

EFW Guideline

European Welding Practitioner for Resistance Welding – EWP-RW



Minimum Requirements for the Education, Training, Examination and Qualification



EFW-621r1-14

MINIMUM REQUIREMENTS FOR THE EDUCATION, TRAINING, EXAMINATION AND QUALIFICATION

EWF GUIDELINE

EUROPEAN WELDING PRACTITIONER FOR RESISTANCE WELDING EWP-RW

Published by: **EWF Secretariat**
Av. Prof. Dr. Cavaco Silva, 33
Taguspark – Apartado 012
P-2741-901 Porto Salvo
Portugal

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Tel: +351.21 4211351
Fax: +351.21 4228122
E-mail: ewf@isq.pt
www.ewf.be

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Minimum Requirements for the Education, Training, Examination and Qualification of European Resistance Welding Practitioner EWP-RW

The use of this guideline is restricted to organisations approved by the Authorised National Body (ANB). The section II of the guideline covers the examination and qualification.

1. Introduction

This guideline for the European education and training of Welding Practitioners for resistance welding has been prepared, evaluated and formulated by members of Technical Committee of the EWF.

It is designed to provide the basic core education in resistance welding as required by resistance welding personal who is active in job functions in accordance to EN ISO 14554-1 (chapter 6.3), technical sales etc.

The education and training covers the elementary knowledge that is needed in a wide range of the job functions in resistance welding e.g. weld setter, instructor, inspector, supervisor, foreman, constructor and technical sales personnel.

European Resistance Welding Practitioner may also be a relevant qualification for people whose job is to assist responsible Resistance Welding Coordinators in accordance to EN ISO 14554-1 (chapter 6.4) in manufacturing companies.

Additional training and/or experience relevant to the specific job function may be required beyond the EWP-RW education. Additional training programmes will be established as required to meet this need.

The guideline covers the minimum requirements for education and training which is related to resistance welding within the EWF, in terms of themes, keywords and recommended times devoted to them.

It will be revised periodically by the Technical Committee of the EWF taking into account any changes that may effect the “state of the art”.

Section I gives the details regarding the training syllabus. Section II covers examination and diploma.

The contents are given in the following structure:

The contents are given in the following structure:

Theoretical Education	teaching hours
1. Resistance welding processes and equipment	12
2. Materials and their behaviour during resistance welding.	4
3. Construction and design	0,5
4. Fabrication, applications engineering	4
	20,5
Fundamental practical skill	19
Examination (oral, written and practical)	4
total:	43,5

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

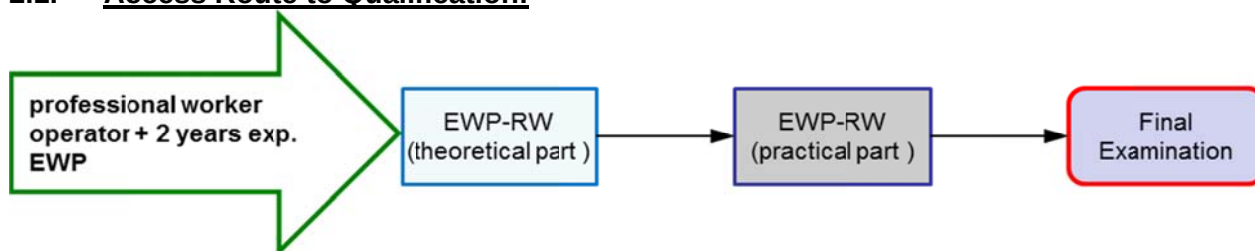
The Guideline details the objectives of all topics, the scope and the learning outcomes as required, to fulfil the requirements for welding specialists for resistance welding. The content is described in greater detail in section I.

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 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. Access to Education

2.1. Access Route to Qualification:



Access Conditions

Minimum recommended age of 18 years and qualified as

- ♦ professional worker, or higher grade, with certificate after examination in metal or electrical working profession
- or
- ♦ EWP
- or
- ♦ operator with an experience of 2 years in resistance welding fabrication (to be affirmed by his company)

Section I: Theoretical and Practical Education EWP-RW

I.1 Theoretical Education EWP-RW

20 hours 30 minutes

1. Resistance Welding processes and equipment **12**

1.1 General introduction to resistance welding technology **1**

Objective:

Understand the resistance welding processes including accepted terminology, standards and abbreviations.

Scope:

Definitions and terminology

Schematic presentation of resistance welding processes

(spot welding, seam welding, projection welding, resistance butt welding, flash butt welding)

General applications for resistance welding processes

Nomenclature for welding processes (international and national standards, e.g. ISO 4063)

Learning Outcome:

Detail the major differences between each type of resistance welding

1.2 Electrotechnology, a review **1**

Objective:

Understand the basics of electricity and electric components

Scope:

current

voltage

resistance

Ohm's Law

Electric circuit

Direct current (DC), polarity, alternating current (AC)

Technical power sources

Conductivity

Effective value (RMS)

Current density

Effects of the electric current:

Joule's law

magnetic fields

electrical work

Learning Outcome:

Explain current, voltage and electrical resistance

Discuss the major differences between AC and DC current

1.3 Electrotechnology of resistance welding processes

1

Objective:

Understand in detail the special electrical effects that are influencing the resistance welding process

Scope:

Parallel and series circuits
Transformer, tap setting
Cooling
Hot resistance
Influence of magnetic field
measuring of welding current

Learning Outcome:

Explain influences of the various items on the welding process
Discuss the selection of appropriate devices and settings for measuring the welding current

1.4 Weld control for resistance welding machines

2

Objective:

Understand in detail the characteristics and components of weld controllers

Scope:

Power section:
electronic switches (e.g. thyristor, IGBT), cooling

Control section:

basic functions, timer functions, pressure control, control parameters, programs, modes of operation, input/output, multiprogram control, current adjustment (phase angle control), constant current, stepper, special functions, symbols, set up and program input

Current programs (up-/downslope, multi pulse, preheat, postheat,...)

Types of power sources

Learning Outcome:

Explain the components of a controller for resistance welding
Discuss the differences between various types and power sources

1.5 Resistance welding electrodes

2

Objective:

Understand in detail the differences between electrode materials and electrode shapes

Scope:

Functions, requirements
Electrode materials
Electrode geometry
Selection of electrodes
Standards review
Cooling
Electrode pick-up
Typical defects of electrodes

Typical defects caused by electrodes

Electrode life, lifetime criteria

Time of replacement

Rework

Tip dressing (various types)

Learning Outcome:

Explain the differences between electrode materials

Interpret standards for resistance welding electrodes

Discuss selection of electrodes and lifetime criteria

1.6 Spot welding

2

Objective:

Understand in detail the resistance spot welding process

Scope:

Procedural principle

Range of application

Requirements on welded joints

Preparation of material to be welded

Dissimilar thicknesses

Direct and indirect welding

Special requirements on the electrodes

Cooling

Influencing variables

Resistances in the joint (bulk and contact resistances)

Special requirements on the electrodes

Welding parameters

Setting of the parameters in accordance with standard values and adjustment tests

Influence of electrode wear

Typical failures, Disturbances

Learning Outcome:

Explain in detail the principle of resistance spot welding

Discuss various types of spot welding processes

Detail parameters to be used for different materials

Interpret appropriate standards and parameter tables

1.7 Projection welding

2

Objective:

Understand in detail the projection welding process

Scope:

Procedural principle

Range of application

Requirements on welded joints

Preparation of material to be welded

Types of projections

Geometry of projections

Cooling

Special requirements on the electrodes

Influencing variables

Special requirements on the electrodes and follow-up

Welding parameters

Upslope

Setting of the parameters following standard values and adjustment tests

Typical failures, disturbances

Learning Outcome:

Explain in detail the principle of projection welding

Discuss various types of projections

Detail parameters to be used for different materials and projections

Interpret appropriate standards and parameter tables

1.8 Roller Seam Welding

1

Objective:

Understand in detail the roller seam welding process

Scope:

Procedural principle

Range of application

Requirements on welded joints

Preparation of material to be welded

Cooling

Special requirements on the Electrodes

Rework of electrodes

Welding parameters

Current programs (e.g. roll spot weld and continuous weld)

Welding speed

Setting of the parameters following standard values and adjustment tests

Typical failures, disturbances

Types of joints (e.g. overlap, mash, butt, with foil, with wire)

Types of seam welding machines

Learning Outcome:

Explain in detail the principle of resistance seam welding

Discuss various types of joints used in resistance seam welding

Detail parameters to be used

Interpret appropriate standards and parameter tables

2. Materials and their behaviour during resistance welding

4

2.1 Materials

1

Objective:

Understand the principles of manufacture and designation of steel and aluminium

Scope:

Classification and properties of metals

Designation of steel materials and treatment conditions

Low carbon steel, Alloyed steel, stainless steel, High strength steel

Aluminium, Aluminium Alloys

Change of properties as a result of resistance welding

Material related imperfections

Learning Outcome:

Explain different types of steel materials
Explain the designation of steels

2.2 Weldability of steel**1****Objective:**

Understand the influence of steel materials on their weldability

Scope:

Material types and properties
Electrical Conductivity
Melting and solidification of weld nuggets
Weldability
Influence of electrode force
Pretreatment
Imperfections (cracking, porosity, spatter...)

Learning Outcome:

Explain basic influences on the weldability
Discuss the weldability of different materials
Discuss reasons for problems that might occur when welding specific materials
Interpret Standards and parameter tables

2.3 Weldability of coated Steel**1****Objective:**

Understand in detail the different types of coated steel materials and their weldability

Scope:

Types of coating: metallic, non-metallic
Range of application
Electrical conductivity
Melting point
Weldability compared to uncoated material
Electrode pick-up
Electrode life
Scatter of strengths
Quality of the welded joint

Welding parameters
Standards review, parameter tables

Learning Outcome:

Explain the different types of coatings commonly used
Discuss the effect of specific coatings on the weldability and electrode life
Interpret Standards and parameter tables

2.4 Weldability of aluminium and aluminium alloys**1****Objective:**

Understand in detail the metallurgy and weldability of aluminium and aluminium alloys

Scope:

Material types and their properties
Weldability of different aluminium alloys

Surface condition and pretreatment
Electrode pick-up
Welding machines: current, current type, follow up behaviour, cooling...
Current and force programs

Welding parameters
Spot, projection and roller seam welding
Standards review, parameter tables

Learning Outcome:

Explain different types of aluminium alloys
Discuss the weldability of different alloys
Interpret Standards and parameter tables

3. Construction and design 0,5

3.1 Material combinations 0,5

Objective:

Understand restrictions when welding material stackups with dissimilar properties

Scope:

Materials with different conductivity
Materials with different coatings
Different thicknesses
Welding of 3 and more sheets

Learning Outcome:

Explain in detail effects caused by combining different materials
Interpretation and use of Standards

4. Fabrication, application engineering 4

4.1 Documentation 0,5

Objective:

Understand in detail the requirements for documentation

Scope:

Test protocol
Welding instructions
WPS, acc. to ISO 15609-5 (welding parameters)
Failure report

Learning Outcome:

Explain in detail the purpose of a WPS and the main advantages to the quality of welded fabrication
Interpretation and use of Standards

4.2 Testing of the weld 1

Objective:

Understand in detail the requirements and function of Quality Control during manufacture

Scope:

General review (standard CEN/ISO)

Imperfections

Visual test

Shop tests: different types, weld diameter, fracture modes

Informative: laboratory tests, metallographic examination, non destructive testing methods

Learning Outcome:

Explain in detail the different methods for assessing the weld quality

Discuss the different methods

Selection of the appropriate method for the given parts

Interpretation and use of Standards

4.3 Maintenance**1****Objective:**

Understand in detail the requirements for regular maintenance

Scope:

Mechanical: electrodes, devices, tools, lubrication

Electrical: contact surfaces, secondary connecting cables, insulation (secondary circuit only!)

Cooling: flow rate, water temperature

Compressed air: air filters, silencer, pressure control, air lubricator, water separator

Maintenance examples, maintenance schedules

Learning Outcome:

Explain the different parts of the device to be maintained

Interpretation and use of Standards

4.4 Machines, resistance welding jigs and fixtures**0,5****Objective:**

Understand in detail the need for and function of auxiliary equipment, jigs and fixtures, around the welding machine

Scope:

Manual and automatic clamping devices

Checking dimensions and condition of electrodes

Shunting currents: vagabonding currents, influence of burrs from cutting and stamping

Follow-up units: principles, effect

Adjustment of multi-tool-devices

Learning Outcome:

Explain the use of welding jigs and fixtures

Discuss the parts to be checked and adjusted

Interpretation and use of standards

4.5 Health and safety**1****Objective:**

Understand in detail the health and safety hazards associated with resistance welding in fabrication processes

Scope:

Accident prevention

Regulations

Instructions

Danger and protective measures: electrical, mechanical, noise, gases, fumes, hazardous materials, standardised safety equipment, safety requirements, responsibilities, procedures.

Personal protective equipment

Learning Outcome:

Explain the risks associated with welding from electricity, gases, fumes, fire, expulsions and noise

Interpret health and safety regulations with respect to the above hazards

Produce safe working procedures to ensure the requirements are met

I.2 Practical Education EWP-RW II **19**

1. Spot welding **4**

Selection and set-up of electrodes
Set-up of welding parameters: according to standard values and based on test experience
Optimisation of the weld quality
Limiting values: stuck weld condition, expulsion limit
Shunting effect: due to technical reasons, avoidable shunts
Window effect: influences by size of secondary window and magnetizeable material
Influence of workpiece geometry: test strip, flange width, fit-up
Imperfections: causes for imperfections and corrective actions

2. Projection welding **2**

Selection and set-up of electrodes
Set-up of welding parameters: according to standard values and based on test experience
Optimisation of the weld quality
Deformation of projections under load
Imperfections: causes for imperfections and corrective measures
Types of current, current distribution

3. Roller Seam welding **1**

Selection and set-up of electrodes
Set-up of welding parameters: according to standard values and based on test experience
Optimisation of the weld quality
Current programs and welding speed
Imperfections: Reasons for imperfections and corrective measures

4. Measurement, control and recording of resistance welding processes **1**

Geometry of secondary circuit and value of the achievable weld current
Weld current measurements: measurement methods, effective value, peak value, measurement of rectified current
Measurement of electrode force (static values and dynamic curve)
Temperature measurements of the cooling water

5. Resistance welding electrodes **2**

Selection and check of the geometry
Check of the cooling circuit
Effects of defective electrode cooling
Defects as a result of inappropriate selection of electrode geometry and material
Defects caused by electrode wear (enlargement of contact area)
Electrode pick-up
Overheating and deformation
Rework, tip dressing
Criteria and interval for exchange or rework

6. Resistance welding of surface refined sheet metal panels 2

Welding of materials with different coating and different thickness (spot, projection and seam welding)

Set-up of the parameters using standard values

Optimisation of the welding parameters

Electrode pick up, electrode life

Scatter of strengths

7. Resistance welding of aluminium and aluminium alloys 2

Welding of aluminium materials, different surface pretreatment

Application of current/force programs

Welding with AC and DC

Influence of electrodes (material and shape)

Demonstrating the behaviour in the cases of spot, seam and projection welding

8. Weld control and power sources 2

Power sources:

- AC (50 or 60 Hz)
- DC (conventional system with 6 pulse rectification)
- Inverter systems: MF-DC (1000 Hz and higher, e.g. 10kHz)

Weld control:

- Program-input (analogue and digital timers)
- Multiprogram controls
- Constant current control
- Stepper-programming

9. Quality control 2

Visual inspection

Measurement of geometry

Workshop testing methods

Laboratory testing methods (demonstration)

Non-destructive testing methods (demonstration of UT)

Metallographic tests (demonstration)

Evaluation and documentation of test results

10. Demonstration of other processes 1

Upset welding

Resistance flash welding

Stud welding (DS and TS)

Mechanical joining processes

Section II: Examination and Qualification

1. Introduction

The Guideline seeks to achieve harmonisation and common standards in the training, qualification of professional welding experts in resistance welding in Europe as required in European Standard EN ISO 14554-1 (Chapter 6.3).

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

Education must have followed this EWF guideline „European Welding Practitioner for Resistance Welding“ and the examination must have been conducted by the national body authorised by EWF for this purpose.

2. Approval of the course and Requirements for Training and Examination centres

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 insure that the essential specialist knowledge and industrial experience to cover the syllabus is adequately represented in the team of teachers and visiting lecturers.

On Appendix I is given the requirements the ATBs shall comply. Additional requirements for teachers and instructors, examiners, training establishments, courses and examination/test centres are documented in EWF-416 (latest revision) “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 of Examiners

An examination Board, acting on behalf of the ANB supervises the examination therefore independence, integrity and fairness of the examination system are maintained.

The Authorised National Body shall nominate the Chairman and the members of the Board of Examiners. The examining board shall consist of:

- a) The Chairman, who shall be representative of the Authorised National Body, and he shall be independent from the training school;
- b) Main teacher(s) of the subjects;
- c) Experts from industry (mandatory only in the case of oral examinations)

The responsibilities of the Board of Examiners are given in the EWF-416 (latest revision):

- a) Organise the examination
- b) Approve the examination question for the written examination
- c) Conduct and mark the examinations

d) Decide on borderline results

4. Admission to the examination

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

- a) who comply with the minimum requirements specified in the access conditions
- b) who have attended at least 90% of the course, approved by the ANB according to this guideline.

In case of special circumstances the board of examiners may use its discretion.

5. Examination procedures

The examination procedures described below are designed to simulate the different situations of a welding expert in resistance welding active in industrie.

The examination shall cover all topics in this Guideline.

5.1 Written examination

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

- a) a series of essay questions covering the whole field of the subject
or
- b) a series of multiple choice questions covering the whole field of the subject,
or
- c) a combination of a) and b) with equal marks allocated to each type.

The time devoted to the written examination shall be a minimum of 1 hour.

5.2 Oral examination

The oral examination will be optional at the discretion of the board of examiners except in borderline cases where it will be mandatory.

5.3 Practical examination

The time dedicated to the practical examination shall be a minimum of 3 hours, approximately 1 hour per process (see in Appendix II).

During the practical examination, it is not allowed to have more than one examinee per machine (tests as described in Appendix II have to be run one by one).

6. Evaluation of performance

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

7. Re-examination and appeals procedure

Failure in written/oral part or practical part of the examination shall require re-examination only in the part failed.

Examinations shall be retaken within 15 months of the initial examination and, in the case of a second failure, one further attempt is permitted within 15 months from the date of the second examination.

If a candidate fails three times in any of the parts, he/she has to retake the complete course.

In the case of re-examination, the 3 years validity period of the examination may be extended by decision of the Lead Assessor, if it has not been possible for the ANB to organize the necessary re-examinations within the relevant period.

In such circumstances, the following conditions shall be fulfilled:

- i. The ANB must provide valid reasons for needing an extension.
- ii. Any re-examinations taken after the first period must include oral examinations covering the whole syllabus.
- iii. Under no circumstances shall the validity period exceed a total of six years.”
Candidates who feel they have been unfairly treated during the examination procedure have the right to appeal to the Authorised National Body.

8. Diploma

After successful examination the Authorised National Body awards the EWP-RW diploma to the candidate.

For more details regarding the diploma layout, information to be inserted in the Diploma and diploma identification code, see EWF-416 (latest revision).

Appendix I: Requirements for Equipment, Personnel and Specimens

A.1. Equipment and Personnel

A.1.1. Resistance Welding equipment

Equipment for the following processes must be available for practical exercises in sufficient number:

- ◆ Spot welding
- ◆ Roller Seam welding
- ◆ Projection welding

During training, the maximum size of study groups per welding machine is 4 participants.

Further processes covered by the syllabus may be shown by means of demonstrations or video presentations.

A.1.2. Other equipment

Mechanical testing and suitable UT-equipment must, metallurgical examination and NDT equipment should be available for both demonstration and laboratory work purposes.

A.1.3. Qualification of Instructors and Trainer

The qualification of welding instructors and trainers shall be on the EWS-RW level.

A.2. Specimens

A reference collection of well documented weld specimens, polished and etched, shall reflect the processes covered by the Guideline.

As a minimum, one specimen per process is required.

Preferably, the specimens should cover a range of different materials and thicknesses.

Appendix II: Practical Examination

No.	Process	Examination subjects	Approval standard
1	Resistance spot welding (21)	Spot welding according to specifications in a manufacturing drawing selection of electrodes, set-up of the welding machine and welding parameters based on - test experience - tables of standard values including optimization of welding parameters, measurement of welding parameters, checking and evaluation of the weld quality (strength and surface)	ISO 14732
2	Resistance projection welding (23)	Projection welding according to specifications in a manufacturing drawing Alignment of the electrodes, set-up of the welding machine and the welding parameters based on - test experience - tables of standard values including optimization of welding parameters, measurement of welding parameters, checking and evaluation of the weld quality (strength and surface)	ISO 14732
3	Resistance seam welding (22)	Seam welding according to specifications in a manufacturing drawing Determination of the electrode geometry, set-up of the welding machine based on - test experience - tables of standard values including optimization of welding parameters, measurement of welding parameters, checking and evaluation of the weld quality (strength and surface)	ISO 14732