FSW-Tech

Friction Stir Welding European Qualifications

Minimum Requirements for the Education, Examination and Qualification

Project Nr: ***2017-1-SK01-KA202-035415***

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Erasmus+

Preface

This document is referred to the Friction Stir Welding Personnel Guideline developed in the scope of the FSW-Tech ERASMUS+ Project (2017/2019) – *Project No: 2017-1-SK01-KA202-035415*

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The next pages will show the guideline content.

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MINIMUM REQUIREMENTS FOR THE EDUCATION, TRAINING, EXAMINATION, AND QUALIFICATION

PERSONNEL WITH FRICTION STIR WELDING QUALIFICATION

Partnership to implement Project E+ *Project E+ 2017-1-SK01-KA202-035415*

Associatia de Sudura din Romania

European Federation for Welding, Joining and Cutting

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1 Introduction

The present guideline covers the minimum requirements for education and training, which have been agreed among the FSW-Tech consortium partners, in terms of objectives, scope, Learning Outcomes and the contact hours to be devoted to achieving them. It will be proposed to be implemented into the EWF Educational system, and then revised periodically by the adequate working group that will consider changes that reflect the "state of the art".

Students successfully completing a course of education and examinations will be expected to be capable of applying the FSW technology at a level consistent with the qualification diploma. Section 6 of the present guideline covers the rules for examination and qualification.

The modular course contents are given in the following structure (overview):

Table 1: FSW Guideline Competence Units

Competence Units	Contact Hours*		
	FSW Operator	FSW Specialist	FSW Engineer
CU 1: FSW Fundamentals	4	6,5	8
CU 2: Joint Preparation and Definition	4,5	5	6,5
CU 3: FSW Process Operation	2	3	5
CU 4: Post Processing	2	1	1
CU 5: Health and Safety	1	1	1
CU 6: Maintenance	1	1,5	1,5
CU 7: Quality	0	3	3
CU 8: Coordination	0	2,5	2,5
CU 9: Designing of Parts	0	0	2,5
CU 10: Tools Design	0	0	3
CU 11: FSW system implementation	0	0	3
CU 12: Case Studies	0	0	2
Total	**14,5**	**23,5**	**39**
WORKLOAD	**29**	**47**	**78**

** Contact Hours are the minimum*

The depth of knowledge and skills to be achieved are specified for the identified level and for all competence units (see 5.2) and will be reflected in the scope and depth of the examination.

The expected results are described and organised as follows: job functions and activities (for the case of functional competence units), knowledge (+detailed knowledge), skills, contact hours and workload. For the case of Cross Cutting Competence Units (which is the case of CU1 in this guideline), the structure is the same, however there are no indication of job functions or activities as these are competence units that don't lead directly to a job function.

Additionally, the "Qualification Outcomes Descriptors" are also assigned to each competence unit, reflecting the EWF Systems Framework levels and its correlation with the European Qualifications Framework for Lifelong Learning (EQF).

In the Detailed Knowledge Tables of the Competence Units, the contact hours are presented in a cumulative way, meaning that, to assess the total number of hours for an engineer, for example, the hours of the operator and specialist should be added to the ones allocated to the engineer; with the exception of the hours identified in blue, that represents the total hours of that profile for that specific detailed knowledge.

2 Routes to Qualification

Distinct routes to gaining the qualifications described in this document have been agreed.

1. The Standard Route
2. The Alternative Route
3. Distance Learning Route

2.1 The Standard Route

The Standard Route requires successful completion of the approved course which is designed to meet all the requirements in this Guideline. This is the route recommended as offering the fastest, most comprehensive manner in which the syllabus may be covered.

2.2 The Alternative Route

The Alternative Route is aimed at individuals who may already have experience of the job function at a particular level without holding the appropriate qualification diploma. These individuals will have already gained full or part knowledge of the syllabus defined in this guideline and can demonstrate their capability to proceed to examination either directly without compulsory attendance at an approved training course or by attending only part of such a course.

2.3 Distance Learning Route

The Cross-Cutting Competence Units may be taught in Blended Learning Programs under control of the ATB. For adequate learning of the functional Competence Units it is mandatory that the trainee attends the classes in person.

3 General Access Conditions

The implementation of the access conditions is the responsibility of the Authorised Training Body (ATB). The minimum access conditions for the Friction Stir Welding Operator are Mandatory Education (according to the country implementing this will vary). For the FSW Specialist, Mechanical, Materials, Chemistry, Civil, Aerospace and shipbuilding bachelor's degree are the minimum access conditions. (*Note: other engineering degrees can be accepted under ANB revision*). The FSW Engineer, Mechanical, Materials, Chemistry, Civil, Aerospace and Shipbuilding Engineering Degrees are the minimum access conditions. *(Note: other engineering degrees can be accepted under ANB revision).*

4 Special Requirements

Applicants (excluding guests) shall satisfy the ANB access conditions. If the ANB decides that the access conditions are adequately met, the applicants are then required to attend a training course conducted by the Approved Training Body (ATB) giving as a minimum the hours of instruction detailed in this Guideline as teaching hours. There will be a written examination for the award of the applicable FSW Diploma.

It is not obligatory to follow exactly the order of the topics given in this guideline and choice in the arrangement of the syllabus is permitted, with the exception that training must be initiated with CU1, as this is the basis that allow to understand all the others.

The depth to which each topic is dealt with is indicated by the number of hours allocated to it in the guideline. This will be reflected in the scope and depth of the examination.

The rules for the conduct of the final examination by the ATB are prescribed in section 6 of the present guideline.

5 Theoretical and Practical Education – Qualification Descriptors and Learning Outcomes

5.1 Qualification Outcomes Descriptors

QUALIFI-CATION	EQF/ EWF LEVEL	KNOWLEDGE	SKILLS	AUTONOMY AND RESPONSIBILITY
FSW Engineer	**7/EXPERT**	Highly specialised and forefront knowledge including original thinking, research and critical assessment of theory, principles and applicability of FSW related technologies.	Highly specialised problem-solving skills including critical and original evaluation, allowing to define or develop the best technical and economical solutions, when applying friction stir welding processes and related technologies, in complex and unpredictable conditions.	Manage and transform the welding processes and related technologies in a highly complex context. Act as the full responsible person for the definition and revision of the FSW and related personnel's tasks.
FSW Specialist	**5/SPECIALISED**	Specialised, factual and theoretical knowledge of the theory, principles and applicability of the FSW and related technologies.	Specialised range of cognitive and practical skills, allowing to develop solutions or choose the appropriate methods, when applying FSW and related technologies, in common/regular problems.	Manage and supervise common or standard friction stir welding applications and related technologies, in an unpredictable context. Take responsibility with limited autonomy for decision making in common or standard work and supervise the FSW and related personnel's tasks.
FSW Operator	**4/INDEPENDENT**	Factual and theoretical knowledge (basic understanding) in the field of FSW technology	Fundamental/basic cognitive and practical skills required to develop proper solutions on simple and specific FSW problems.	Self-manage of professional activities and simple standard applications. Take responsibility for supervising routine FSW tasks and related personnel, as well as for decision making in basic work.

5.2 Learning Outcomes

5.2.1 Competence Unit 1: FSW Fundamentals

CU 1 – FSW FUNDAMENTALS	CONTACT HOURS		
SUBJECT TITLE	**FSW OPERATOR**	**FSW SPECIALIST**	**FSW ENGINEER**
Introduction to FSW	1	2	3
FSW equipment	1	1	1
FSW design	1	1,5	2
Parent materials	1	2	2
Total	4	6,5	8
WORKLOAD	**8**	**13**	**16**

LEARNING OUTCOMES – FSW FUNDAMENTALS			
QUALIFICATION	FSW Operator	FSW Specialist	FSW Engineer
KNOWLEDGE	Factual and broad knowledge of: – FSW fundamentals – Welding equipment and processes – Parent materials	Specialised, factual and theoretical knowledge of: – FSW fundamentals – Welding equipment and processes – Parent materials	Highly specialised and forefront knowledge including original thinking, research and critical assessment of: – FSW fundamentals – Welding equipment and processes – Parent materials
SKILLS	– Identify the main mechanisms of the process – Recognize the main terminology used within FSW – Identify the main advantages and disadvantages of the process – Identify the main applications for FSW – Recognise the machine – Identify the main components of a FSW machine – Identify the limitations of the machine – Identification and assembly of essential components (such as the probe/pin/tool) – Prepare the correct welding tools according to the WPS (position and clamping) – Understands the importance of the cooling system – Follow the maintenance procedures – Recognise the design limitations of the process – Recognise different types of welding probe/pin/tool – Correlate different types of welding probe/pin/tool to the operations/material/thickness – Recognise the limitations of the process for the different materials + thicknesses – (Aluminium, Copper, Magnesium, Steel, Thermoplastics, Titanium, Dissimilar)	– Explain the main mechanisms of the process – Identify the main terminology used within FSW – Explain the main advantages and disadvantages of the process – Identify the main applications for FSW – Associate the variants of the process for the different applications – Identify the systems used for the different variants – Explain the main functionalities of the FSW system components – Identify the limitations of the machine – Explain the differences between different welding tools – Identify the advantages and disadvantages of the welding tools – Discuss the materials weldability in correlation with the influencing factors	– Explain the main mechanisms (detail according to the fundamentals) of the process – Explain the design limitations of the process – Explain the limitations of the process for the different materials + thicknesses – Discuss the materials weldability in correlation with the influencing factors – Identify the metallurgical properties for each parent material

5.2.2 Competence Unit 2: Joint Preparation and Definition

CU 2 – JOINT PREPARATION AND DEFINITION	CONTACT HOURS		
SUBJECT TITLE	**FSW OPERATOR**	**FSW SPECIALIST**	**FSW ENGINEER**
Cleaning	0,5	0,5	0,5
FSW Equipment and Accessories	0	1	1
Clamping	0,5	1	1
FSW Programs	0	0	1
FSW Parameters	2	1	1
Welding Procedure Specification (WPS)	1	1	1
Types of joints	0,5	0,5	0,5
Total	4,5	5	6
WORKLOAD	**9**	**10**	**12**

QUALIFICATION	EQF/ EWF LEVEL	JOB FUNCTIONS	JOB REQUIRED ACTIVITIES	CONTACT HOURS	WORKLOAD
FSW Operator	4 / Independent	Preparation of the joint according to the WPS	Cleaning the edges to be welded	**4,5**	**9**
			Measuring of thickness and length		
			Adjusting and set-up of jigs and fixtures		
			Clamping the weld pieces		
			Selecting the program to be used among a list of programs		
			Verifying the parameters (and its limits) within the control system		
			Setting and adjustment of parameters within the WPS		
			Adjusting the pin/probe/tool		
FSW Specialist	5 / Specialised	Generation of the welding procedure specification (WPS)	Defining the joint design	**5**	**10**
			Defining the cleaning method		
			Defining the tool and its positioning		
			Defining clamping arrangements		
			Defining backing plates		
FSW Engineer	7 / Expert		Defining parent material	**6**	**12**
			Defining the equipment		
			Defining FSW parameters (and its limits)		
			Selecting jigs and fixtures		
			Indicating the program to be used among a list of programs		

LEARNING OUTCOMES – JOINT PREPARATION AND DEFINITION			
QUALIFICATION	FSW OPERATOR	FSW SPECIALIST	FSW ENGINEER
KNOWLEDGE	Factual and broad knowledge of: – Joint preparation – Welding Procedure Specification	Specialised, factual and theoretical knowledge of: – Joint definition – Establishment of the Welding Procedure Specification	Highly specialised and forefront knowledge including original thinking, research and critical assessment of: – Joint definition – Establishment of the Welding Procedure Specification
SKILLS	– Recognise the importance of cleaning – Distinguish different cleaning methods – Identify the consequences of using an unappropriated thickness – Identify different measuring devices – Measure the thickness and length of the parts to be welded – Recognise the importance of using jigs and fixtures – Understand the importance of the clamping systems – Understand the importance of choosing the correct program – Identify the influence of parameters in the weld – Distinguish between variable and fixed parameters during welding – control system – Recognise the parameters in the control system – Interpret the WPS – Distinguish between different types of pin/probes/tools – Adjust the pin/probes/tools according to the WPS – Perform the tool/pin/probe offset (x-y) – Control the plunge depth – Adjust the z position (z)	– Define the joint design – Explain the importance, advantages and disadvantages of cleaning – Select the cleaning method – Identify the types of tools – Define the tool to be used according to the part/material to be welded – Define the positioning of the tools according to the part/material to be welded – Explain the importance of clamping – Explain the methods of clamping – Define the clamping arrangements – Explain the influence of the clamping in the welding process – Explain the importance of the backing plates – Explain why the backing plates needs to be cooled – Identify types and materials for the backing plates – Explain the wear mechanisms of the backing plates – Explain the influence of the back plates on the weld quality – Verify the compliance between the certificates and the materials – Discuss the suitability parent material – Define the equipment for an application – Define the welding parameters – Explain the influence of the parameters in the weld – Distinguish between variable and fixed parameters during welding – control system – Select the adequate jig/fixture	– Define the thermal conditions of the backing plate – Choose the correct program

5.2.3 Competence Unit 3: FSW Process Operation

CU3 – FSW PROCESS OPERATION	CONTACT HOURS		
SUBJECT TITLE	**FSW OPERATOR**	**FSW SPECIALIST**	**FSW ENGINEER**
Auxiliary equipment	1	1,5	1,5
Problems of FSW during the process and actions to solve them	1	1,5	1,5
Total	2	3	3
WORKLOAD	**4**	**6**	**6**

QUALIFICATION	EQF/ EWF LEVEL	JOB FUNCTIONS	JOB REQUIRED ACTIVITIES	CONTACT HOURS	WORKLOAD
FSW Operator	4 / Independent	Weld the joints	Operating the auxiliary equipment Monitoring the welding process and taking basic actions if needed	**2**	**4**
FSW Specialist	5 / Specialised	Supervise the Friction Stir Welding Process	Selecting auxiliary equipment Monitoring the welding process and taking specific decisions for solving specific problems	**3**	**6**
FSW Engineer	7 / Expert	Supervise the Friction Stir Welding Process	Selecting of auxiliary equipment Monitoring the welding process and taking specific decisions for solving complex problems	**3**	**6**

LEARNING OUTCOMES – FSW PROCESS OPERATION			
QUALIFICATION	FSW Operator	FSW Specialist	FSW Engineer
KNOWLEDGE	Factual and broad knowledge of: – Auxiliary Equipment – Most common problems of FSW	Specialised, factual and theoretical knowledge of: – Auxiliary Equipment – Most common problems of FSW	Highly specialised and forefront knowledge including original thinking, research and critical assessment of: – Auxiliary Equipment – Most common problems of FSW
SKILLS	– Distinguish between different types of auxiliary equipment – Recognise the purpose of each auxiliary equipment – Identify the most-common basic problems that can occur during the process – Take basic actions to solve those problems	– Distinguish between different types of auxiliary equipment – Identify the purpose of each auxiliary equipment – Decide on the use of auxiliary equipment – Identify the specific and unusual problems that can occur during the process – Take specific actions to solve those problems	-

5.2.4 Competence Unit 4: Post Processing

CU4 – Post Processing	CONTACT HOURS		
SUBJECT TITLE	**FSW OPERATOR**	**FSW SPECIALIST**	**FSW ENGINEER**
Visual Inspection	1	0,5	0,5
Actions to avoid imperfections/defects	1	0,5	0,5
Total	**2**	**1**	**1**
WORKLOAD	**4**	**2**	**2**

QUALIFICATION	EQF/ EWF LEVEL	JOB FUNCTIONS	JOB REQUIRED ACTIVITIES	CONTACT HOURS	WORKLOAD
FSW Operator	4 / Independent	Post Processing of the welded joints	Unclamping the welded pieces	**2**	**4**
			Performing visual inspection		
			Preventing weld imperfections and applying basic corrective actions if necessary		
FSW Specialist FSW Engineer	5 / Specialised 7 / Expert	Post Processing of the welded joints	Performing visual inspection	**1**	**2**
			Preventing of weld imperfections and apply corrective actions if necessary		

LEARNING OUTCOMES – POST PROCESSING			
QUALIFICATION	FSW Operator	FSW Specialist	FSW Engineer
KNOWLEDGE	Factual and broad knowledge of: – Post processing – Visual Inspection	Specialised, factual and theoretical knowledge of: – Post processing – Visual Inspection	Highly specialised and forefront knowledge including original thinking, research and critical assessment of: – Post processing – Visual Inspection
SKILLS	– Recognise unclamping precautions – Identify weld imperfections/defect and its causes – Recognise causes and appearance of weld imperfections – Implement preventive and corrective actions for imperfection/defects	– Identify weld imperfections/defect and its causes – Explain the causes and appearance of weld imperfections – Implement preventive and corrective actions for imperfection/defects	-

5.2.5 Competence Unit 5: Health and Safety

CU 5 – Health and Safety	CONTACT HOURS		
SUBJECT TITLE	**FSW OPERATOR**	**FSW SPECIALIST**	**FSW ENGINEER**
Safety Regulations	0,5	0,5	0,5
Accidents, their causes & preventive actions	0,5	0,5	0,5
Total	1	1	1
WORKLOAD	**2**	**2**	**2**

QUALIFICATION	EQF/ EWF LEVEL	JOB FUNCTIONS	JOB REQUIRED ACTIVITIES	CONTACT HOURS	WORKLOAD
FSW Operator	4 / Independent	Implementing Health & Safety instructions	Applying safety regulations and precautions	1	2
			Preventing accidents		
FSW Specialist FSW Engineer	5 / Specialised 7 / Expert	Manage Health & Safety procedures and plans	Applying the health and safety plan instructions	1	2
			Supervising the implementation of the health and safety measures		
			Preventing risks and accidents		

LEARNING OUTCOMES – HEALTH & SAFETY			
QUALIFICATION	FSW Operator	FSW Specialist	FSW Engineer
KNOWLEDGE	Factual and broad knowledge of: – Health & Safety	Specialised, factual and theoretical knowledge of: – Health & Safety	Highly specialised and forefront knowledge including original thinking, research and critical assessment of: – Health & Safety
SKILLS	– Apply safety regulations and precautions – Identify possible accidents that may occur due to the use of FSW – Associate the accidents and its causes – Implement preventive actions – Recognise the risks (electrical, mechanical, heat and noise) associated to FSW – Recognise the need to apply the H&S measures associated to each risk – List the preventive and protective measures to minimize or reduce the risk – Use the personal protective equipment correctly	– Apply the Health and Safety plan – Check the implementation of the Health and Safety measures (general and FSW) – Identify the need to apply the H&S measures associated to each risk – Identify the risks/accidents – Explain the causes of the risks/accidents (mechanical, electrical and noise) – Recommend measures to prevent/minimize risks – Perform risk analysis	-

5.2.6 Competence Unit 6: Maintenance

CU 6 – Maintenance	CONTACT HOURS		
SUBJECT TITLE	**FSW OPERATOR**	**FSW SPECIALIST**	**FSW ENGINEER**
Back plate conditions	0,25	0,5	0,5
Tool conditions	0,5	0,5	0,5
Clamping/positioning devices conditions	0,25	0,5	0,5
Total	**1**	**1,5**	**1,5**
WORKLOAD	**2**	**3**	**3**

QUALIFICATION	EQF/ EWF LEVEL	JOB FUNCTIONS	JOB REQUIRED ACTIVITIES	CONTACT HOURS	WORKLOAD
FSW Operator	4 / Independent	Maintenance of the FSW machine	Verifying the condition of the back plate and recording changes	**1**	**2**
			Verifying the conditions of the probe/pin/tool and recording changes		
			Verifying the conditions of the clamping/positioning devices		
FSW Specialist FSW Engineer	5 / Specialised 7 / Expert	Prepare instruction plan for Maintenance of the FSW system	Defining the condition tolerances of the back plate	**1,5**	**3**
			Defining the condition tolerances of the tool		
			Defining the condition tolerances of the clamping/positioning		

LEARNING OUTCOMES – MAINTENANCE			
QUALIFICATION	FSW Operator	FSW Specialist	FSW Engineer
KNOWLEDGE	Factual and broad knowledge of: – Proper vs. damaged conditions of back plate, probe, clamping and positioning devices	Specialised, factual and theoretical knowledge of: – Proper vs. damaged conditions of back plate, probe, clamping and positioning devices	Highly specialised and forefront knowledge including original thinking, research and critical assessment of: – Proper vs. damaged conditions of back plate, probe, clamping and positioning devices
SKILLS	– Distinguish when the backplate needs to be changed/replaced or cleaned – Distinguish when the backplate needs to be changed/replaced – Identify when the clamping system needs repair	– Analyse the acceptance criteria of the welded part – Define the tolerances of proper conditions for the tool – Analyse the acceptance criteria of the welded part – Define the tolerances of proper conditions for the clamping/positioning	-

5.2.7 Competence Unit 7: Quality

CU 7 – Quality	CONTACT HOURS	
SUBJECT TITLE	**FSW SPECIALIST**	**FSW ENGINEER**
Destructive Tests (DT)	1	0
Non-destructive Tests (NDT)	1	0
Acceptance Criteria	0,5	0
Equipment Calibration	0,5	0
Total	3	3
WORKLOAD	**6**	**6**

QUALIFICATION	EQF/ EWF LEVEL	JOB FUNCTIONS	JOB REQUIRED ACTIVITIES	CONTACT HOURS	WORKLOAD
FSW Specialist	5 / Specialised	Define quality assessment and inspection plan	Defining destructive tests applicable	3	6
			Defining non-destructive tests applicable		
FSW Engineer	7 / Expert		Defining acceptance criteria for all tests and inspection		
			Verifying equipment calibration		

LEARNING OUTCOMES – QUALITY		
QUALIFICATION	FSW Specialist	FSW Engineer
KNOWLEDGE	Specialised, factual and theoretical knowledge of: – Quality Assurance in FSW	Highly specialised and forefront knowledge including original thinking, research and critical assessment of: – Quality Assurance in FSW
SKILLS	– Select the destructive testing applicable – Identify the importance, advantages and disadvantages of DT methods – Validate the DT results according to the specification – Select the non-destructive testing applicable – Identify the importance, advantages and disadvantages of NDT methods – Validate the NDT results according to the specification – Define the acceptance criteria according to standards or costumer requirements – Explain the importance of calibration of equipment /measurement devices – Identify the standards used for Equipment/measuring devices calibration	-

5.2.8 Competence Unit 8: Coordination

CU 8 – Coordination	CONTACT HOURS	
SUBJECT TITLE	**FSW SPECIALIST**	**FSW ENGINEER**
Contract requirements items	1	1
Work management principles	0,5	0,5
Manufacturing plan	1	1
Total	2,5	2,5
WORKLOAD	**5**	**5**

QUALIFICATION	EQF/ EWF LEVEL	JOB FUNCTIONS	JOB REQUIRED ACTIVITIES	CONTACT HOURS	WORKLOAD
FSW Specialist FSW Engineer	5 / Specialised 7 / Expert	Perform coordination activities (for personnel and resources & logistics)	Defining the operator certification + qualifications	2,5	5
			Performing a technical review of the construction verifying the fabrication or process constraints		
			Reviewing contract requirements		
			Subcontracting activities		
			Coordinating FSW personnel		
			Specifying, developing and managing a manufacturing plan		

LEARNING OUTCOMES – COORDINATION		
QUALIFICATION	FSW Specialist	FSW Engineer
KNOWLEDGE	Specialised, factual and theoretical knowledge of: – Coordination activities	Highly specialised and forefront knowledge including original thinking, research and critical assessment of: – Coordination activities
SKILLS	– Verify the compliance with the certification according to the standard 25239 – Identify process constraints and limitations in order to perform a technically review of the construction – Compare between the contract requirements and the process implementation (review the – Perform subcontracting activities according to the established rules/contracts/standards – Attribute/distribute and plan the tasks – Provide instructions to operators – Specify, develop and manage a manufacturing plan	-

5.2.9 Competence Unit 9: Parts Design

CU 9 – Parts Design	CONTACT HOURS
SUBJECT TITLE	**FSW ENGINEER**
Variants of Friction Stir Welding Process	0,5
Technical specifications for the final products	1
Guidance's for Design in FSW	1
Total	2,5
WORKLOAD	**5**

QUALIFICATION	EQF/ EWF LEVEL	JOB FUNCTIONS	JOB REQUIRED ACTIVITIES	CONTACT HOURS	WORKLOAD
FSW Engineer	7 / Expert	Adapt the part design to fit to the FSW process	Evaluating the current design	2,5	5
			Analysing the parts needs		
			Adapting the part design to fit to the FSW process		

LEARNING OUTCOMES – PARTS DESIGN	
QUALIFICATION	FSW Engineer
KNOWLEDGE	Highly specialised and forefront knowledge including original thinking, research and critical assessment of: – Design for FSW parts – Technical specifications
SKILLS	– Compare between the current design and the possibilities of FSW – Analyse the parts needs according to the technical specification – Adapt the part design to fit to the FSW process, if needed

5.2.10 Competence Unit 10: Tools Design

CU 10 – Tools Design	CONTACT HOURS
SUBJECT TITLE	**FSW ENGINEER**
Good practices for FSW tools development	1
Tool performance	1
Tool working conditions	1
Total	3
WORKLOAD	**6**

QUALIFICATION	EQF/ EWF LEVEL	JOB FUNCTIONS	JOB REQUIRED ACTIVITIES	CONTACT HOURS	WORKLOAD
FSW Engineer	7 / Expert	Designing of the tool according to the needs	Defining the geometry of the tool Defining the material of the tool	3	6

LEARNING OUTCOMES – TOOLS DESIGN	
QUALIFICATION	FSW Engineer
KNOWLEDGE	Highly specialised and forefront knowledge including original thinking, research and critical assessment of: – Design for FSW tools
SKILLS	– Discuss the performance of the tool, its influence on the weld bead – Assess the tool range of working conditions

5.2.11 Competence Unit 11: FSW System Implementation

CU 11 – FSW System Implementation	CONTACT HOURS
SUBJECT TITLE	**FSW ENGINEER**
FSW Costs	1
Requirements for FSW system installation	1
Post processing operations	1
Total	3
WORKLOAD	**7**

QUALIFICATION	EQF/ EWF LEVEL	JOB FUNCTIONS	JOB REQUIRED ACTIVITIES	CONTACT HOURS	WORKLOAD
FSW Engineer	7 / Expert	Implementation the FSW system	Assessing costs related to FSW production	3	6
			Assessing fabrication needs		
			Defining post processing operations		

LEARNING OUTCOMES – FSW SYSTEM IMPLEMENTATION	
QUALIFICATION	FSW Engineer
KNOWLEDGE	Highly specialised and forefront knowledge including original thinking, research and critical assessment of: - FSW implementation costs assessment
SKILLS	– Determine all the costs involved in FSW production – Analyse the aspects influencing the fabrication needs – Take decisions for implementation of the process – Select the adequate post processing operations

5.2.12 Competence Unit 12: Case Studies

CU 12 – Case Studies	CONTACT HOURS
SUBJECT TITLE	**FSW ENGINEER**
Case Study	2
Total	2
WORKLOAD	**4**

LEARNING OUTCOMES – CASE STUDIES	
QUALIFICATION	FSW Engineer
KNOWLEDGE	Highly specialised knowledge and critical assessment of theory, principles and applicability of: – Analysis of high complex construction projects
SKILLS	Evaluate complex construction projects on aluminium and other materials used in FSW construction structures, such as Autoclave fixtures, vibration test tables, crack repairs, solar panels, underground vehicles and naval shipbuilding panels, to define the best welding conditions to achieve the proper quality requirements.

DETAILED KNOWLEDGE – CASE STUDIES	
Qualification	**FSW ENGINEER**
CONTACT HOURS	**2**
DEPTH*	**E**
Case Study	2
Simple and basic FSW welded projects: – Autoclave fixtures – Vibration test tables – Crack repairs – Solar panels – Underground vehicles – Naval shipbuilding panels – Others case studies (if relevant) Standards and specifications Choice of materials Tools and welding procedures Tolerances on weld preparation and fit-up Post weld heat treatment, NDT and quality control Visual Inspection practice	

6 Examination

The guideline aims to achieve harmonization of examination and qualification of personnel involved in the Friction Stir Welding process.

The education of the trainees must follow the specifications within the present guideline and is organized by Technical Authorized Body. The examination of the trainees is conducted by the Authorized National Body.

Examination procedures and administration

All the procedural and administrative aspects are covered by Document EWF 416.

Approval of the training course

The organization of a training course by a Technical Authorized Body, based on the present guideline, shall be approved by the Authorized National Body. The Technical Authorized Body will assure appropriate number of teachers/trainers to ensure that the essential specialist knowledge and industrial experience to cover the syllabus is adequately represented.

Examination Board

An Examination Board, acting on behalf of the Authorized National Body supervises the examination. The independence, integrity and fairness of the examination system are the responsibility of the Examination Board.

Admission to the examination

It will be allowed to participate to the examination leading to the award of the Friction Stir Welding personnel diplomas to those who fulfil both of the next conditions:

a) persons who comply with the minimum requirements specified in the Access conditions
b) persons who have attended a course organized by Technical Authorized Body according to the present guideline, course that was approved by the Authorized National Body.

Examination procedures

The examination of the candidate is dedicated to the evaluation of the knowledge and understanding of different information and situations related to Friction Stir Welding applied in industry.

The examination will have two components: theoretical examination and practical examination.

The theoretical examination will be based on a written exam. Each candidate will receive questionnaire containing a number of questions (function of the contact hours) relevant for all the Competence Units mentioned in the guideline. The table below summarizes the number of questions to be applied per competence unit and qualification.

Competence Units	No. of Questions for Examination		
	FSW Operator	FSW Specialist	FSW Engineer
CU1 – FSW Fundamentals	8	13	16
CU2 – Joint Preparation and Definition	8	9	12
CU3 – FSW Process Operation	4	5	12
CU4 – Post Processing	4	2	2
CU5 – Health & Safety	2	2	2
CU6 – Maintenance	2	3	4
CU7 – Quality	-	5	6
CU8 – Coordination	-	5	5
CU9 – Parts Design	-	-	5
CU10 – Tools Design	-	-	6
CU11 – FSW System Implementation	-	-	6
CU12 – Case Studies	-	-	-
Total Questions	28	44	76

The questions will be multiple choice questions with one correct answer (simple choice) for the operator and specialist levels of qualification. The questions must be relevant, and they must reflect the course topics. The questions will be randomly chosen from a specific database. The duration of the written examination shall be of 1 min per each question (meaning a total duration of 30 minutes for the Operator and 45 minutes for the Specialist). In order to pass the theoretical examination, the trainee should have a final assessment of at least 60% of the questions correct.

For the Engineer level the multiple-choice questions will have from 1 to 4 correct answers, and 80 questions. In this case the time dedicated to each question will be of 1,2 min, resulting in an exam with 95 minutes.

The practical examination will consist on performing one welding joint for specific application. The organization of the practical examination session shall fulfil the requirements presented in Annex 1. The duration of the practical examination will be maximum of 30 min. The performance of the candidate within the practical examination will be scored as PASS or FAIL. This part of the assessment is only applicable for the operator level.

If a trainee passes the theoretical examinations and the practical examination, he/she will receive a diploma for the respective qualification – European FSW Operator.

For the Specialist and Engineer, if the trainee passes the theoretical exam, he/she will receive a diploma for the respective qualification – European FSW Specialist and European FSW Engineer.

Evaluation of performance

In order to pass the examination, the candidates should meet both of the following requirements:

a) to provide correct answers for at least 60% of the questions
b) to be granted with mark PASS to the practical examination session

Re-examination and appeals procedure

If a candidate does not fulfil both requirements for passing the examination, the candidate is eligible to a re-examination for the not-passed theoretical examination or for the practical examination.

Re-examination may be retaken within max 3 months of the initial examination.

Failure in this second attempt will result in the candidate being treated as an initial candidate and a retake of the whole course.

Candidates who feel they have been unfairly treated during the examination procedure have the right to appeal to the Authorized National Body.

European Friction Stir Welding Personnel diploma

After successful examination, the applicable diplomas are awarded to the candidate by the Authorized National Body.

7 Annex 1 – FSW Practical Examination Requirements

Task 1
Preparation of the FSW equipment for the operation for a specific joint.
To be evaluated:

1. general verification of the equipment, base materials and environmental conditions before welding
2. verification of the material data sheets of the material being welded
3. assess if the relevant H&S measures were applied

Task 2
Preparation of the materials being welded and associated equipment.
To be evaluated:

1. recognizing the base materials
2. verifying the dimensions of the plates to be welded
3. selecting the tool to be used (according to the WPS)
4. application of the cleaning procedure (if needed)
5. assess if the relevant H&S measures were applied

Task 3
Performing the FSW process
To be evaluated:

1. reading and setting up the parameters in the machine (specified in the WPS)
2. development of the process (actual welding of the components)
3. correct cleaning the working place
4. assess if the relevant H&S measures were applied

Task 4
Verification of the quality of the joint
To be evaluated:

1. checking the general aspect of the weld
2. checking for surface imperfections / defects
3. assess if the relevant H&S measures were applied