

**EFW Guideline**  
**Dedicated Knowledge for Personnel with the Responsibility**  
**for Welding Coordination to comply with EN 1090-2**



**Minimum Requirements for the Education, Training,**  
**Examination and Qualification**



**EFW-652r1-11/SV-0**

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

### EFW GUIDELINE

#### DEDICATED KNOWLEDGE FOR PERSONNEL WITH THE RESPONSIBILITY FOR WELDING COORDINATION TO COMPLY WITH EN 1090-2

**This is a reduced version; it is not the full Guideline**

**For more information regarding the Qualification System,  
the EWF Secretariat or the National ANB should be contacted**

**(see in the EWF site the ANB contacts)**

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## Section 1: Minimum Requirements for the Education, Training, Examination and Qualification of European EN 1090 Welding Coordination Personnel for Steel Constructions for the Levels “Specific” and “Basic”

The use of this guideline is restricted to organizations approved by the EWF Authorized National Body (ANB).

### 1. Introduction

This guideline for the education and examination of Welding Coordination Personnel (WCP) for Steel Constructions for the levels “B” and “S”, as outlined in EN 1090-2 for Execution Class 2. (see table 1), has been prepared, evaluated and formulated by members of the Technical Committee of EWF.

It is not designed to provide a comprehensive knowledge in welding technology (this can only be achieved through the qualification as specified in the IIW Guideline “Personnel With Responsibility For Welding Coordination”, IAB doc. 252), it is however meant to refresh and update the knowledge of personnel that have been working as welding coordination personnel in the field of metal construction as defined in the European Standard EN 1090-2 and required through the application of the European Directives 89/106/EEC and 93/68/EEC.

EXC	Steels (Steel group)	Reference standards	Thickness (mm)		
			$t \leq 25^a$	$25 - t \leq 50^b$	$t > 50$
EXC 2	S235 – S355 (1.1, 1.2, 1.4)	EN 10025-2, EN 10025-3, EN 10025-4, EN 10025-5, EN 10149-2, EN 10149-3, EN 10210-1, EN 10219-1	B	S	C <sup>c</sup>
	S420 – S700 (1.3, 2, 3)	EN 10025-3, EN 10025-4, EN 10025-6, EN 10149-2, EN 10149-3, EN 10210-1, EN 10219-1	S	C <sup>d</sup>	C
EXC 3	S235 – S355 (1.1, 1.2, 1.4)	EN 10025-2, EN 10025-3, EN 10025-4 EN 10025-5, EN 10149-2, EN 10149-3, EN 10210-1, EN 10219-1	C	C	C
	S420 – S700 (1.3, 2, 3)	EN 10025-3, EN 10025-4, EN 10025-6, EN 10149-2, EN 10149-3, EN 10210-1, EN 10219-1	C	C	C
EXC 4	All	All	C	C	C

<sup>a</sup> Column base plates and endplates  $\leq 50$  mm  
<sup>b</sup> Column base plates and endplates  $\leq 75$  mm  
<sup>c</sup> For steels up to and including S275, level S is sufficient.  
<sup>d</sup> For steels N, NL, M and ML, level; S is sufficient.

**Table 1.** Field of application of this guideline (white area)  
(This table is equivalent to table 14 of EN 1090-2:2008)

This personnel needs to have a formal recognition of their knowledge to become “Responsible Welding Coordinators” at the level “B” and “S” of the EN 1090-2. The Objective of this scheme is to educate personnel to fulfil the criteria for (R)WC and who has essential know-how, best or good practice and solid knowledge to fulfil the need of the European welding metal fabrication industry in line with EN 1090-2 and ISO 14731 standards.

(Responsible) Welding Coordination on the higher level (“Specific”) in Execution Class 2 and the highest level (“Comprehensive”) in all Execution Classes is considered to be adequately covered by the E/WE/IWE and the EWT/IWT levels of education as outlined in detail in the document IAB 252.

For the lower levels (“B” and “S”, as defined for Execution Class 2), welding coordination personnel having an EWE/IWE, EWT/IWT, or an EWS/IWS diploma generally are accepted.

This Guideline covers the minimum requirements for education and examination which is related to welding coordination at the above given levels as defined in the ISO 14731, however is only related to the requirements for the (Responsible) Welding Coordinator for steel constructions as described in EN 1090-2, it shall not be applied for any other type of products.

The Guideline gives an open access through two routes as described in par. 2 and 3 of this document. Both routes are supplemented by a dedicated seminar. A subsequent section covers the examination and diploma.

*Note: The diploma provides the proof that the general and specific technical knowledge of the candidate was positively assessed; it doesn't mean that the candidate will be automatically (R)WC, as this is considered to be a job function.*

Students who have successfully completed this course of education and examination, may later apply for access to the relevant full IAB course, where the knowledge from this Guideline may be formally recognised following one of the alternative routes as described in document IAB 252, or in the case of the standard courses, at the discretion of the ANB, this Guideline may cover “Part 1” of the Guideline IAB-252.

## **2. The education**

The contents are given in the following structure:

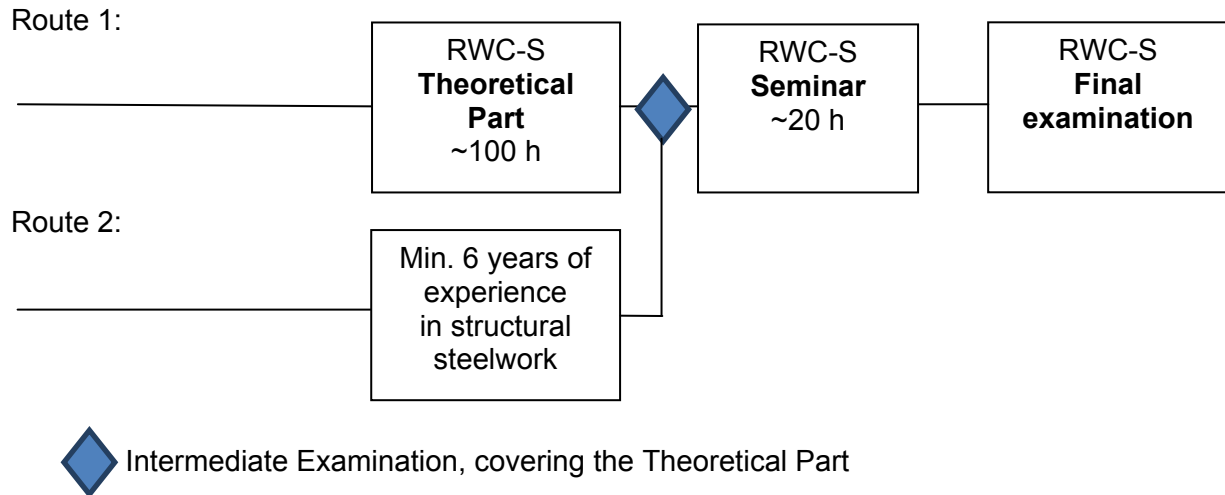
<b>Theoretical Education</b>	<b>Teaching hours</b>	
	<b>RWC-S</b>	<b>RWC-B</b>
Welding processes and equipment	20	14
Materials and their behaviour during welding	19	10
Construction and design	12	3
Fabrication, applications engineering	44	24
Seminar on EN 1090	21	13
<b>Sub total</b>	<b>116</b>	<b>64</b>
	<b>(14,5 days)</b>	<b>(8 days)</b>
Examination (Intermediate and Final)	3h45	2h30
<b><u>Total approximately:</u></b>	<b><u>120</u></b>	<b><u>65</u></b>

A teaching hour will contain at least 50 minutes of direct teaching time.

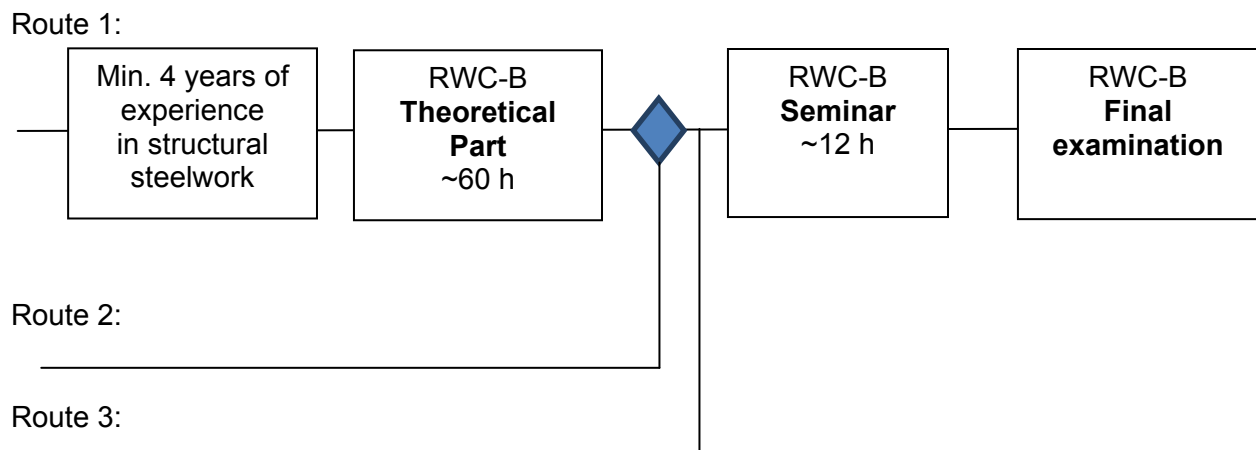
It is not obligatory to follow exactly the order of the topics given in this guideline. It is the choice in arrangement of the syllabus by the authorised training body (ATB).

The Guideline details the objectives of all topics, the scope and the expected results as required, to fulfil the requirements for welding coordination. The depth to which each topic is dealt with is indicated by the objectives and the number of hours allocated to it in the guideline. This will be reflected in the scope and depth of the examination to meet the required result.

## 2.1 Routes to Qualification for the “Specific” level



## 2.2 Routes to Qualification for the “Basic” level



## 2.3 Access Conditions for the “S” level

### Route 1:

The minimum requirements for a candidate to enter the system through route 1 are at least:

1. Minimum education level equivalent to EWS/IWS for Route 1 or 2 national access conditions requirements and
  2. Must be active in the field of metal construction as a welding coordinator (as defined in EN ISO 14731) and three (3) years of experience in the last five (5) years. Experience in the material group and thickness range as defined in the appropriate table 14 or 15 of the EN 1090-2 shall be demonstrated, and
  3. Candidate’s CV showing relevant experience, training, and education must be endorsed by the employer, and approved by the ANB.
- OR

1. Minimum education level equivalent to EWT/IWT or EWE/IWE for Route 1 or 2 entry requirements and;
2. Two (2) years of experience in the last three (3) years. Experience in the material group and thickness range as defined in the appropriate table 14 or 15 of the EN 1090-2 shall be demonstrated, and;
3. Candidate's CV showing relevant experience, training, and education must be endorsed by the employer, and approved by the ANB.

#### Route 2:

The minimum requirements for a candidate to enter the system through route 2 are at least:

1. Minimum education level equivalent to EWS/IWS for Route 1 or 2 entry requirements, or higher and
2. Must be active in the field of metal construction and with six (6) years of experience in the last eight (8) years,  
Experience in the material group and thickness range as defined in the appropriate paragraph of the EN 1090-2 shall be demonstrated. This experience shall show that the work has been performed at the level of a welding coordinator, and
3. Candidate's CV showing relevant experience, training, and education must be endorsed by the employer, and approved by the ANB.

## 2.4 Access Conditions for the "B" level

#### Route 1:

The minimum requirements for a candidate to enter the system through Route 1 are at least:

1. Four years of experience on the last six years, in the material group and thickness range as defined in the appropriate paragraph of the EN 1090-2 shall be demonstrated. This experience shall show that the work has been performed at the level of a welding coordinator.
2. Candidate's CV showing relevant experience, training, and education must be endorsed by the employer, and approved by the ANB.

#### Route 2:

The minimum requirements for a candidate to enter the system through Route 2 are at least:

1. Eight (8) years of experience on the last ten (10) years, in the material group and thickness range as defined in the appropriate paragraph of the EN 1090-2 shall be demonstrated. This experience shall show that the work has been performed at the level of a welding coordinator.
2. Candidate's CV showing relevant experience, training, and education must be endorsed by the employer, and approved by the ANB.

#### Route 3:

The minimum requirements for a candidate to enter the system through Route 3 are at least:

1. Those having a EWP/IWP diploma, and
2. Six (6) years of experience on the last eight (8) years, in the material group and thickness range as defined in the appropriate paragraph of the EN 1090-2 shall be demonstrated.

This experience shall show that the work has been performed at the level of a welding coordinator.

3. Candidate's CV showing relevant experience, training, and education must be endorsed by the employer, and approved by the ANB.

## **2.5 Instruction programme**

The full EWF course consists of four modules, a seminar and examination.

The recommended periods of time given in the modules 1 thru 4 and the seminar represent the recommended time required to attain the expected level of knowledge.

The theoretical education given to the applicants aims at a basic understanding of the appropriate welding process, construction, materials and practical applications behaviour including standards and safety regulations. The themes and keywords are given as 'scope' in the module descriptions, together with the 'objective' and the 'expected result'.

## 2.6 Module 1: Welding processes and equipment

Hours as indicated are minimum teaching hours

<b>1.1 General introduction to welding technology</b>		
<b>Objective for level S and B</b> Explain the different welding processes including terminology, standards and abbreviations.		
<i>Qualification Teaching hours</i>	<b>(R)WC-S</b>	<b>(R)WCB</b>
<b>Scope:</b>	1	1
History .....	X	X
General applications for welding .....	X	X
Schematic presentation of welding processes .....	X	X
Brief description with characteristics .....	X	X
Applicability of the most common welding processes .....	X	X
Abbreviations used for welding processes .....	X	X
Hints in use for welding processes .....	X	X
Welding positions and Terminology (ISO 6947, ISO 17659).....	X	X
Symbolic representation of joints (overview) .....	X	X
Classification of welding processes (ISO, CEN and national standards) ..	X	X

<b>1.2 The arc</b>		
<b>Objective for level S and B:</b> Describe an electric arc, its characteristics, limitations and application in welding.		
<i>Qualification Teaching hours</i>	<b>(R)WC-S</b>	<b>(R)WCB</b>
<b>Scope:</b>	1	1
Arc physics (producing an electric arc, the main arc areas, stability of the arc, gas ionization, ionization potentials, arc forces) .....	X	X
Voltage distribution across the arc .....	X	X
Heat generation at the cathode and anode.....	X	X
Polarity and arc characteristics in AC and DC and its control for the key welding processes.....	X	X
Influence on the welding process .....	X	X
Temperature distribution in the arc and effects .....	X	X
Influence of the magnetic fields on the arc (why, how to solve) .....	X	X
Limits of application .....	X	X

<b>1.3 Power sources for arc welding</b>			
<b>Objective for level S and B:</b> Have an outline working knowledge of components of arc welding power sources.			
<b>Scope:</b>	<b>Qualification Teaching hours</b>	<b>(R)WC-S</b>	<b>(R)WCB</b>
		2	1
Power source classification, types and characteristics (static and generators, and each sub-group) .....		X	X
Power source electrical characteristics (static and dynamic).....		X	X
Relationship between static characteristic and welding process .....		X	X
Control of the electrical static characteristic (flat and drooping).....		X	-
Arc stability for the main processes (MMA, TIG, MIG/MAG, SAW, PAW).		X	X
The operation working point .....		X	X
Inverter technology (overview, in terms of the most important blocks).....		X	-
Power sources controlled by a CPU .....		X	-
Stability of processes in AC and DC .....		X	-
AC (sine wave and square wave) and DC power sources .....		X	X
Open circuit voltage, short circuit current, power factor of transformers		X	-
Duty cycle of a power source and typical values for the most common arc welding processes .....		X	X
Voltage losses, relationship between welding current value and cable section.....		X	X
Current and voltage setting (electromagnetic and electronic devices)			
Standards related with welding power sources and their requirements			

<b>1.4 TIG Welding</b>			
<b>Objective for level S and B:</b> Outline the TIG welding fundamentals, equipment, applications, main variables, safety and specific problems.			
<b>Scope:</b>	<b>Qualification Teaching hours</b>	<b>(R)WC-S</b>	<b>(R)WCB</b>
		3	1
Power source characteristics .....		X	X
Methods for arc ignition and necessary equipment .....		X	X
Equipment and accessories: torches, gas lens, control panel, up and down slope, pulse techniques.....		X	X
Effect of current type and polarity: DC(+), DC(-) and AC.....		X	-
Specific requirements for different materials, e.g. Al.....		X	X
Consumables: shielding gases, filler materials, electrodes .....		X	X
Welding parameters: current, voltage, travel speed, gas flow rate.....		X	X
Joint preparation: typical joint design for welding, fit-up, cleaning.....		X	X
Special techniques: spot-welding, key-hole, hot-wire, orbital welding, tube to tube and tube to sheet, narrow gap and others.....		X	-
Standards for filler materials, (only for non alloy steels), and electrodes,		X	X
Welding applications, typical problems and how to solve them .....		X	X
Health and safety issues specific to the process .....		X	X

<b>1.5.1 MIG/MAG Welding</b>			
<b>Objective for level S and B:</b> Outline the MIG/MAG fundamentals, including equipment, applications, main variables, safety and common problems.			
<b>Scope:</b>	<b>Qualification Teaching hours</b>	<b>(R)WC-S</b>	<b>(R)WCB</b>
			2
Power source characteristics for conventional process and CPU controlled power sources.....		X	X
Effect of current type and polarity.....		X	X
Equipment and accessories: torches, wire feeders, hose assembly, control panel.....		X	X
Metal transfer modes (dip, globular, spray, pulsed and rotating), and their Application.....		X	X
Welding parameters and settings: current, voltage, travel speed, gas flow rate, etc.....		X	X
Consumables: shielding gases, filler materials (solid wires), and their combinations.....		X	X
Joint preparation:, fit-up, cleaning.....		X	X
Special techniques: electro-gas welding, high efficiency processes, spot welding, double wire, flat wire, electronic stability control (arc and wire feed), etc.....		X	-
Standards for filler materials, (only for non alloy steels).....		X	X
Welding applications, typical problems and how to solve them.....		X	X
Health and safety specific to the process.....		X	X

<b>1.5.2 Flux Cored Arc Welding</b>			
<b>Objective for level S and B:</b> Outline the FCAW fundamentals, including equipment, applications, main variables, safety and common problems.			
<b>Scope:</b>	<b>Qualification Teaching hours</b>	<b>(R)WC-S</b>	<b>(R)WCB</b>
			2
Power source characteristics for conventional process and CPU controlled power sources (only the specific aspects for FCAW).....		X	X
Effect of current type and polarity.....		X	X
Equipment and accessories: torches, wire feeders, .....		X	X
Relation between the consumables and the type of Metal transfer mode, and their applications.....		X	X
Welding parameters and settings: current, voltage, travel speed, gas flow rate, etc.....		X	X
Consumables: shielding gases, filler materials (flux cored wires), and their combinations.....		X	X
Joint preparation: fit-up, cleaning.....		X	X
Standards for filler materials (only for non alloy steels) .....		X	X
Welding applications, typical problems and how to solve them.....		X	X
Health and safety specific to the process.....		X	X

<b>1.6 MMA Welding</b>			
<b>Objective for level S and B:</b> Outline the MMA fundamentals, including equipment, applications, safety and common problems.			
<b>Scope:</b>	<b>Qualification Teaching hours</b>	<b>(R)WC-S</b>	<b>(R)WCB</b>
		4	2
Process principles and arc characteristics .....		X	X
Effect of current type and polarity .....		X	X
Power source characteristics applicable to MMA (open circuit voltage, static and dynamic characteristics, types of current, arc striking methods)		X	X
Equipment and accessories.....		X	X
Process application range, typical problems and how to solve them.....		X	X
Covered electrodes (functions of the coating and rod, types of electrodes, slag-metal and gas-metal covered reactions) .....		X	X
Production of electrodes (how, typical defects) .....		X	-
Handling and storage of electrodes (storage environment, redrying).....		X	X
Standards for filler materials (only for non ally steels) .....		X	X
Selection of covered electrodes for applications .....		X	X
Welding parameters: current, voltage, run out length, etc .....		X	X
Joint preparation: fit-up, cleaning, welding position.....		X	X
Relationship between electrode diameter and current range, rod material, electrode length and welding position .....		X	X
Special techniques (gravity welding, etc.).....		X	X
Health and safety specific to this process .....		X	X

<b>1.7 Submerged Arc Welding</b>			
<b>Objective for level S and B:</b> Outline the SAW fundamentals, including equipment, applications, main variables, safety and common problems.			
<b>Scope:</b>	<b>Qualification Teaching hours</b>	<b>(R)WC-S</b>	<b>(R)WCB</b>
		2	1
SAW process principles and arc characteristics .....		X	X
Effect of current type and polarity.....		X	X
Power source characteristics applicable to SAW (open circuit voltage, static and dynamic characteristics, types of current, arc striking methods)			
Equipment and accessories .....		X	X
Process application range, typical problems and how to solve them.....		X	X
Consumables (functions of the flux and wire -solid or flux cored-, types of flux and wire, wire-flux combination, slag-metal and gas-metal reactions).		X	X
Production of consumables (how, typical defects) .....		X	X
Handling and storage of consumables (storage environment, re-drying)			
Standards for filler materials wires and fluxes (only for non ally steels)....		X	X
Welding parameters: current, voltage, travel speed, type of flux and particle size, stick-out, etc .....		X	X
Joint preparation: fit-up, cleaning .....		X	X
Relationship between the wire-flux combination and the characteristics of deposited material.....		X	X
One side welding including backing methods.....		X	-
Single-wire and multi -wire techniques.....		X	X
Special techniques (strip-cladding, iron-powder addition, cold and hot wire addition.....		X	-
Health and safety specific to SAW process.....		X	X

<b>1.8 Stud Welding</b>			
<b>Objective for level S and B:</b> Outline/the fundamentals and the field of application of stud welding. Including equipment, main variables and most common problems.			
<b>Scope:</b>	<b>Qualification</b>	<b>(R)WC-S</b>	<b>(R)WCB</b>
	<b>Teaching hours</b>	1	1
Basic principles .....		X	X
Equipment and accessories .....		X	X
Typical process applications and problems .....		X	X
Consumables.....		X	-
Welding parameters .....		X	-
Standard EN-ISO 14555.....		X	X
Health and safety specific to the processes .....		X	X
Appropriate national and international standards for each process .....		X	X

<b>1.9 Cutting, Drilling and other edge preparation processes</b>			
<b>Objective for level S and B:</b> Outline the basic principles and the field of application of the most common cutting and edge preparation processes used in weld construction, including equipment, main variables, safety and common problems.			
<b>Scope:</b>	<b>Qualification</b>	<b>(R)WC-S</b>	<b>(R)WCB</b>
	<b>Teaching hours</b>	2	2
Survey of edge preparation processes.....		X	X
Mechanical cutting .....		X	X
Principles of flame and flame powder cutting, equipment, applications and auxiliaries.....		X	X
Flame cutting parameters, edge quality, oxygen purity grades.....		X	X
Materials suitable for flame cutting.....		X	X
Basic principles of the various arc cutting processes (arc-air, carbon and metal-arc, oxy-arc cutting, gauging with carbon electrode) equipment and auxiliaries.....		X	X
Materials suitable for arc-cutting, applications, cutting parameters for each process.....		X	X
Fundamentals of plasma and laser cutting, equipment and auxiliaries..		X	X
Materials suitable for plasma cutting, applications, cutting parameters, cutting gases.....		X	X
Plasma gouging.....		X	-
Fundamentals of arc gouging and flame gouging, parameters and applications.....		X	X
Appropriate national and international standards for each process.....		X	X
Health and safety.....		X	X

## 2.7 Module 2: Materials and their behaviour during welding

Hours as indicated are minimum teaching hours

<b>2.1 Structure and properties of metals</b>				
<b>Objective for level S and B:</b> Acquire basic knowledge of structure and properties of metal materials				
		<b>Qualification</b>	<b>(R)WC-S</b>	<b>(R)WCB</b>
		<b>Teaching hours</b>		
<b>Scope:</b>			1	0
Crystalline structures.....			X	
Crystal lattice structure types and imperfections.....			X	
Deformation (elastic/plastic).....			X	
Cold and hot deformation.....			X	
Work hardening and strain aging .....			X	
Recrystallization.....			X	
Properties (influence of temperature, loading speed, environment).....			X	

<b>2.2 Phase Diagrams and Alloys</b>				
<b>Objective for level S and B:</b> Outline the principles of alloying, the structures of alloys and phase diagrams				
		<b>Qualification</b>	<b>(R)WC-S</b>	<b>(R)WCB</b>
		<b>Teaching hours</b>		
<b>Scope:</b>			1	0
Pure metals and alloys.....			X	
Alloying elements .....			X	
Binary diagrams (basic types, non-, fully- and partly soluble components).....			X	
Structure of alloys .....			X	
Strengthening mechanisms (solid solution, precipitation, grain size).....			X	
Ageing.....			X	
Mechanical properties versus microstructure .....			X	

<b>2.3 Iron – Carbon Alloys</b>				
<b>Objective for level S and B:</b> Basics to understand metallurgical processes occurring in welding of iron carbon alloys.				
		<b>Qualification</b>	<b>(R)WC-S</b>	<b>(R)WCB</b>
		<b>Teaching hours</b>		
<b>Scope:</b>			2	1
Iron solidification and changes in solid state.....			X	X
Fe-C equilibrium diagram.....			X	X
Microstructure of Fe-C alloys (perlite, ledeburite, etc.).....			X	-
Influence of alloying elements on the Fe-C equilibrium diagram.....			X	-
Carbide forming elements .....			X	X
Influence of cooling rate, hardenability.....			X	X
TTT and CCT diagrams.....			X	X
Influence of alloying elements on TTT diagrams.....			X	-
Grain growth effect.....			X	-
Classification of heat treatment.....			X	X

<b>2.4 Classification of steels</b>		
<b>Objective for level S and B:</b> Fundamentals of steel classification and standardization, steel semi-products		
<b>Qualification</b>	<b>(R)WC-S</b>	<b>(R)WCB</b>
<b>Teaching hours</b>	1	1
<b>Scope:</b>		
Processing of steel products (hot, cold rolling, casting, etc.) .....	X	X
Chemical composition and impurities .....	X	X
Properties of steels .....	X	X
Discontinuities and defects in steel .....	X	X
Classification of steel (purpose of use, ISO/TR 15608).....	X	X
Designation of steels (National, EN Standards, Wr. No.) .....	X	X
Steel products (plates, tubes, profiles).....	X	X
Inspection Certificate (i.e. EN 10204).....	X	X

<b>2.5 Behaviour of structural steels in fusion welding</b>		
<b>Objective for level S and B:</b> Metallurgical fundamentals of welding of all types of structural steels		
<b>Qualification</b>	<b>(R)WC-S</b>	<b>(R)WCB</b>
<b>Teaching hours</b>	2	1
<b>Scope:</b>		
Heat input and efficiency of heat input.....	X	X
Peak temperature .....	X	X
Cooling rate and thermal cycle, $\Delta t_{8/5}$ .....	X	X
Heat flow.....	X	X
Heat-affected zone (grain growth and grain refinement, CCT diagrams)...	X	X
Properties of HAZ.....	X	X
Carbon equivalent.....	X	X
Weld pool, weld shape.....	X	X
Structure of weld metal.....	X	X
Effect of multi pass welding.....	X	X
Weld metal structure (weld protection, consumables, etc.).....	X	X
Solidification of weld pool.....	X	X
Relationship grain size – toughness.....	X	X
Transition temperature.....	X	X

<b>2.6 Heat treatment of base materials and welded joints</b>			
<b>Objective for level S and B:</b> Name the metallurgical transformations of materials during different heat treatment.			
<b>Scope:</b>	<b>Qualification Teaching hours</b>	<b>(R)WC-S</b>	<b>(R)WCB</b>
		2	1
Heat treatment of base materials:			
Normalising.....		X	X
Hardening.....		X	-
Quenching and Tempering.....		X	X
Solution annealing.....		X	-
Homogenisation.....		X	X
Recrystallisation annealing.....		X	X
Precipitation hardening.....		X	-
Heat treatment of welded joints and work pieces:			
Post Weld Heat Treatment (Stress relieving, normalizing, hardening).....		X	X
Technical guidelines for heat treatment:			
Heat treatment procedures.....		X	X
Introduction to heat treatment equipment.....		X	X
Regulations/guidelines (codes and technical reports)			
ISO/TR 17663.....		X	-
Introduction to temperature measurement and recording			
ISO 13916.....		X	X

<b>2.7 Structural Steels</b>			
<b>Objective for level S and B:</b> Structural unalloyed steels and effect of welding processes on the weld joint			
<b>Scope:</b>	<b>Qualification Teaching hours</b>	<b>(R)WC-S</b>	<b>(R)WCB</b>
		2	2
Steels group 1 according to ISO/TR 15608.....		X	X
Chemical composition.....		X	X
Grades of unalloyed steels .....		X	X
Carbon equivalent CE .....		X	X
Relationship CE – hardenability .....		X	X
Welding processes.....		X	X
Filler materials, choice, standards.....		X	X
HAZ microstructure and properties (hardness, toughness).....		X	-
Effects of weld heat treatment.....		X	X
Applications.....		X	-
Standards, global (ISO), regional (CEN) and national standards .....		X	X

<b>2.8 High Strength Steels</b>		
<b>Objective for level S and B:</b> Explain the effects of micro-alloying elements on structure, mechanical properties and weldability with reference to fine-grained and high strength steels.		
<b>Qualification</b>	<b>(R)WC-S</b>	<b>(R)WCB</b>
<b>Teaching hours</b>	2	1
<b>Scope:</b>		
Steels group 2 and 3 according to ISO/TR 15608.....	X	X
Principles of treatment (controlled rolling, accelerated cooling, direct quench, thermomechanical treatment etc.) .....	X	X
Normalised grades (Chemical composition, properties).....	X	X
Quenched and tempered grades (Chemical composition, properties)....	X	X
High strength steels (Chemical composition, Mechanical properties) ....	X	X
Weldability, $\Delta t_{3/5}$ concept, preheat and interpass temperature, CE.....	X	-
Influence of welding process on HAZ (microstructure, properties).....	X	-
Steels for automotive industries (TRIP, TWIP, dual phase, etc.).....	X	X
Applications .....	X	X
Standards, global (ISO), regional (CEN) and national standards .....	X	X
Choice of filler metal (mismatching, etc.).....	X	-

<b>2.9 Cracking Phenomena in welded joints</b>		
<b>Objective for level S and B:</b> Name the fundamentals of cracking mechanisms in welded joints and the way in which welding variables affect the incidence of cracking. Name causes and avoidance.		
<b>Qualification</b>	<b>(R)WC-S</b>	<b>(R)WCB</b>
<b>Teaching hours</b>	2	1
<b>Scope:</b>		
For unalloyed, heat resistant and stainless steels as appropriate:		
<i>Cold cracking:</i>		
Cracking mechanisms in weld metal and HAZ, causes and avoidance.....	X	X
Effect of hydrogen.....	X	X
Source and diffusion of hydrogen .....	X	X
Control of hydrogen .....	X	X
Effect of microstructure.....	X	X
Susceptible microstructure and its control .....	X	X
Influence of alloying elements on susceptibility .....	X	X
Effect of stresses.....	X	X
Influence of restraint .....	X	X
Influence of preheat .....	X	X
Influence of austenitic weld metal .....	X	X
Determination of preheat and interpass temperature (diagrams)		
ISO/TR 17671-2 and ISO 13916 .....	X	-
<i>Lamellar tearing:</i>		
Cracking mechanism; causes and avoidance .....	X	X
Effects of inclusions, joint configuration, stress.....	X	X
Control of lamellar tearing by material choice and joint configuration ISO/TR 17671-2 .....	X	X
Steels with increased resistance to lamellar tearing.....	X	X

<b>2.10 Stainless steels</b>		
<b>Objective for level S and B:</b> Explain the fundamentals of the various types of stainless steels and their weldability including the principles of joining dissimilar materials and filler material choice.		
<b>Scope:</b>	<b>Qualification</b>	<b>(R)WC-S</b>
	<b>Teaching hours</b>	<b>(R)WCB</b>
	2	1
Effect of alloying elements on binary diagrams and phase composition...	X	X
Austenite and ferrite formers .....	X	X
Influence of nitrogen .....	X	X
Cr- and Ni-equivalent .....	X	-
Schaeffler diagram, DeLong and other constitution diagrams.....	X	-
Survey on stainless steels (fully austenitic, ferrite-containing steels, duplex stainless steels) TR ISO/TR 15608, groups 8 and 10.....	X	X
Welding of stainless steels .....	X	X
Applicable welding processes .....	X	X
Weldability and selection of consumables .....	X	X
Choice of filler materials .....	X	X
Shielding and backing gases .....	X	X
Details of joint design .....	X	X
Passivation .....	X	X
Standards, global (ISO), regional (CEN).....	X	X

<b>2.11 Testing of materials and welded joints</b>		
<b>Objective for level S and B:</b> Name the fundamental aspects of testing materials with particular reference to welded test pieces.		
<b>Scope:</b>	<b>Qualification</b>	<b>(R)WC-S</b>
	<b>Teaching hours</b>	<b>(R)WCB</b>
	2	1
<u>Destructive testing</u>		
Tensile tests.....	X	X
Bend tests .....	X	X
Impact tests .....	X	X
Hardness tests.....	X	X
Fatigue tests .....	X	X
Fracture mechanics tests (CTOD, etc.) .....	X	-
Determination of hydrogen content.....	X	-
<u>Metallographic examination of materials and their welded joint</u>		
Preparation of specimens (grinding, polishing, etching).....	X	-
Equipment for preparation (manual, mechanical, automatic).....	X	-
Microscopes for examination (optical, electron).....	X	-
Microscopic and macroscopic examination of welds.....	X	X
Standards, global (ISO), regional (CEN) and national standards.....	X	-

## 2.8 Module 3: Construction and design

Hours as indicated are minimum teaching hours

<b>3.1 Basic theory of structural systems</b>			
<b>Objective for level S:</b> Understand the effect of external loads on structures, the types of structural systems and the relationship between external loads and internal forces.			
<b>Scope:</b>	<b>Qualification</b>	<b>(R)WC-S</b>	<b>(R)WCB</b>
	<b>Teaching hours</b>	2	0
Structural elements (cables, bars, beams, plates, slabs, shells) .....		X	
Theory of forces .....		X	
Combination and resolution of forces .....		X	
Equilibrium of forces and torques .....		X	
Bearings, constraints and basic types of connections .....		X	
Equilibrium of structural systems .....		X	
Statically determinate and indeterminate systems .....		X	
Stress in structural systems resulting from external actions .....		X	

<b>3.2 Fundamentals of the strength of materials</b>			
<b>Objective for level S:</b> Understand the principles governing the behaviour of metallic structures under loading.			
<b>Scope:</b>	<b>Qualification</b>	<b>(R)WC-S</b>	<b>(R)WCB</b>
	<b>Teaching hours</b>	2	0
Types of stresses (normal stress, shear stress) .....		X	
Types of deformation (axial strain, shear strain) .....		X	
Stress-strain relationship, yielding theories.....		X	
Elastic and plastic deformation .....		X	
Young's modulus, shear modulus, transverse contraction coefficient ...		X	
Characteristic material properties .....		X	
Different stresses resulting from internal forces and moments .....		X	
Different types of section properties .....		X	
Cross section variables .....		X	

<b>3.3 Joint design for Welding</b>			
<b>Objective for level S and B:</b> Design and draw weld details related to a given material, wall thickness, accessibility, loading, welding process, welding position, welding symbols, available equipment, tolerances.			
<b>Scope:</b>	<b>Qualification</b>	<b>(R)WC-S</b>	<b>(R)WCB</b>
	<b>Teaching hours</b>	2	2
Introduction (importance of welding joint design and groove shapes, influence on welding stresses and distortion) .....		X	X
Types of welded/brazed joints.....		X	X
Importance of weld joint design and groove shapes, types of welded joints, design of welded joints .....		X	X
Classification of groove shapes (by material type, thickness, welding process, accessibility) .....		X	X
Tolerance requirements (ISO 13920) .....		X	X
Welding symbols on drawings, symbols for groove shapes .....		X	X
Symbolic representation of welded, brazed and soldered joints according to ISO 2553 .....		X	X
Other Standards, global (ISO), regional (CEN) and national standards....		X	X

<b>3.4 Basics of weld design</b>		
<b>Objective for level S and B:</b> Understand the relationship between external loads on structures, internal forces and the stresses induced with especially with regard to welds.		
<b>Scope:</b>	<b>Qualification</b>	<b>(R)WC-S</b>
	<b>Teaching hours</b>	<b>(R)WCB</b>
		2
		0
Types of stresses in welded joints (nominal stress, hot spot stress, notch stress) .....	X	
Stresses in butt welds, stresses in fillet welds .....	X	
Calculation of cross section variables of welded joints .....	X	
Determination of nominal stresses in single welded joints .....	X	

<b>3.5 Behaviour of welded structures under different types of loading</b>		
<b>Objective for level S and B:</b> Understand the different types of loading and the influence of ambient conditions on structures.		
<b>Scope:</b>	<b>Qualification</b>	<b>(R)WC-S</b>
	<b>Teaching hours</b>	<b>(R)WCB</b>
		1
		0
Static strength .....	X	
Influence of notches and weld defects .....	X	
Types of fracture (ductile fracture, fatigue fracture, brittle fracture, lamellar tearing) .....	X	
Selection of steel quality groups, Z-quality.....	X	

<b>3.6 Design of welded structures with predominantly static loading</b>		
<b>Objective for level S and B:</b> Be able to identify joints and relevant details of welded metallic structures		
<b>Scope:</b>	<b>Qualification</b>	<b>(R)WC-S</b>
	<b>Teaching hours</b>	<b>(R)WCB</b>
		3
		1
Steel constructions including lightweight structures .....	X	
Structural details e.g. (stiffeners, knots, columns, base- and cap-plates, reinforced structures, supports, frame-corners, frame structures, trusses, nodal joints, weld connections, braces / bracing, lattice work structures, etc.) .....	X	-
Use of different types of welds related to joint types .....	X	X
Use of standards and specifications .....	X	X

## 2.9 Module 4: Fabrication, applications engineering

Hours as indicated are minimum teaching hours

<b>4.1 Introduction to quality assurance in welded fabrication</b>		
<b>Objective for level S and B:</b> Explain / Outline the principles of quality assurance and quality control and recognise the related standards and their application to welded fabrication as a special process.		
<i>Qualification Teaching hours</i>	<b>(R)WC-S</b>	<b>(R)WCB</b>
<b>Scope:</b>	2	1
Concept of quality assurance and quality control (including analysis, continuous improvement).....	X	X
Testing and Inspection Plan (goal, content and sources to develop it)...	X	X
Audit of plant.....	X	X
Personnel and Equipment.....	X	-
Maintenance.....	X	X
Inspection.....	X	X
Activities of the welding engineer/technologist/specialist/practitioner in the different functions in industry (ISO 14731).....	X	X
Standards (ISO 9000, ISO 3834, national, regional and international standards).....	X	-
<b>4.2 Quality control during manufacture</b>		
<b>Objective for level S and B:</b> Explain / Outline the requirements and function of Quality Control during manufacture . Explain the standards related to welders/operators and welding procedure qualification including weld joint traceability methods. Need for calibration and monitoring of welding parameters.		
<i>Qualification Teaching hours</i>	<b>(R)WC-S</b>	<b>(R)WCB</b>
<b>Scope:</b>	7	3
Advantages to the quality of welded constructions .....	X	X
Welding sequence .....	X	-
Welding coordination and inspection personnel; qualification tasks and responsibilities (ISO 14731, ISO 9712, CEN and National standards).....	X	X
Welder Approval /Qualification and Welding Procedure Qualification - Introduction/Overview.....	X	X
Welder Approval/Qualification (ISO 9606, CEN and National Standards).	X	X
Welding Procedure Specification – The goal, how to create and develop (ISO 15607 and 15609, CEN and National Standards).....	X	X
Welding Procedure Qualification (ISO 15610, 156111, 15612, 15613 and 15614), Regional and National standards).....	X	X
Welding Operator Qualification (ISO 14732, CEN and national standards).....	X	X
Traceability (materials identification, welder/operator, procedures, certificates) .....	X	X
Practical exercises:		
Welding procedure qualification	2 hours	1 hour
Welder and welder operator qualification	2 hours	1 hour

<b>4.3 Residual Stresses and Distortion</b>		
<b>Objective for level S and B:</b> Explain the main factors affecting welding stress and distortion in welded fabrications and how these effects can be measured and minimised.		
<i>Qualification</i>	<b>(R)WC-S</b>	<b>(R)WCB</b>
<i>Teaching hours</i>	2	1
<b>Scope:</b>		
Influencing factors .....	X	X
Origin of the residual stresses and deformation .....	X	X
Relationship between the material at a certain temperature and its mechanical characteristics.....	X	X
Magnitude of longitudinal and transverse shrinkage stresses .....	X	X
Distribution of the residual stresses at weld (parallel to the weld axis, perpendicular, and through thickness, influence of the material thickness)	X	X
Relationship between heat input, shrinkage stresses and distortion .....	X	X
Welding sequence techniques.....	X	X
Effects of residual stresses on the behaviour of the structure in service...	X	X
Methods of reducing residual stresses or distortion .....	X	X
Examples to prevent and control of distortion.....	X	X
Weld straightening, correction and removal of welding deformation (pressing, rolling, local heating, etc.).....	X	X

<b>4.4 Plant facilities, welding jigs and fixtures</b>		
<b>Objective for level S and B:</b> Explain / Outline the need for, and function of, auxiliary equipment, jigs and fixtures from the viewpoint of quality, economics and the environment.		
<i>Qualification</i>	<b>(R)WC-S</b>	<b>(R)WCB</b>
<i>Teaching hours</i>	4	2
<b>Scope:</b>		
Layout of production line .....	X	X
Jigs, fixtures and positioners (types, applications, advantages, special precautions) .....	X	X
Roller beads, manipulators.....	X	X
Cables, electrical connections, and special precaution.....	X	X
Operational environment.....	X	X
Auxiliary equipment (for fit up, movement, backing gas devices, flow meters, etc.).....	X	X
Joint fit up .....	X	X
Tack welding (specific cares, distribution, length and their removal).....	X	X
Equipment for preheat, postheat, and other heat treatments, also temperature control including furnace and local heat treatment.....	X	X

<b>4.5 Health and Safety</b>		
<b>Objective for level S and B:</b> Outline the health and safety hazards associated with welding and fabrication processes, including techniques to minimise them.		
<b>Scope:</b>	<b>Qualification</b>	<b>(R)WC-S</b>
	<b>Teaching hours</b>	<b>(R)WCB</b>
		4
		4
Introduction to health and safety requirements .....	X	X
Survey of safety and environmental aspects, risk assessment .....	X	X
Hazards of electric power .....	X	X
Electro-magnetic fields .....	X	X
Connecting of equipment .....	X	X
Problems with shielding gases .....	X	X
Radiation and eye protection .....	X	X
Welding fume emission .....	X	X
Ventilation filters (ISO 15012) and fume extraction (type of equipment and airflow).....	X	X
Ergonomics .....	X	X
Noise levels and ear protection .....	X	X
Special risks for automated processes .....	X	-
Standards and National regulations .....	X	X
Protective clothing.....	X	X
Health effects of grinding (vibration and dust).....	X	X
Hazards regarding the heat (spatter, flame, combustion, fire).....	X	X
Oxygen environment enrichment.....	X	X

<b>4.6 Measurement, Control and Recording in Welding</b>		
<b>Objective for level S and B:</b> Explain / Outline the requirements for measurement, control and recording during welding and allied operations.		
<b>Scope:</b>	<b>Qualification</b>	<b>(R)WC-S</b>
	<b>Teaching hours</b>	<b>(R)WCB</b>
		4
		2
Methods of measurement (electrical parameters, gas flow rate, temperature, velocity) .....	X	X
Instruments (types, measuring applications) .....	X	X
Temperatures (ISO 13916), humidity, wind .....	X	X
Cooling time e.g. $\Delta t_{8/5}$ .....	X	X
Welding parameters (voltage, current, speed, gas flow rate, etc.).....	X	X
Laboratory exercises	1 hour	1 hour

<b>4.7 Non Destructive Testing</b>		
<b>Objective for level S and B:</b> Outline the use of Non Destructive Testing as applied to welding fabrications.		
<i>Qualification</i>	<b>(R)WC-S</b>	<b>(R)WCB</b>
<i>Teaching hours</i>	8	4
<b>Scope:</b>		
Types of weld imperfections according to EN ISO 6520 standards .....	X	X
General rules and quality levels for imperfections (e.g. EN ISO 17635, EN ISO 5817) .....	X	X
Fundamentals of NDT methods (visual, dye penetrant, magnetic particle, eddy current, acoustic emission, radiography, ultrasonic, etc.) .....	X	X
Field of application and limitations .....	X	X
Design in respect of NDT .....	X	X
Calibration .....	X	X
Interpretation (IIW Radiographic reference) .....	X	X
Recording of data .....	X	X
Correct selection of the NDT methods versus application (e.g. CEN/TR 15135) .....	X	X
Qualification and certification of NDT personnel (EN 473, ISO 9712).....	X	X
NDT procedures .....	X	X
Health and safety aspects .....	X	X
Review of documents and protocols from NDT test sites.....	X	-
Laboratory exercises	2 hours	2 hours

<b>4.8 Economics and Productivity</b>		
<b>Objective for level S and B:</b> Explain / Outline the economics of welding operations applied to welded fabrications.		
<i>Qualification</i>	<b>(R)WC-S</b>	<b>(R)WCB</b>
<i>Teaching hours</i>	2	1
<b>Scope:</b>		
Analysis of welding costs.....	X	X
Deposition rate.....	X	X
Costs of labour.....	X	-
Costs of welding consumables.....	X	-
Costs of equipment.....	X	-
Welding processes operation factor .....	X	X
Calculation of welding costs .....	X	-
Cost awareness (labour, consumables, equipment, gases, energy, etc.).....	X	X
Measures for decreasing welding costs .....	X	X
Mechanisation.....	X	-
Automation.....	X	-
Robotics.....	X	-

<b>4.9 Repair Welding</b>		
<b>Objective for level S and B:</b> Outline the problems of repair welding both for in-manufacture and in-service situations.		
<i>Qualification</i>	<b>(R)WC-S</b>	<b>(R)WCB</b>
<i>Teaching hours</i>	1	1
<b>Scope:</b>		
Welding repair procedure specification.....	X	X
Welding repair plan.....	X	X
Welding repair procedure qualification.....	X	X
NDT of the weld repair.....	X	X
Special precautions.....	X	X

<b>4.10 Case Studies</b>		
<b>Objective for level S and B:</b> To understand and be able to handle welding related tasks in respect to the manufacture of specific welded products. The best way to give this education is a combination of experts from industry presenting special cases and project work of the students split up into groups followed by a general discussion and comments by the experts. All of the following subjects have to be dealt with, the depth to which, however, will depend on the national needs.		
<i>Qualification Teaching hours</i>	<b>(R)WC-S</b>	<b>(R)WCB</b>
<b>Scope:</b>	10	5
Steel constructions.  Common items to be covered: Standards and specifications, design, Choice of materials, welding processes, Site welding (transport and final assembly), Consumables, welding procedures, Tolerances on weld preparation and fit-up, NDT and quality control,  Visual Inspection practice (interpretation and evaluation of fractures and welds including interpretation of fracture tests of fillet welds)	X	X

### 3. Seminar

Recommended minimum teaching hours: for (R) WC-S is 20 hours, for (R)WC-B is 12 hours. The contents of the seminar are fully based on “Annex B” from EN ISO 14731.

<b>3.1 Background of the EN 1090-1</b>		
<b>Objective for level S and B:</b> understanding the meaning of the harmonised part of the EN 1090: EN 1090-1.		
<i>Qualification Teaching hours</i>	<b>(R)WC-S</b>	<b>(R)WCB</b>
<b>Scope:</b>	1	1
Meaning of Initial type testing and calculation according to EN 1090-1.....	X	X
Fabrication production control and the development of Inspection and Testing Plans, according to EN 1090-1.....	X	X
The CE marking methods of declaration, according to EN 1090-1.....	X	X
Review of the requirements mentioned on the item 7 of EN 1090-2.....	X	X

<b>3.2 Review of requirements, technical review</b>		
<b>Objective for level S and B:</b> understanding the importance of technical contracts regarding technical requirements. Evaluating the (sub) contractor's ability for welding fabrication.		
<i>Qualification Teaching hours</i>	<b>(R)WC-S</b>	<b>(R)WCB</b>
<b>Scope:</b>	2	1
EN 1090-2, together with any supplementary requirements.....	X	X
a) EN 10021: General technical delivery requirements for steel products.....	X	X
b) EN 10025-serie: Hot rolled products of structural steels.....	X	X
c) the capability of the manufacturer to meet the requirements.....	X	X
Is the manufacturer ISO 9000 and /or ISO 3834 certified.....	X	X
a) the parent material(s) specification and welded joint properties <ul style="list-style-type: none"> <li>• Examples of material specifications/ requirements.....</li> <li>• Examples of impact-test requirements.....</li> <li>• Examples of hardness requirements.....</li> </ul>	X X X	X X X
b) the joint location with relation to the design requirements..... <ul style="list-style-type: none"> <li>• Examples of wrong weld-positioning.....</li> <li>• Welds in highest tension area.....</li> <li>• Weld-positioning regarding pre-heating.....</li> </ul>	X X X	X X X
c) quality and acceptance requirements for welds <ul style="list-style-type: none"> <li>• Acceptance criteria of EN ISO 5817.....</li> </ul>	X	X
d) the location, accessibility and sequence of welds, including accessibility for inspection and non-destructive testing..... <ul style="list-style-type: none"> <li>• Examples of bad construction-design regarding weldability and Non Destructive Testing.....</li> </ul>	X X	X X
e) Other welding requirements, e.g. batch testing of consumables, ferrite content of weld metal, ageing, hydrogen content, permanent backing, use of peening, surface finish, weld profile..... <ul style="list-style-type: none"> <li>• short illustration of the several methods.....</li> <li>• which tools are available in the market.....</li> </ul>	X X	X X
f) the dimensions and details of joint preparation and completed weld..... <ul style="list-style-type: none"> <li>• how can it be measured (available tools) and when should it be executed.....</li> </ul>	X X	X X
g) performing an audit at the subcontractor.....	X	X
	X	X

<b>3.3 Welding personnel</b>		
<b>Objective for level S and B:</b> survey of welding personnel regarding qualifications.		
<i>Qualification Teaching hours</i>	<b>(R)WC-S</b>	<b>(R)WCB</b>
<b>Scope:</b>	1	1
Range of approval regarding certificates (e.g. EN 287-1, EN ISO 9606-2)	X	X
Confirmation and prolongation of welders qualification.....	X	X
Guidance on the execution of welders qualifications.....	X	X

<b>3.4 Equipment</b>		
<b>Objective for level S and B:</b> the appropriate use, identification and availability of weld equipment.		
<i>Qualification Teaching hours</i>	<b>(R)WC-S</b>	<b>(R)WCB</b>
<b>Scope:</b>	1	1
Welding Machine Performance in relation to weld thickness.....	X	X
Roll equipment --> load capacity, rubber wheels, etc.....	X	X
Machinery dimensions --> pipe diameter requirements.....	X	X
In which way are the several machine tagged /can be distinguished from others.....	X	X
How to perform shielding gas checks.....	X	X
Overview of available personnel protective tools.....	X	X
Equipment maintenance: obliged annual check(s) and registration of it....	X	X

<b>3.5 Production Planning</b>		
<b>Objective for level S and B:</b> understand the workflow during manufacturing / the stages of fabrication, Application and identifying the limitations of the approvals during manufacturing, Providing documents to regulate production planning.		
<i>Qualification Teaching hours</i>	<b>(R)WC-S</b>	<b>(R)WCB</b>
<b>Scope:</b>	3	1
Examples of sheets (Welding Inspection Sheets) in which the relation between PQR <-> WPS <-> drawing number can be seen.....	X	X
One-way relation between WPS and the product to be welded.....	X	X
Examples of welding procedures.....	X	X
Practical examples of weld sequences and the consequences explaining/providing transparent rules for on-site welding conditions.....	X	X
Shop conditions.....	X	X
Preheating: how and when.....	X	X
Are there more welding coordinators? Who's responsible for which part of the production? How and where is this being indicated?.....	X	X
Check of base material weld edge preparation: entrance-check.....	X	X
Fit-up approval.....	X	X
Visual check.....	X	X
Evaluating NDT-reports.....	X	X
Preparing correct assignment towards NDT-company (technical).....	X	X
Assessment of available machinery.....	X	X
Calibration scheme available.....	X	X
Examples of data storage <-> product digitalize.....	X	X
Use of hold points. Example: dye-penetrant check of root pass.....	X	X
Use of extension plates regarding destructive testing.....	X	X
Heat-input considerations regarding location of extension plates.....	X	X
Time of performing production test: day- or night-shift considerations.....	X	X

<b>3.6 Qualification of the welding procedures</b>		
<b>Objective for level S and B:</b> survey of welding procedure qualifications.		
<i>Qualification Teaching hours</i>	<b>(R)WC-S</b>	<b>(R)WCB</b>
<b>Scope:</b>	4	2
Total view of range of welding procedure qualifications (e.g. EN ISO 15610 – EN ISO 15614).....	X	X
Determine the required number and type of welding procedures for a project.....	X	X
Determine the required tests to be performed for new procedures .....	X	X

<b>3.7 Welding procedure specifications and work instructions</b>		
<b>Objective for level S and B:</b> to understand the requirements and purpose of a welding procedure specification and to understand the importance of toolbox meetings.		
<i>Qualification Teaching hours</i>	<b>(R)WC-S</b>	<b>(R)WCB</b>
<b>Scope:</b>	1	1
Essential variables in WPS according EN ISO 15609.....	X	X
Examples of toolbox meetings.....	X	X
Distribution of work instructions.....	X	X

<b>3.8 Welding consumables</b>		
<b>Objective for level S and B:</b> to categorize the welding consumables and their compatibility manufacturing requirements regarding storage. To understand the importance of certificates.		
<i>Qualification Teaching hours</i>	<b>(R)WC-S</b>	<b>(R)WCB</b>
<b>Scope:</b>	1	1
Application of new filler material? Consequences for range of approval PQR.....	X	X
Weldability tests on plates or on the real product? .....	X	X
Boxes, pallet-boards, vacuum packed, marathon pack.....	X	X
Entrance check of filler materials? Did you receive what you ordered! ...	X	X
Certificates of filler material (batch numbers).....	X	X
Temperature & humidity.....	X	X
Traceability.....	X	X
Ware house: in- and outgoing of filler material. Who is managing this?	X	X
Preventing of exchanging filler-wires.....	X	X

<b>3.9 Materials</b>		
<b>Objective for level S and B:</b> understand the standards. How to handle, categorizing and identifying materials during welding manufacturing.		
<i>Qualification Teaching hours</i>	<b>(R)WC-S</b>	<b>(R)WCB</b>
<b>Scope:</b>	1	1
Material certificates according EN 10204.....	X	X
Additional requirements like: impact tests, hardness, Z-quality.....	X	X
Storage systems.....	X	X
Transport of materials.....	X	X
Handling of pre-protected materials (Oil, foils).....	X	X
How to deal with pieces of material.....	X	X
Re-marking of materials.....	X	X

<b>3.10 Inspection and testing before, during and after welding</b>			
<b>Objective for level S and B:</b> to understand the importance of inspection and testing before, during and after welding.			
<b>Scope:</b>	<b>Qualification</b>	<b>(R)WC-S</b>	<b>(R)WCB</b>
	<b>Teaching hours</b>	3	1
<b>Before welding:</b> <ul style="list-style-type: none"> <li>• Validation of welder certificates.....</li> <li>• Acceptance of WPS.....</li> <li>• Material identification: how to handle if traceability is not given...</li> <li>• Filler materials: code explanation.....</li> <li>• Tags.....</li> <li>• Coordination with planning / purchase department.....</li> <li>• Entry-check.....</li> <li>• Joint preparation (e.g. shape and dimensions).....</li> <li>• Use of hold points.....</li> </ul>		X X X X X X X X X	X X X X X X X X X
<b>During welding:</b> <ul style="list-style-type: none"> <li>• Welding parameters: ways of measuring.....</li> <li>• Measuring instruments.....</li> <li>• Software (independent system).....</li> <li>• Preheating/ interpass temperature: how, where and when</li> <li>• Calibration (apparatus or tempil sticks).....</li> <li>• Cleaning, shape, sequence of weld runs: ways of control.....</li> <li>• Gouging: available systems. In- and outs, safety.....</li> <li>• Distortion: measuring, joint preparation, prevention, calculation...</li> <li>• Intermediate examination: how, where and when.....</li> <li>• Hold points.....</li> </ul>		X X X X X X X X X X	X X X X X X X X X X
<b>After welding:</b> <ul style="list-style-type: none"> <li>• Visual inspection: eye test, light intensity.....</li> <li>• Interpretation of EN ISO 5817.....</li> <li>• Outsourcing NDT: levels of required competence.....</li> <li>• NDT Acceptance criteria.....</li> <li>• Destructive testing: laboratories, traceability of documents.....</li> <li>• Standard EN ISO 13920 / welded constructions / tolerance classes.....</li> <li>• Examples of registrations of records regarding post-operations (post weld heat treatment).....</li> </ul>		X X X X X X X	X X X X X X X

<b>3.11 Non-conformance, corrective actions and quality records</b>			
<b>Objective for level S and B:</b> To understand the importance of NCR's and the submitted corrective actions. To understand the importance of manufacturing books			
<b>Scope:</b>	<b>Qualification</b>	<b>(R)WC-S</b>	<b>(R)WCB</b>
	<b>Teaching hours</b>	2	1
How to deal/ handle with NCR's		X	X
Examples of fabrication manuals		X	X
Storage requirements		X	X

<b>3.12 Calibration and validation of measuring, inspection and testing equipment</b>		
<b>Objective for level S and B:</b> to understand the importance of calibration, validation of measuring, inspection and testing equipment		
<i>Qualification Teaching hours</i>	<b>(R)WC-S</b>	<b>(R)WCB</b>
<b>Scope:</b>	1	1
Instrument assessment.....	X	X
Methods of registration.....	X	X
Calibration - independent - periodical / requirements.....	X	X
The correct use of testing equipment.....	X	X

## **Section II: Examination and Qualification**

**Note:** Other rules/procedures are covered in Document IAB-001 / EWF-416.

### **1. Introduction**

The guideline seeks to achieve harmonisation and common standards in the training and qualification of welding coordinators at the required level.

The national welding organisations, being members of EWF, mutually acknowledge the Diploma awarded in any Member State, following examination conducted in accordance with this Guideline.

Education must have followed this EWF guideline and the examination must have been conducted by the national body authorised by EWF for this purpose.

### **2. Approval of the course**

Any training course leading to the EWF examination must be approved by the ANB. The number of teachers required to give the course shall be sufficient to ensure that the essential specialist knowledge and industrial experience to cover the syllabus is adequately represented in the team of teachers and visiting lecturers. Standard requirements are documented in Doc. EWF-416, "Rules for the implementation of European Federation for Welding, Joining and cutting (EWF) Guidelines for the education, examination, qualification and certification of welding personnel".

### **3. Examination Board**

An Examination Board, acting on behalf of the ANB supervises examinations. In this way, independence, integrity and fairness of the examination system are maintained.

### **4. Admission to the Intermediate and Final Examination**

Admission to the examination leading to the award of the qualification will be restricted to those who

- comply with the minimum requirements specified in the access conditions and
- have attended at least 90% of the course, approved by the ANB according to this guideline (not applicable for the intermediate examination).

Exceptions are at the discretion of the Board of Examiners.

### **5. Examination procedures**

The examination procedure described below is designed to simulate the different situations of a Responsible Welding Coordinator active in the industry. The examination shall cover all topics in this guideline.

At the discretion of the Board of Examiners the written examination shall consist of:

- i. A series of essay questions covering the whole field of the subject
- or
- ii. A series of multiple choice questions covering the whole field or the subject

The Intermediate examination is a written examination and shall cover the Theoretical part.

Final exam:

- the written examination shall cover the seminar content;
- the oral examination shall cover the full syllabus (theoretical part plus the seminar).

At the discretion of the ANB Intermediate examination can be performed on the same day of the final exam.

Examination questions for written exams either for the intermediate examination or for final written examination shall be taken from the IAB/EWF question database as per OP 17 for the relevant subjects for a minimum of 50% of the total duration of the examination.

An oral examination covering all modules of the guideline completes the final examination.

## **6. Minimum Duration of Exams**

Qualification Level	Intermediate Exam	Final Exam	
	Written	Written	Oral
RWC-S	1,5 hours	1,5 hours	45 minutes
RWC-B	1 hour	1 hour	30 minutes

## **7. Evaluation of performance**

In order to pass the examination, candidates must achieve at least 60% of the maximum possible mark in both written and oral examination.

## **8. Re-examination and appeals procedure**

Re-examination and appeals are covered by Doc. IAB-001 / EWF-416.

## **9. Diploma**

After successful examination a Diploma is awarded to the candidate by the ANB.