	<p>Communication networks basic information:</p> <p>Student can classify different networks like LAN and WAN and describe their topologies.</p> <p>Student can describe Ethernet standard, especially:</p> <ul style="list-style-type: none"> - IP addressing, - TCP port configuration, - Cables, sockets and plugs,
PMTEC.U4.E2.PC2	<p>Wireless networks:</p> <p>Student can classify and describe different of radio network standards and their applications.</p>
PMTEC.U4.E2.PC3	<p>Internet infrastructure examples:</p> <p>Student is able to describe examples of network infrastructure devices like PC servers, data hubs and Switches,</p>

Table 23: Performance Criteria for the Element PMTEC.U4.E2

3.6.3 Unit PMTEC.U4 - Element 3: Industrial Networks (PROFINET, Ethernet, Devicenet, ASI, ProfiBus).

Acronym: PMTEC.U4.E3

Element Title: “Industrial Networks (PROFINET, Ethernet, Devicenet, ASI, ProfiBus).”

Element Note:

This learning element describe few most popular standards of industry networks, with examples and explaining differences between them.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria/skills (PCs):

Performance Criterion	Evidence Check: The student can demonstrate
PMTec.U4.E3.PC1	<p>Industrial communication most popular standards:</p> <p>Student is able to name several types of industrial networks and describe their topology and configuration.</p>
PMTec.U4.E3.PC2	<p>Physical layer equipment:</p> <p>Student is able to recognize physical elements such as cables, sockets and plugs from various types of networks. He can properly select and install them.</p>

Table 24: Performance Criteria for the Element PMTec.U4.E3

3.6.4 Unit PMTec.U4 - Element 4: PLC Controllers Programming

Acronym: PMTec.U4.E4

Element Title: “PLC Controllers Programming.”

Element Note:

This learning element shows basic information about PLC programming. Classify most popular PLC families and other cooperative devices, like HMI panels or remote I/O modules.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria/skills (PCs):

Performance Criterion	Evidence Check: The student can demonstrate
PMTec.U4.E4.PC1	<p>Most popular PLC families:</p> <p>Student is able to classify most popular families of PLC and name software for these devices.</p>
PMTec.U4.E4.PC2	<p>Hardware PLC in details:</p>



	<p>Student is able to recognize physical plc elements, name them and describe functions. Especially according to I/O modules, their signals and communication methods.</p> <p>Student knows how to create simple PLC (ladder) program to read data from sensor and execute some calculation on this data.</p>
PMTec.U4.E4.PC3	<p>HMI devices:</p> <p>Student is able to classify devices and describe them, based on acronyms HMI, MMI and SCADA</p>
PMTec.U4.E4.PC4	<p>OPC software:</p> <p>Student knows what kind of software is necessary to gather data from PLC via communication channel. For different PLC families.</p> <p>Student is able to connect and read data, from PLC to MS Excel.</p>

Table 25: Performance Criteria for the Element PMTec.U4.E4

3.6.5 Unit PMTec.U4 - Element 5: Sensors and Data Acquisition.

Acronym: PMTec.U4.E5

Element Title: “Sensors and Data Acquisition”

Element Note:

This learning element classify different types of sensors and data acquisition/detection devices. After this module student should know what type of sensor can be applied to detect objects or measure physical values.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria/skills (PCs):

Performance Criterion	Evidence Check: The student can demonstrate
PMTec.U4.E5.PC1	<p>Types of sensors in industrial applications:</p> <p>Student is able to classify and recognize the types of sensors, such as digital (security, object presence, pulse) and analog (temperature,</p>

	humidity, vibration, speed, frequency, current, voltage, etc.), can correctly select and connect them.
PMTec.U4.E5.PC2	<p>Physical values measure sensors:</p> <p>Student is able to recognize and classify different types of sensor according to physical value and data character, which can be applied on machine.</p> <p>Student understand differences between sensor signal levels and its nature.</p>
PMTec.U4.E5.PC3	<p>Vision systems and sensors:</p> <p>Student knows modern types of smart sensor, based on shape recognition and graphic processing.</p>

Table 26: Performance Criteria for the Element PMTec.U4.E5

3.6.6 Unit PMTec.U4 - Element 6: Development and Reading Machine Documentation.

Acronym: PMTec.U4.E6

Element Title: “Development and Reading Machine Documentation”

Element Note:

During this module students will learn how work with machine documentation. What is a standard for different types of documents and how to proceed with changes according to standards and law regulations.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria/skills (PCs):

Performance Criterion	Evidence Check: The student can demonstrate
PMTec.U4.E6.PC1	<p>Types and standard of machine documentation:</p> <p>Student must know how to classify machine documentation and where looks for requested element.</p>
PMTec.U4.E6.PC2	<p>Mechanical documentation:</p> <p>Student understand from which part (elements) consist mechanical documentation and is able to recognize its completeness.</p>
PMTec.U4.E6.PC3	<p>Electrical documentation:</p> <p>Student understand from which part (elements) consist electrical documentation and is able to recognize its completeness.</p>



PMTec.U4.E6.PC4	Pneumatic documentation: Student understand from which part (elements) consist pneumatic documentation and is able to recognize its completeness.
PMTec.U4.E6.PC5	Documentation procedures: Student understand how to proceed changes in machine documentation. Student knows international symbols. Student knows rules how operate with documentation according to CE rules and local registrations.

Table 27: Performance Criteria for the Element PMTec.U4.E6

3.6.7 Unit PMTec.U4 - Element 7: Construction and Parameters of Sensors

Acronym: PMTec.U4.E7

Element Title: “Construction and Parameters of Sensors”

Element Note:

This learning element shows students construction of different types of machine sensors. During this module student will also know how different sensors looks on schematic and how to connect it to input interface.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria/skills (PCs):

Performance Criterion	Evidence Check: The student can demonstrate
PMTec.U4.E7.PC1	Digital sensor construction: Student is able to recognize different types of digital sensors and describe methods of object detection.
PMTec.U4.E7.PC2	Analog sensor construction: Student is able to recognize different types of analog sensors and describe methods of signal measure. (f.e. vibration, humidity etc.)
PMTec.U4.E7.PC3	Sensor communication standards:

	Student knows how to connect different sensors for proper type of input module.
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Table 28: Performance Criteria for the Element PMTec.U4.E7

3.6.8 Unit PMTec.U4 - Element 8: Sensor Interfaces

Acronym: PMTec.U4.E8

Element Title: “Sensor Interfaces”

Element Note:

This learning element describe standards of sensor interfaces and measuring channels types. It also shows different examples of connection sensors to data logging device.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria/skills (PCs):

Performance Criterion	Evidence Check: The student can demonstrate
PMTec.U4.E8.PC1	Sensor signal types: Student is able to classify different sensor signal types and characters according to kind of sensor.
PMTec.U4.E8.PC2	Sensor wires, plugs and sockets: Student is able to recognize sensor connection wires.
PMTec.U4.E8.PC3	Connection examples: Student knows how to connect different types of sensor to proper input module.

Table 29: Performance Criteria for the Element PMTec.U4.E8



ANNEXES

The annex provides overview of used skills set, coverage of Qualification Schemas and Legal background for Certification

ANNEX A ECQA DESCRIPTION

ECQA – EUROPEAN CERTIFICATION AND QUALIFICATION ASSOCIATION

ECQA standards are used to describe the skills sets delivered within the DRIVES project (www.project-drives.eu). ECQA is the pilot Certification body, which structure is mapped to DRIVES Reference and Recognition Framework providing the EU-wide overview of training courses and possible certifications, and micro-credentials. DRIVES Reference and Recognition Framework provides links to ESCO[7], EQF[8], ECTS[9] and ECVET[10]. See more in deliverable DRIVES-D4.1.1 Reference and Recognition Framework – Analysis.pdf (www.project-drives.eu).

Europe Wide Certification

The ECQA is the result of a number of EU supported initiatives in the last ten years where in the European Union Life Long Learning Programme different educational developments decided to follow a joint process for the certification of persons in the industry.

Through the ECQA it becomes possible that you attend courses for a specific profession in e.g. Spain and perform a Europe wide agreed test at the end of the course.

Access to a Vast Pool of Knowledge

ECQA currently supports 27 professions in Europe and with the continuous support until 2012 by the European Commission the pool is growing to 30 certified professions in Europe. ECQA offers certification for professions like IT Security Manager, Innovation Manager, EU project manager, E-security Manager, E-Business Manager, E-Strategy Manager, SW Architect, SW Project Manager, IT Consultant for COTS selection, Internal Financial Control Assessor (COSO/COBIT based), Interpersonal Skills, Scope Manager (Estimation Processes), Configuration Manager, Safety Manager, and so forth.

The ECQA guide can be downloaded at www.ecqa.org -> Guidelines.

Defined procedures are applied for:

- Self assessment and learning



- http://www.ecqa.org/fileadmin/documents/Self_Assessment/eucert-users-self-assessment-learning-guide-v5-doc.pdf
- Exam performance
- http://www.ecqa.org/fileadmin/documents/ECQA_Exam_Guide_Participant_v2.pdf

ECQA SKILLS DEFINITION MODEL

The ECQA skills definition model, used for Job Role definition, is described in section 2 of this document.

ECQA SKILL SET STRATEGY

Imagine that in the future Europeans will have a skill set like a card with a chip which stores your skill profile to fulfil specific professions, job roles, and tasks. It's working like an ID card. This future scenario requires -

- A standard way to describe a skill set for a profession, job, or specific task.
- A standard procedure to assess the skill and to calculate and display skill profiles.

Such a common set of skill sets in Europe is needed due to the free mobility of workers. European countries such as UK, The Netherlands, and France already have well established open universities which support APL (Accreditation of Prior Learning). In APL the skills of students are assessed, already gained skills are recognised, and only for the skill gaps a learning plan is established. The skill assessment bases on defined skill units and a skill profile displaying how much of the skill units are covered.

In a previous project CREDIT (Accreditation of Skills via the Internet) [1] in which some of the project partners were involved such an Internet based skills assessment system has been built. Therefore another possible scenario of the future is that representative educational bodies per country in Europe maintain skill profiles in databases which can be accessed via defined ID codes for people.

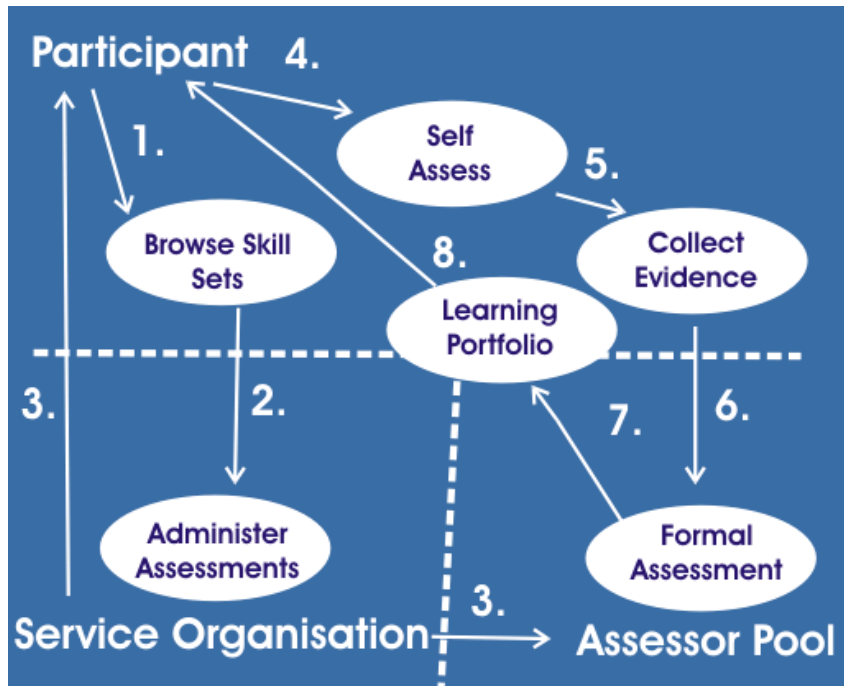
ECQA SKILLS ASSESSMENT MODEL

Step 1 – Browse a Skills Set: You select a set of skills or competencies, which are required by your profession or job using national standards or your company standards. You browse different skills cards and select a job role you would like to achieve.

Step 2 – Register for Self Assessment with a Service Unit : This can be a service unit inside your own company (e.g. a personnel development department) or a skills card and assessment provider outside

your company which offers skills assessment services. In case of the Safety Manager Project the registration will automatically assign a predefined service unit.

Step 3 – Receive an Account for Self-Assessment and Evidence Collection : With the registration you automatically received an account to login to the working space in which you can go through the steps of online self assessment and the collection of evidences to prove that you are capable of certain performance criteria.



Picture 1: Basic steps of the skills assessment model

Step 4 – Perform Self Assessment: You log into the system , browse through the skills required and self assess performance criteria, whole elements or whole units with a standard evaluation scale of non-applicable, not adequate, partially adequate, largely adequate, and fully adequate. A skills gaps profile can be generated and printed illustrating in which areas your self assessment shows improvement potentials.

Testing of Skills (Addition to Step 4) – The system provides a multiple-choice test for each performance criteria so that you can check your capabilities as realistically as possible.

Step 5 – Collect Evidences: Before you want to enter any formal assessment you need to prove your skills by evidences. Evidences can be any electronic files (sample documents, sample graphics, results of some analysis, etc.) or any references with details (e.g. a certificate received from a certain



institution). Evidences you can then link to specific performance criteria or whole elements of skills units.

Testing of Skills (Addition to Step 5) – In traditional learning schemes people have always needed to go to a learning institution (university, accreditation body, professional body, etc.) to take exams and they received a certificate if they pass. This traditional approach however is insufficient when it comes to measuring experience and (soft) skills learned on the job and fails to give recognition to skills gathered on the job. The APL (Accreditation of Prior Learning) approach, by contrast, collects so called evidences. Evidences can be certificates obtained in the traditional way, but also references from previous employers, materials from previous projects in which the person took ownership of results (e.g. a test plan) to prove their capability, as well as any kind of proof of competence gathered on the job. The assessors will then evaluate the evidences provided and not only rely on certificates and exams.

Step 6 – Receive Formal Assessment: Formal assessors are assigned by the service unit to the skills assessment. Once formal assessors log into the system they automatically see all assigned assessments. They select the corresponding one and can see the uploaded evidences. They then formally assess the evidences and assess the formal fulfilment of performance criteria, whole elements or whole units with a standard evaluation scale of non-applicable, not adequate, partially adequate, largely adequate, and fully adequate. In case of missing competencies they enter improvement recommendations, as well as learning options.

Step 7 – Receive Advise on Learning / Improvement Options: After the formal assessment the participants log into the system and can see the formal assessment results from the assessors, can print skills gaps profiles based on the assessor results, and can receive and print the improvement recommendations and learning options. If required, the generation of learning options can also be automated through the system (independent from assessor advises).

ECQA CERTIFICATE TYPES

In the standard test and examination procedures for levels of certificates are offered:

- Course Attendance Certificate
 - Received after course attendance
 - Modular per Element
- Course / Test Certificate
 - Test in a test system (European pool of test questions)
 - 67% satisfaction per element



- Summary Certificate
 - Overview of covered elements where the student passed the test, all elements shall be covered
 - Generation of certificate
- Professional Certificate
 - Uploading applied experiences for review by assessors
 - Rating by assessors
 - Observation of 2 years

The certificates show credited elements in comparison to all required.



ANNEX B ECQA COVERAGE OF QUALIFICATION SCHEMAS

MAPPING BASED ON NVQ QUALIFICATION LEVELS

Qualification / training levels: Five levels of qualification / training are defined by European legislation and this structure can be used for comparability of vocational qualifications from the different European countries.

- Level 1: semi-skilled assistant performing simple work
- Level 2: basic employee performing complex routines and standard procedures
- Level 3: skilled professional with responsibility for others and performing independent implementation of procedures
- Level 4: middle management & specialist performing tactical and strategic thinking
- Level 5: professional / university level

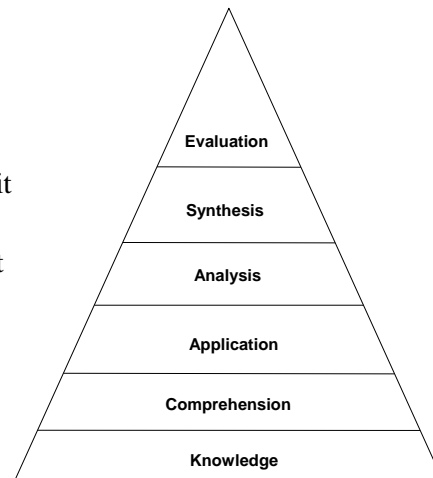
In most cases the same job role can be offered on different levels. e.g. IT Security Manager Basic Level (NVQ level 2), IT Security Manager Advanced level (NVQ Level 3), and IT Security Manager Expert Level (NVQ Levels 4 and 5).

MAPPING BASED ON EUROPEAN QUALIFICATION FRAMEWORK (EQF) LEARNING LEVELS

- **Six level taxonomy:**

Level 0: I never heard of it

1. Knowledge (I can define it):
2. Comprehension (I can explain how it works)
3. Application (I have limited experience using it in simple situations)
4. Analysis (I have extensive experience using it in complex situations)
5. Synthesis (I can adapt it to other uses)
6. Evaluation (I am recognized as an expert by my peers)



Picture 3: Blooms Learning levels

Level	Knowledge	Example
Level 1	Basic general knowledge	
Level 2	Basic factual knowledge of a field of work or study	
Level 3	Knowledge of facts, principles, processes and general concepts, in a field of work or study	Six Sigma Yellow Belt
Level 4	Factual and theoretical knowledge in broad contexts within a field of work or study	
Level 5	Comprehensive, specialised, factual and theoretical knowledge within a field of work or study and an awareness of the boundaries of that knowledge	
Level 6	Advanced knowledge of a field of work or study, involving a critical understanding of theories and principles	Six Sigma Green Belt
Level 7	<ul style="list-style-type: none"> • Highly specialised knowledge, some of which is at the forefront of knowledge in a field of work or study, as the basis for original thinking and/or research • Critical awareness of knowledge issues in a field and at the interface between different fields 	Six Sigma Black Belt

Level	Knowledge	Example
Level 8	Knowledge at the most advanced frontier of a field of work or study and at the interface between fields	Six Sigma Master Black Belt

Picture 4 : EQF Learning levels

MAPPING BASED ON ECTS AND ECVET SCHEMA

ECQA has established a procedure to map ECQA skills sets onto the ECTS (European Credit Transfer System) and the ECVET framework in the European Union.

A job role is assigned ECTS and ECVET points using a defined framework.

ECTS Mapping

Each element of the skills set is assigned hours of lecturing and exercises. These hours determine the ECTS points which are then agreed among a cluster on different universities in Europe.

Level	Knowledge	AQUA	ECTS	Safety Manager	ECTS
Level 1	Basic general knowledge	-		-	
Level 2	Basic factual knowledge of a field of work or study	-		-	
Level 3	Knowledge of facts, principles, processes and general concepts, in a field of work or study				
Level 4	Factual and theoretical knowledge in broad contexts within a field of work or study				
Level 5	Comprehensive, specialized, factual and theoretical knowledge within a field of work or study and an awareness of the boundaries of that knowledge				
Level 6	Advanced knowledge of a field of work or study, involving a critical understanding of theories and principles	AQUA - Automotive Quality Integrated Skills - presentations / theory	3	AQUA - Automotive Quality Integrated Skills - presentations / theory	3
Level 7	- Highly specialized knowledge, some of which is at the forefront of knowledge in a field of work or study, as the basis for original thinking and/or research - Critical awareness of knowledge issues in a field and at the interface between different fields	AQUA - Automotive Quality Integrated Skills - with exercises to apply on nan example (e.g. ESCL)	4	AQUA - Automotive Quality Integrated Skills - with exercises to apply on nan example (e.g. ESCL)	4
Level 8	Knowledge at the most advanced frontier of a field of work or study and at the interface between fields	AQUA - Automotive Quality Integrated Skills - implementation in a research at PhD level / with link to a real project	5	AQUA - Automotive Quality Integrated Skills - implementation in a research at PhD level / with link to a real project	5

Picture 5 : Example Automotive Quality Engineer and Safety Manager

The 2 job roles illustrated in the picture above have been assigned to ECTS and are taught using the same skills set at industry and also universities.



ECVET Mapping

Also ECQA provides a framework to assign ECVET points onto elements of the skills set. The ECQA guidance recommends to offer the ECQA course (which is offered as a lecture at university) as a short course (2 weeks with exercises) in industry to retrain for a job role in industry. The recommended size is 30 ECVET points in total. The lecturing time and exercise per element determine how many ECVET points are assigned to an element of the skills set.

Automotive Quality Engineer			
			ECVET L7&8
U1	4	U1.E1: Introduction	2
		U1.E2: Organisational Readiness	2
U2	32	U2.E1 Life Cycle	8
		U2.E2 Requirements	8
		U2.E3 Design	8
		U2.E4 Test and Integration	8
U3	12	U3.E1: Capability	2
		U3.E2: Hazard and Risk Management	8
		U3.E3 Assessment and Audit	2
U4	12	U4.E1: Measurement	6
		U4.E2: Reliability	6
ECVET Points Total			60

Picture 6 : ECVET Mapping example - Automotive Quality Engineer

Functional Safety Manager / Engineer			
			ECVET L7&8
U1	2	U1.E1 International Standards	1
		U1.E2 Product Life Cycle	1
		U1.E3 Terminology	
U2	4	Safety management on organisational	1
		Safety Case Definition	1
		Overview of Required Engineering an	1
		Establish and Maintain Safety Plannin	1
U3	16	System Hazard Analysis and Safety Co	4
		Integrating Safety in System Design &	4
		Integrating Safety in Hardware Design	4
		Integrating Safety in Software Design	4
U4	4	Integration of Reliability in Design to I	2
		Safety in the Production, Operation an	2
U5	4	Legal aspects and Liabilities	2
		Regulatory & Qualification Requireme	2
ECVET Points Total			30

Picture 7 : ECVET Mapping example – Functional Safety Manager / Engineer



ANNEX C ECQA LEGAL BACKGROUND FOR CERTIFICATION

ISO/IEC 17024 STANDARD FOR PERSONNEL CERTIFICATION PROGRAMMES

The ISO/IEC 17024 standard describes standard processes for the examination and certification of people. Some of the basic principles described include:

- Standard exam procedure
- Standard certification procedure
- Identification of persons receiving the certificate
- Independence of examiner and trainer
- Certification system that allows to log the exam to keep a record/proof that the examinee passed the exam
- Mapping of processes towards ISO 17024

ECQA AND ISO/IEC 17024 STANDARD

- ECQA defined standard exam processes
- ECQA defined standard certification processes
- ECQA developed an exam system that generates random exams and corrects exams.
- ECQA developed a certification database to identify persons and map them to exam results
- ECQA established a mapping onto the ISO 17024 norm and published that in form of a self declaration.

LIASION WITH NATIONAL UNIVERSITIES

ECQA established cooperation with national universities who teach job roles with ECTS. The same job roles are offered with ECVET on the market by training bodies.



ANNEX D REFERENCES

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